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Energy Policy Research Foundation

Power Vision 2030

Creating a Sustainable Pathway to Secure the American Economy

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Prepared for the Joint Working Group on the Future of American Electric Power

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So, you attach infinite value to stopping the disease and saving a life. You attach a zero value to whether this actually totally disrupts people's lives, ruins the economy, and has many kids kept out of school in a way that they never quite recovered. This is a public-health mindset, which is another mistake we made.

Dr. Francis Collins
Former Director, National Institutes of Health
as quoted in the Wall Street Journal, December 29, 2023

Electric Power 2030
Creating a Sustainable Pathway to Secure the American Economy

Project Overview

The next five years present an enormous challenge for either new Administration. A substantial and unexpected increase in electricity demand from data centers, new manufacturing, and growing electrification for EVs and other applications is bearing down on grid operators. This surge in power demand is taking place at the same time utilities are facing an array of complex and costly new regulations aimed at accelerating the retirement of fossil fuel generation. Despite the rapid growth in capacity, non-hydro renewable energy has added only a small fraction of the power needed and comes with its own costs and penalties due to the variable nature of the power produced. These challenges, if not properly addressed, will constrain the U.S. economy and damage national security should we fail to deploy sufficient reliable power to satisfy rising power requirements.

The Energy Policy Research Foundation has recently kicked off the Power Vision 2030, a multi-year initiative to help policymakers address the above challenges to ensure reliable, affordable, and sustainable power systems across the country. Given the large presence of the federal government in the U.S. power sector, the initial stage of the project will include:

- Identification of regional centers where power demand is surging and an assessment of the adequacy of the existing grid structure/generation to meet these growing power requirements.
- Analysis of demand requirements by region and source, especially requirements to meet power demand for AI, manufacturing, and EVs.
- Identification of regulations impeding the expansion of additional electricity generation, including the construction of new power plants and the continued operation of existing power plants.
- An assessment of the potential contribution of rapid deployment of natural gas infrastructure and construction of new gas-fired power plants to meet rising power demand in the near term (either as backup for intermittent production sources or as new baseload power production).
- Sustained education and outreach to stakeholders and the public to communicate the importance of meeting the challenge for new power generation, a major condition for sustaining economic growth and national security.
- Analysis of the production functions of U.S. power systems, followed by a stylized assessment of 5-6 electricity generation models.

Research Questions

Throughout the initiative, industry experts and academics will be invited to address important questions, such as:

- If current initiatives promulgated by EPA to regulate the electric power sector are fully implemented, what are the likely implications for the cost of electricity and reliability for the U.S. electric grid by region?
- Are some utility systems constraining electric power distribution to new industrial facilities, data centers, and manufacturing facilities? What is the cost of such constraints to economic growth and productivity improvements in the national economy?
- What plans or programs are electric power producers and RTOs undertaking to limit the risks of blackouts and contain cost escalation?
- What specific facilities should be targeted with delayed retirement to reduce blackout risks and cost escalation? How many dispatchable power facilities (coal, natural gas, and nuclear) can be extended and where?
- Are there efficiencies in the transmission of electric power that could limit rising power costs and improve reliability of national power systems?
- The U.S. has vast resources of natural gas. What are the implications of a national initiative to permit substantially higher levels of natural gas distribution (i.e., pipelines) and resource development for the cost and reliability of electric power? Is the Florida model workable and transferrable to other regions of the country?
- What measures are needed to ensure the U.S. can produce sufficient domestic natural gas at affordable prices for rising electric power requirements, domestic feedstock, and exports of both LNG and pipeline natural gas?
- What regulatory changes are most important to ensure the U.S. can continue to produce resilient and low-cost electricity to meet rising demand?

Discussion

The observation of Dr. Francis Collins on how the nation addressed Covid-19 is a common principle held by economists for more than two centuries. Resources are scarce, so tradeoffs must be considered and made, even when engaged in measures to halt a pandemic. For the Covid pandemic, failure to fully understand this basic principle yielded large and enduring costs to the national economy and social cohesion. For electric power generation, the lesson is straightforward. If we are going to radically alter the way we produce electricity to meet a single objective (i.e., lower carbon emissions), we should have a careful understanding of second and third order effects of policies that seek to alter the ways that this regulated sector has produced and delivered electricity. At a minimum, we should have a detailed understanding of the likely costs and reliability of electric power if current policies and regulations are fully implemented.

The slide presentation associated with this paper indicates that for the U.S. electric power sector, a singular and rapid deployment of technologies to reduce carbon emissions offers considerable potential to undermine the historic reliability of electric power delivered to businesses and residential consumers and at the same time may substantially increase power costs. This is a highly complex issue, but the comparison between Florida and California is informative (Figures 1 & 2 in Appendix), even if somewhat incomplete. California has chosen to mandate a rapid transition to so-called carbon-free power production technologies, which are largely intermittent. The state is now experiencing rapid cost escalation and by some measures also delivering less resilient power supply. Florida has taken a more cautious approach, and in the process of phasing out the use of coal has relied largely on natural gas. Intermittent energy supplies from solar power have been deployed in Florida, but at a more measured and regular pace than California.

The Biden Administration, through financial incentives provided in the Inflation Reduction Act, regulatory policies implemented by EPA, and other measures is seeking to rapidly accelerate the transition of electric power from fossil fuels to energy sources that do not emit carbon. While cost-effective technologies exist to lower carbon emissions from the production and combustion of natural gas, many policy makers are seeking to implement programs that fully eliminate all fossil fuels from the production of electricity. In terms of dispatchable 24-hour power, nuclear reactors offer an obvious zero carbon solution, but large-scale deployment of nuclear reactors face a range of headwinds in the near term.

