ASPEN ECONOMIC STRATEGY GROUP
aspen institute

CHAPTER

An Energy Strategy for National Renewal

by Joseph Majkut

Suggested Citation: Majkut, Joseph. 2025. "An Energy Strategy for National Renewal." In *Advancing America's Prosperity*, edited by Melissa S. Kearney and Luke Pardue. Washington, DC: Aspen Institute. https://doi.org/10.5281/zenodo.17409626.

An Energy Strategy for National Renewal

AUTHOR

Joseph Majkut*

ABSTRACT

The United States' energy strategy must bridge economic policy and geopolitical power, while offering a calibrated response to climate change. While the country experienced two decades of relatively constant energy consumption, it now faces a surge in power demand driven by artificial intelligence, domestic manufacturing, and continued electrification. These developments challenge an already-constrained domestic electricity grid with limited spare capacity. This paper argues that a renewed strategy should motivate new action to increase energy supply, build infrastructure, and approach greenhouse-gas emissions reductions with competition in mind. Appropriate actions include expanding the development and deployment of nuclear energy, investing in improvements to the high-voltage interstate transmission system, building new natural-gas plants capable of being later retrofitted with carbon capture equipment, and establishing rigorous carbon-accounting standards.

* Director, Energy Security and Climate Change Program, Center for Strategic and International Studies.

Introduction

Over the past 20 years, the United States became the world's leading producer of oil and natural gas, as the sensitivity of the economy to oil prices decreased. Renewables became the fastest-growing source of new electricity generation, and greenhouse gas emissions fell 27 percent from their 2007 peak. The vulnerability and rising pollution that once drove US energy seem like they could soon be problems of the past. But now policymakers are facing new challenges, and it is imperative to consider what American energy strategy should be in 2025.

Intensifying geopolitical competition is motivating a renewed focus on growth in strategic sectors and technology competition. At home, rising prices and worsening services are challenging the contract between government, industry, and people. And the work of reducing global greenhouse-gas emissions has yet to begin. Energy is central to those objectives, because it is itself a major sector of and critical input to the economy.

Driven by exploding demand for artificial intelligence, domestic manufacturing, and electrification, the power sector is poised for incredible growth in the coming decades. Forecasts for demand growth between now and 2040 range from 16 to 105 percent (McGeady 2024). An electrified economy running on mostly clean power is one of the most cost-efficient methods for deeply cutting greenhouse gas emissions but will require substantial growth in the power demand. Managing this growth will require care and deliberate action to avoid excessive price increases, threats to reliability, and inordinate delays in meeting new demand or reducing emissions.

> ***"The United States' energy strategy will need to serve as a bridge between economic policy, geopolitical power, and a calibrated response to climate change."***

The United States' energy strategy will need to serve as a bridge between economic policy, geopolitical power, and a calibrated response to climate change. This paper argues that a renewed strategy should motivate new action to increase energy supply, build infrastructure, and approach greenhouse gas emissions reductions with competition in mind. That strategy will rely on the electricity, or power, sector rising to the occasion.

1. State of play, 2024–2025

The evolution of the US energy system since the middle of the first decade of the 2000s has been remarkable. It has been influenced by new production of oil and gas from the twin innovations of hydraulic fracturing and horizontal drilling, both of which unlocked shale resources; it has also been influenced by the rise of renewables as sources of low-carbon power generation.

In the middle of the first decade of the 2000s:

- US imports of crude oil and petroleum products peaked in 2005 at 13.7 million barrels per day. In that year, 60 percent of US oil consumption came via imports, making the country heavily dependent on foreign energy (US EIA 2025b).
- In 2005–2006, most experts thought that the U.S. was destined to become an importer of liquified natural gas (LNG),[1] with commercial plans underway to build importing terminals and sign long-term contracts with overseas suppliers.
- In 2007, US greenhouse-gas emissions peaked at 6,130 million metric tons of CO2, accounting for 19 percent of the global total that year. China had surpassed the US as the world's largest emitter just a year before, following rapid growth that began earlier that decade (Ritchie and Roser 2020).
- The average kilowatt-hour of electricity cost the average consumer 8.1 cents in 2005, and in that year the majority of power was generated from coal (US EIA 2025a).

Now:

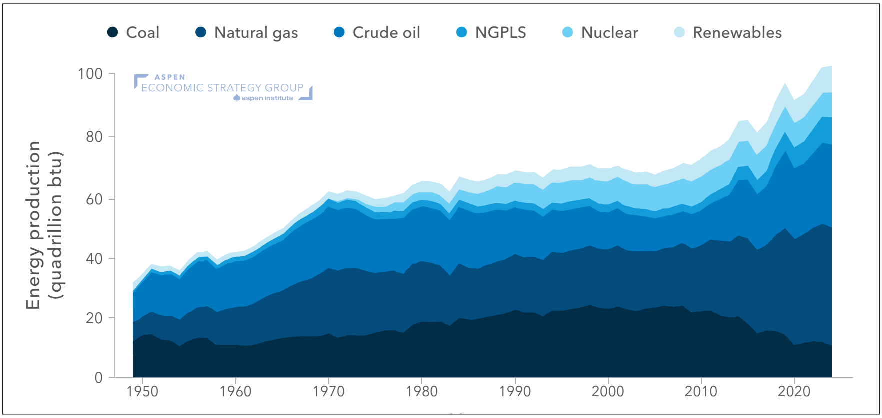
- The US has experienced a renaissance of energy production from shale formations, with total energy production growing by approximately 30 percent since 2005, while consumption has declined slightly due to efficiency improvements.
- The US became a net exporter of petroleum products in 2020 and emerged as the world's leading exporter of LNG in 2023, completely reversing the import dependency that characterized the middle of the first decade of the 2000s.
- US greenhouse-gas emissions have declined by 15 percent from their 2007 peak, dropping to approximately 5,200 million metric tons of CO2 by 2021, as coal plants retired and their generation was replaced with a combination of natural gas and renewables.
- The average kilowatt-hour of electricity cost the average consumer 12.9 cents (nominal) in 2024, and in that year most power was generated by natural gas.

As shown in figure 1, throughout this period the production of primary energy increased nearly 30 percent, mostly due to increased production of oil and gas, while consumption fell slightly. The difference was exported. The fact that consumption fell while the economy grew shows that the energy intensity of GDP decreased. Over that period, the energy sector's contribution to GDP has declined as well, mostly through decreases in the relative size of the oil-and-gas sector.

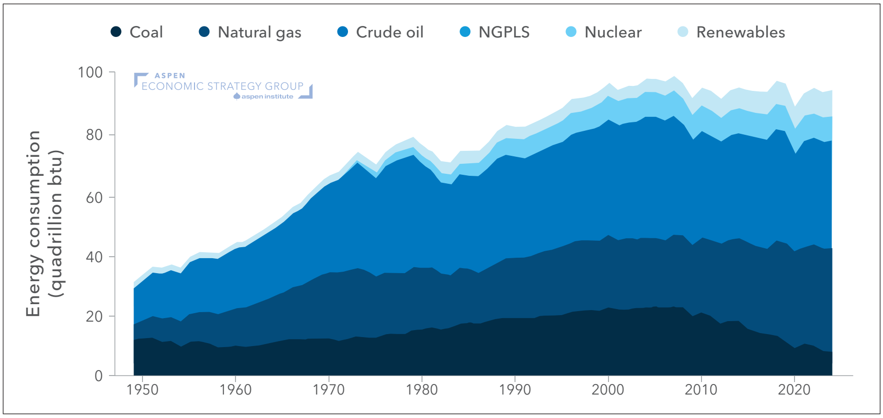
1 The US EIA's 2007 *Annual Energy Outlook* projected that the US would import 4.38 trillion cubic feet of LNG in 2025. In 2024, the US exported an average of 11.9 billion cubic feet per day, for a yearly total of 4.36 trillion cubic feet.

