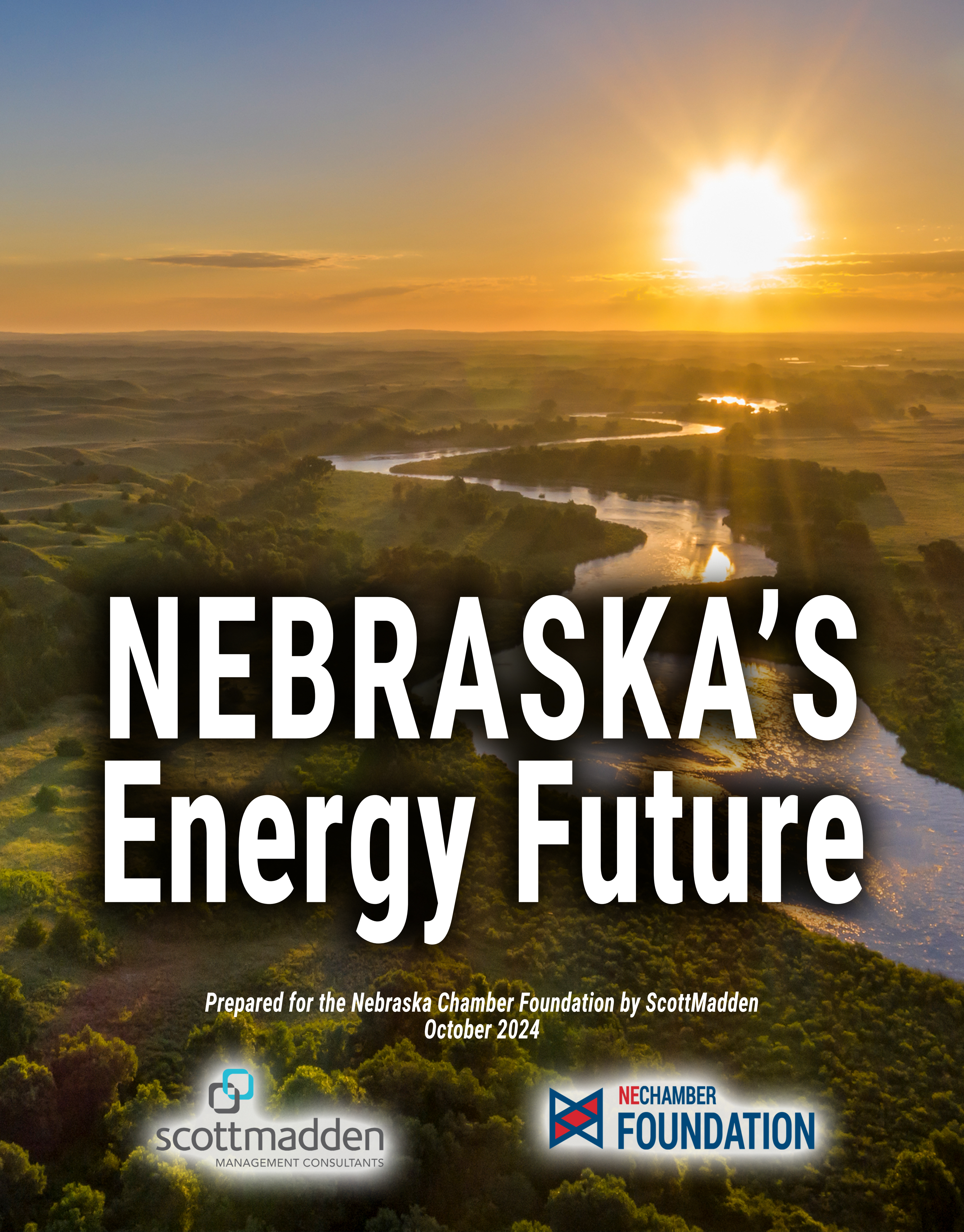

NEBRASKA'S Energy Future

Prepared for the Nebraska Chamber Foundation by ScottMadden
October 2024

scottmadden MANAGEMENT CONSULTANTS

NECHAMBER FOUNDATION

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NE Chamber Foundation – LEADING NEBRASKA'S FUTURE

The Nebraska Chamber Foundation's work focuses on key economic issues that will limit or grow our state's economy depending on our ability to take action. We need to be consistently aware of economic headwinds and tailwinds – staying aware of changing demographics, talent supply, housing trends, technology and innovation developments, and other key metrics that fuel Nebraska's growth trajectory.