Challenges of Intermittent Power

In an attempt to address environmental objectives, federal and state policies and directives subsidize and mandate the construction and dispatch of variable renewable energy (VRE) resources, notably wind and solar. However, electric power generated from wind and solar resources is both intermittent and unpredictable. These intermittent power sources present genuine challenges to maintaining adequate voltage across the electric power grid and can be costly to distribute as solar and wind resources often cannot be constructed along existing power transmission corridors. Some distributed power sources such as home-based solar power systems can remove customers entirely from the grid or place power into the grid, but only for short periods of time. These intermittent supplies can be "backed up" through the use of oscillating generation such as combined cycle natural gas power plants or, in some instances, hydroelectric power when available through pumped storage. Utility networks can also "price-in" a higher number of intermittent consumers to help stabilize grid operations. All of the potential solutions to rising VRE resources require expenditures to properly operate the power system. The cost of integrating higher volume of VREs into power operations is often not well understood and the cost to consumers are not easily discovered.

Rising levels of VRE resources arguably create new challenges for capacity market designs because VRE resources suppress wholesale energy prices while providing relatively little capacity. This effect becomes more pronounced the higher the VRE penetration in a market. In any instant of time, system operators generally choose the lowest cost power available on the grid. System operators argue that existing power auction systems, especially for future capacity requirements, represents an efficient system because power is distributed from the lowest cost supplier and that separate markets or arrangements are made to assure the grid remains stable and reliable. Such grid stability measures are often implemented through arrangements that require the system network grid to have a fixed capacity of on-demand power.

Capacity Management

One of the consequences of rapid growth of VRE generation is that "net load" on the grid (electricity demand minus VRE generation) has effectively shifted down requirements from base load power, but also increased the peak to trough ranges, requiring growth in oscillating power and in some cases construction of additional grid connections. In some cases VREs can distort power prices to the point where they are creating negative prices for power producers. The low cost of dispatched power by VREs is the result of a combination the technology used and government policy. VREs are intermittent and unpredictable, have low operating costs, and operate under incentives to dispatch power even when its value to the power system may be negative. In many instances, rapid deployment of VREs substantially raise system costs.

To meet federal and state electric power reliability requirements, grid operators must ensure that load-serving entities have enough resources to meet expected demand plus a "reserve margin." This reserve margin provides a cushion during unexpected spikes in demand or potential loss of supply or transmission resources. Reserve margins help operators maintain the reliability of the system. Capacity markets in RTO/ISO regions are typically set up to ensure that there are sufficient resources available to serve load plus reserves at some point in the future, typically from one month to several years out in time. They may use auctions to lock in prices for electric capacity from generation resources well before they are actually needed (3 years in some markets). Capacity markets can also be marketplaces for demand response in which customers reduce their demand when called upon to do so in exchange for capacity payments similar to what generators receive. Prices vary by location and timing of capacity commitments and typically not by size or fuel type. ISO New England, PJM, MISO and NYISO operate capacity markets, while other ISOs do not currently have capacity markets.

RTOs and ISOs, with their capability to move power across a wide geographic area and draw upon different kinds of capacity resources, can in theory use a diversified pool of power generators to meet both cost and reliability objectives. However, studies undertaken by the Foundation for Resilient Societies, the Center of the American Experiment, and the North American Electric Reliability Corporation (NERC), among others, all have documented growing threats to the resilience of power delivery systems in both PJM and MISO regions.

What's Ahead: Power Demand is on the Rise

Population, economic growth, advanced manufacturing, and growing power requirements for EVs and new devices are all driving increases in U.S. power consumption. According to the U.S. Energy Information Administration, U.S. power consumption will rise to record highs in 2024 and 2025. EIA projected power demand will rise to 4,096 billion kilowatt-hours (kWh) in 2024 and 4,125 billion kWh in 2025. That compares with 4,000 billion kWh in 2023 and a record 4,067 billion kWh in 2022. Rising power requirements present a host of challenges to reduce the risks of supply interruptions (blackouts) and escalating costs. Figures 3 (retirements) and Figure 4 (likely blackouts) from the Foundation for Resilient Societies provide a sober reminder of the challenges ahead. These results are similar to research undertaken for the MISO region by the American Experiment. The National Electric Reliability Corporation has raised similar concerns regarding likely risks to blackouts, especially in the MISO and PJM regions.

Recommended Readings

Loyola, M., Dayaratna, K. D., & Weiss, A. (2024, October 23). *Why electricity prices are soaring in blue states*. The Heritage Foundation. https://www.heritage.org/environment/report/why-electricity-prices-are-soaring-blue-states

Nakano, J., & Majkut, J. (2024, September 10). *Strategic Equilibrium: The United States' Manufacturing Resurgence and the Role of Natural Gas in a Carbon-Competitive World*. Center for Strategic and International Studies. https://www.csis.org/analysis/strategic-equilibrium-united-states-manufacturing-resurgence-and-role-natural-gas-carbon

Difiglio, C. (2024). *Plenary Session Summary: The Power Market and the Energy Transition*. International Seminars on Planetary Emergencies, 56th Session, Erice. Energy Policy Research Foundation, Inc. https://eprinc.org/wp-content/uploads/2024/11/Energy-PMP-Plenary-Summary-2024.pdf

Electric Power Research Institute. (2024, October 30). *Data Center Load Growth and Emissions Impacts: Modeling and Analysis*. https://www.epri.com/research/products/000000003002031198

Governors of Pennsylvania, Illinois, Maryland, New Jersey, and Delaware. (2024, October 25). Letter to PJM Board of Managers and President & CEO Regarding Capacity Auctions. PJM Interconnection. https://www.pjm.com/-/media/about-pjm/who-we-are/public-disclosures/2024/20241025-governors-letter-regarding-capacity-auctions.ashx