Figure 1: US energy trends, 1950-2023

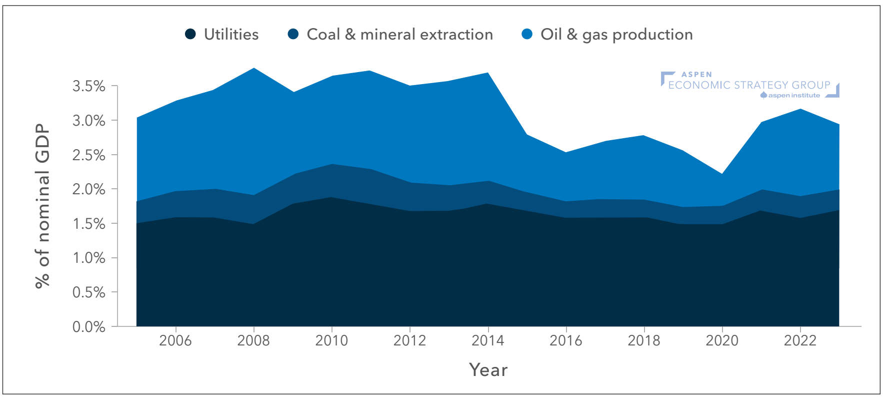
(a) US Primary energy production by source



(b) US Primary energy consumption by source



(c) US Primary energy sector contribution to GDP



Note: "NGPL" stands for "natural-gas plant liquids." "Petroleum" refers to petroleum product excluding biofuels, which are included in renewables.

Source: US EIA 2025; US BEA 2024a; US BEA 2024b; US BEA 2025

Energy efficiency and growth in digital services mean that energy makes up less of the economy over time.

The rise of the US to become the world’s leading exporter of LNG is remarkable, as until 2016 the industry did not exist outside of small projects exporting gas from Alaska. It is now an economic and geopolitical juggernaut. Following the Russian invasion of Ukraine, Europe entered a crisis as it had to replace lost pipeline imports of Russian natural gas (Palti-Guzman and Majkut 2023). US LNG filled the gap, following high prices into Europe and reducing the power of Putin’s attempt at economic coercion (Bergmann et al. 2024). This period also saw huge new interest in US LNG around the world, as buyers signed long-term contracts with new export facilities. US LNG exports are now set to double through 2032, and new export terminals—which require large cooling units to liquefy natural gas—have become a significant destination for capital investment in the country. Industry analysis finds that US LNG exports have added 408 billion dollars to US GDP through 2024 and annually amount to double the value of film- and television-related exports (Yergin et al. 2024).

1.1 New competition

Today, economic competition extends beyond top-line growth. Policymakers are seeking to cultivate specific industries, from generative AI and semiconductor manufacturing, two key technologies of the future, to copper mining, one of humanity’s oldest and enduring pursuits. These investments are meant to give the US pole position in the race to tomorrow’s technologies and security in its supply of critical inputs.

In reshoring manufacturing, they might also help reassure middle- and working-class people about their stake in the US’s economic future. Energy and electricity prices are still high on the list of political sensitivities. And many trends now point to worrying increases, particularly in the price of electricity, where new sources of demand, rapid changes in generation, and a sclerotic and complicated industry combine to frustrate rapid progress.

1.1.1 AI data centers

Perhaps more than any other industry, the AI data-center sector demonstrates the opportunity available when the United States can provide access to power. A nearly nonexistent category just a few years ago, investment in AI data centers is booming. In 2024, capital investment into AI data centers in the US was about 125 billion dollars. In prior work, my colleagues and I estimated that cumulative capital expenditures into data centers in the United States could approach $2 trillion through 2030 in high-growth scenarios (Smith et al. 2025). In that high-growth scenario, annual investment in data-center construction would exceed investment into oil-and-gas production.

Our scenarios for AI data-center investment were tested for feasibility against three key constraints: finance, hardware availability, and electric-power demands. For finance, even the multitrillion-dollar investments we projected could be managed by the large capital markets in the US, if enough value were associated with rapidly growing investments. As a point of comparison, we estimated that the depreciation and interest costs on AI data-center investment would be roughly equivalent to the savings US companies would capture if generative AI made software engineers 42 percent more productive. Or, if used for entertainment, 20 percent of the developed world would need to pay $160 a month for generative AI services on a subscription basis.

Such rapid-growth plans, in many cases backed by orders for hundreds of thousands of advanced chips, hinge on the availability of power.

In energy terms, data centers are measured in gigawatts (GW), which represents their capacity to draw power off the grid at any moment. Today, a large data center might draw 100–200 megawatts of power (MW; 1,000 MW = 1 GW). The large AI companies are contemplating building data-center clusters that will draw 1–2 GW in the next couple of years, and they foresee building data centers of 5 GW or more by the end of the decade (Belanger 2024). These electricity loads will be the largest on the planet, each one comparable to that of a mid-sized city. But even those comparisons are inadequate, as industrial facilities often generate their own power, and a city has many ups and downs in its power usage in any given day, month, or year. Very large data centers, by contrast, will want to continuously draw power very close to their full capacity, to utilize the capital investment made for the chips within.

What does it take to power a 1-, 2-, or 5-GW data center? As a point of comparison, the Hoover Dam generates about 1 GW of power. A large nuclear reactor will generate about 1 GW (though reactors are typically grouped so one facility will produce a few GWs). A large natural-gas-fired turbine will generate about 500 MW (again, such turbines are typically grouped together), and the largest solar project in the US generates about 700 MW (but won't do much at night). To match large data centers with new generation requires substantial additions of large energy infrastructure.

For the United States, the challenge is powering not just a few gigawatt-scale data centers scattered around the country but a fleet of data centers that will grow toward 100 GW by the end of the decade. In the highest-growth scenario, my colleagues and I projected that data centers used exclusively for generative AI would grow from about 4 gigawatts of demand in 2024 to 84 GW in 2030 in the highest case or 50 GW in the lowest case. Notably, our estimates were for data centers used exclusively for artificial intelligence. We should expect to see higher total data-center needs when including expansions of conventional computing clusters as well.

Table 1: Power consumption forecasts for US and global data centers from six major research institutions

Group	Projection subject	Current value	Projection value and date	Subject growth value
CSIS	US AI data centers	4 GW in 2024	84 GW (highest case) or 49.9 GW (lowest case) by 2030	2,100 percent
LBNL	US data centers	20 GW in 2023	74–132 GW by 2028	370–660 percent
RAND	Global AI data centers	11 GW in 2024	68 GW by 2027; 327 GW by 2030	618 percent
SemiAnalysis	Global data centers	49 GW in 2023	96 GW by 2026	196 percent
BCG	Global data centers	60 GW in 2023	127 GW by 2028	212 percent
McKinsey	Global data centers	55 GW in 2023	171–219 GW by 2030	311–398 percent

ASPEN ECONOMIC STRATEGY GROUP aspen institute

Source: McGeady et al. 2025

Projections of cumulative data-center demand show a lot of variation, but all expect dramatic growth in the next few years. Table 1 above shows a selection of analyses from think tanks, nonprofits, and industry analysts with projections for AI-exclusive data centers in the US, all data centers in the US, and global data centers. Looking across those studies, one sees that the US is primed to lead in data-center growth globally and that most of that growth will come from data centers for generative AI.

