Affordability, Rates, and Clean Capital Efficiency

PRESENTED BY

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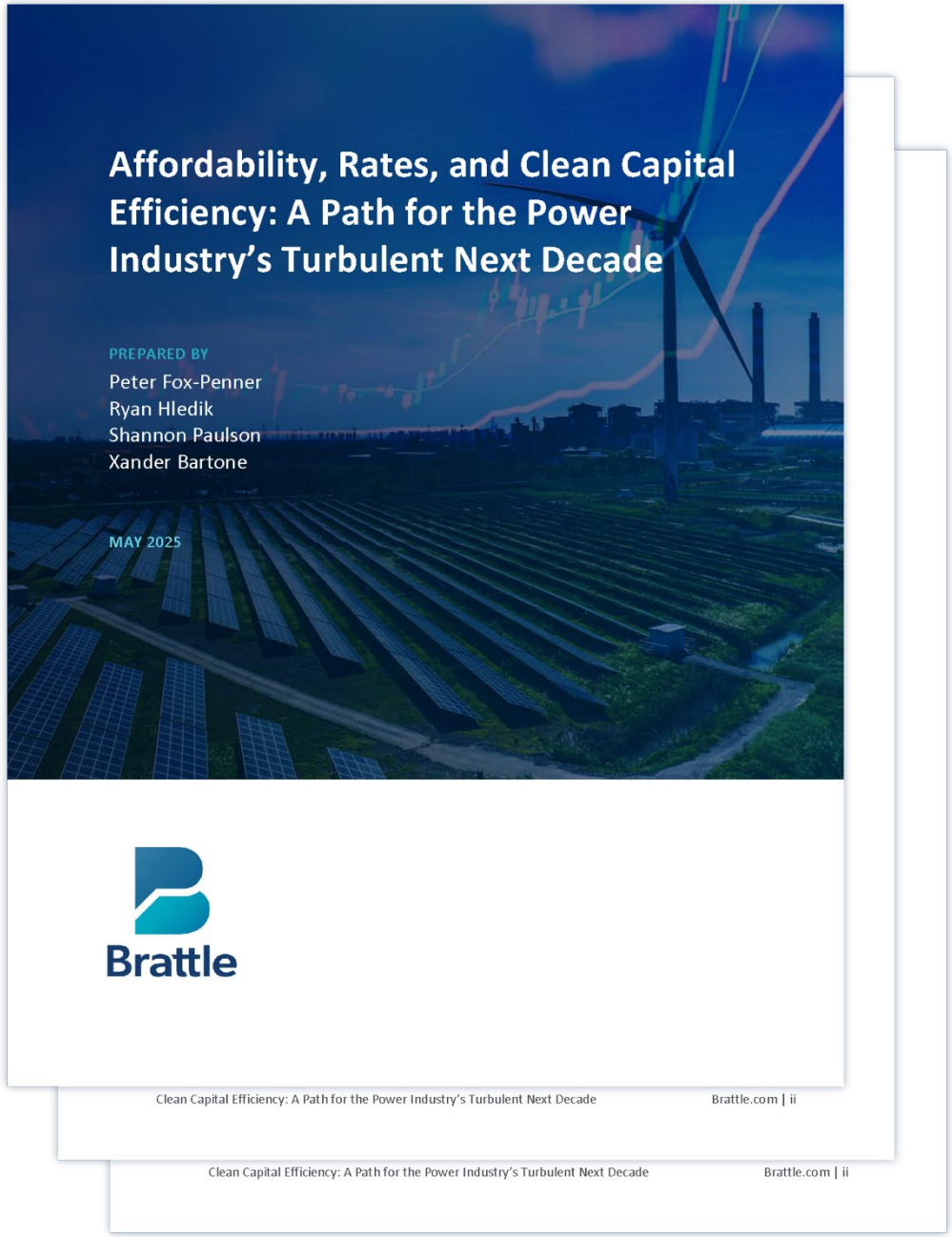
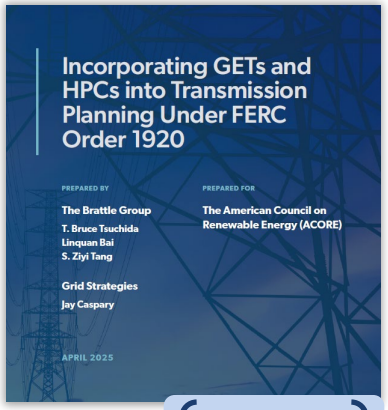
JULY 29, 2025

Brattle



Reference Sources for this Deck



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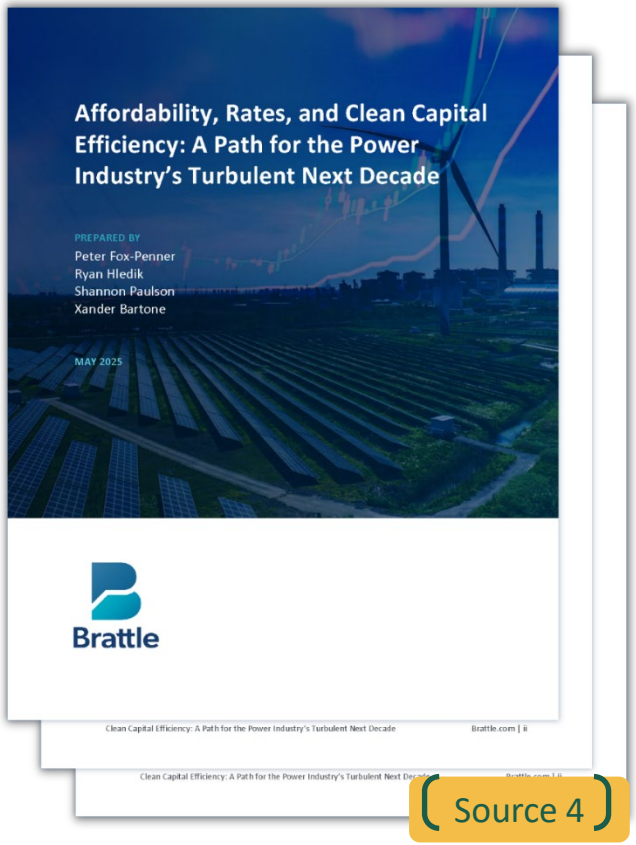

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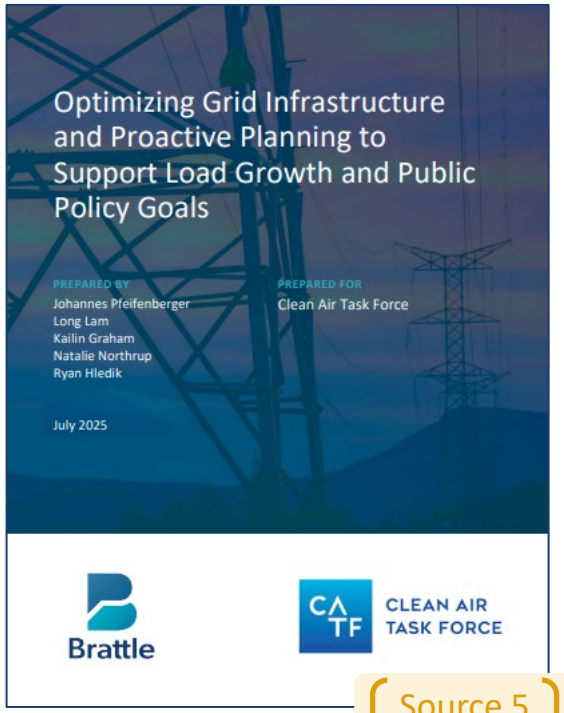
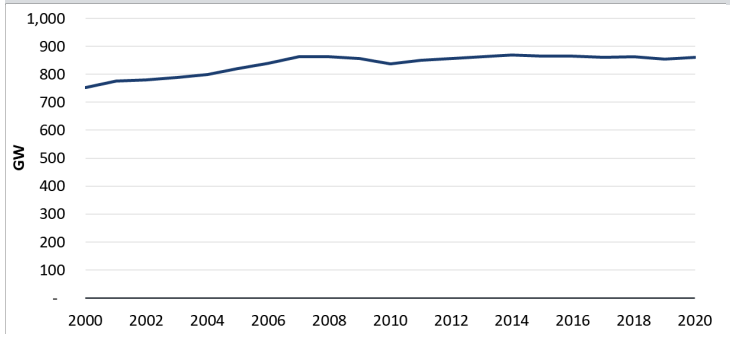


Source 5

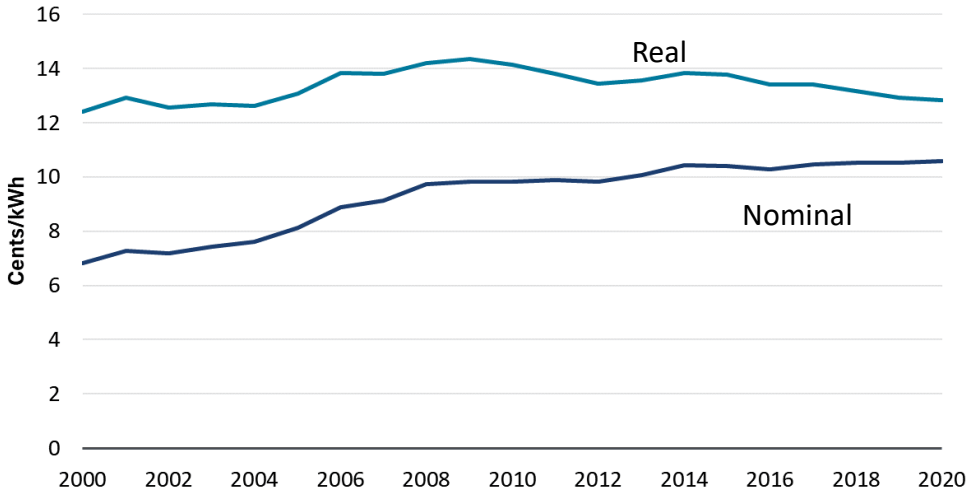
The Years 2000–2020 Were Good to the Electric Utility Sector

- Peak US demand + 0.7% per year; flat 2008-2020.
- Electric CO2 emissions peaked in 2007 and fell 33% by 2019.
- Electric stock returns tracked an upward market.
- Inflation – adjusted rates essentially flat.

