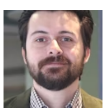
THIRD WAY

**MEMO** *Published April 11, 2024 • 13 minute read*

# Tackling America's Electricity Challenges

**Shane Londagin**
Senior Policy Advisor for Innovation
@ShaneLondagin


## Takeaways

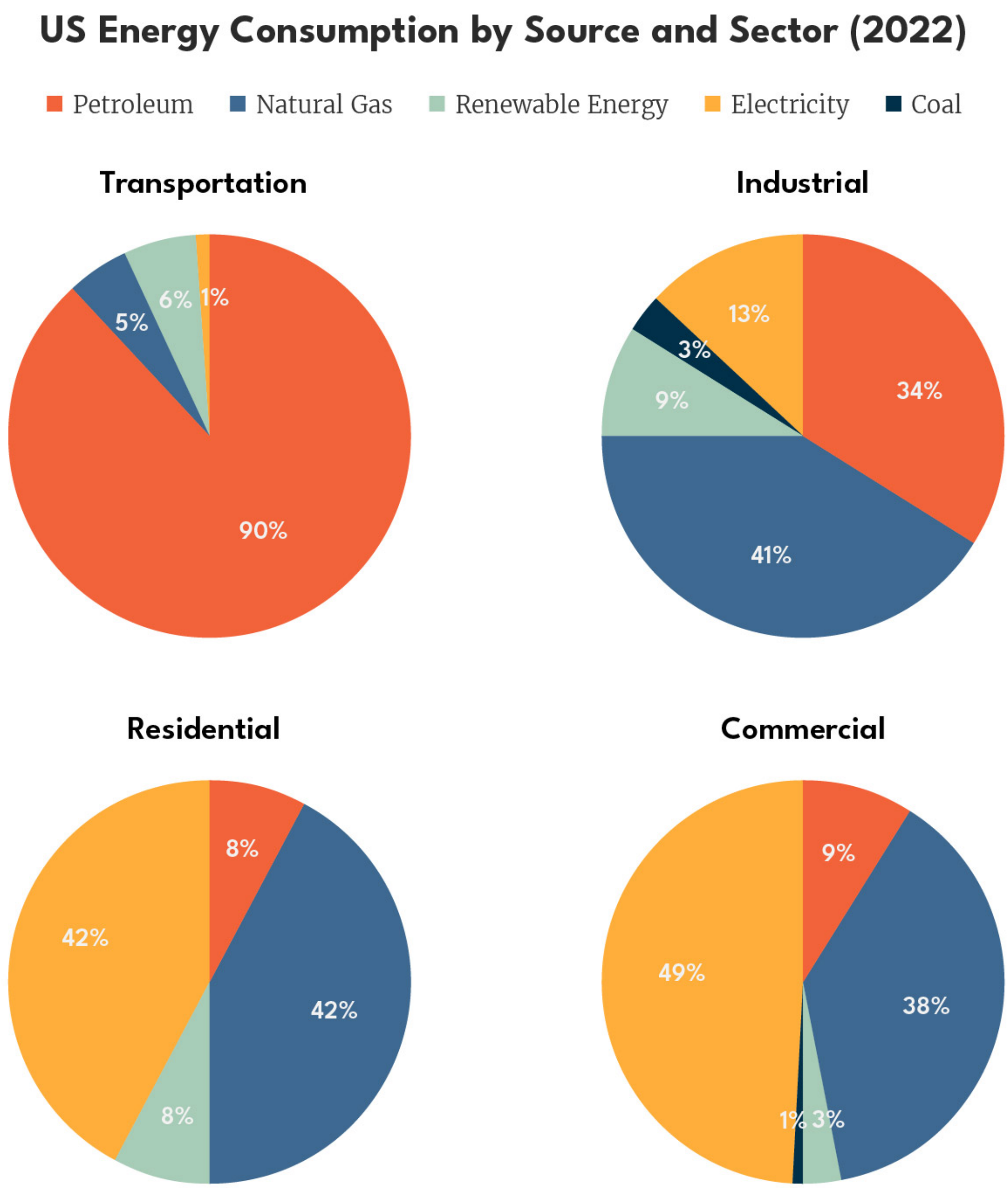
- The twin challenges of economy-wide *electrification* and *grid decarbonization* are already pushing our aging electricity system to its limits.
- New reports are now highlighting a surge in electrical load growth, driven mainly by a boom in new data centers and manufacturing facilities. This growing demand threatens to exponentially exacerbate these twin challenges, increasing their complexity and shortening our timeline for action.