With such growth, data centers will grow significantly as a share of power consumption. Peak demand for the whole US grid reached 745 GW in 2024. The year before, data centers consumed about 4.4 percent of national power generation. Analysis from Lawrence Berkeley National Lab indicates that all data centers could grow to 74–132 GW by 2028, which would account for 6.7 to 12 percent of national power generation totaled throughout the year (Shehabi et al. 2024).

Utilities are scrambling to meet this demand, and the economics point toward a familiar portfolio: Solar, natural gas, and battery storage dominate recent deployment figures (McGeady et al. 2025). But the sudden surge in demand is causing real supply-chain stress. Gas turbine prices have doubled as manufacturers are booked solid through 2028 or 2029. Solar modules, which had been getting cheaper for decades, have stopped falling in price, and in some cases, costs have gone up with new tariffs contributing to higher prices. The infrastructure we need to power the next phase of American economic growth is getting more expensive just when we need it most.

This problem snuck up on us. Over the past twenty years, US electricity demand barely grew. Our country replaced coal plants with natural gas and renewables, but in the process did not add to our ability to power large loads that run nearly around the clock. Adding major new demand to a system with little spare capacity creates reliability problems, as the power sector operates on increasingly thin reserve margins during periods of peak demand. So, every new, large data center must essentially bring its own power supply. Bringing transmission or additional generation to power data centers and cover peak times will cause rate increases for existing power consumers.

Despite the enormous economic promise, electricity supply has become the primary bottleneck constraining AI growth. Northern Virginia hosts the largest collection of data centers in the world, and new facilities there now face wait times of up to seven years just to connect to the grid. Such a wait is impossible for individual firms to countenance and completely inconsistent with the growth anticipated for the sector.

"Despite the enormous economic promise, electricity supply has become the primary bottleneck constraining AI growth."

Data-center developers have fanned out across the country hunting for available power, and the results show the scale of the problem: Industry data indicate that 29 states expect to double their data-center capacity, but 70 percent of the nation's data centers in 2030 will still be concentrated in just nine states. Developers are gravitating toward Texas, the Midwest, the Southwest, and the Southeast—places where power regulations and permitting allow rapid buildout (McGeady et al. 2025).

For AI data centers, power is an essential input but not a dominant cost. The capital cost of high-performance chips still dominates the cost of building a new data center, followed by the cost of the data center itself, and then the cost power for operations (these cost categories accounting, respectively, for roughly 80, 15, and 5 percent of total costs for the data center (Smith et al. 2025). Power constitutes a larger share of operational costs, but the cost sensitivity for power is low amidst the rush to dominate the AI industry. This low sensitivity is evidenced by the industry's willingness to pay high prices to restart older nuclear plants and build new natural-gas turbines amidst high inflation.

1.1.2 Strategic manufacturing

Reshoring manufacturing represents another major driver of electricity demand growth, and the manufacturing boom is not happening by accident. Policymakers, and to some extent firms, are still responding to the COVID-era lesson of how a vulnerable supply chain can contribute to inflation. And they see paths to revitalization for the working class and a US role in the value chains that will define economic and national security in the future.

Since 2020, investments in new manufacturing facilities have accelerated dramatically in the United States, driven primarily by two key sectors: semiconductors and electric vehicles. By April 2024, project announcements had reached $368 billion for semiconductor manufacturing and $84 billion for EV manufacturing, including the battery supply chain (Nakano and Majkut 2024). Those investments are now in question, as shifting policies related to vehicle electrification, manufacturing subsidies, and tariffs are imposing significant uncertainty for investors and manufacturers. But regardless, these two sectors now represent a substantial fraction of new manufacturing investment in the United States—a remarkable concentration that reflects both market forces and strategic policy choices.

Currently, manufacturing and industrial activities account for about 35 percent of energy consumption in the United States, distributed across different sectors (US EIA 2021). Chemical manufacturing and petroleum refining are the top industrial energy consumers, together accounting for 43 percent of total industrial energy use. Fifth-ranked iron and steel production accounts for 8 percent of manufacturing energy consumption. More strategic sectors like semiconductors, electronics, and aerospace manufacturing account for a much smaller fraction of industrial energy consumption (together 2.6 percent).

While semiconductor and battery manufacturing historically represent a small fraction of the energy used in manufacturing, their rapid growth does create new demand for the energy system. And similar to AI data centers, they will draw on the electricity grid and create large new demand centers in places that attract manufacturing investment.

Arizona is a key example. The new Taiwan Semiconductor Manufacturing Company (TSMC) fabrication site in Arizona is estimated to require up to 1.2 GW of power. These new loads will compound with the growth in data centers and other sectors to pressure states and grids. In Arizona, where the TSMC plant will be built, the Arizona Public Service projects that energy needs in its territory will increase at 3.7 percent annually through 2038. This increase translates to approximately 3.4 GW of new capacity requirements over the next 15 years.

Georgia presents an even more dramatic example. During the first half of 2023, the manufacturing sector, including solar, EVs, and aerospace, represented 67 percent of job creation and 81 percent of capital investment in the state. Georgia Power filed an updated integrated resource plan projecting electricity load growth of 6.6 GW through 2030–2031—approximately 17 times larger than anticipated in its 2022 plan.

EV battery production is particularly energy-intensive, requiring approximately 44 kilowatt-hours of energy to produce each kilowatt-hour of battery capacity. The Rhodium Group estimates that if all investments announced since 2018 are realized, they would create 1,062–1,288 gigawatt-hours of domestic battery production capacity by 2030. At current energy intensities, 1,000 GWh of annual battery manufacturing capacity would require approximately 6.6 GW of electricity generation capacity.

The expansion of strategic manufacturing also creates ripple effects throughout the supply chain. New factories need steel, aluminum, critical minerals, concrete, and other materials that will see increased demand and are themselves energy intensive. These materials are also essential inputs into the defense industrial base, which has atrophied. The multiplier effects for reshoring mean that the total energy impact extends far beyond the consumption of just the targeted industries.

As with the companies leading the charge on data centers, leading manufacturers have aggressive corporate-sustainability commitments. These commitments create additional pressure on regional electricity systems to provide power that is not just affordable and reliable but ever cleaner.

The geographic concentration of manufacturing investments in states like Arizona, Georgia, Texas, and others means that the energy system impacts will be regionally concentrated, more than nationally distributed. This concentration allows for more coordinated planning at the state and regional levels, but it also requires more scaling of generation and transmission capacity within specific corridors and markets. Federal policy responses will need to enable and foster state-led solutions.

2. Energy and competitiveness

"When you drive our energy prices up, you don't make things in the United States. They get offshored, and mostly to China."

— Chris Wright, Secretary of Energy (US House Subcommittee on Energy 2025)

Concerns about high energy prices as a barrier to economic growth and investment are highly salient, but how much do they matter in practice? The political challenges that come from a constituency paying high energy prices are also salient to policymakers. If energy prices are too high, if energy is in too short supply, or if energy simply cannot be built expediently, then we may risk losing out on investments in the next generation of factories and in new technologies, thereby sacrificing the future to more-competitive jurisdictions.