US Peak Electricity Demand



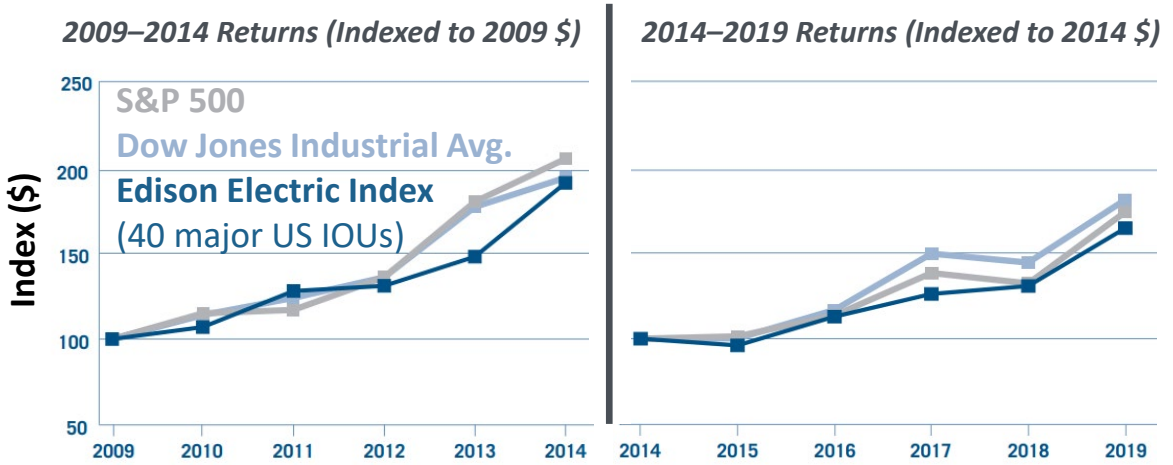
Average Electric Rates All Sectors (cents/kWh)



Sources and notes: Shows near-term forecasts of peak demand; NERC, 2023 Long-Term Reliability Assessment, December 2023, Supplemental Charts and Graphs, Table F. US Energy Information Administration (EIA), Electricity data browser, accessed April 30, 2025, and EIA, Annual Energy Review, 2012. Inflation adjustment from the US Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers.

Electric Utility Stock Return Compared to Market

Assumes $100 invested on 12/31/2009 (left) and 12/31/2014 (right)

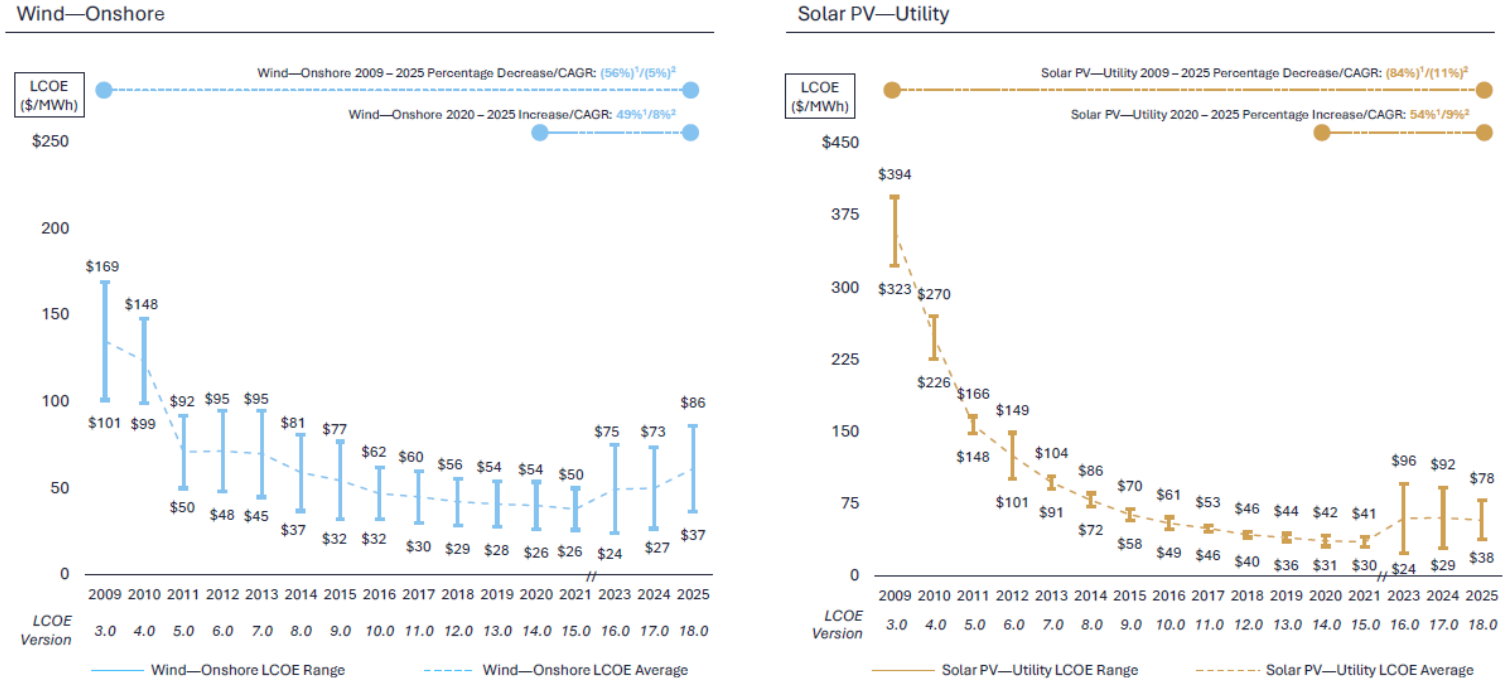


Sources and notes: Reflects reinvested dividends. See Edison Electric Institute, 2014 Financial Review, 2015; 2019 Financial Review, 2020.

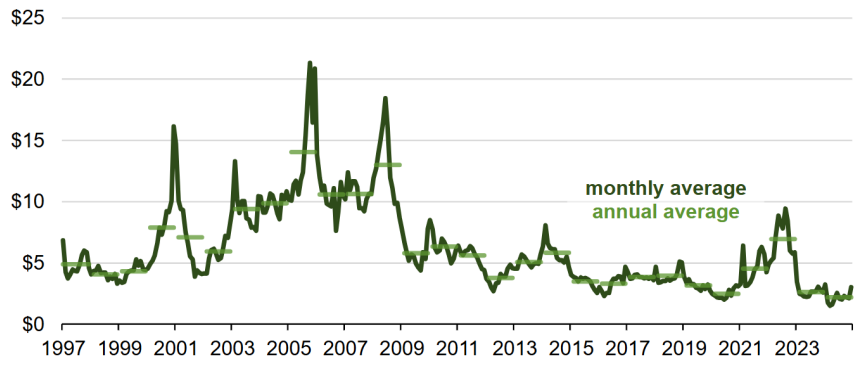
Generation Costs were on a Tech-Driven Decline

Levelized Cost of Energy Comparison—Historical Renewable Energy LCOE

This year's analysis shows a divergence in trends between wind and solar with solar costs declining slightly and wind costs increasing, likely reflecting the difference in supply chain conditions across each technology



Monthly and annual average Henry Hub real natural gas spot price (1997–2024)
real 2024 dollars per million British thermal units



Data source: U.S. Energy Information Administration, based on nominal prices from Refinitiv Eikon and adjusted for inflation using the November 2024 Consumer Price Index

LAZARD
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Source: Lazard estimates and publicly available information.
1 Reflects the average percentage increase/(decrease) of the high end and low end of the LCOE range.
2 Reflects the average compounded annual growth rate of the high end and low end of the LCOE range.