Our focus is to make Nebraska a top competitive state by investing in the latest nonpartisan research and data on leading issues. Ensuring our efforts are driven by fact and informed by data is key. Our reports equip and empower informed decisions about top priorities to guide communities in the right direction on the road to growth.

Nebraska's Energy Future

Nebraska's economic growth relies heavily on a strong energy infrastructure. This study helps the Foundation create conversations and strategies based on where we are and where we need to be to remain a competitive state.

Foundation Investors

The Nebraska Chamber Foundation thanks all the companies who invested in this study and provided insight for this research effort. This study would not have been possible without the participation of these key stakeholders and partners of the Nebraska Chamber Foundation. You can find all of the NE Chamber Foundation's research work at www.nechamber.com/foundation.

It is our hope that Nebraska leaders will collaboratively leverage the data found in all our studies to find regional and statewide solutions that will strengthen and grow our economy for years to come.

Sincerely,

Tera Norris
President
NE Chamber Foundation

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INTRODUCTION

The Nebraska Chamber Foundation commissioned ScottMadden to describe the current state of the electric industry in the state and its role in supporting economic development. While this paper primarily focuses on the electric industry, the roles of other sources of energy, such as natural gas, are also described as they are closely linked with both the delivery of electricity and meeting customers' end-use energy needs.

The electric sector is facing several important challenges across the United States, including significant load growth and a changing generation mix. Nebraska faces many of the same issues as the rest of the country, but they may manifest in unique ways. This paper describes the national landscape and how Nebraska is adapting to both local and national needs and trends. ScottMadden conducted both primary and secondary research for this study, including interviews of key stakeholders, and as such were presented a variety of views on the state's energy industry and changes various parties believe are necessary. This paper also provides some areas of opportunity policymakers may consider in enabling further growth of the energy industry in the state.