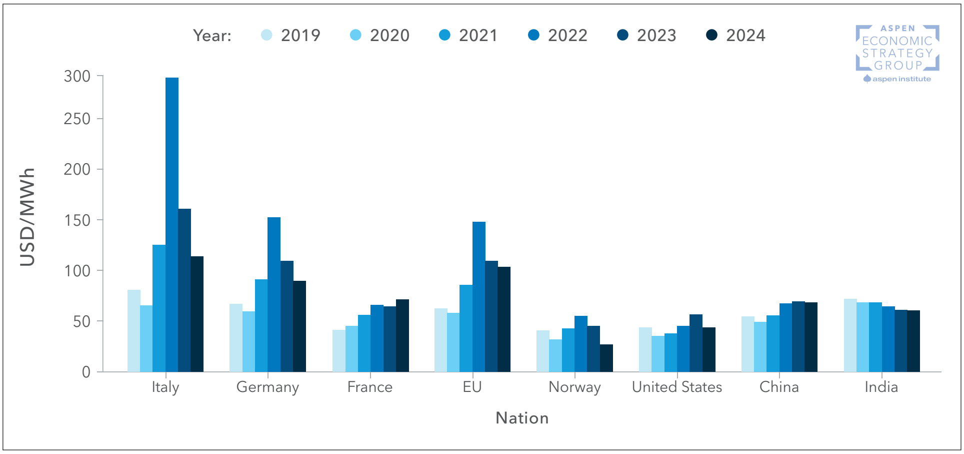
For almost all manufacturing, energy costs in the US are one set of costs among many. For a few energy-intensive industries, like primary metals, chemicals, paper, and cement, energy costs exceed 10 percent of inputs. But most manufacturing sectors are less energy-intense, which means that manufacturing output has a muted response to energy-price volatility.

The muted response of manufacturing to energy prices explains, in part, why the dramatically falling natural-gas prices of the past few years did little to spur manufacturing. During the shale revolution, natural gas prices fell significantly. But since fuel costs for generation account for less than 40 percent of electricity costs, a halving of gas price can only reduce prices by 20 percent or so. And as more gas is consumed, offsetting coal generation, the effect of falling gas prices is eroded by higher consumption.

Falling natural-gas prices did not lead to a manufacturing or economic renaissance. The academic literature shows a statistically significant, but small, effect of energy prices on manufacturing in the United States (Kahn and Mansur 2010; Wolverton et al. 2022). The 50 percent drop in natural-gas prices between 2007 and 2012 increased manufacturing employment by 0.6 percent. In the sectors most directly using natural gas, employment increased up to 2 percent. These changes are modest given such a large change in the price of an important input.

In terms of international competition, the US has substantially lower energy prices than other developed countries, as shown in figure 2. In June 2022, the average industrial rate in the US was 84 USD/MWh. That compares quite favorably to 205 USD/MWh in Germany, 163 USD/MWh in Japan, and 148 USD/MWh in France. And compared to China's 62 USD/MWh, the US industry pays about 35 percent more than their Chinese competitors (IEA 2025).

Figure 2: Estimated final electricity prices for large industrial customers in energy-intensive industries, by nation, 2019–2024



Source: IEA 2025

3. Multisector demand growth on a constrained grid

Rapid demand growth should be good news. Despite trade conflicts and macroeconomic uncertainty, the United States is positioned to power more economic growth and strategic industries than we've seen in decades. The benefits could be substantial: maintaining US dominance in AI technology, securing critical supply chains, creating good manufacturing jobs, and accelerating the clean energy transition.

But achieving those benefits hinges on a straightforward question: Can utilities provide enough energy and build enough electricity, affordably and reliably, to meet this surge in demand? Policymakers are now confronted with a challenge that is immediately critical for data centers but extends to the broader challenges of strategic competition.

3.1 Electricity pricing in the United States

Much of the new energy demand will be supplied by electricity, so electricity prices are essential to the question of competitiveness—both between states and between the US and other countries. Electricity pricing around the country varies widely. Consumers in Louisiana, Utah, and Washington pay the lowest rates in the continental US, while consumers in California and Connecticut pay the most. A variety of factors contribute to that large spread, including the market structure within a state, the sources of generation, and regulatory and policy decisions. In each state, electricity prices are influenced by the model used to govern the power sector. In vertically integrated or *regulated* markets, state utility commissions set retail electricity rates to reflect utilities' capital expenditures, operational costs, and regulated rates of return. In the 33 states with regulated markets, utilities often maintain control over the generation, transmission, and distribution of power to consumers.

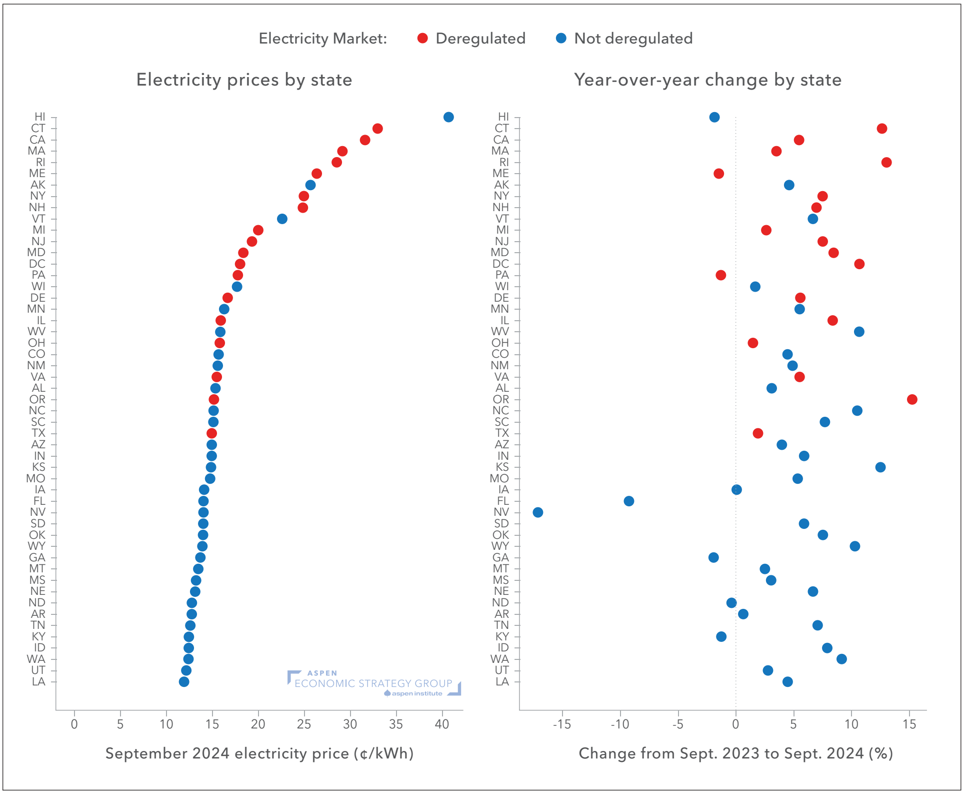
In restructured, or *deregulated*, markets, generation is separated from transmission and distribution, and independent power producers compete to sell electricity into wholesale markets. Depending on the state, competition may also be allowed at the retail level, allowing consumers to choose service providers. While transmission and distribution are still regulated monopolies, rates in the deregulated states may not be directly set by the regulator, though regulators still oversee planning and reliability.