Interview of former Chairman of FERC James Danly on the central regulatory challenges facing the US power sector (video): https://youtu.be/iSvClb1vk74?t=21612

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Appendix: Electric Power Vision 2030

Creating a Sustainable Pathway to Secure the American Economy

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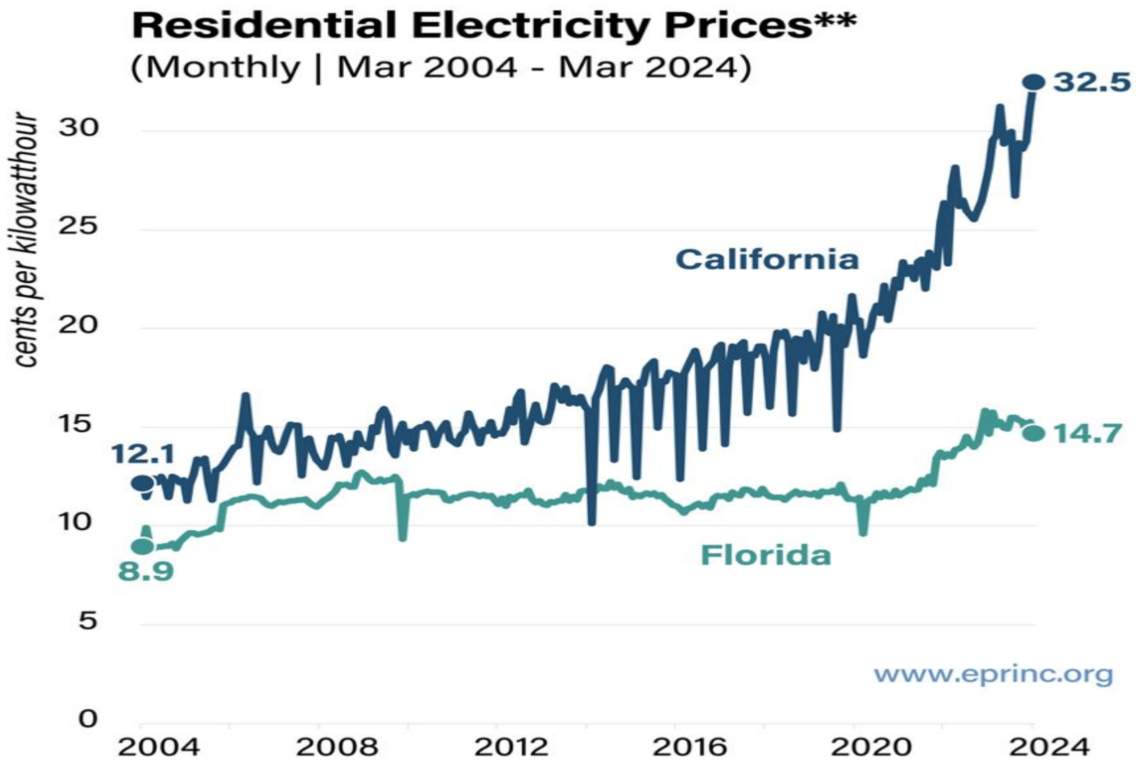
Figure 1

Rapid Deployment of Intermittent Power Can Increase Power Prices and Lower Resilience



**Average Prices of Electricity to Ultimate Residential Customers
Data: EIA

- California's aggressive program to drive out baseload with intermittent wind and solar has put cost pressure on electricity prices
- Growing power demand for AI, Data Centers, EVs and advanced manufacturing will be constrained by high power prices and power interruptions (blackouts)
- Florida's approach to accelerate natural gas use and pace the deployment of intermittent power has limited price increases for electricity
- What are the lessons from the California experience for national policy?