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But 2023 Signaled the Start of the New Era

Levelized Cost of Energy Comparison—Historical Renewable Energy LCOE

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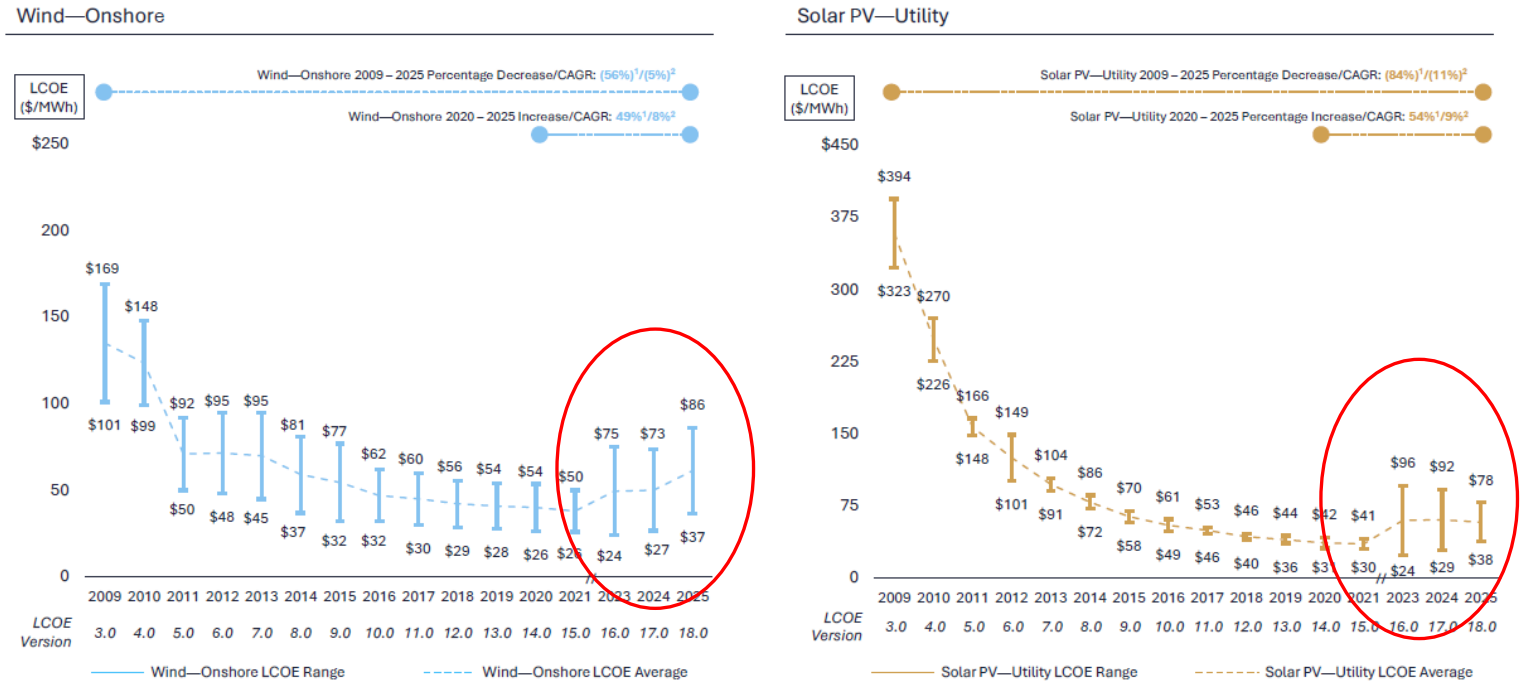

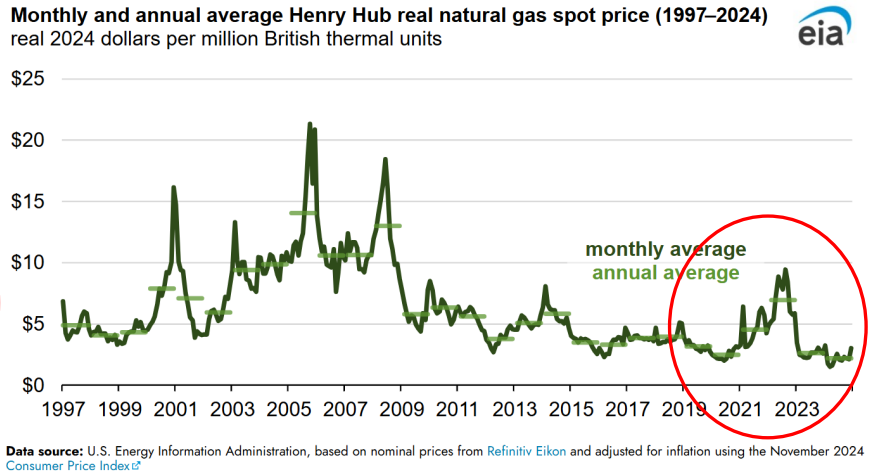

Data source: U.S. Energy Information Administration, based on nominal prices from Refinitiv Eikon and adjusted for inflation using the November 2024 Consumer Price Index

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Source: Lazard estimates and publicly available information.
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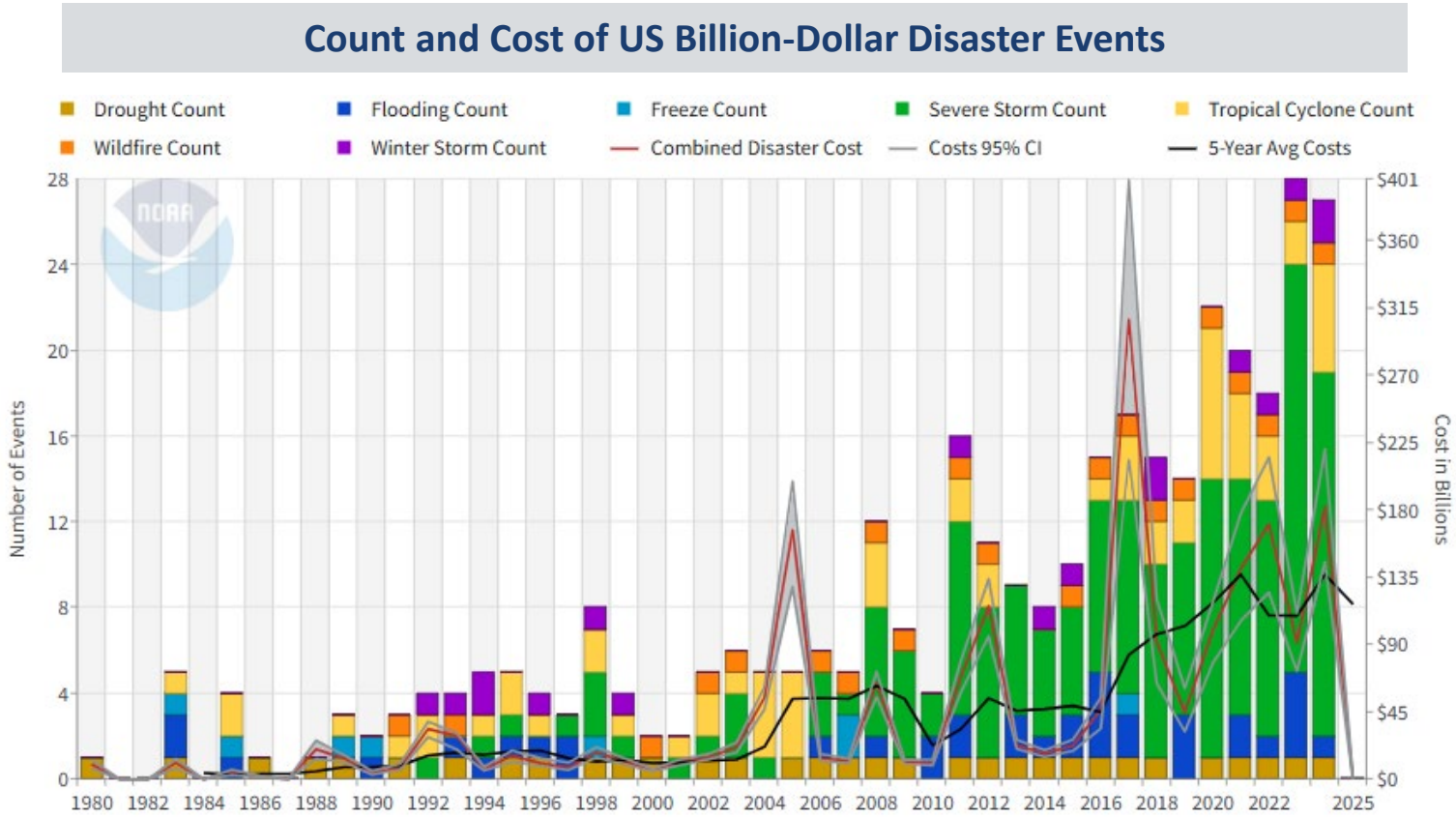
The Costs of Climate Change Are Already Large, Visible, and Rising – Decarbonizing Power Remains Urgent

- Over half of utility T and ~ two-thirds of D capex for replacement and resilience (EEI).
- Excessive heat already estimated to kill around 12,000 Americans annually – Global deaths attributed to heat: ~450,000 in 2021.
- Extreme weather and climate change-related health impacts in 2023: 512 billion potential labor-hours, $835 billion in income losses.
- Food and water insecurity are already triggering mass migration.



Source: All dollar values reported in nominal dollars; see NOAA, Billion-Dollar Weather and Climate Disasters, accessed April 22, 2025.