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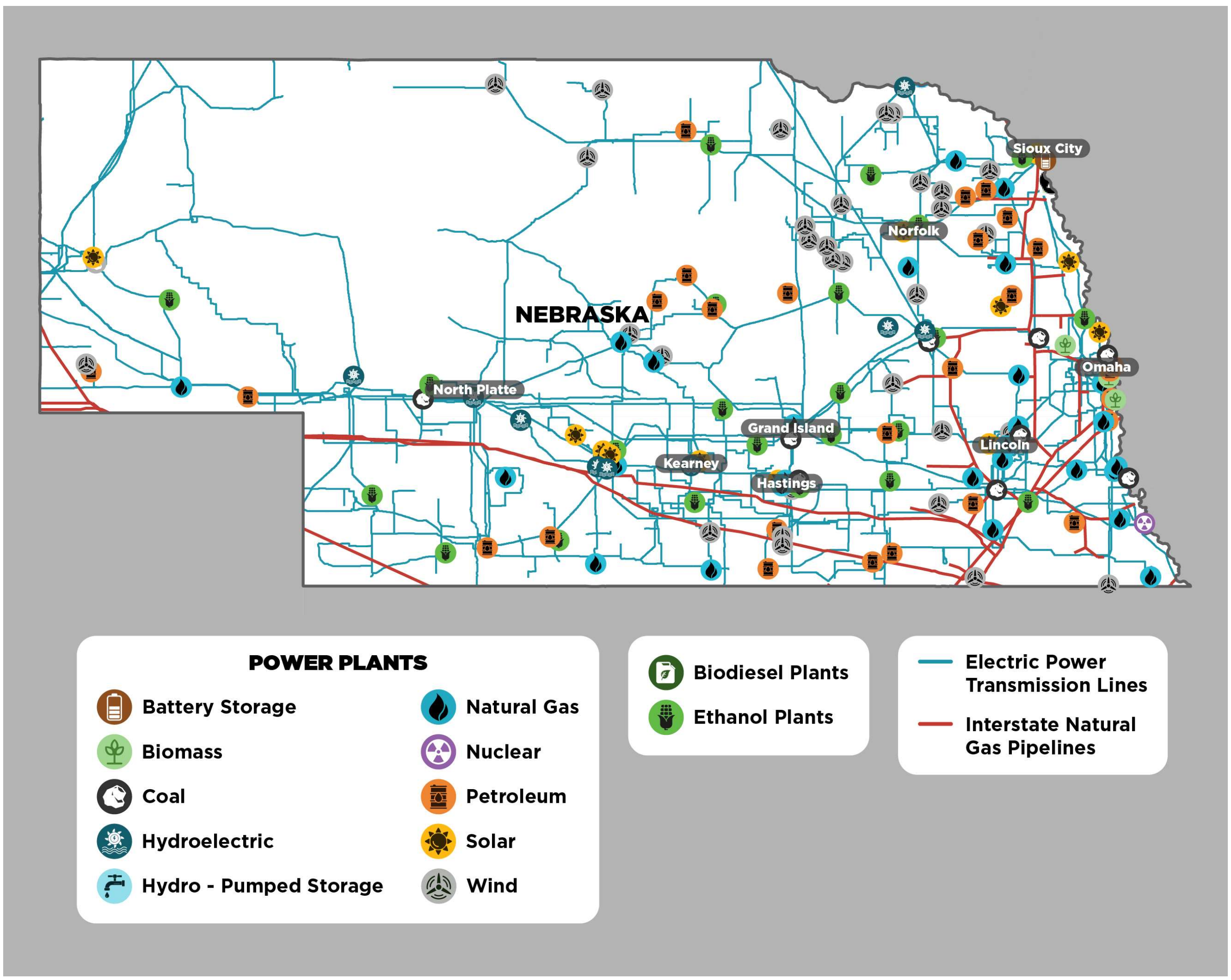
EXECUTIVE SUMMARY

The availability of affordable, reliable electricity is critical to economic development. More and more, our society depends on electricity to power its vital industries, and those industries are expanding. Nowhere is this more true than in Nebraska. The agricultural sector drives the economy of the state, and as clean fuels become more prevalent, the state is poised for additional industrial growth on this agricultural base. Large technology companies looking to site data centers are also seeking to enter the state or expand their presence in Nebraska. Manufacturers, agribusiness, biotechnology, hydrogen production, and sustainable fuel production are just a few of the other industries that seek to grow their businesses in the state. The growth of these sectors depends on the availability of affordable, reliable energy, and Nebraska has both. The state's electricity ranks among the most affordable and reliable in the country.

Figure 1: Nebraska Power, Natural Gas, Ethanol, and Biodiesel Facilities



Source: EIA, U.S. Energy Atlas

National Context

There are changes in both national and state energy needs that require broad stakeholder consideration.[1] Demand growth for electricity in the United States had plateaued beginning in 2007, coincident with start of the Great Recession. After more than a dozen years of relatively flat electricity consumption growth, demand growth (including peak or maximum hourly demand) has seen a resurgence since 2020.

The drivers vary, depending upon the region, but the key changes are from electrification and emerging large loads (i.e., consumers of power). Vehicle electrification, whether passenger cars or fleets, is growing although not as rapidly as anticipated a few years ago. Building electrification is another area of load growth, as electric heat pumps and other technologies are of increasing interest in replacing older oil- and natural gas-based applications. Industrial applications such as process heating are electrifying, although cost remains a factor.

Large loads are also beginning to appear across the country. Artificial intelligence (AI), web-based commerce, and other internet-based applications require power around the clock for processing at data centers. The amount of power required by AI is several times that needed by traditional applications, meaning the size of these data center loads is much larger than in the past. Manufacturing demand has also grown, buoyed by federal policy and incentives. Interest in Bitcoin and other cryptocurrencies has led to a proliferation of "mining"; these operations have significant computational and energy-related needs to produce units of these currencies.