Figure 2

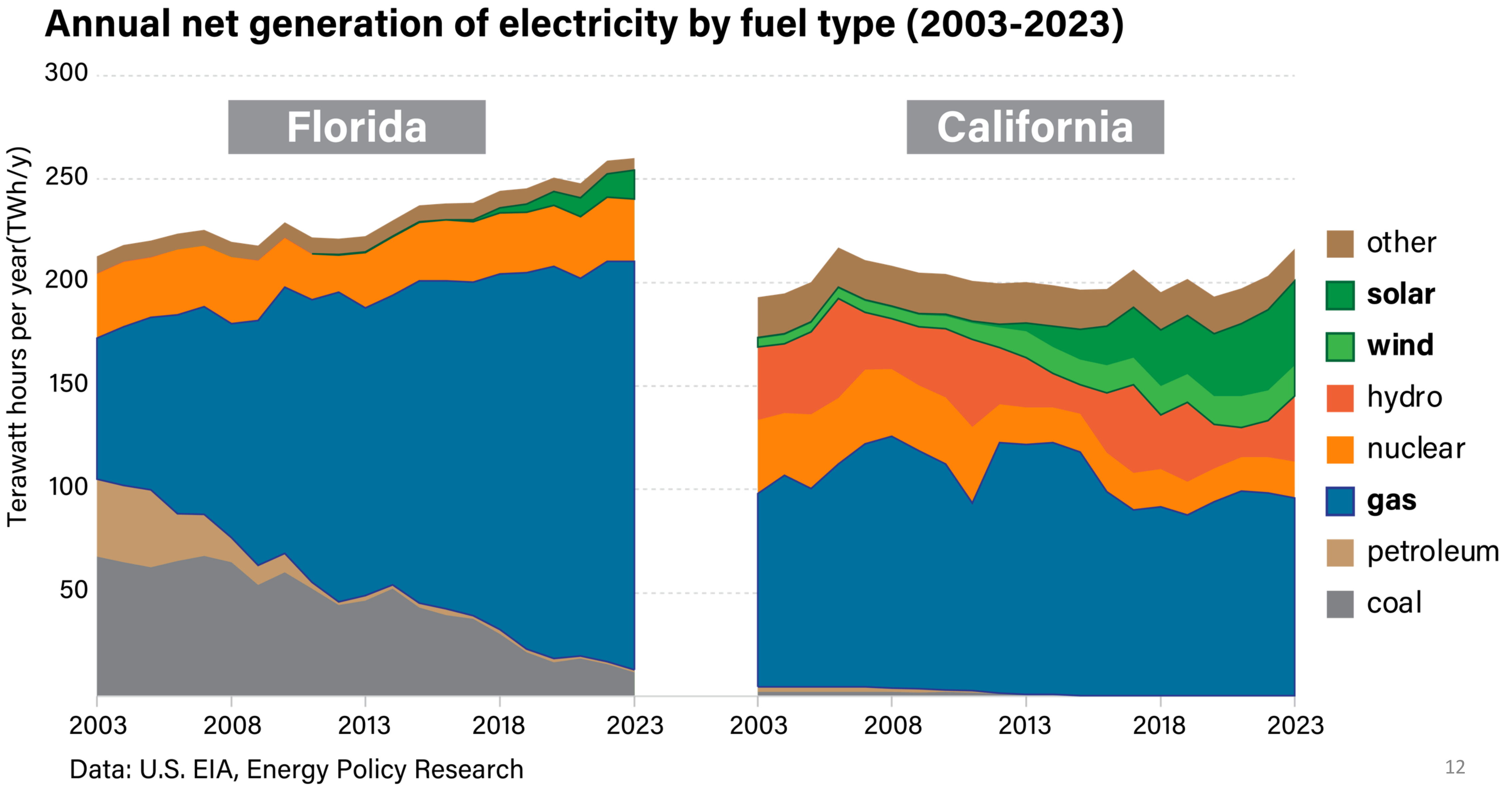
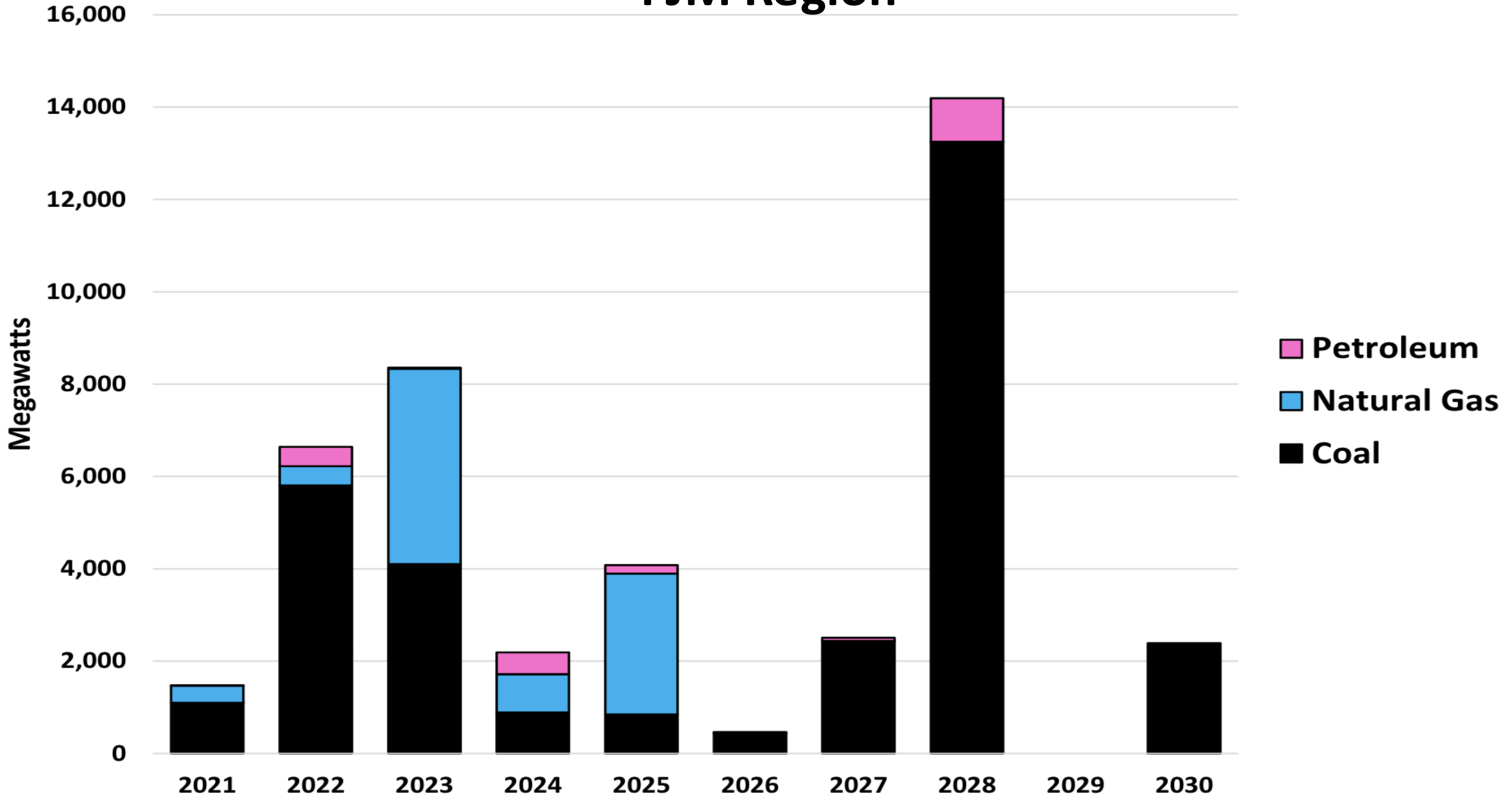