- Our analysis finds that while existing capacity is mostly sufficient to meet new demand in the near-to-medium term, without a significant expansion of transmission and clean generation, demand growth has the potential to 'lock-in' existing fossil fuel infrastructure.
- Fortunately, many of the solutions that we need are deployable today. But robust policy support is needed to bring these ambitious, durable, and scalable solutions to market.

## Electrify Everything, Everywhere, All at Once

The electrical grid is the largest and most complex machine humankind has ever built. It spans continents and oceans, producing, transforming, transmitting, and consuming electricity instantaneously. But as impressive as our current system is, it is not prepared for the challenges of the future.

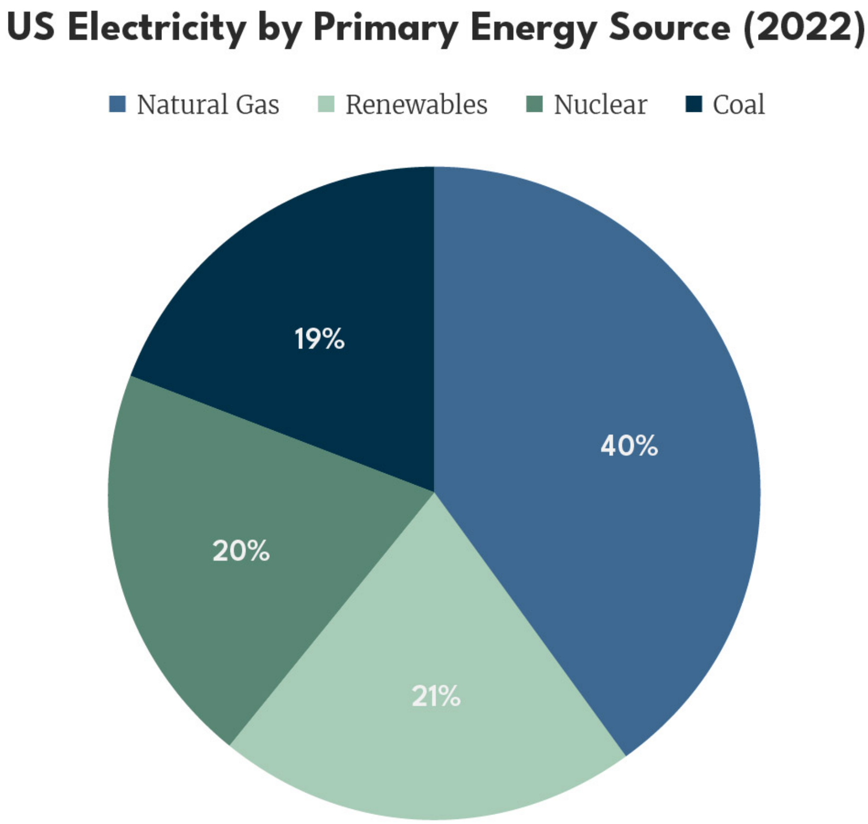
Hitting the US' 2050 net-zero commitment requires the rapid electrification of our economy. [1] This approach to decarbonization—known as "*electrify everything*"—calls for increasing the use of electricity in traditionally fossil fuel-dependent sectors like transportation and heavy industry. But electrifying these sectors will only help reduce greenhouse gas emissions if that electricity itself is generated by clean sources of energy. That's why the first stop on the path to a net-zero economy is a 100% clean electricity target, set by the Biden Administration for 2035. Despite some progress, we remain far from hitting those sequential targets. Today, electricity only powers a fraction of key sectors in the United States, or ~20% of final energy consumption.




**Source:** "U.S. Energy Facts Explained." U.S. Energy Information Administration - EIA , Energy Information Administration, 16 Aug. 2023, www.eia.gov/energyexplained/us-energy-facts/.

"Energy Flow Charts." Flowcharts, Lawrence Livermore National Laboratory, flowcharts.llnl.gov/commodities/energy. Accessed 28 Mar. 2024.