Historically, states with higher prices adopted deregulation to reduce costs through competition. Results have been mixed. Observed rate increases have been slightly higher in deregulated markets than regulated markets over decades. However, some deregulated markets have been good for discerning consumers (e.g., Texas), including large industrials—which have used these deregulated markets to buy renewables and access low prices in wholesale markets. And in recent years, Texas has been the leading state in adding new resources to the grid. Neither model has dispositively emerged as better for managing price increases.

Eventually, the costs of operating the power system fall on ratepayers. Those costs reflect three components of the power system: the generation of electricity, transmission between power plants and demand centers, and the local distribution network. According to the Energy Information Administration, generation costs accounted for 22 percent of operational expenses and 25 percent of capital expenses for utilities (US EIA 2025a). Generation is a significant contributor to utility costs and the price of power. States with abundant low-cost generation resources often have low energy prices. Such abundance can come in several forms. For example, coal- and natural-gas-rich Utah and hydropower-rich Washington both have low power prices. High-price outlier Hawaii has high prices because it depends on petroleum fuels that must be transported to the islands.

The same EIA analysis shows that the costs of transmitting and distributing power have been rising as a proportion of cost in the power sector. Between 2019 and 2023, operations and maintenance costs for distribution and transmission increased, while generation costs fell over the same period. Capital expenditure for distribution grew 50 percent and transmission grew 20 percent over the same period. By contrast, capital expenditure on generation decreased 40 percent over the same period.

Figure 3: Electricity prices by state, September 2024 (left) and year-over-year percent change since September 2023 (right)



Source: US EIA 2025a

The costs of transmission and distribution investment and maintenance represent quite different geographical phenomena. Dense urban areas might require expensive upgrades for underground lines, higher labor costs, higher property costs, or lengthy legal and permitting challenges. Rural areas may have lower costs for installations but need more installations to serve small, far-flung populations. And capital and maintenance costs can be quite spiky. Individual projects can increase spending across several years, for example fire remediation costs in California, making it hard to assess a single driver of cost increases.

State policies for climate and other environmental regulations have some influence on pricing, either through direct carbon pricing or rules requiring that renewables be increasingly added to the generation mix. These climate-based policies are thought to have some effect on prices, though studies show that these effects are modest. A survey study of 27 states that mandate a certain amount of renewable power found that such mandates raised electricity prices less than 2 percent and "scarcely moved manufacturing employment or output—about one-tenth the move in power prices," reports my CSIS colleague Elaine Buckberg (2025).

4. Demand growth and climate

Historically, energy, emissions, and economy have moved in lockstep. As economies expanded, more people engaged in more activities, driving higher energy consumption. Since energy systems mostly relied on fossil fuels, rising energy use meant rising emissions. This relationship was attenuated in the US over the past 20 years as electricity emissions fell, but that attenuation happened in an environment of slow demand growth in the power sector. A key question for this new era of growth will be how to meet growing demand without reversing course on climate.

The energy portfolio emerging over the next few years will primarily combine natural gas and solar power, with smaller contributions from battery storage and wind. Market economics are driving utilities and power producers toward this mix. The trend is already visible in the numbers. At the start of this year, project developers expected to build 32.5 GW of new solar, 7.7 GW of wind, 4.4 GW of natural-gas power plants, and 18.2 GW of battery storage (US EIA 2025c). This reflects an emerging portfolio strategy visible across America: Utilities are planning gas-solar-storage combinations that deliver both low-cost energy from renewables and reliable capacity from natural gas.

Despite potentially higher emissions, this energy expansion is the cleanest in history and one that will see carbon intensity continue to fall. The National Renewable Energy Lab has calculated lifecycle emissions factors for different generation technologies, including manufacturing, operation, and decommissioning (NREL 2021). Solar produces 43 grams of CO2 per kilowatt hour (gCO2e/kWh), wind produces 13, batteries produce 33, and natural gas produces 486. Adjusting for their uptime producing power and deployment ratios, this emerging portfolio delivers an expected emissions intensity of 75 gCO2e/kWh, which is 80 percent cleaner than today's grid.

However, despite the ever-cleaner intensity of new generation, the sheer scale of increased demand and the continued addition of fossil fuel-based resources raises concerns that America's decades-long trend of falling emissions could stall or the country fail to meet ambitious climate goals. A prolonged stall in emissions reductions is unlikely, as the additional portfolio of generation is so clean, and because utilities continue planning coal plant retirements.

The main risk lies in emergency interventions. Coal plants might be kept open under emergency authorities to preserve grid reliability and are already seeing increased utilization to meet rising demand (Maguire 2025). In this scenario, total emissions could indeed rise, in an outcome that the climate community would find objectionable.

The framing of stalled progress on climate strongly depends on the policy objective that defines success. The 2015 Paris Climate Agreement aimed to limit global warming to well below 2 degrees centigrade, with the ambition of 1.5 degrees C, to avoid dangerous climate change. Achieving these goals requires reaching net-zero greenhouse gas emissions by around 2050 for the 1.5-degree target and between 2070 and 2090 for the 2-degree target (Hausfather 2022). The range reflects uncertainty about both the warming response of the climate to emissions and the pace of global reductions.

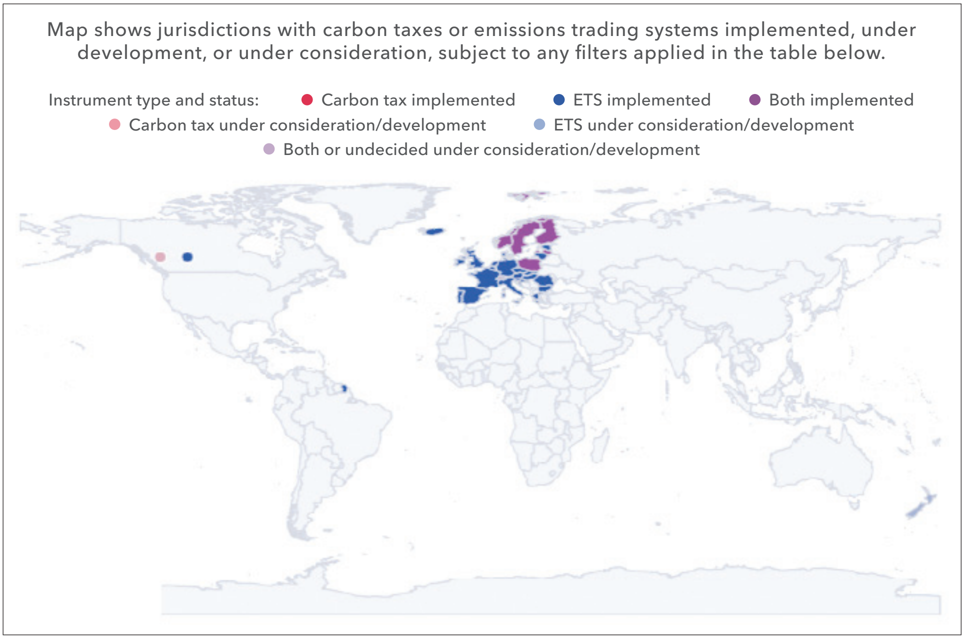
"Our response to climate change cannot meaningfully compromise America's economic security or technological competitiveness."

But this framing misses the bigger picture. Any emissions increase from building strategically or competitively essential industries would be modest compared to existing US emissions and negligible compared to rising emissions elsewhere in the world. More fundamentally, our response to climate change cannot meaningfully compromise America's economic security or technological competitiveness.