Annual net generation of electricity by fuel type (2003-2023)
Florida
California
Terawatt hours per year(TWh/y)
300
250
200
150
100
50
2003
2008
2013
2018
2023
2003
2008
2013
2018
2023
other
solar
wind
hydro
nuclear
gas
petroleum
coal
Data: U.S. EIA, Energy Policy Research

Figure 3

Retirements of Dispatchable Power Pose Serious Risks to Power Systems PJM Region



Source: Resilience Foundation, US EIA. See:
https://www.resilientsocieties.org/uploads/5/4/0/0/54008795/blackouts_predicted_presentation_for_nasuca_on_june_10_2024_as_shown.pdf

Figure 4

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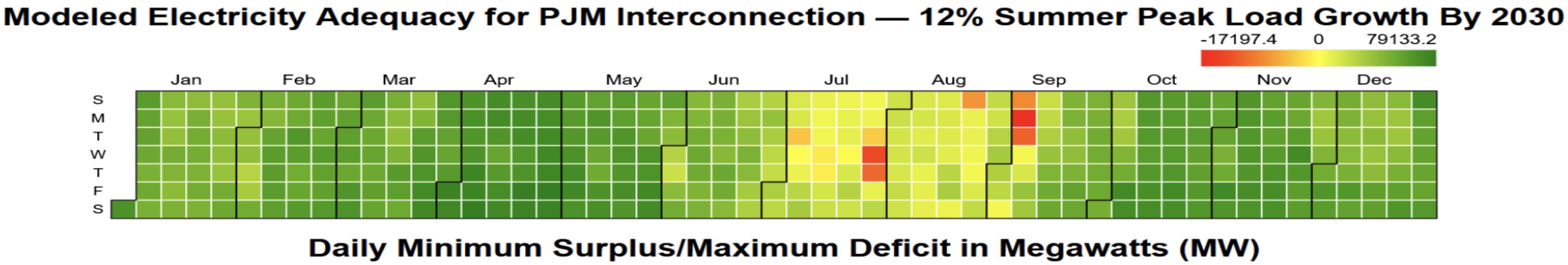
Requirements for AI, Data Centers, Advanced Manufacturing Will Require Substantial Additions of Reliable, Low-Cost Electric Power

PJM—12% Summer Peak Load Growth by 2030



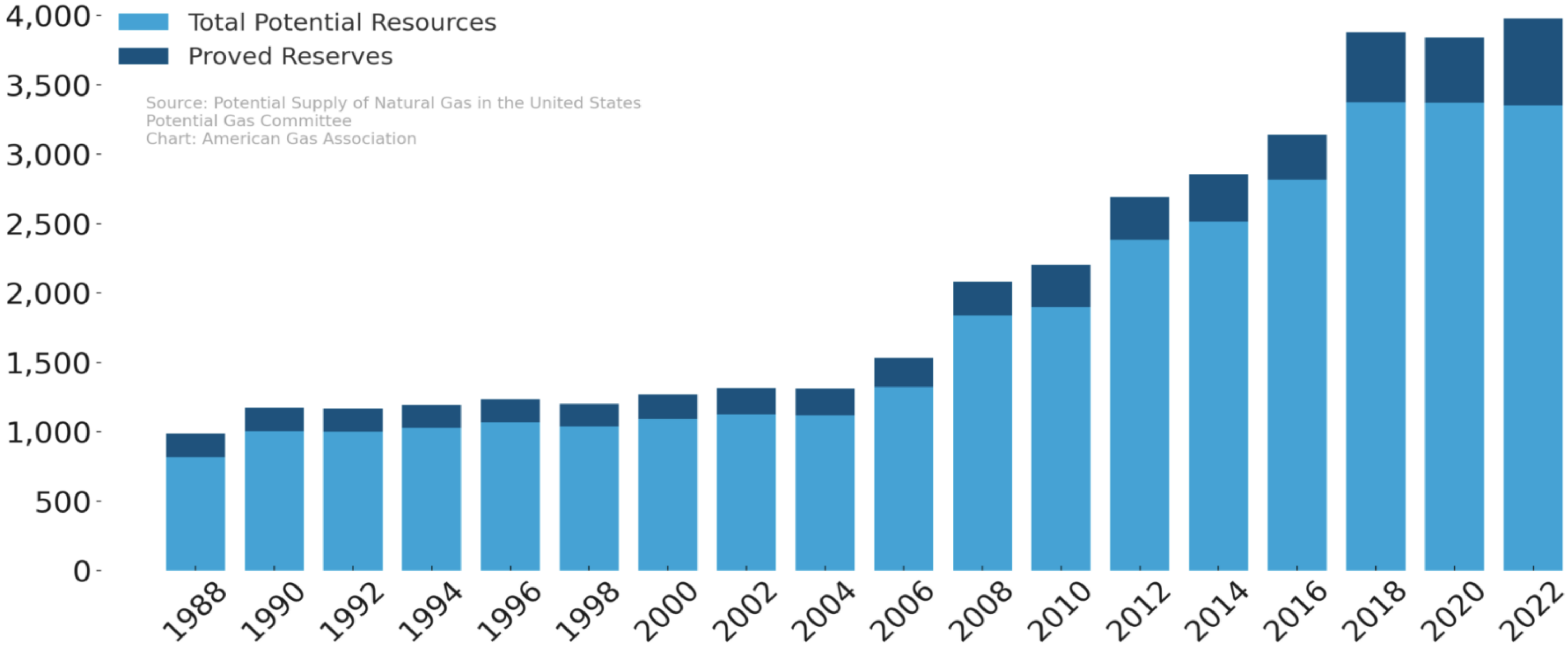
For the modeled "High Entry" scenario in PJM Interconnection, expected generation capacity and imports minus demand (also subtracting necessary reserves) is estimated to be -17,197 megawatts, 10.2% below demand, at the critical hour of 5 PM EST on September 5.