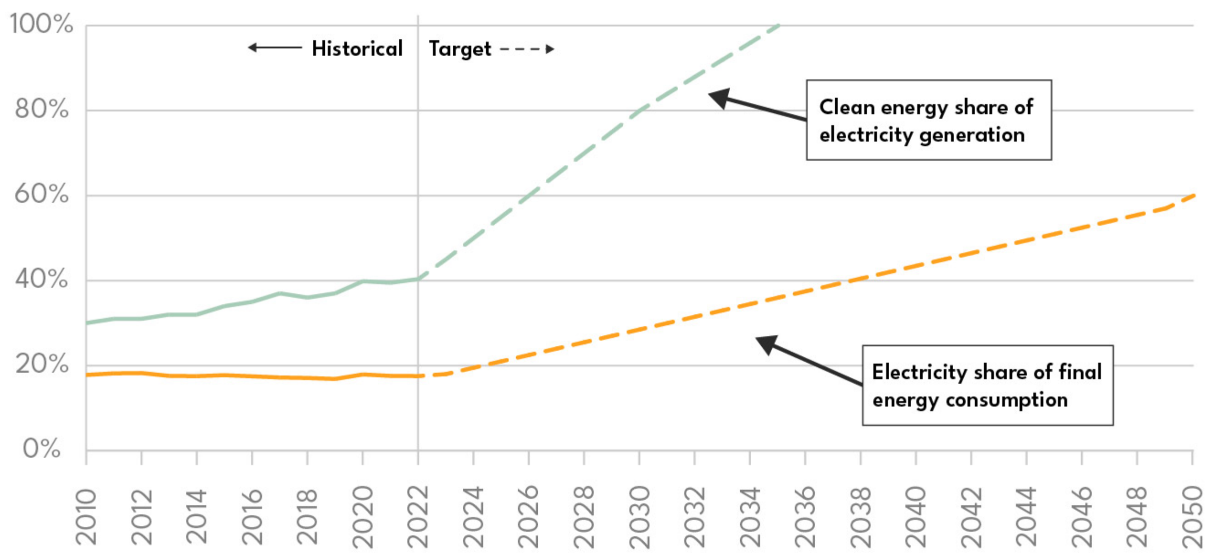
And while progress has been made, 60% of that electricity is still produced by fossil fuel sources.




**Source:** "U.S. Energy Facts Explained." U.S. Energy Information Administration - EIA , Energy Information Administration, 16 Aug. 2023, www.eia.gov/energyexplained/us-energy-facts/.

These are the twin challenges of the energy transition: *electrification* and *grid decarbonization*. And while grid decarbonization has progressed at a steady pace over the last decade (~1.0% annual growth), economy-wide electrification has remained stagnant. **Both rates need to rapidly increase.** Clean energy's share of electricity generation needs to double in the next 8 years, up to 80% in 2030, and then 100% by 2035 (or, about 5.0% annual growth). This paves the way for electricity to displace dirtier sources of energy in other sectors, with economy-wide electrification needing to triple, up to ~60% of final energy consumption, in support of the US' 2050 net-zero commitment. [2] Both targets are necessary, and one without the other is woefully insufficient.

**Electrification and Grid Decarbonization**

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Electrifying everything, everywhere, all at once will transform the way we convert, move, and consume energy, fundamentally reshaping the geography of our electrical grid.

Alone, both grid decarbonization and electrification represent monumental, decades-long projects. Projects that, while well-understood, remain frustratingly challenging to complete.

# New Projections, New Challenges

Grid planners have long been preoccupied with these well-understood challenges. But one emerging concern has largely caught the industry flat-footed and is raising alarm bells far beyond the planning community [3] : *exponential demand growth.*

For decades, US electricity demand has remained relatively flat, with an annual growth rate of around half a percent. But the increasing prevalence of energy-intensive data centers (for novel technologies such as artificial intelligence and cryptocurrency), and a manufacturing renaissance [4] spurred by recent historic investments from the Biden Administration, have caused demand to spike.

New reports from industry watchdog Grid Strategies [5], the North American Electric Reliability Corporation (NERC) [6], and the International Energy Agency (IEA) [7] are all in agreement that peak demand is surging to record rates. As NERC writes, "electricity peak demand and net energy growth rates in North America are increasing more rapidly than at any point in the past three decades."