Grid operators and power providers are determining how to meet this demand with new generating and grid resources. This comes at a time where the composition and characteristics of the country's generation fleet have been changing.

Power supply options are driven by several factors: clean energy policy, availability, and cost of resources to fuel power plants (natural gas, solar, and wind). Coal power plants—traditionally baseload workhorses of U.S. power systems—have been retiring, affected by increasing federal environmental strictures, increasing age and related maintenance, and competition with growing amounts of low marginal cost renewable and natural gas power plants. Meanwhile, many utilities, states, municipalities, as well as many private companies have net-zero goals and renewable portfolio standards that affect which types of power plants are preferred. Indeed, many of the power plants in line for construction are solar, battery storage, or hybrid solar-plus-storage plants. The selection of non-greenhouse gas-emitting resources has been encouraged not only by net-zero goals but also by tax incentives under the Inflation Reduction Act of 2022.

Securing the right power supply resources to meet these new demands is challenging. Grid operators must study the impact of new resources before they connect to the grid. Because new resources are generally smaller in capacity than historically larger thermal plants, and the volume is greater, it takes longer to study those impacts. In the grid with which Nebraska is interconnected, it can take the grid operator more than six years to approve new supply for interconnection.[2]

Moreover, as the nature of generators on the grid shifts from dispatchable (able to turn on and run upon demand) thermal units to an increasing amount of variable and weather-dependent sources, reliability officials are monitoring potential shortfalls during extreme weather and critical demand periods. Grid

[1] See Appendix F: Factors Driving Power Needs Across the United States
[2] See Appendix E: Overview of the Southwest Power Pool

operators are adapting their operating practices and planning power lines to help move needed energy across longer distances.

Nebraska and Regional Trends

Many of these broad national trends are also reflected in regional and state trends in and around Nebraska. Large loads are coming to Nebraska as they are to many other states. In addition, the generation mix is changing as new resources look to connect to the grid.

As new industry comes, whether agriculture-adjacent (e.g., sustainable aviation fuel) or new (e.g., data centers), Nebraska is starting from a solid foundation. Utilities in the state are preparing to meet these increasing electric loads with new generation and grid infrastructure. Importantly, this expansion of infrastructure is taking place at a time when many industries and customers are increasing their commitments to clean energy and reduced CO2 emissions, lowering the carbon intensity of their products.

While Nebraska does not have a renewable portfolio standard, federal incentives and policy and customer demand are driving adoption of renewables both within the state (with its favorable wind and solar resources)[3] and within the Southwest Power Pool (SPP), of which the state's largest utilities are members. Generally, the state is advancing clean energy at the pace of customer adoption through the net-zero objectives of its largest utilities and in support of specific customer needs. The state has also seen development of renewable resources owned by private developers, increasing the availability of these sources of electricity within the state.

Meeting Nebraska's Growing Energy Needs

Energy is vital to all aspects of economic development; however, in recent years the focus on energy has increased as various factors drive load growth. This question is being posed across the country, "Do we have enough energy to power the industries that need it?" In Nebraska, like the rest of the country, energy infrastructure is foundational to economic development, and as such the adequacy of its generation resources and grid infrastructure are being questioned in light of the significant projections of load growth and new industry coming to the state.

While this may seem like a "new" question in Nebraska, the state's utilities have focused on meeting its energy needs for generations. As described in this paper, the state is starting from a very good place in terms of the cost of electricity and its reliability. These remain at the forefront of utility decision-making even with the significant growth happening in the state. The utility mandate to provide reliable, affordable power remains, and load growth in the state is being managed accordingly. The scale of this influx of new customers and loads is unprecedented, but it has not changed the utilities' priorities.

Utilities and power developers, with required approvals, determine what types of resources are to be built in the state, and the SPP plays a significant role in generation development. As described later in Appendix E to this paper, SPP manages the generation interconnection process and assesses the reliability of the grid in light of the new generation facilities looking to interconnect. This both preserves reliability of the network and dictates the timeline within which those resources may be available. This may speed up or slow down the interconnection of large loads dependent on those resources.