For all of the 365-day Demand Profile, the estimate is 41 Loss of Load Hours (LOLH) over 10 days and 250,566 megawatt-hours of Expected Unserved Energy (EUE).

Source: Resilience Foundation, US EIA. See: https://www.resilientsocieties.org/uploads/5/4/0/0/54008795/blackouts_predicted_presentation_for_nasuca_on_june_10_2024_as_shown.pdf

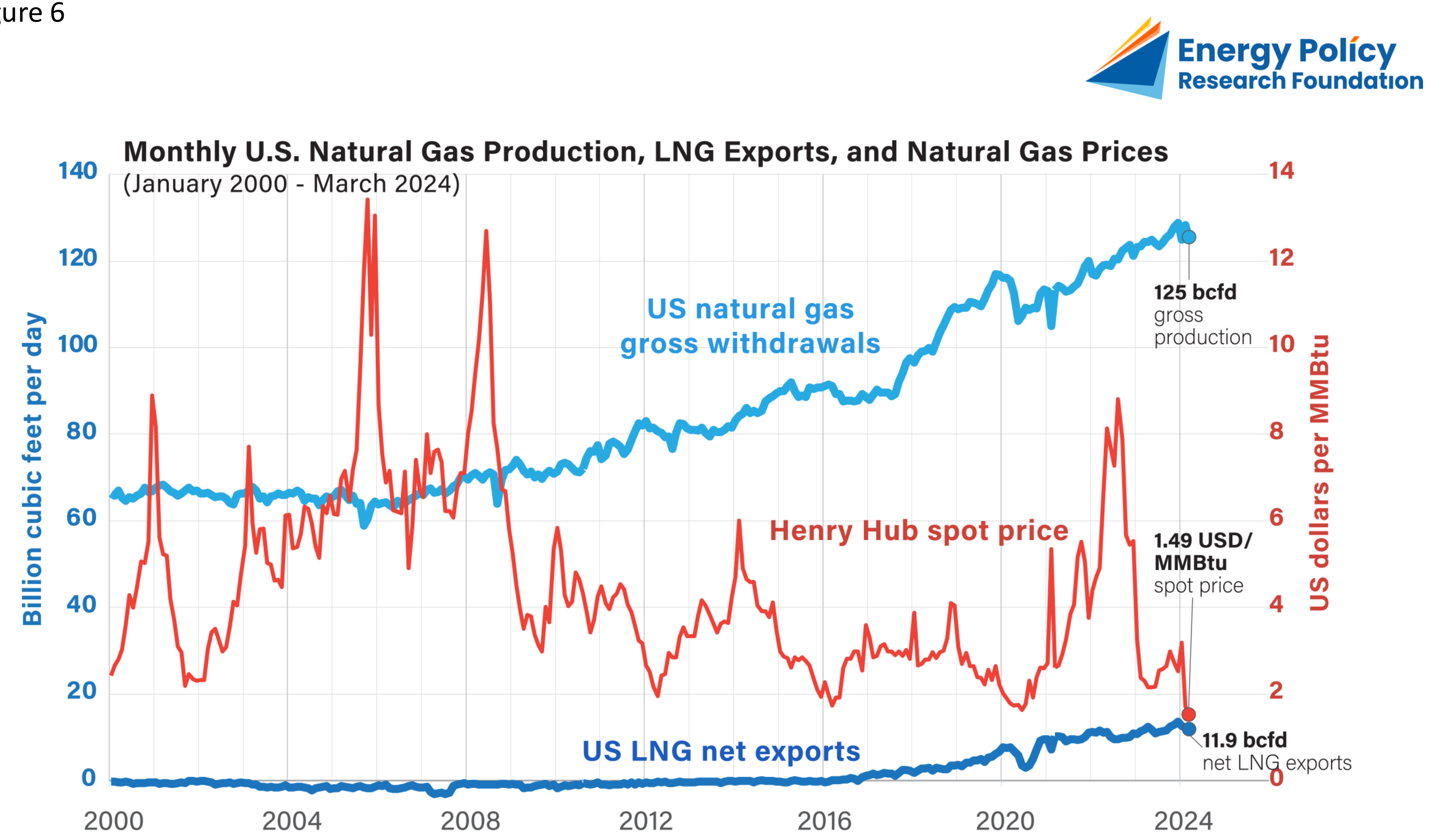
Figure 5

Potential Supply of Natural Gas in the United States



Source: AGA. As of 2022, the Future Gas Supply, which includes both Resources and Proved Reserves, has reached an all-time high. It totals 3,978 trillion cubic feet (Tcf), marking a 3.6% increase from the 2020 year-end estimate. Estimate from the Potential Gas Committee. 2022 estimate.