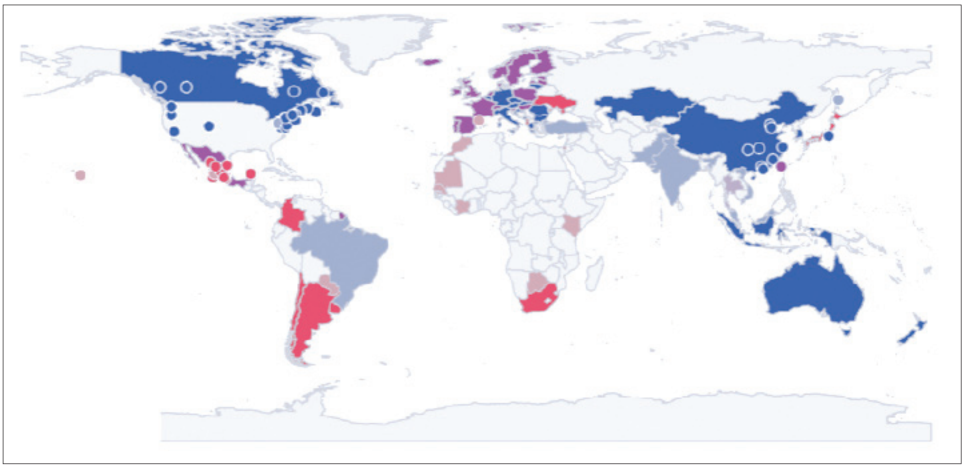
This reality demands a climate approach that enables rather than constrains growth and one that aligns with America's economic and strategic imperatives. Fortunately, global markets are creating exactly this opportunity. As more countries implement carbon regulations and pricing mechanisms, the carbon intensity of products is becoming a key competitive differentiator in international markets.

Figure 4: Compliance carbon-pricing instruments around the world, 2007 and 2025

(a) 2007



(b) 2025



Source: World Bank n.d.

As displayed in figure 4, carbon pricing schemes have grown enormously in the last 20 years. As of 2025, 28 percent of global emissions are covered by some form of carbon pricing—with prices ranging from $0.1 to $160 per ton—and account for more than $100 billion in annual government revenue.

As carbon pricing schemes proliferate and affect a broader swath of the economy, they are set to reshape global trade policy and flows. In 2021, the European Union announced plans for a Carbon Border Adjustment Mechanism (CBAM) that charges importers based on their products' carbon intensity, to avoid the potential offshoring of emissions due to their increasingly binding emissions trading system (Benson et al. 2023). Currently in a transitional reporting phase, the CBAM will become a payment obligation in 2026.

This trend is accelerating globally. The UK and Turkey, close trading partners of the EU, are now both implementing carbon border measures to complement their carbon pricing programs. The UK's system is set in law to begin in January 2027. Japan is studying a border adjustment to complement its upcoming industrial-emissions trading system. And China is pursuing a national accounting standard for estimating the carbon intensity of manufactured goods, as preparation for compliance with international border measures.

The shift toward carbon-based trade policy creates significant opportunities for the United States. As displayed in table 2, America already holds distinct carbon-intensity advantages in key production sectors, particularly compared to China. As border adjustments and carbon pricing continue to expand internationally, these carbon advantages translate into pricing advantages for US exports in global markets. And the competitive benefit would be realized domestically if the US were to implement its own border adjustment or to base tariffs on carbon intensity. However, the embrace of carbon pricing by the United States—both at the border and domestically—has been politically elusive.

The US also cannot lose its carbon advantage and hope to maintain international competitiveness, as markets shift toward cleaner imports. This point has implications for domestic policy and energy strategy, as it creates additional motivation for investing in ever-cleaner energy technologies and accelerating the continued deployment of today's clean electricity portfolio to meet rising demand. It is through developing a cleaner and more accessible energy system that the US can build an economic strategy that will be responsive to growing demand and competitive in the long term.

Table 2: Carbon intensity across industries in the EU, US, and China

	European Union	United States	China
Semiconductor manufacturing (mt CO2e)	5 [−28.5%]	7	15 [114.0%]
NMC111 EV battery* per kilowatt-hour of battery capacity (g CO2e/kWh)	66.9 [−9.0%]	73.7	100.6 [36%]
Electricity (g CO2 / kWh)	213 [−45%]	384	560 [146%]

Source: Nakano and Majkut 2024; Graham et al. 2025 (electricity)

5. Priorities for policymakers

In a previous AESG paper, Borenstein and Kellogg (2021) tackled the challenge of reducing greenhouse gas emissions while maintaining reliable, on-demand energy services. Their policy prescription centered on broad incentives such as carbon pricing and clean-energy production subsidies. Such technology-neutral approaches favor low-carbon production without picking winners. To amplify those incentives, they argued for investing in research, development, and support for early-stage deployment of diverse clean technologies; wholesale power market reforms to promote price transparency; enhancing federal authority over long-distance transmission; and reforming retail electricity rates to more accurately reflect society's full marginal cost. Many of those priorities were addressed by policy in the Bipartisan Infrastructure Bill and the Inflation Reduction Act. In particular, the Inflation Reduction Act established long-term technology-neutral subsidies for low-carbon power generation that applied to wind, solar, batteries, nuclear power, enhanced geothermal, hydropower, and more. The One Big Beautiful Bill, once implemented, modified that package to rapidly phase out subsidies for wind and solar but maintain subsidies for clean, firm sources like nuclear into the 2030s.

"Failure to supply adequate energy will also slow our ability to compete at the economic frontier."

Intellectually, those recommendations are sound. The fundamentals of energy and climate policy haven't changed. What has changed is the strategic context in which these policy goals can be achieved and the urgency of supplying adequate power for economic competition.

It is increasingly clear that failure to supply adequate energy will also slow our ability to compete at the economic frontier. The convergence of artificial intelligence, strategic manufacturing, and intensifying global competition—increasingly defined by new lines of technology and by carbon intensity—has elevated the need to build quickly and sustainably. Meanwhile, there are worrying signals that the United States may not be able to meet that growth challenge and maintain the reliability, affordability, and decarbonization that were the starting point of the previous paper and clear imperatives for policymakers.

So what should an energy strategy for 2025 look like in practice?

The need to meet new demand with energy supply efficiently and expediently requires a focus on policy measures that will remove regulatory burdens and coordinate the disparate activities of firms, states, and the federal government to make strategic investments or prepare for future competitive advantage.

5.1 *Making energy investments with growth in mind*

Nuclear power

The federal government has a strong role to play in supporting the development and deployment of nuclear power, which provides a complement to the existing portfolio of solar, storage, and natural gas by providing carbon-free and firm power in large amounts. But the sheer size of capital investment necessary to build new nuclear capacity, along with cost-overrun risks, creates huge challenges for financing plants. Utilities and utility commissioners are unwilling to take such large risks or impose them on their ratepayers. The recently completed Vogtle reactors in Georgia eventually cost $32 billion, after $18 billion in cost overruns, and required multiple rounds of support from the Department of Energy's Loan Programs Office.

A more direct procurement of new nuclear capacity by the federal government could play a helpful role in developing nuclear power. In previous work, colleagues and I have encouraged a framework in which the Department of Energy (DOE) could buy offtake rights for new nuclear projects (McGeady et al. 2025). This *anchor tenancy* model would allow the DOE to be a contracted purchaser of power from a project under development, so that private developers could secure funding from capital markets and attract other potential offtakes, enabling financing and the start of construction. As other customers crowd in to contract offtake from the project, the government can sell off or auction its contracted volumes to recover costs and leave the new infrastructure in the private market.