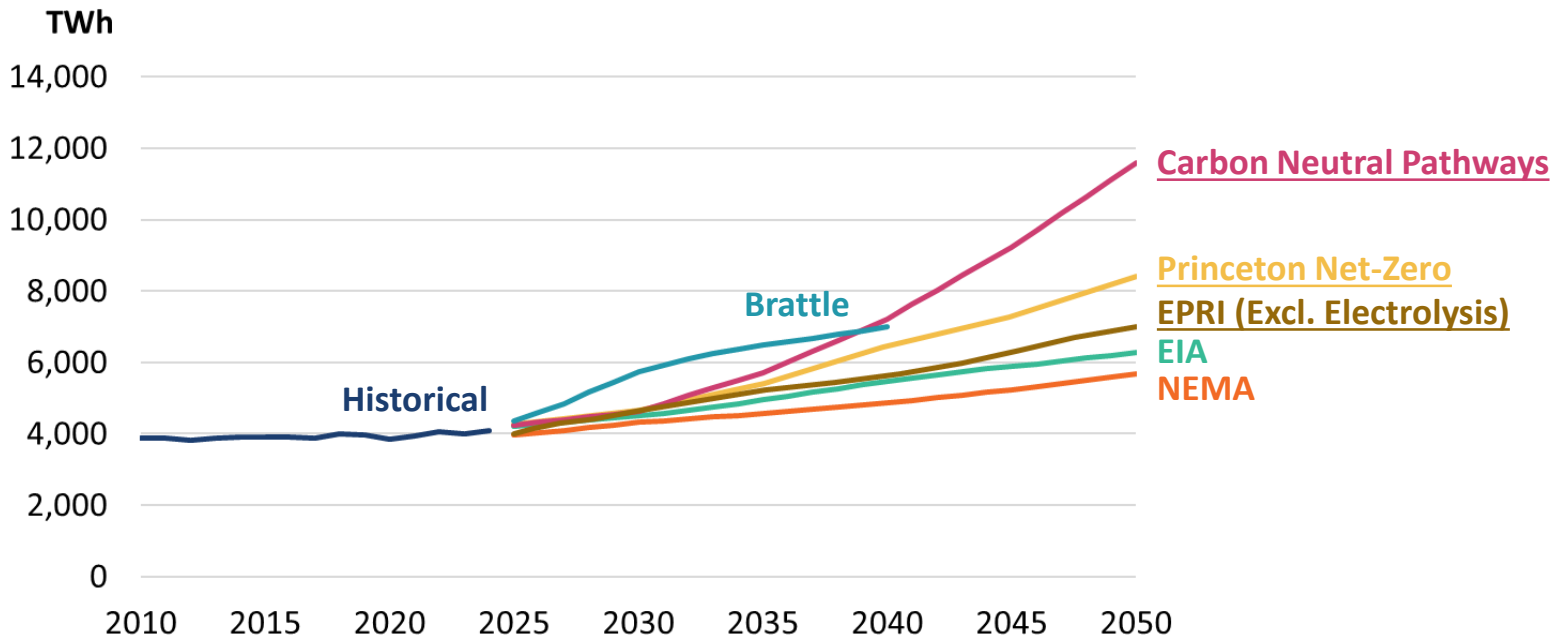
Sources and notes: Romanello et al., "The 2024 report of the *Lancet* Countdown on health and climate change: facing record-breaking threats from delayed action," *Lancet*, 2024. See also GBD 2021 Risk Factors Collaborators," Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990–2021," *Lancet*, 2024; and Shindell et al., "The Effects of Heat Exposure on Human Mortality Throughout the United States," *Good Health*, 2020.

Non-Data Center Demand *isn't Growing Fast Enough…*

Clean electricity is a part of the solution, not part of the problem.

Studies of US pathways to net zero indicate need to roughly double clean power by 2050, 2.7% average annual growth.

Projected Total US Electricity Consumption in Net Zero and Other Studies
Includes Electrolysis and Intermed. Load Unless Noted; Net Zero Studies Underlined

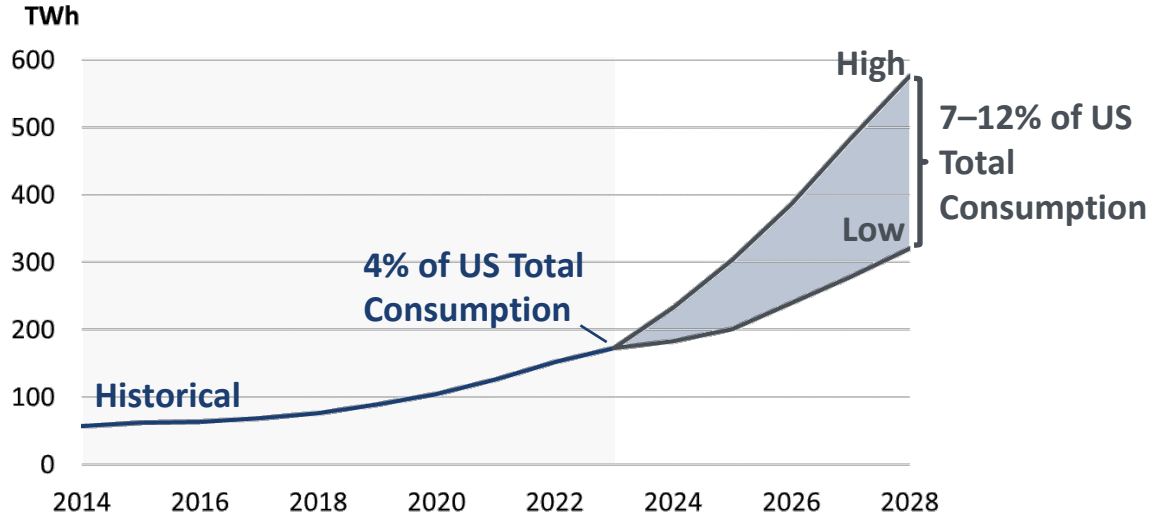


Sources and notes: Brattle forecast based on recent RTO and utility load forecasts for their own service territories. Historical data from EIA, Short-Term Energy Outlook Data Browser, 2025. See appendix for details and sources.

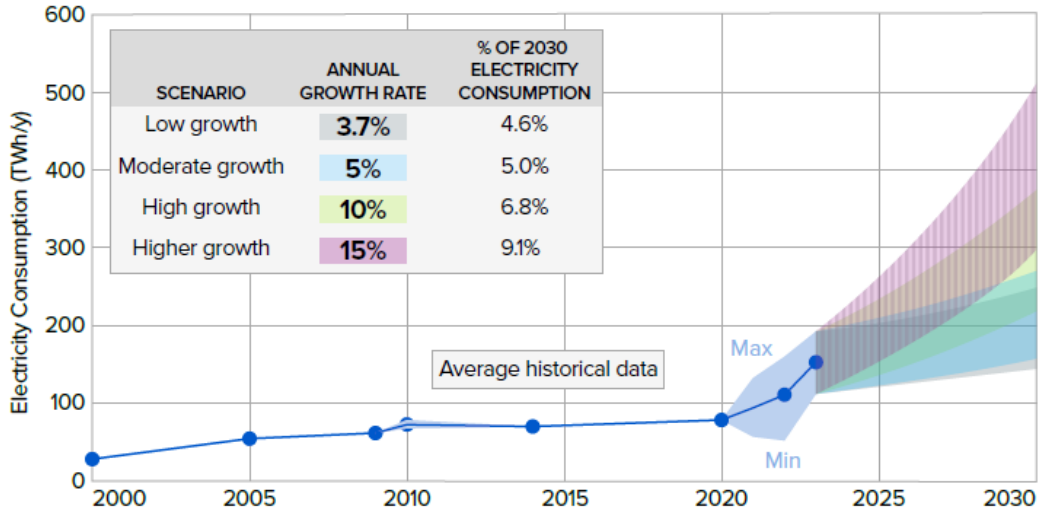
...while Data Center Load Overloads Supply Chain and Sets Back Climate Goals

- LBNL/ EPRI forecast DC energy grows 4% -27%/yr through 2030. S&P +70 GW. Wood Mac “tracking” +134 GW.
- Hyperscalers missing their climate targets; Amazon +6% CO2 2023-2024; Google +51% since 2019.
- Some experts forecast two-thirds of the additional DC power from fossil energy; +2.5 GT added carbon by 2030.

LBNL Forecast Data Center Energy Consumption



EPRI Forecast Data Center Energy Consumption



Source: LBNL, 2024 United States Data Center Energy Usage Report, 2024.
Additional sources: Google’s emissions up 51% as AI electricity demand derails efforts to go green, Google, The Guardian. Washington Examiner Daily, Callie Patteson and Maydeen Merino, 7/17/25. Data center carbon Global data center industry to emit 2.5 billion tons of CO2 through 2030, Morgan Stanley says | Reuters.

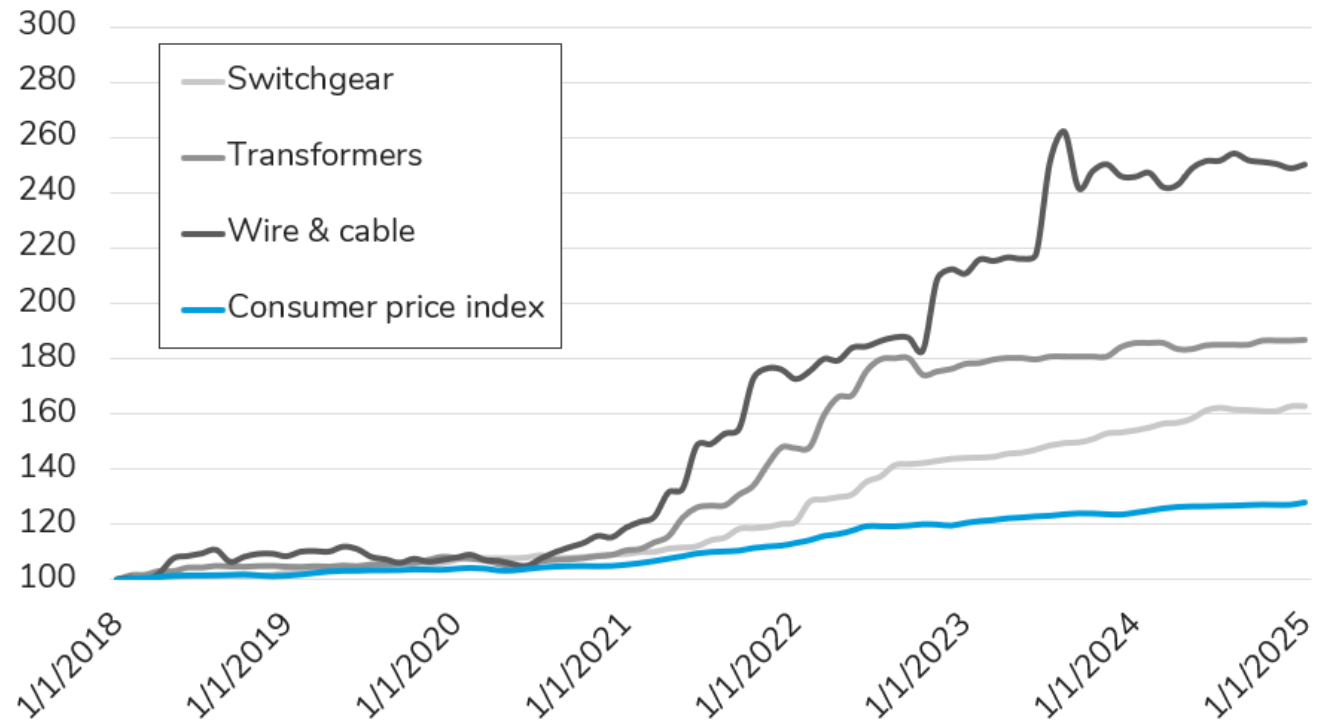
Source: EPRI, Powering Intelligence, 2024.