Figure 6



Source: EIA, Energy Policy Research

Figure 7

Understanding the Scale Challenge

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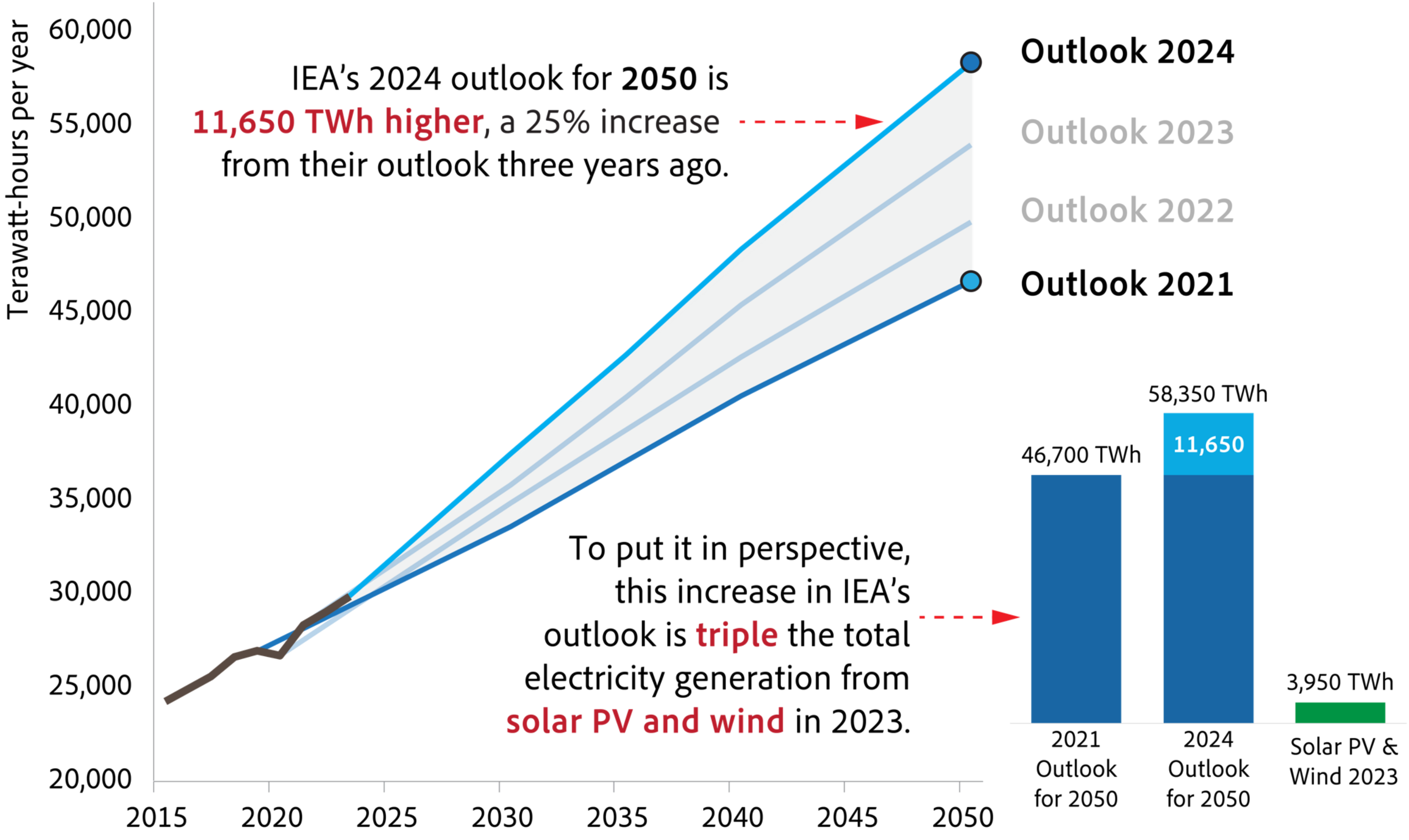
IEA's long-term world electricity generation outlooks to 2050