[3] See Appendices B and C

The region has seen a large influx of renewable generation. Because of its interconnection to SPP, Nebraska has access to these resources, and many such resources are located in the state. While the "accredited" capacity (to meet peak demand)[4] of renewable energy resources is subject to a different calculation than nuclear or coal plants, they generate significant energy. Nebraska's renewable resources generated nearly 20% of the state's energy in 2022, behind coal but ahead of both nuclear and natural gas. The industry rightly considers accredited capacity to make decisions about meeting demand; however, the energy provided by these resources also helps keep the lights on.

Areas for Consideration

Energy infrastructure and its expansion are necessary to support ongoing economic development in the state. In Nebraska, it is important that the state focus on three things through this period of load growth and transition. First, public education and transparency about energy infrastructure in the state is critical. Citizens, customers, stakeholders, and legislators need to understand the industry and be informed about the need for and trade-offs across different types of critical energy resources. Second, there is an opportunity to consider streamlining zoning and permitting processes for renewables to be more consistent across counties. These facilities are a part of the energy landscape and can play an important role as part of a diverse portfolio of generation resources. Third, the various stakeholders who are working to bring these large load customers into the state can look to create more flexible rate schedules and contracting as well as unique, creative partnerships across customers, utilities, and renewables developers that may facilitate interconnection of these facilities.

New industry and the expansion of energy infrastructure are important economic development opportunities for the state. The infrastructure in the state today has served it well to support a variety of industrial customers. Thoughtful planning, stakeholder engagement, and creative policymaking can enable the energy infrastructure to expand to support the growing industrial base and do so in a way that keeps energy reliable and affordable for all.

[4] The Southwest Power Pool requires that all load-responsible entities (i.e., utilities that provide power to customers) maintain adequate capacity to meet seasonal peak demand requirements plus a margin to account for unexpected loss of a generator or transmission line. This is known as a resource adequacy requirement. Capacity for this requirement is not the generator's nameplate capacity but its accredited capacity, which is typically less than nameplate.

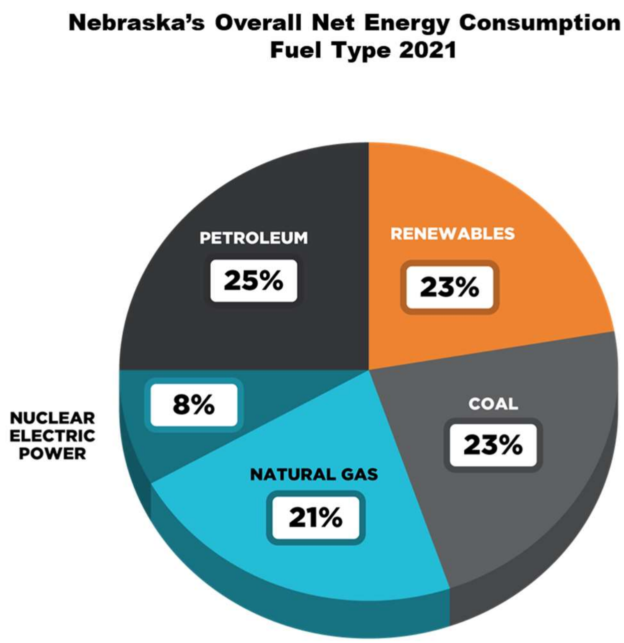
For thermal units, a generating unit's accredited capacity is calculated factoring their performance, discounting capacity based upon historical outage rates. For variable resources (e.g., solar and wind) and energy storage, accredited capacity is based upon probabilistic measure of the facility's nameplate rating that can be relied on to serve load using an analysis known as equivalent load-carrying capability. (Sources: SPP (June 14, 2024), 2024 SPP Resource Adequacy Report; SPP (Aug. 2024), 2024 ELCC Wind Solar and ESR Study Report)

NEBRASKA'S ENERGY LANDSCAPE

Nebraska is a top agricultural state, ranking third nationally in corn production and second in ethanol production and capacity. Because of the combination of energy intensity in the industrial sector and relatively low population, the state ranked eighth in 2022 in per capita energy consumption.[5] Approximately 45% of the state's energy consumption and 39% of retail electricity sales go to the industrial sector, which includes meatpacking, agriculture, livestock, and food processing, as well as chemical and machinery manufacturing.[6]

While electricity provides a significant portion of the energy serving industrial customers, natural gas plays an important role as well. The chart below shows the resources that provide energy to Nebraska's economy.