High Demand, Meet High Cost Supply

General inflation, tariffs, and an inelastic supply chain vs. demand all contributing:

- Raw copper prices + 40% since ’21 and now tariffs.
- Finished power transformers cost an average of 60–80% more – after as much as a four-year wait.
- Wholesale power costs will increase 19% in the next three years (ICF model).
- Cost to build a natural gas plant has tripled in the last few years (CEO of NextEra Energy).

Producer Price Index for Critical Power System Equipment, St. Louis Fed

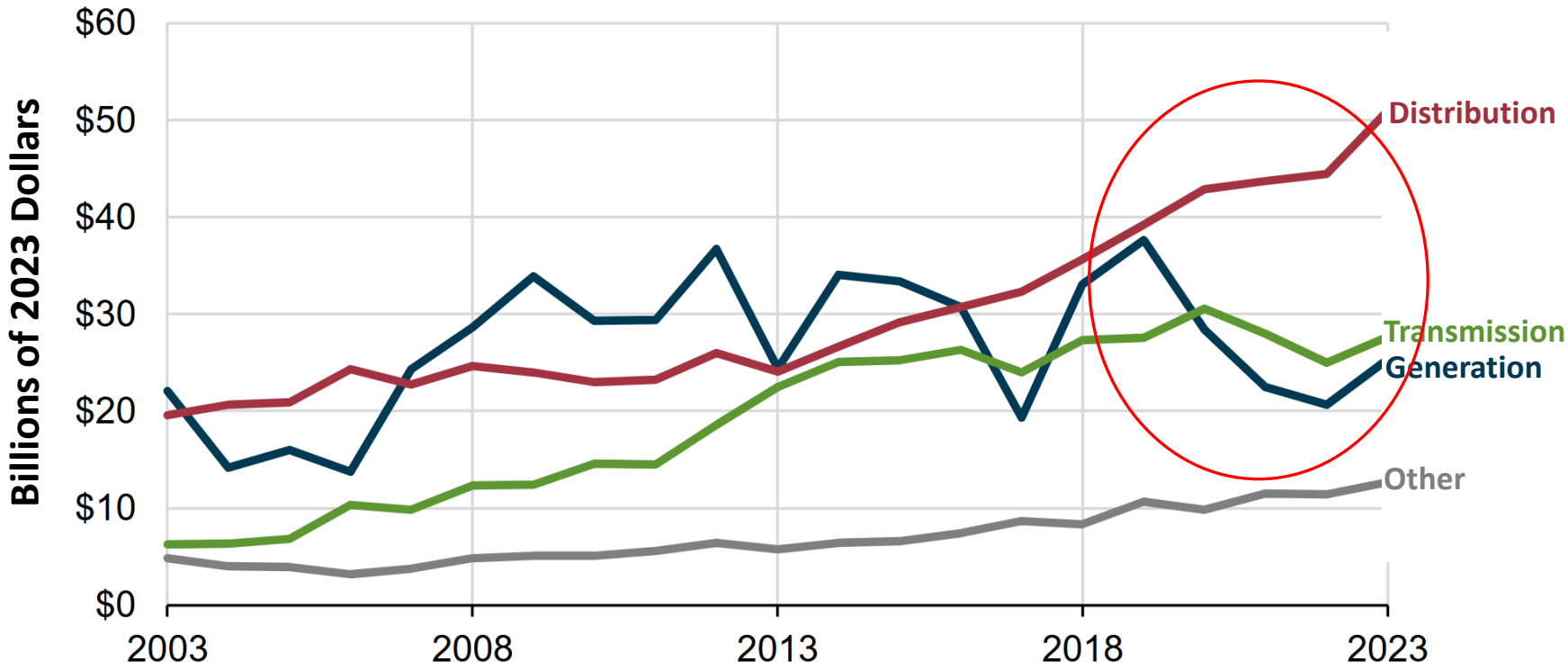


Source: Andy Lubershane, Steel for Fuel, 2025. Data from St. Louis Federal Reserve FRED databased, Producer Price Indices Accessed April 29, 2025.

Distribution and Generation CapEx have both Overtaken Generation Capex

- **Distribution + 2.5x real dollars**
- **Transmission + 4x real dollars**
- **Generation relatively flat**
- **Particular gen decline in early 2020s with wind/solar boom**

Inflation- Adjusted Annual US Capital Additions by Sector (2003–2023)

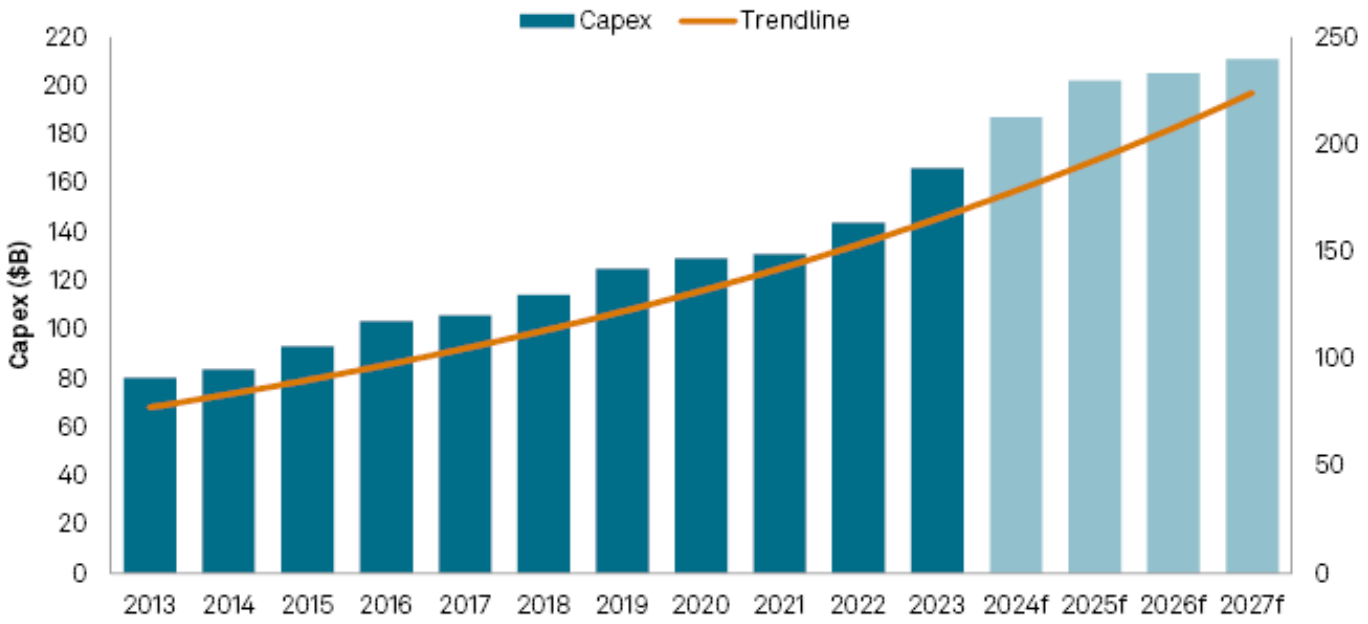


Sources and notes: Data from US Energy Information Administration and Federal Energy Regulatory Commission (FERC) financial reports, accessed by Ventyx Velocity Suite. See EIA, Grid infrastructure investments drive increase in utility spending over last two decades, accessed April 30, 2025.

Record-Setting Capital Expenditures (CapEx)

- IOU capex set to double 2014-25, according to EEI.
- RRA (right) shows nominal capex 3x 2014-2027.
- Jeffries estimates 2025 capex +22% over 2024 – "reliability-driven grid mod, DC demand, electrification, and transmission are all drivers."

Energy Utility Actual and Estimated Capex



Source: Regulatory Research Associates, a group within S&P Global Commodity Insights, "Energy utility capex projected to eclipse $790B from 2025 through 2028," *S&P Global Market Intelligence,* January 9, 2025. Data compiled December 23, 2024. Jeffries data from Julien Dumoulin-Smith, Equity Research email 6/20/25.