The scale of demand growth and preferences for low-carbon electricity make this approach fiscally prudent and strategically important. Existing nuclear plants, or nuclear plants that can be restarted, have already attracted renewed commercial interest. And the risk to public coffers would be manageable given robust demand for the resulting power, while the benefits for energy security, grid quality, and emissions reductions would be substantial.

This program should be large enough to generate momentum for the industry. A commitment to contracts supporting 10 GW of new nuclear-reactor construction would help foster economies of scale, rebuild a domestic workforce and supply chain, and attract further commercial investment. Such a target would return the US to a position of global leadership while meeting the administration's ambitions for a nuclear renaissance.

Grid enhancements

High-voltage interstate transmission represents one of the most strategic long-term investments that the federal government can make in America's economic future. And the federal government is uniquely suited to make it. Transmission infrastructure routinely operates for 80 years or more, and, unlike rapidly evolving generation technologies, transmission infrastructure provides a durable foundation for economic growth and technological enhancement.

Federal investment is essential because states will underinvest in interstate transmission. While transmission projects deliver regional and national benefits, no individual state has sufficient incentive to fund infrastructure to benefit the whole system, especially into the future. The result is that states channel investment into lower-value local projects while forgoing higher-value regional and interregional lines that stabilize the grid and unlock broader economic opportunities and lower system costs.

Federal investment should focus on projects that expand regional and interregional transfer capacity, particularly to areas that are hosting strategic industries and data centers. Increased federal funding can be paired with enhanced federal authority to site and promote interstate transmission projects. Enhanced federal authority helps by streamlining approvals through a single federal agency, diluting the power of political interests to lobby individual states, and forestalling conflict between state officials and the federal government. Similar to the authority the Federal Energy Regulatory Commission has to site and permit interstate natural-gas pipelines, this authority would allow for faster buildout of a truly national-scale grid.

Carbon capture readiness

Building new natural-gas plants ready for later retrofit with carbon capture and storage equipment represents a pragmatic approach to expanding natural-gas generation. Natural-gas generation will inevitably play a significant part in meeting growing demand this decade. Recognizing this reality but also the need to prepare for longer-term emissions reductions, policymakers should ensure that new plants are designed for future emissions reductions.

Capturing the carbon released by burning natural gas and storing it underground or in some durable media is an effective way to reduce the emissions intensity of gas generation by up to 90 percent. And existing tax credits will reward firms for doing just that. But the necessary infrastructure, affordable technologies, and regulatory models are not available today to meet the immediate timeline for growing power demand, especially not nationwide. However, plants built today could operate for decades, making retrofit capability essential for continued emissions reductions.

To minimize the cost of future retrofits, today's facilities can be designed and planned appropriately. Active planning and engineering studies at the project development stage can ensure that plants are built with the layout, piping, CO2 compression equipment, and additional power and water requirements necessary for capture and storage in mind. They can be sited near existing or planned infrastructure for CO2 capture. Avoiding siting and design choices that will make future retrofit impossible or expensive should become an industry standard in this moment of growth.

Establishing standard practices for CCS-ready natural-gas plants will make the economics of widely deployed carbon capture more favorable and contribute to the long-term viability of the natural-gas fleet and its suppliers. Energy modeling from the National Renewable Energy Laboratory shows that in scenarios with near-net-zero emissions in the power sector, natural gas with CCS can provide as much generation as gas does today while enabling carbon competitiveness and a robust market for future natural-gas producers. It's a climate hedge for the natural-gas industry.

Federal and state policy should encourage CCS readiness as a condition of accelerated permitting and incentives for new gas generation. This approach would create a pathway for natural gas to play a long-term role in a decarbonizing economy and to function as an option for future grid managers, utilities, and power producers. But it also does not, at this moment, require too burdensome a cost on expensive technologies or slow deployment with an impossible standard for immediate CCS deployment. It's a strategy that acknowledges today's imperatives while allowing for tomorrow's to be met flexibly.

5.2 Realizing carbon competitiveness

Establishing rigorous carbon-accounting standards is the first step toward realizing the intersection of American economic competitiveness with an increasingly carbon-conscious economy. As the EU, Japan, China, and others establish their own systems for carbon accounting, American exporters will start to face markets sensitive to emissions intensity without a credible domestic-emissions accounting system. A harmonized US approach, leveraging expertise in the Department of Energy and the Commerce Department, could create the accounting infrastructure necessary to allow producers to realize the carbon advantages the U.S. already holds and develop strategies for how to extend them.

US-led standards for carbon accounting could guide strategic investment in emissions reductions. Standardized metrics allow firms and policymakers to identify where decarbonization investments will deliver competitive returns in international or domestic markets. And they can be built with the flexibility to allow US firms to show reduced intensity through cleaner electricity, process improvements, or supply chain management. Such a market-driven approach would provide flexibility for different industries and regions to pursue cost-effective reductions, investing in reductions where they see premium pricing or preferential market access. It would also allow the US government to represent US interests in trade negotiations with its own approach to how emissions should be calculated.

Perhaps most importantly, a credible and US-based carbon accounting system could be designed with learning mechanisms to build political and industry trust and support for broader climate policies. As businesses invest based on carbon metrics and as international markets for carbon-differentiated products expand, firms and the government can pursue a virtuous cycle of expanding market access while reducing emissions through economic competition. Both Democratic and Republican leaders are starting to realize that American manufacturing efficiency offers not just a comparative advantage but an environmental advantage as well. Proving this point will go a long way to sustaining that efficiency.

Conclusion

Energy strategy is a key component of economic strategy. And the US finds itself revisiting its energy strategy amidst a new competitive landscape. The convergence of artificial intelligence, manufacturing, and electrification of the economy are creating new pressures on the energy system and demand for rapidly buildable, affordable electricity. Unlike the last era of relatively stagnant demand, the country now faces the challenge of enabling rapid, sustainable growth at rates not seen since the boom in power demand following World War II. But now sustainability means keeping prices affordable, reliability intact, and emissions trending downward.

The policy framework outlined here aims to enable this growth under today's state-led model for developing energy infrastructure. By investing in the hardest-to-finance infrastructure, with broadly felt benefits, the recommendations aim to unlock the potential of the US to discover low-cost and efficient options for meeting growing demand with markets, while creating long-term opportunities for growth and competitiveness. More than technical solutions, the paper has aimed to position these moves as strategic investments in America's long-term competitive advantage.

By ensuring speed-to-power for strategic industries, building the grid infrastructure of the future, and preparing for a more carbon-constrained world, the United States can utilize its resources, technology, and market power as engines of economic leadership. Doing so requires moving beyond the traditional framework that treats energy supply and climate action as competing priorities, toward an integrated approach that recognizes abundant—and ever-cleaner—energy as a pillar of economic security.

References

Belanger, Ashley. 2024. "OpenAI Asked US to Approve Energy-Guzzling 5GW Data Centers, Report Says." *Ars Technica*, September 25. https://arstechnica.com/tech-policy/2024/09/openai-asked-us-to-approve-energy-guzzling-5gw-data-centers-report-says/.

Benson, Emily, Joseph Majkut, William A. Reinsch, and Federico Steinberg. 2023. "Analyzing the European Union's Carbon Border Adjustment Mechanism." Center for Strategic and International Studies, February 17. https://www.csis.org/analysis/analyzing-european-unions-carbon-border-adjustment-mechanism.