Figure 2: Nebraska's Overall Net Primary Energy Consumption by Fuel Type (2021)



Source: NDEE 2023 Annual State Energy Report

[5] U.S. Energy Information Administration (EIA), https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use_capita.html&sid=US
[6] EIA, Nebraska State Energy Profile (last updated July 20, 2023) (EIA Profile)

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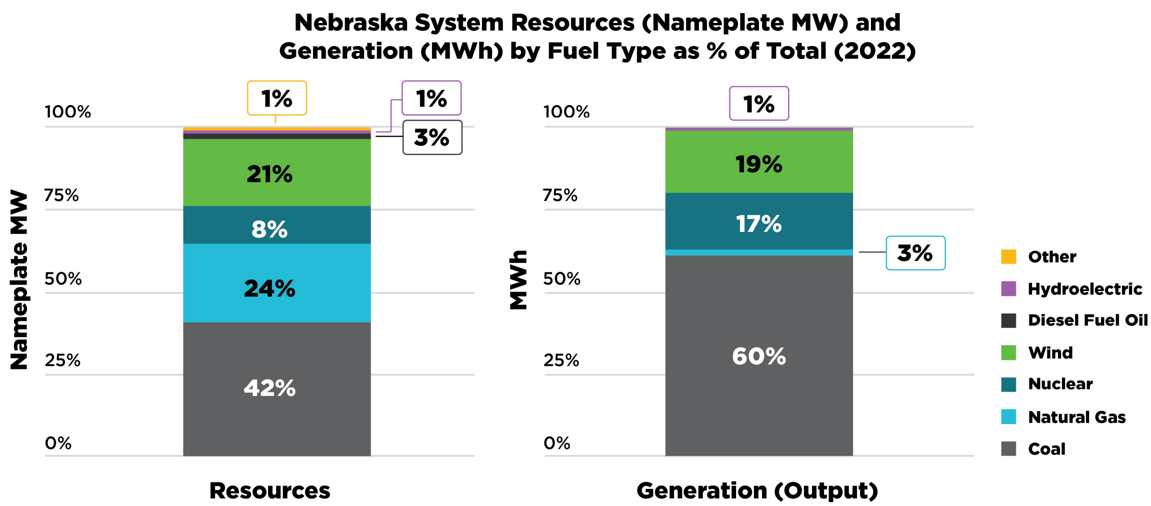
NEBRASKA'S ENERGY RESOURCES AND INFRASTRUCTURE

Electric Power

While Nebraska is interconnected to the regional grid, it is largely self-sufficient in terms of generation resources. There are approximately 9,924 megawatts (MW)[7] (nameplate capacity[8]) of in-state power generation.[9] The peak electric demand for the state for the summer peak was 6,115 MW in 2022. Winter peak was 5,215 MW in 2022.[10]

The state is highly reliant on baseload coal-fired power plants, which provide approximately 60% of its energy in 2022, followed by wind, which produced 19% of megawatt-hours (MWh)[11] in the state, and nuclear generation, which provided 17%. Natural gas-fired generation produced 3% of energy.[12]

Figure 3: Nebraska Power Generation Nameplate Capacity and MWh by Fuel Type (2022)