## What is Peak Demand?

While peak demand (also known as peak load or on-peak) is an important measurement tool for grid engineers, planners, and operators, it is easy to confuse it with other metrics, such as consumption, load, and capacity.

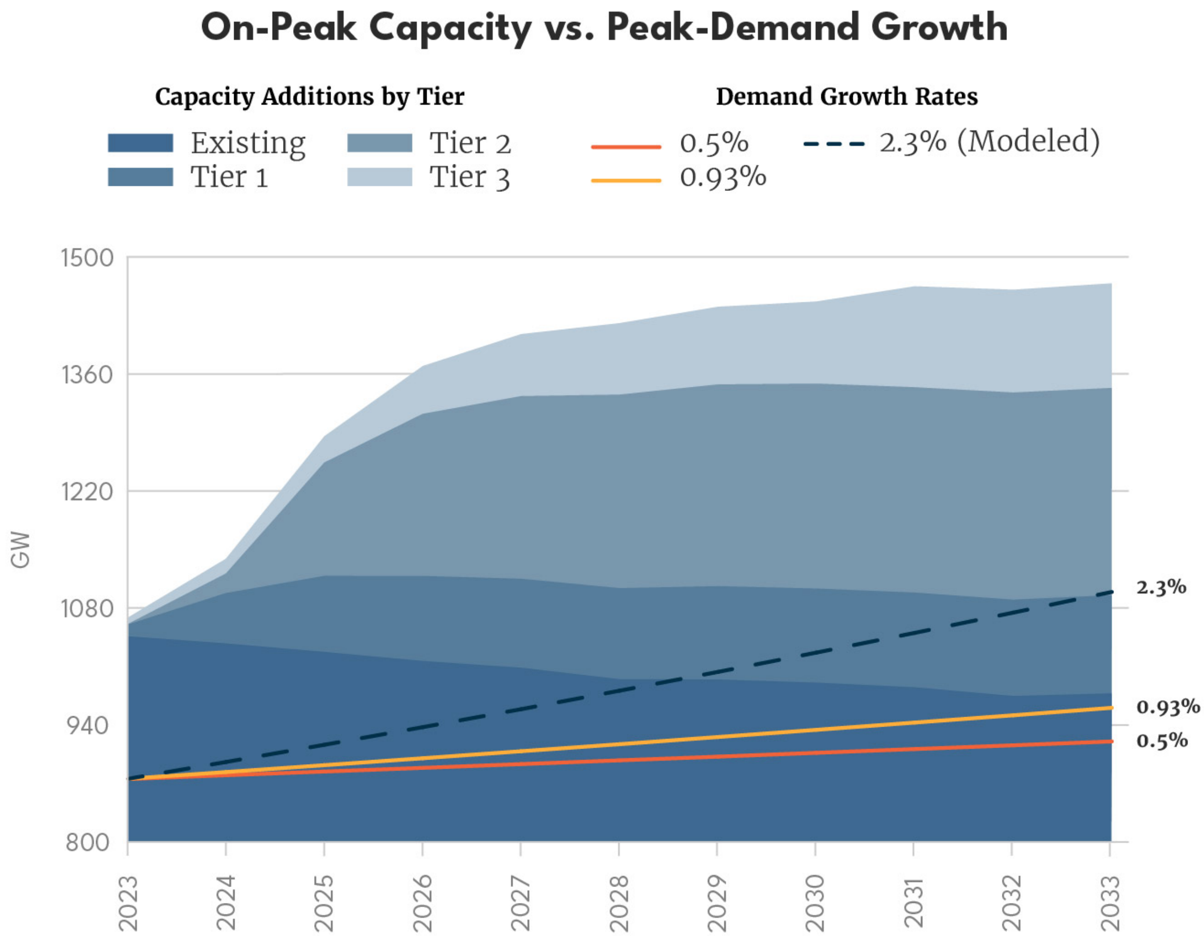
*Consumption* reflects the total amount of energy used (by electrical devices, or electrical *loads*) while *demand* measures the rate of that consumption. The energy available to meet instantaneous total load in a given area is known as *capacity*. *Peak demand* then, describes a specific time period in which servicing total electrical load requires significantly higher than average capacity. Our electrical grid is engineered to service peak demand in even the most extreme circumstances. While that's good for reliability during on-peak events, the capacity of our grid is largely "over-built" for the majority of service time.