Rate Increases and Affordability Take Center Stage

Utility Rates and Health Insurance Show Rapid Inflation Is Alive and Kicking

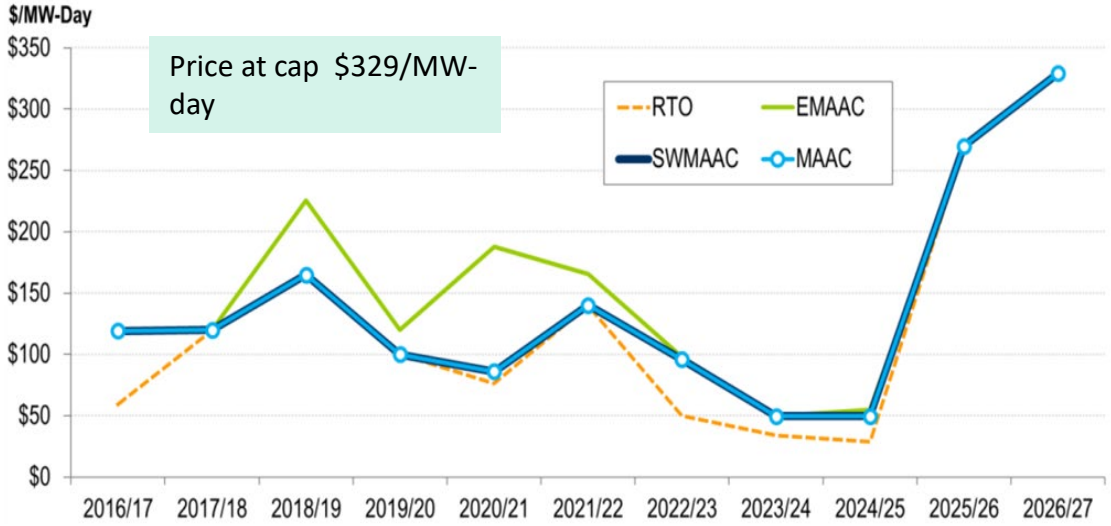
Government data says consensus underestimates Q2 2025 growth of consumer-related revenues

JOHN LONSKI

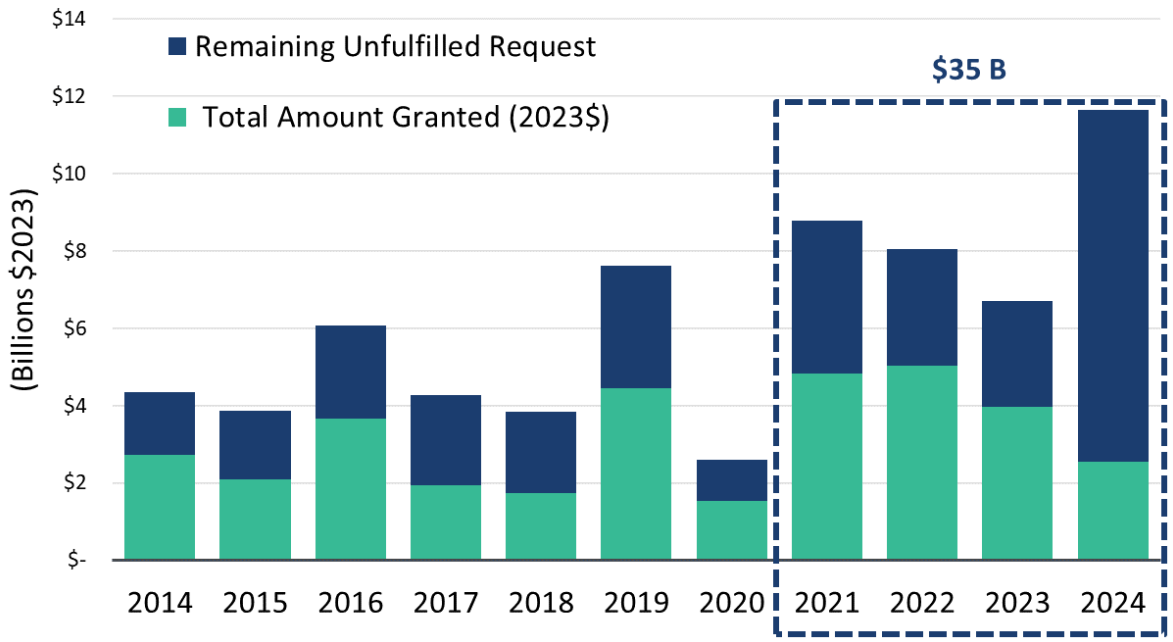
JUL 21

6/24-6/25
General inflation: +2.7%
Natural gas: + 14.7%
Electricity: +5.8%

Figure 1. BRA Clearing Prices by Delivery Year for Major LDAs



Total Amount Requested in Electric Rate Case Filings

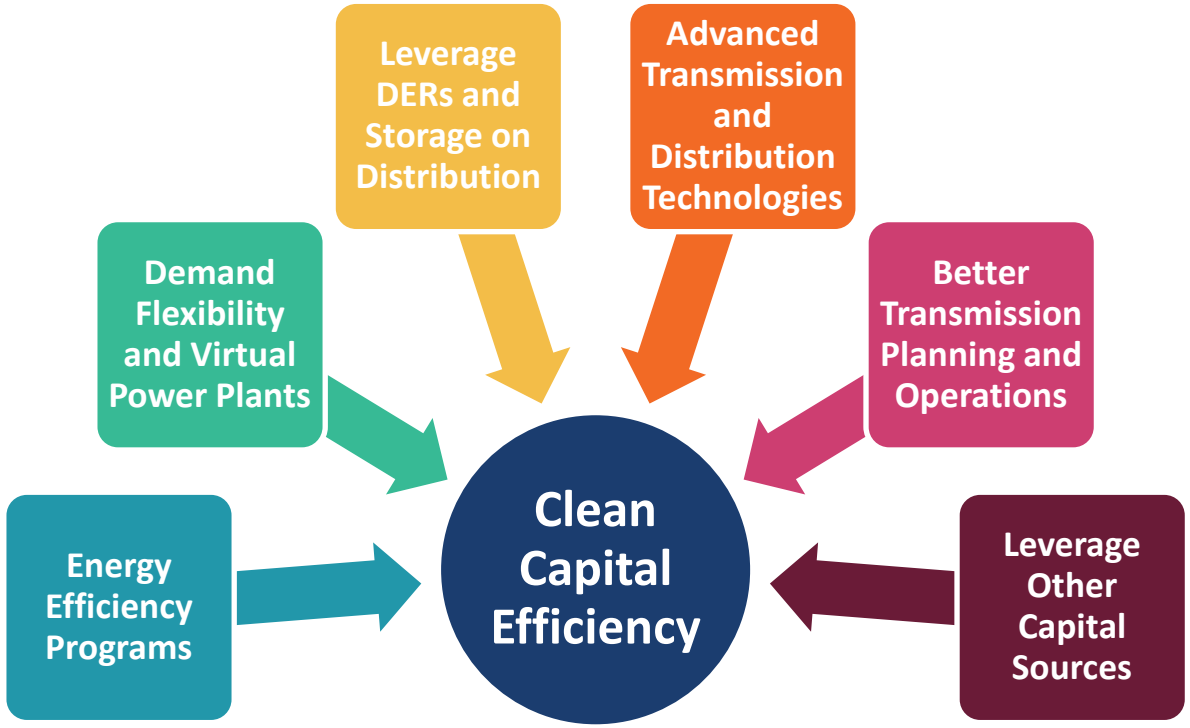


- Utility analysts predict that **17 large utility companies** (out of about 45) may see **rate hikes above inflation** before 2027.

Sources: Above S&P Global, expressed in 2023 dollars. Left, John Lonski <thruthecycle@substack.com> July 21, 2025. PJM, 2026-2027-bra-report.pdf.

Easing Build Costs Via T&D Strategies

- We're in a long-term build cycle at a time of record-high supply costs.
- Unlike last time, we can't expect tech-driven G cost declines to offset higher G,T&D costs:
  - Wind and solar – less room to decline
  - Natural gas gen unlikely to decline
  - Geothermal and nuclear have potential, but not soon
- What's different now: advanced T&D tech and business models have come of age.
- T&D is where cost relief is most needed, and where we can get it.
- Five strategic areas stand out, plus one relief valve.

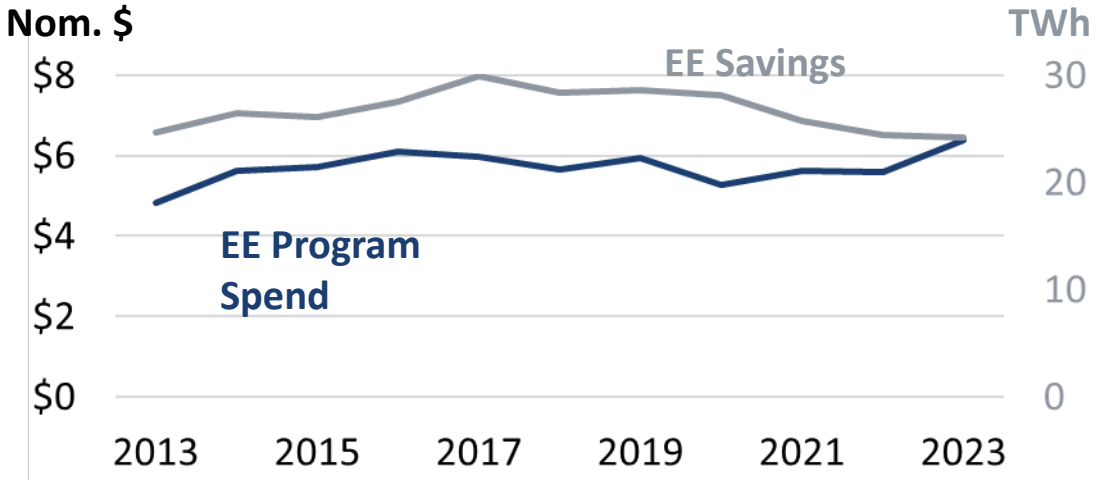


Energy Efficiency (EE)

It is critical that utilities "think outside the box" to galvanize EE efforts as a means of offsetting rate increases.