Source: NPA 2023 Load and Capability Report

[7] "A key measure of electricity used in industry is the rate at which it is produced, transferred, or consumed—how much energy per unit of time a generator produces, with the units of electricity called watts. Similar measures are kilowatts (kW) (=1,000 watts), and megawatts (MW) (=1,000 kilowatts). A watt, kilowatt, or megawatt is a unit of power…. The amount of electricity a generator can produce instantaneously is its capacity, which is typically noted as megawatts." (Source: FERC (Dec. 2023), Energy Primer: A Handbook for Energy Market Basics (FERC Primer)).
[8] Nameplate capacity is the maximum generation output from a generation facility based upon ideal conditions, typically expressed in MW. Further discussion of nameplate and accredited capacity is in sections on resource adequacy at Appendices A and E and in the Executive Summary.
[9] Nebraska Power Association (NPA) (Aug. 2023), 2023 Load and Capability Report (Load and Capability Report), Exhs. 7, 14
[10] NPA (2023), Load and Capability Report, Exh. 12
[11] As noted earlier, capacity is the maximum amount a generator can produce. However, a generator may not always operate at full power. The amount of electric energy generated, transmitted, or used over time is measured as the number of watt-hours (also expressed as kilowatt-hours, megawatt-hours, or gigawatt-hours). (Source: FERC Primer)
[12] NPA (2023), Load and Capability Report, Exh. 16

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Nebraska's three largest utilities—Omaha Public Power District (OPPD), Nebraska Public Power District (NPPD), and Lincoln Electric System (LES)—are responsible for ownership, maintenance, and expansion of the transmission and distribution infrastructure within their respective service territories.[13] Collectively, they operate an extensive network of approximately 7,000 transmission line-miles, with OPPD owning 1,300, NPPD owning 5,400, and LES owning 300 line-miles.[14] Together they own or lease almost 19,000 miles of distribution lines, connecting their power stations to the customers they service, with OPPD owning 14,000, NPPD owning or leasing 3,000, and LES owning 2,000 line-miles.[15]

The largest utilities in the state are members of the Southwest Power Pool (SPP), a regional transmission organization (RTO).[16] Membership in an RTO sees utilities transfer some control over the operation and planning of generation and transmission assets, while RTOs coordinate the electricity generation and transmission of participants across a region, leading to cost savings and increased efficiency. SPP manages the wholesale electricity market within its multistate territory, balancing supply and demand while overseeing resource adequacy. It operates day-ahead and real-time markets, ensuring reliable electricity supply to customers and managing the financial transactions for movement of energy across its footprint. For Nebraska, SPP provides a platform to sell excess generation or acquire additional energy when needed.

In transmission planning, SPP develops regional transmission plans compliant with Federal Energy Regulatory Commission's (FERC) standards, particularly Orders 1000 and 1920 (issued in 2024) which govern regional planning and cost allocation. SPP also oversees the generation interconnection process crucial for integrating new power sources into the grid. This process involves conducting technical studies, assessing costs, and determining necessary grid updates. Consequently, any new generation resources seeking to connect to the Nebraska system must undergo SPP's comprehensive interconnection evaluation.

(Note: please see Appendix E for further discussion of the functions SPP performs and its operations.)