Bergmann, Max, Cy McGeady, Otto Svendsen, Mathias Zacarias, and Ignacio Urbasos. 2024. *Power Plays: Europe's Response to the Energy Crisis*. Center for Strategic and International Studies, September. https://csis-website-prod.s3.amazonaws.com/s3fs-public/2024-09/240903_Bergmann_Power_Crisis.pdf?VersionId=2ge2hwdyWP79graodpVTsz95vY.t_CeS.

Borenstein, Severin, and Ryan Kellogg. 2021. "Challenges of a Clean Energy Transition and Implications for Energy Infrastructure Policy." In *Rebuilding the Post-Pandemic Economy,* edited by Melissa S. Kearney and Amy Ganz, 234–71. Aspen Institute Press. https://www.economicstrategygroup.org/publication/borenstein-kellogg/.

Buckberg, Elaine. 2025. "Not So Fast: Why U.S. Manufacturing Is Likely to Stay Home Through Decarbonization." Commentary. Center for Strategic and International Studies, January 3. https://www.csis.org/analysis/not-so-fast-why-us-manufacturing-likely-stay-home-through-decarbonization.

Graham, Euan, Nicolas Fulghum, and Katye Altieri. 2025. "Major Countries and Regions." In *Global Electricity Review* 2025. Ember, April 8. https://ember-energy.org/latest-insights/global-electricity-review-2025/major-countries-and-regions/.

Hausfather, Zeke. 2022. "Analysis: What the New IPCC Report Says About How to Limit Warming to 1.5C or 2C." *Carbon Brief*, April 6. https://www.carbonbrief.org/analysis-what-the-new-ipcc-report-says-about-how-to-limit-warming-to-1-5c-or-2c/.

International Energy Agency (IEA). 2025. *Electricity 2025.* International Energy Agency. https://www.iea.org/reports/electricity-2025.

Kahn, Matthew E., and Erin T. Mansur. 2010. "How Do Energy Prices, and Labor and Environmental Regulations Affect Local Manufacturing Employment Dynamics? A Regression Discontinuity Approach." Working paper no. 16538. National Bureau of Economic Research, November. https://www.nber.org/papers/w16538.

Maguire, Gavin. 2025. "US Power Pollution Climbs on Higher Coal Use." Reuters, July 1. https://www.reuters.com/markets/commodities/us-power-pollution-climbs-higher-coal-use-2025-07-01/.

McGeady, Cy. 2024. "Strategic Perspectives on U.S. Electric Demand Growth." Commentary. Center for Strategic and International Studies, May 20. https://www.csis.org/analysis/strategic-perspectives-us-electric-demand-growth.

McGeady, Cy, Joseph Majkut, Barath Harithas, and Karl Smith. 2025. *The Electricity Supply Bottleneck on U.S. AI Dominance*. Center for Strategic and International Studies, March 3. https://www.csis.org/analysis/electricity-supply-bottleneck-us-ai-dominance.

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

National Renewable Energy Laboratory (NREL). 2021. "Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update." NREL/FS-6A50-80580. National Renewable Energy Laboratory. https://docs.nrel.gov/docs/fy21osti/80580.pdf.

Palti-Guzman, Leslie, and Joseph Majkut. 2023. "U.S. LNG: Remapping Energy Security." Center for Strategic and International Studies, January 17. https://features.csis.org/us-lng-remapping-energy-security/.

Ritchie, Hannah, and Max Roser. 2020. "CO_2 and Greenhouse Gas Emissions." *Our World in Data*, June; revised January 2024. https://ourworldindata.org/co2-emissions.

Shehabi, Arman, Alex Newkirk, Sarah J. Smith, Alex Hubbard, Nuoa Lei, Md Abu Bakar Siddik, et al. 2024. *2024 United States Data Center Energy Usage Report*. Lawrence Berkeley National Laboratory, December 20. https://escholarship.org/uc/item/32d6m0d1.

Smith, Karl, Cy McGeady, Joseph Majkut, and Barath Harithas. 2025. *The AI Power Surge: Growth Scenarios for GenAI Datacenters Through 2030*. Center for Strategic and International Studies, March 3. https://www.csis.org/analysis/ai-power-surge-growth-scenarios-genai-datacenters-through-2030.

US Bureau of Economic Analysis (US BEA). 2024a. "Gross Domestic Product: Mining (Except Oil and Gas) (212) in the United States [USMINEXOILGASNGSP]." FRED, Federal Reserve Bank of St. Louis, September 27. https://fred.stlouisfed.org/series/USMINEXOILGASNGSP.

US Bureau of Economic Analysis (US BEA). 2024b. "Gross Domestic Product: Oil and Gas Extraction (211) in the United States [USOILGASNGSP]." FRED, Federal Reserve Bank of St. Louis, September 27. https://fred.stlouisfed.org/series/USOILGASNGSP.

US Bureau of Economic Analysis (US BEA). 2025. "Value Added by Industry: Utilities as a Percentage of GDP [VAPGDPU]." FRED, Federal Reserve Bank of St. Louis, June 26. https://fred.stlouisfed.org/series/VAPGDPU.

US Energy Information Administration (US EIA). 2007. *Annual Energy Outlook 2007: With Projections to 2030*. US Energy Information Administration. https://www.eia.gov/outlooks/archive/aeo07/pdf/0383(2007).pdf.

US Energy Information Administration (US EIA). 2021. "Manufacturing Energy Consumption Survey (MECS) 2018." US Energy Information Administration. https://www.eia.gov/consumption/manufacturing/data/2018/.

US Energy Information Administration (US EIA). 2025a. "Electricity." US Energy Information Administration. https://www.eia.gov/electricity/data.php.

US Energy Information Administration (US EIA). 2025b. "U.S. Imports of Crude Oil and Petroleum Products." US Energy Information Administration. https://www.eia.gov/petroleum/data.php.

US Energy Information Administration (US EIA). 2025c. "Today in Energy: Solar, Battery Storage to Lead New U.S. Generating Capacity Additions in 2025." US Energy Information Administration, February 24. https://www.eia.gov/todayinenergy/detail.php?id=64586.

US House Subcommittee on Energy. 2025. *Hearing on Department of Energy's FY 2026 Budget*. 119th Cong., 1st sess. https://energycommerce.house.gov/posts/chairman-latta-delivers-opening-statement-at-subcommittee-on-energy-hearing-on-department-of-energy-s-fy-2026-budget25.

Wolverton, Ann, Ronald Shadbegian, and Wayne B. Gray. 2022. "The U.S. Manufacturing Sector's Response to Higher Electricity Prices: Evidence from State-Level Renewable Portfolio Standards." Working paper no. 30502. National Bureau of Economic Research, September. https://www.nber.org/papers/w30502.

World Bank. n.d. "State and Trends of Carbon Pricing Dashboard." World Bank Group. Accessed July 1, 2025. https://carbonpricingdashboard.worldbank.org/.

Yergin, Daniel, Carlos Pascual, Michael Stoppard, Eric Eyberg, Leandro Caputo, Mohsen Bonakdarpour, et al. 2024. *Major New US Industry at a Crossroads: A US LNG Impact Study—Phase 1*. S&P Global, December 17. https://www.spglobal.com/en/research-insights/special-reports/major-new-us-industry-at-a-crossroads-us-lng-impact-study-phase-1.