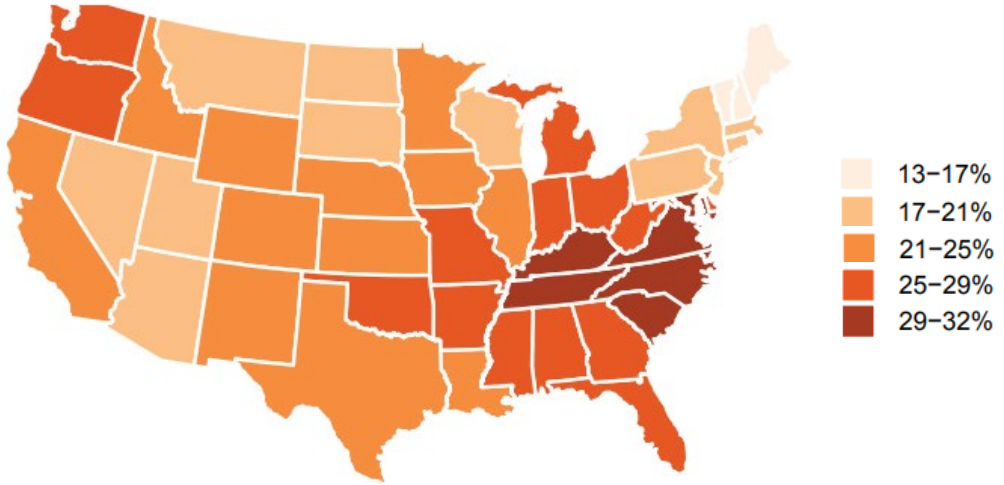
- Potential options include integrating EE into sectoral decarbonization targets such as building codes or IRA programs; expanding utility ownership of behind-the-meter (BTM) efficiency assets; and considering co-benefits of EE (in addition to cost savings) in program evaluation.
- EE is particularly important and impactful for low-income households, who spend a larger portion of household income on energy bills than any other customer class.
- Utility co-funding and collaboration with states is crucial to advance EE and make full use of the $8.8 billion of federal funds earmarked for home EE and electrification services in the IRA.
- According to the Rocky Mountain Institute, EE can save industry $437 billion annually and can enable a carbon-free energy system a decade earlier than would be possible otherwise.

US Energy Efficiency Annual Spend and Electricity Savings



Source: EIA, Form EIA-861, 2013 – 2023 data files, accessed April 21, 2025.

Low-Income Household Potential Electricity Savings from EE



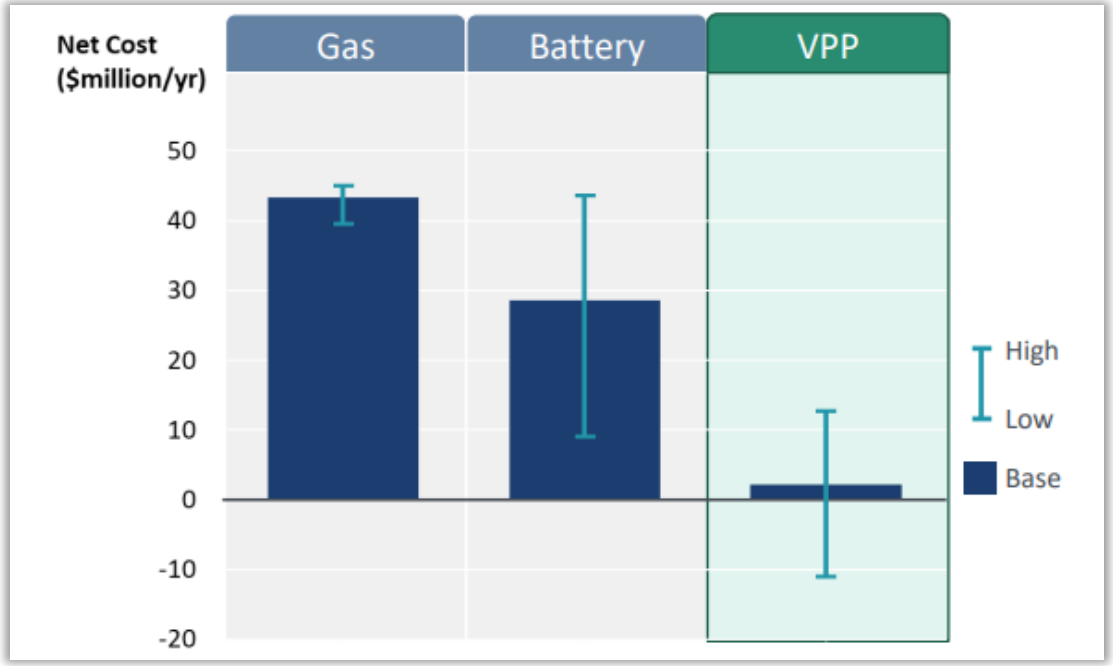
Source: US DOE, Low-Income Household Energy Burden Varies Among States — Efficiency Can Help In All of Them, 2019.

Demand Flexibility and Virtual Power Plants

Virtual Power Plants (VPPs) and Load Flexibility offer an emerging opportunity for utilities to cost-effectively manage peak load and reduce overall consumption, all while engaging customers in the energy transition.

- Like DR, VPPs aggregate controllable consumer energy technologies such as smart thermostats and EV chargers into “virtual” generating resources.
- Recent analysis by the US Department of Energy and Brattle estimated the total addressable market for VPP deployment can increase from its current 30 GW to between 80 and 160 GW by 2030 – potentially supplying up to 20% of US peak demand by then.
- However, greater reliance on VPPs will require utilities to adapt to a new method of grid control (i.e., orchestrating control over hundreds of thousands of small-scale resources).

Net Cost to Provide 400 MW of Resource Adequacy



Source: Represents range across all sensitivity scenarios. The Brattle Group, Real Reliability: The Value of Virtual Power, May 2023.

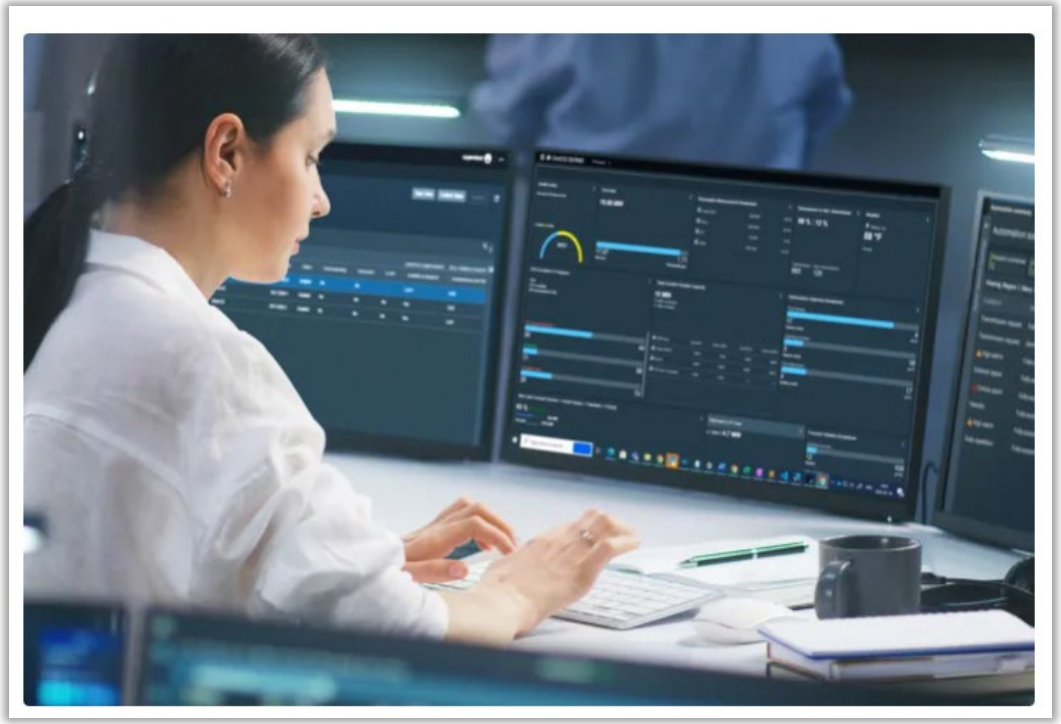
Leverage DERs and Storage on Distribution (NWAs)

Non-Wires Alternatives (NWAs) – which reduce or defer needs for traditional infrastructure upgrades – are not always cheap or feasible, but when/where they are, they should be used:

- NWAs can and should be used (where appropriate) to defer costly transformer upgrades, even by a few years.

Full dispatch of the distribution system is the next logical step beyond dispatching load:

- Installing distributed energy resource management systems (DERMs) can be expensive and disruptive.
- Installed distributed energy resource (DER) base now significant enough to matter in many urban areas.