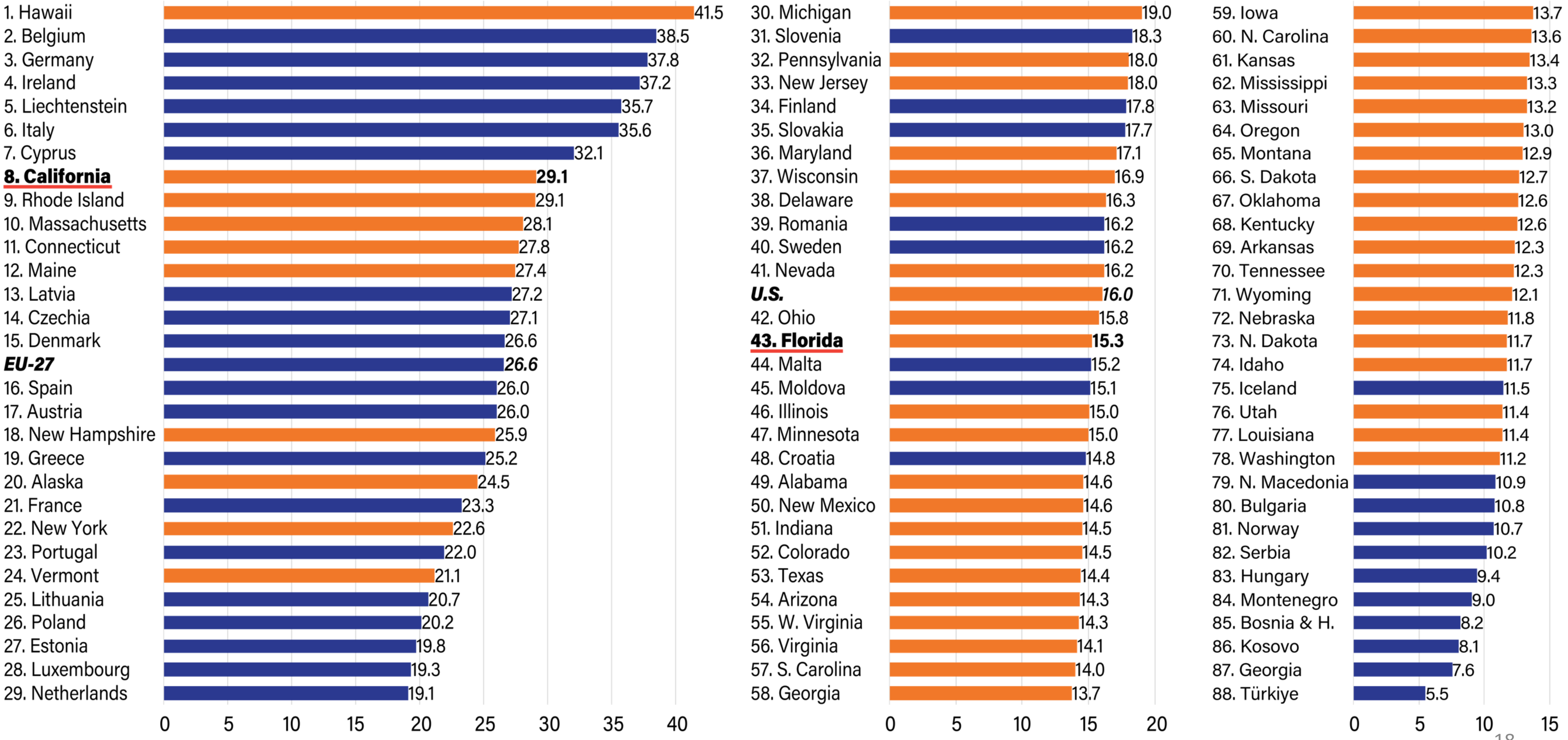


Note: Projection lines represent IEA's Stated Policies Scenario. Source: Energy Policy Research based on IEA's World Energy Outlook data

Figure 8

Europe vs. U.S. States

Average Household Electricity Prices (cent/kWh) in Second Half of 2023

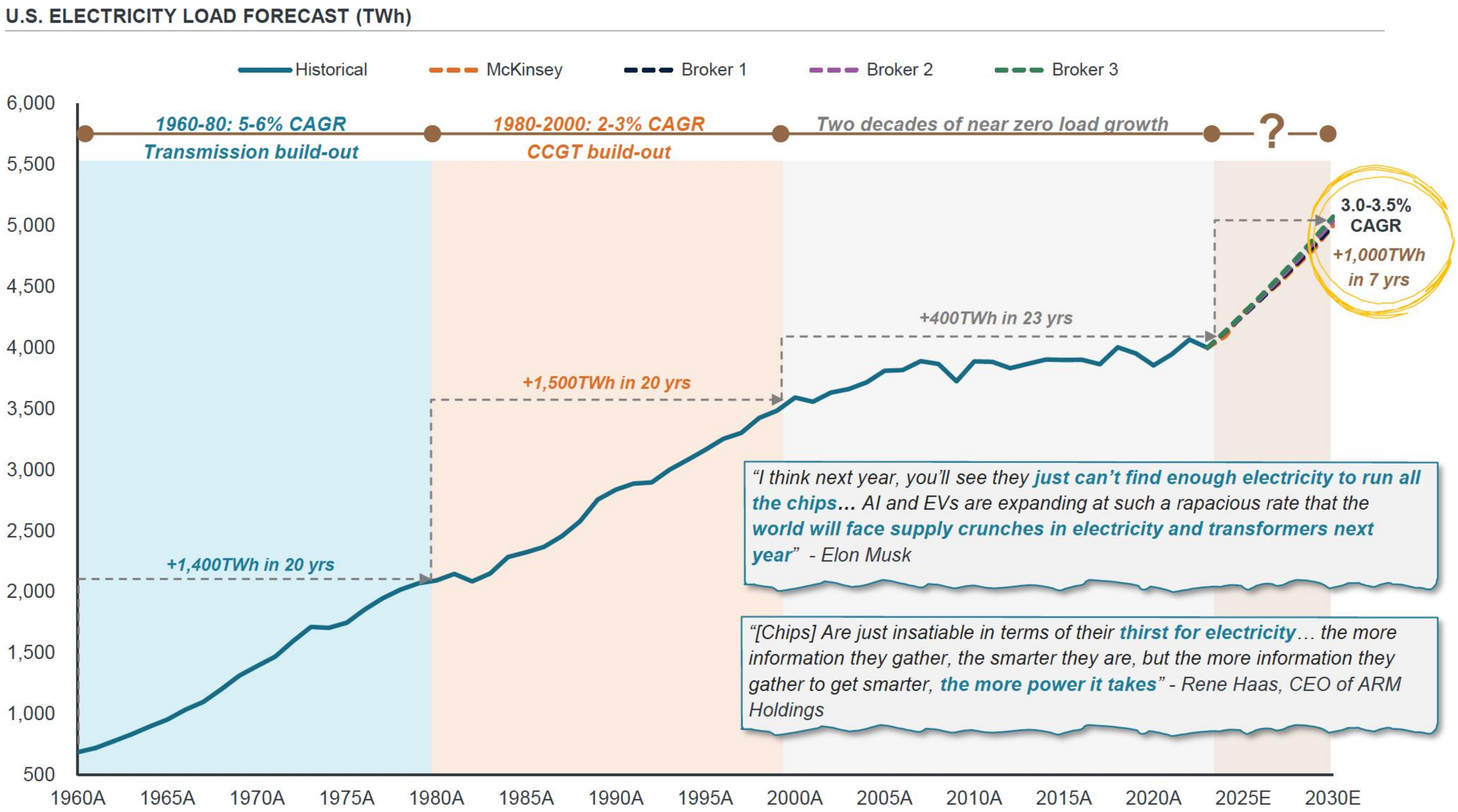


Note: The household electricity prices paid by ultimate customers exclude VAT and other recoverable taxes and levies. The EUR-USD exchange rate of 1.082 (average during the period) is applied.

Sources: EIA, Eurostat, ECB, Energy Policy Research

Figure 9

US Electricity Load Growth Forecast: JPMorgan



Source: JPMorgan