According to Grid Strategies, grid planners have nearly doubled their peak demand forecasts from last year, now **increasing the annual growth rate through 2028 from 0.5% to 0.93%** (and they admit these numbers are most likely underestimates). Estimates from NERC and IEA are similarly dramatic, forecasting significant increases in both summer and winter peak demand. In reality, the lag in reporting (most utility filings are based on forecasts from early 2023 or late 2022) likely means that the annual growth rate is measurably higher, potentially 2.0-2.5% [8].

But surging demand is only half the story. Because while demand *is* increasing, so too is our ability to service it. The revised 0.93% growth rate could see peak demand increasing by nearly 100GW over the next ten years (from 875GW today to 960GW in 2033). A number that, while significant, would still be below our existing on-peak capacity in 2033 (977GW), even when accounting for planned retirements. Assuming the recent historical average amount of planned projects clear the interconnection queue and come online (~14% of total queue capacity), serviceable on-peak capacity could increase to nearly 1,050GW over the same time period. Nearly covering even a modeled 2.3% growth rate.

Of course, not all those gigawatts will be available to service peak demand. New heavy-load centers are popping up across the country, often in places far removed new capacity additions. Without significant transmission upgrades, these gigawatts won't go to where they are most needed. Furthermore, as we move to replace existing natural gas plants (which can be easily ramped up and down to meet demand surges) with variable weather-dependent renewables, matching hourly fluctuations in generation and consumption is becoming ever more complex. Extreme weather events (brought about by a worsening climate [9] ) and mandatory maintenance also frequently reduce available capacity, shrinking the "reserve margin" necessary to maintain grid integrity and reliability.

The chart below displays these dynamics in scene together: placing historical, revised, and modeled growth rates against the backdrop of existing and planned capacity additions.




**Note:** NERC separates projects in the interconnection queue into tiers based current project status, with **Tier 1** being the closest to grid connection (signed agreement), **Tier 2** being further way (signed study) and **Tier 3** being the furthest. **0.5%** represents the demand growth rate of the last two decades, **0.93%** is the newly adjusted growth rate as reported by Grid Strategies, and **2.3%** is potential growth as modeled by the REPEAT Project.

**Source:** 2023 Long-Term Reliability Assessment. North American Electric Reliability Corporation (NERC), Dec. 2023. https://www.nerc.com/pa/RAPA/ra/Pages/default.aspx

Wilson, John, and Zach Zimmerman. The Era of Flat Power Demand Is Over. Grid Strategies, Dec. 2023. https://gridstrategiesllc.com/wp-content/uploads/2023/12/National-Load-Growth-Report-2023.pdf

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NERC separates projects in the interconnection queue into tiers based on current project status. Tier 1 projects are in the final stages of connection i.e., under construction or with a signed agreement (Interconnection Service Agreement, Power Purchase Agreement, Construction Service Agreement, etc.). Tier 2 projects are further from completion, i.e., projects with a completed study (feasibility, system impact, etc.), while Tier 3 includes all other projects in the queue that do not meet Tier 1 or 2 requirements. It is important to note that even Tier 1 projects are not sure things. Supply chain issues, regulatory challenges, and economic factors frequently cause projects to be delayed or canceled across the tiers. In fact, from 2000-2017, **only 21% of total projects eventually came online** (or 14% of proposed capacity).

# Diving Deeper

Further breaking down existing and planned capacity reveals another difficult reality: surging demand is—and will likely continue to be—serviced largely by fossil fuel generated capacity.