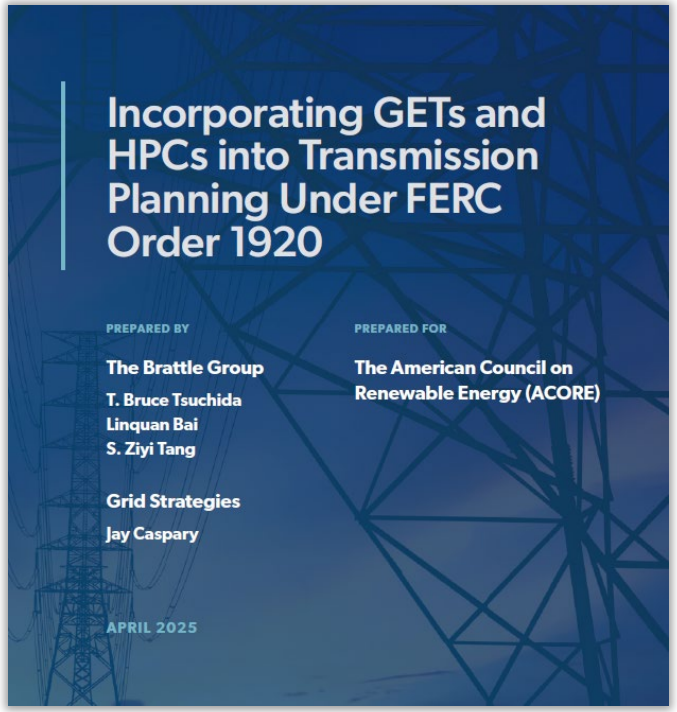


Source: GE Vernova, Distributed Energy Resources Management System, 2025.

Advanced Transmission and Distribution Technologies (ATTs)

ATTs, which include dynamic line ratings, HVDC lines, and grid-enhancing technologies (GETs), provide benefits relative to traditional wires solutions: cost savings, increased flexibility, and reduced losses.

- ATTs include GETs, which are hardware and/or software changes that dynamically increase the capacity, efficiency, reliability, or safety of the power system faster and/or cheaper than traditional wires-based solutions.



Link to the full report.

Comparison of Potential Solutions to Relieve Congestion in PPL

	Reconductor	Rebuild	Dynamic Line Rating
Time to Implement	2-3 Years	3-5 Years	~1 Year
Downtime	Extended Outages	Extended Outages	No Outages
Cost	$0.5 Million per mile	$2-3 Million per mile	<$50 Thousand per mile*
Est. Capacity Benefit	+34%	+106%	+10-30%

Source: *<$1 Million total cost on 20-mile line & longer lines are cheaper. See Brattle, *Incorporating GETs and HPCs into Transmission Planning under FERC Order 1920*, 2025.

Better Transmission & Distribution Planning and Operations

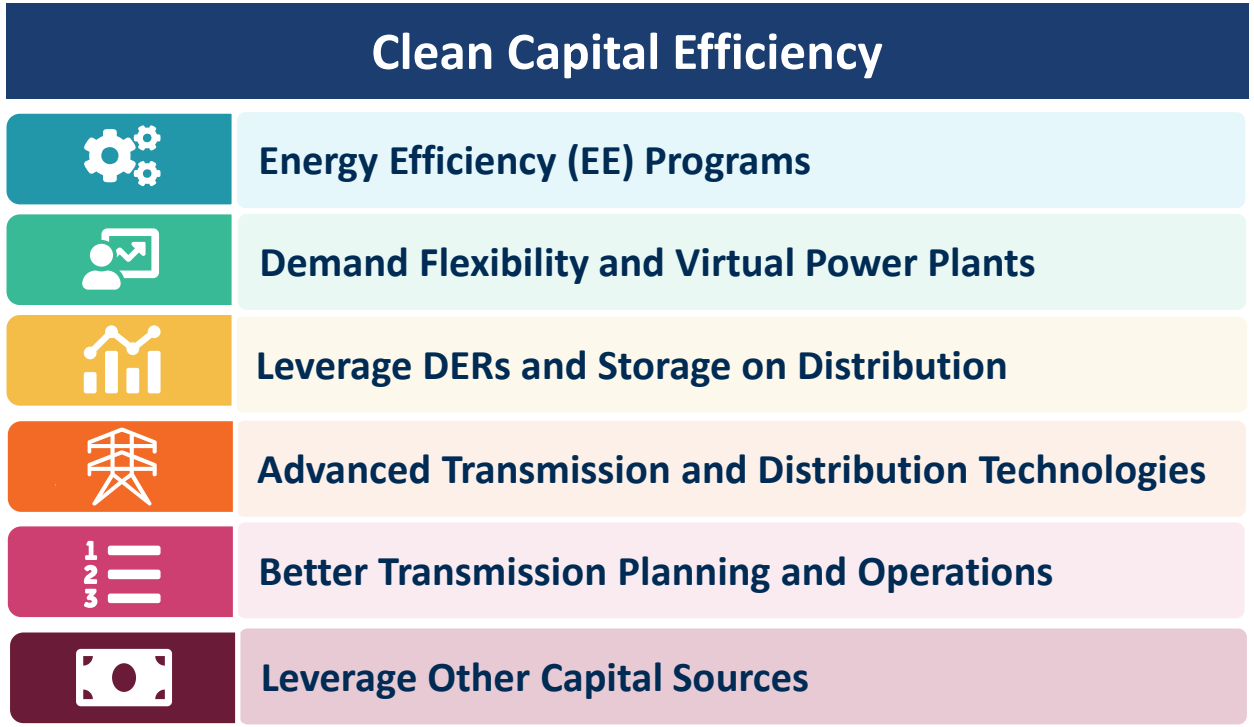
- Plan transmission by studying all measurable benefits; use scenario planning with "least regrets" criteria.
- Study all GETs, including Remedial Action Schemes first, then reconductoring/HVDC conversions, then all new line options (rail corridor, HVDC, etc.).
- Reform interconnection process to "first ready/first connect," "connect and manage," or other accelerations.
- Consolidate/coordinate local, regional, and interregional planning.
- The FERC echoes the need for advanced transmission planning and technologies. Commissioner Judy Chang recently stated: "Planners in transmission utilities absolutely should be using the cutting edge, best in class, advanced technologies when building out our network…[To] squeeze as much as possible out of existing grid and new grid, we need to use the best technologies."

Brattle Report on Improved Transmission Planning

Source: See Brattle, *Order 1920 Compliance: An Opportunity to Improve Transmission Planning beyond Mandates*, October 22, 2024.

Summary

- **Due to the level of growth pushing on an inelastic supply chain, a long cycle of higher cost awaits.**
- **We must add new G,T&D for economic and climate security without breaking the bank or the climate.**
- **Getting more out of existing infrastructure via T&D tech and better planning – Clean Capital Efficiency – is a necessary complement to G additions and *should receive equal or greater focus.***



Authors

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Ryan Hledik is a Brattle principal based in San Francisco. He focuses his consulting practice on regulatory, planning, and strategy matters related to emerging energy technologies and policies. His work on distributed resource flexibility has been cited in federal and state regulatory decisions, as well as by *Forbes, National Geographic, The New York Times, Vox*, and *The Washington Post.*

Shannon Paulson is an Energy Analyst and **Xander Bartone** is an Energy Specialist at Brattle.

ACKNOWLEDGMENTS

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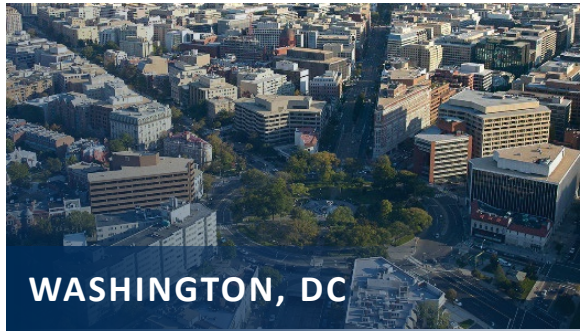

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TOP 25 PRACTICES

- Accounting
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- Bankruptcy & Restructuring
- Broker-Dealers & Financial Services
- Consumer Protection & Product Liability
- Credit, Derivatives & Structured Products
- Cryptocurrency & Digital Assets
- Electricity Litigation & Regulatory Disputes
- Electricity Wholesale Markets & Planning
- Environment & Natural Resources
- Financial Institutions
- Healthcare & Life Sciences
- Infrastructure
- Intellectual Property
- International Arbitration
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- Regulatory Investigations & Enforcement
- Securities Class Actions
- Tax Controversy & Transfer Pricing
- Technology
- Telecommunications, Media & Entertainment
- White Collar Investigations & Litigation

Clarity in the face of complexity

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Appendix

Electricity Consumption Forecast Sources

- **EIA Annual Energy Outlook:** EIA, Annual Energy Outlook 2025, Table 8, accessed April 30, 2025.
- **EPRI:** Excludes electrolysis load. Perry Stephens, EPRI Decarbonization Pathways Analysis, EPRI, January 13, 2025.
- **Princeton Net-Zero America:** Uses "E+ RE-" scenario (aggressive end-use electrification; wind and solar rate of increase constrained to 35 GW/y (~30% greater than historical maximum single-year total). Includes effects of flexible intermediate loads that absorb variable wind and solar generation (electrolysis, direct air capture, and electric boilers). Princeton University, *Net-Zero America: Potential Pathways, Infrastructure, and Impacts*, October 29, 2021.
- **Brattle:** Based on most recent utility and RTO load forecasts. For a prior iteration of this forecast (circa February 2025) see Newell et al., *A Wide Array of Resources is Needed to Meet Growing US Energy Demand*, The Brattle Group, 2025.
- **NEMA*:** Forecast produced by PA Consulting for NEMA. See NEMA, *A Reliable Grid for an Electric Future*, 2025.
- **Carbon-Neutral Pathways*:** Includes electrolysis and electric boiler load. Williams et al., *Carbon-Neutral Pathways for the United States*, AGU Advances, 2020.

** Assumes linear growth between dates for which data is published (e.g., if consumption is forecast in 2025 and 2030, assumes linear growth between these dates).*