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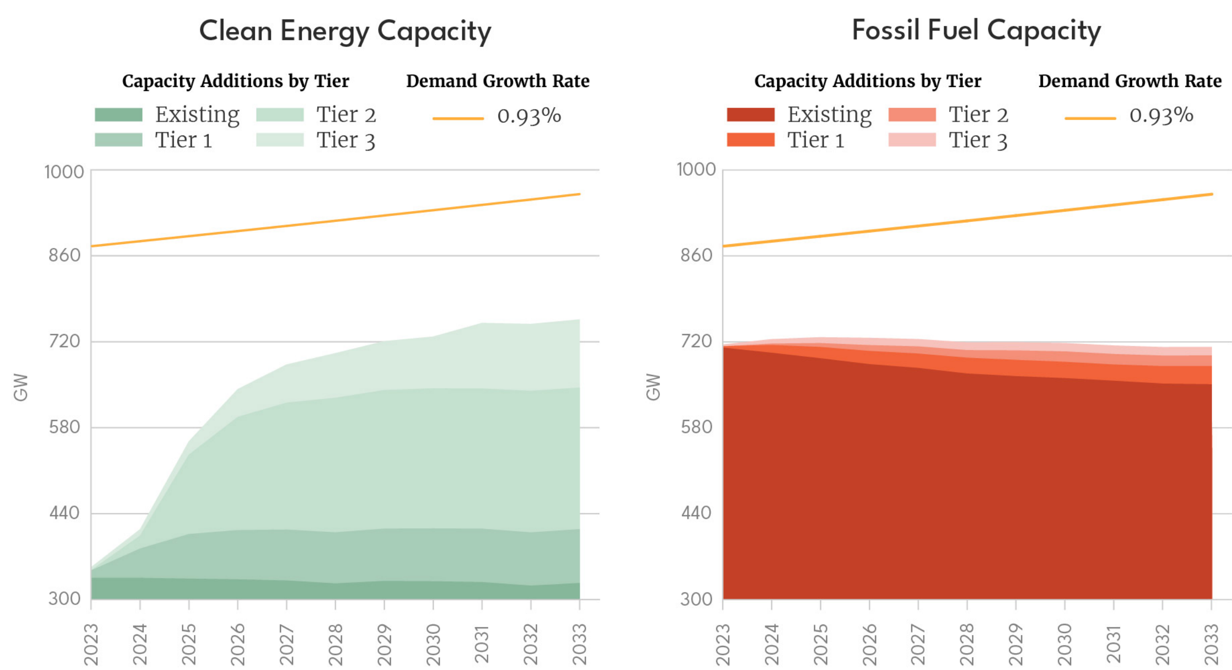
**On-Peak Capacity vs. Peak-Demand Growth**

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Wilson, John, and Zach Zimmerman. The Era of Flat Power Demand Is Over. Grid Strategies, Dec. 2023. https://gridstrategiesllc.com/wp-content/uploads/2023/12/National-Load-Growth-Report-2023.pdf

What does this mean for the twin challenges of grid decarbonization and economy-wide electrification?

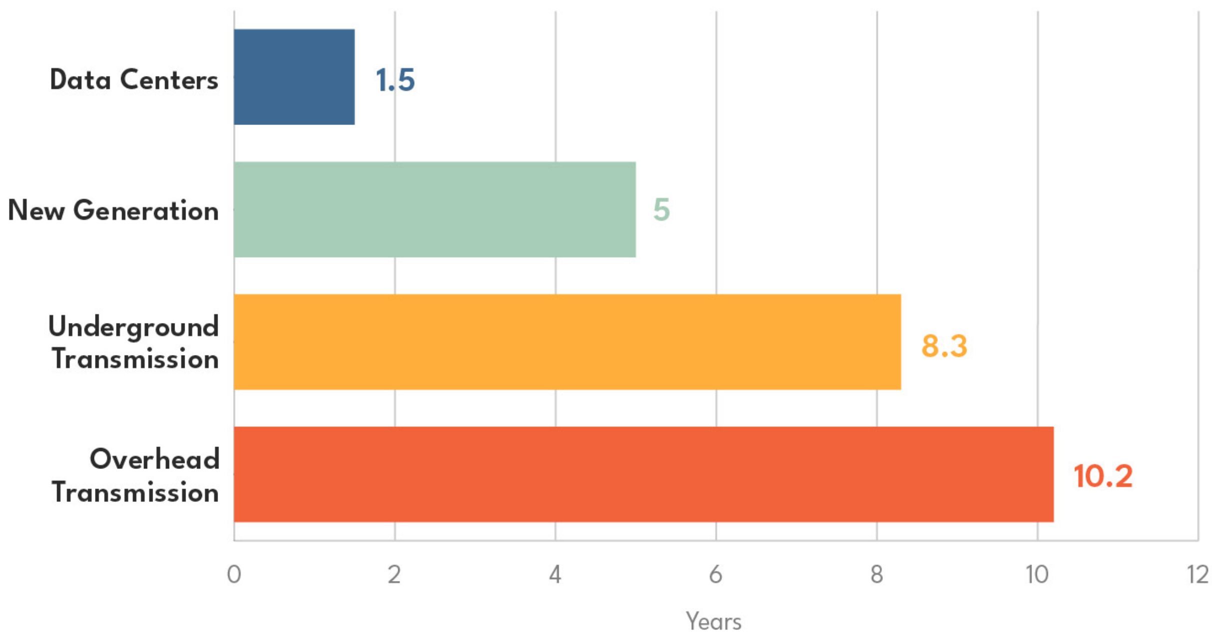
1. Firstly, on grid decarbonization, surging demand has the potential to "lock-in" existing sources of carbon. Our targets for 80% clean by 2030 and 100% clean by 2035 will be impossible to hit if utilities perpetuate fossil-fuel use in a scramble to serve load-hungry customers. Currently, fossil fuels provide over 700GW of peak capacity while clean sources only supply around 300GW.

2. Secondly, on electrification, the good news is that we are trending in the right direction. Planned clean capacity dramatically outweighs planned fossil. Unfortunately, even assuming every planned project comes online (a very, *very* optimistic assumption) we would still fall well short of the new 0.93% growth line (which says nothing of a potential 2.3% rate).

The bottom line: **Surging demand threatens to exponentially exacerbate the twin challenges of grid decarbonization and electrification, increasing their complexity and shortening our timeline for action.**

We simply need to add *a lot* more clean capacity to the grid. And we need to do it in record time. This presents a troubling timing problem. Historic legislation—the Bipartisan Infrastructure Law of 2021 (BIL), the CHIPS and Science Act of 2022, and the Inflation Reduction Act of 2022 (IRA)—has already catalyzed historic public and private investment in energy intensive facilities. From semi-conductor manufacturing plants to AI data centers, new types of load are coming online at record pace, with new facility development averaging under two years. Capacity expansions simply are not matching that speed. From 2000-2007, new generation moved through interconnection, construction, and operation in less than two years. But in 2022, that number had ballooned to five years. [10] The permitting alone for transmission projects now takes upwards of seven years, with construction taking another three. [11]

## Average Lead Times to Build Key Load & Capacity Assets




**Source:** IEA, Average lead times to build new electricity grid assets in Europe and the United States, 2010-2021, IEA, Paris https://www.iea.org/data-and-statistics/charts/average-lead-times-to-build-new-electricity-grid-assets-in-europe-and-the-united-states-2010-2021, IEA. Licence: CC BY 4.0.

Rand, Joseph, et al. "Queued Up: Characteristics of Power Plans Seeking Transmission Interconnection as of the End of 2022." Lawrence Berkeley National Laboratory, Apr. 2023.

Wilson, John, and Zimmerman, Zach. The Era of Flat Power Demand Is Over. Grid Strategies, Dec. 2023.

This fundamental mismatch—surging demand against the delayed deployment of capacity additions—creates three basic pathways forward:

- **Extended Reliance on Fossil Fuels:** The fossil fuel plants that were scheduled for retirement are forced to stay in service longer, and new ones come online to meet rising demand. Grid decarbonization stalls, and the benefits of economy-wide electrification are muted.
- **Delayed Deployment of BIL, CHIPS, and IRA Investments:** Local economic development, spurred by new facility growth, is delayed as utilities are forced to halt new connections due to insufficient capacity.
- **Supply-Demand Mismatch Worsens:** Retirements proceed as planned, new load centers are connected, and balancing the grid becomes either economically or technically unfeasible, threatening grid reliability and resilience.

Admittedly, none of those options are ideal. Fortunately, diligent planning, thoughtful policy and regulation, and new technological innovations provide tangible solutions to many of these challenges and can chart new pathways forward.

## New Challenges Require Innovative Solutions

Technologically, increasing the capacity of our grid is both a generation and transmission challenge. We need to add more, but we also need to make better use of what we already have. On the generation side, NERC's report clearly identifies the criticality of firm baseload sources of energy to maintain grid reliability. The co-location of battery storage with variable renewables is a welcomed development (as of 2022, nearly 48% of solar projects awaiting interconnection were paired with batteries a 51% increase over 2021). [12] Beyond battery storage, we have long advocated for the expanded use of nuclear and geothermal energy in the power sector. These "always-on" sources of energy can help balance the intermittency of a renewable-heavy grid. Furthermore, innovative behind-the-meter applications of small-modular reactors and enhanced geothermal systems are demonstrating new ways to meet novel data center demand. [13]

Our first three recommendations are centered on bringing more clean energy sources of generation online. Beyond generation, NERC, Grid Strategies, and the IEA are also clear-eyed about the critical role expanding transmission will play in meeting this moment. Our final three recommendations speak to that challenge.

### Policy Recommendation #1: Reform the interconnection queue process.

A new survey of wind and solar developers found the interconnection queue as the number one cause of project delays and cancelations over the last five years. [14] Speeding up the process of interconnection is a critical first step in bringing more clean energy online. FERC Order 2023 took meaningful steps forward, but deeper reform is needed to meet surging demand. FERC should consider additional tools such as a "connect and manage" approach to resource interconnection studies, coupling the interconnection process with transmission planning, and aligning the interconnection processes with competitive resource solicitations. [15]

### Policy Recommendation #2: Prioritize clean firm sources of energy, like advanced nuclear.

As the primary energy source responsible for half of all clean electricity generation in the US, nuclear energy must continue to be a foundational part of electrical system. Not only should regulators prioritize keeping our existing fleet of nuclear reactors online, but Congress must continue to fully-fund the Department of Energy's Advanced Reactor Demonstration Program (ARDP) to develop the next generation of nuclear energy. As our recent blog argued, first-of-a-kind projects—like the one's supported by ARDP—may be expensive, but their outsized economic and electrical capacity impact make them worth it.

## Policy Recommendation #3: De-risk the next generation of geothermal technologies.

Enhanced geothermal systems (EGS) and other innovations have the potential to expand access to this clean, firm source of electricity to every part of the US. But many of these technologies are in the so-called "valley of death" where we've proven their feasibility, but they're still too risky for private capital. De-risking project development, particularly during exploratory drilling, will be key to getting more wells in the ground, more quickly. Policymakers can accomplish this by providing more public funding for demonstration projects, or by establishing a geothermal risk reduction fund that would help offset exploratory drilling costs and give companies the confidence to develop faster.

## Policy Recommendation #4: Pass significant transmission permitting reform legislation.

Currently, legislation aimed at reforming our outdated siting and permitting process is moving its way through both Chambers of Congress, with significant progress being made in the Senate Energy and Natural Resources Committee. A minimum transfer capacity requirement between regions and as well as new interregional planning and cost allocation authorities will be critical elements of a successful bill.

## Policy Recommendation #5: Deploy innovative technologies to increase the capacity of our existing T&D system.

From virtual power-plants to dynamic line-ratings, existing technological innovations can bring the grid of the future into the present, often at a fraction of the cost and lead-time of greenfield expansion. A forthcoming explainer on these technological solutions will be hitting our website soon, and the Department of Energy will soon be releasing a new Liftoff Report on the topic as well.

## Policy Recommendation #6: Expand Interregional Renewable Energy Zone (IREZ) corridors nationwide.

First pioneered in Texas two decades ago, an IREZ is a geographic area that contains a "very high concentration of very low-cost developable renewable energy potential." [16] A new report from NREL finds that combining IREZs with IREZ corridors (dedicated high-voltage transmission paths) can increase grid reliability through improved resource adequacy. All at a relatively small net impact to electricity bills thanks to their application of commercially mature technologies. Federal and state regulators should equip grid planners with the tools needed (new finance, authorities, and technical assistance) to deploy IREZ corridors at scale nationwide.

# Conclusion

The electrical grid is a modern marvel, one of the most impressive feats of human ingenuity, vision, and purpose. And yet, report after report—from the National Academies of Sciences, Engineering, and Medicine [17] to the IEA [18] —continue to highlight it as the "single greatest technological danger to a successful energy transition" and the "weak link of clean energy transitions."

This isn't just another issue on our decarbonization roadmap. Unplanned for electrical load growth has the potential to become *the* issue that threatens to knock down all future decarbonization dominos. For grid planners and operators to adapt to the changing landscape, they need new tools to meet new challenges. Policymakers and regulators must meet this moment with ambitious, durable, and scalable solutions that rapidly increase the deployment of clean energy generation and associated transmission. Indeed, without immediate action, the clean energy transition risks stalling out as it is beginning to spark.

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