Renewable Energy

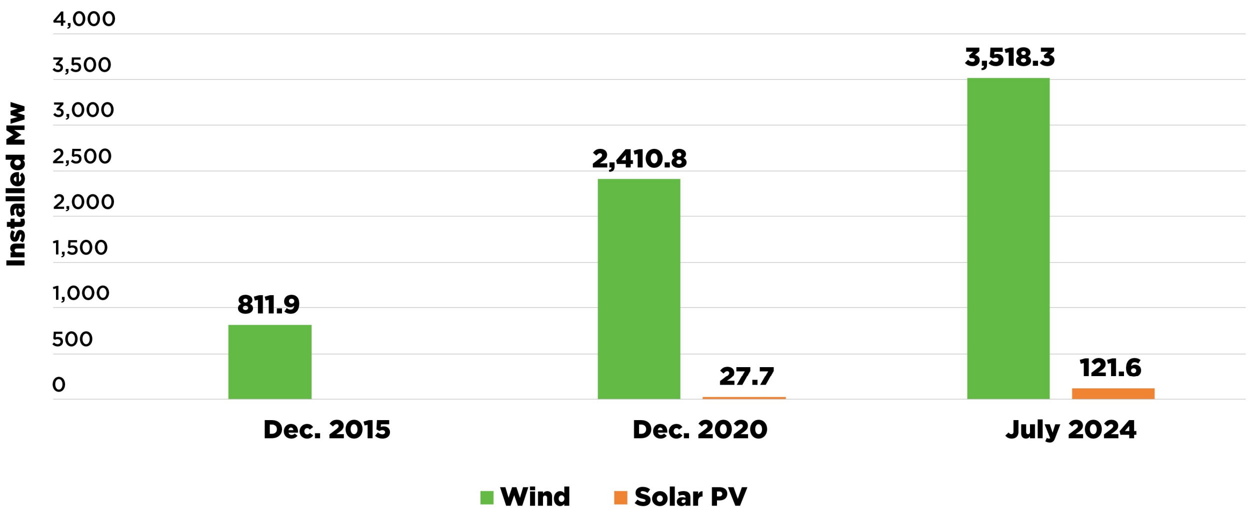
Nebraska has significant solar irradiance and wind speed to support renewables development (see Appendices B and C).[17] According to the Department of Energy (DOE), in 2022, Nebraska ranked third in the nation in land-based wind capacity installations, adding 602 MW that year.[18] As of the end of 2022, wind power comprised 21% of in-state nameplate generation.[19] This level of development is consistent with that of the SPP, in which Nebraska is situated.

While wind development has dominated renewable capacity additions in Nebraska (see Figure 4 below), utility-scale solar development has been increasing over the past several years, although not at the scale of wind development.[20] The amount of solar energy generated in the state is quite small, only 0.1% of all

[13] Rural electric cooperatives and other public power districts and other municipal utilities also operate and maintain electric distribution facilities.
[14] NPPD (2023), Annual Report, p. 3; LES (2023), Key Facts Sheet; OPPD (2021), IRP, p. 52
[15] NPPD (2023), Annual Report, p. 3; LES (2023), Key Facts Sheet; OPPD (2021), IRP, p. 52; The Wire (2018), https://oppdthewire.com/power-lines-15567-miles/; ScottMadden analysis
[16] SPP, at https://www.spp.org/about-us/members-market-participants/
[17] National Renewable Energy Laboratory; U.S. Dept. of Energy
[18] DOE (Aug. 2023), Land-Based Wind Market Report: 2023 Edition
[19] NPA (2023), Load and Capability Report, at Exh. 14. Percentage shown is that of nameplate capacity.
[20] NDEE (2022), Generation in Nebraska by Fuel Type

electricity consumed in 2021.[21] While solar photovoltaic results in a land use change from agriculture, its low-profile footprint is attractive to some communities, and landowners can potentially benefit from higher annual revenue without commodity price risks.[22] As of July 2024, nearly 5 MW of battery storage was operating in Nebraska, with 420 MW of solar with storage under construction in Pierce County.[23]

Figure 4: Wind and Solar Photovoltaic Development over Time in Nebraska (Cumulative Summer Operating Capacity (MW))



Source: EIA Monthly Electric Generator Inventory (last updated Aug. 2024); ScottMadden analysis[24]

Appendix D shows a map of Nebraska electric, gas, and ethanol infrastructure. The location of wind and solar facilities in the state is noted therein.

Natural Gas

As mentioned above, natural gas is an important energy source for the industrial sector; it also provides heating to approximately 60% of residential customers in the state.[25] Natural gas-fired generation is critical part of the power generation fleet in the state, although it is primarily used for peaking capacity. Natural gas provided 26% of accredited generation capacity and 3% of energy (MWh) in 2022.[26]

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[21] NDEE (2023), Annual State Energy Report (State Energy Report), at Fig. 24
[22] Interviews
[23] EIA, Form EIA-860, "Annual Electric Generator Report;" Form EIA-860M, "Monthly Update to the Annual Electric Generator Report;" ScottMadden analysis
[24] EIA, Form EIA-860. Capacity from facilities with a total generator nameplate capacity less than 1 MW are excluded from this report. This exclusion may represent a significant portion of capacity for some technologies such as solar photovoltaic generation.
[25] EIA Profile
[26] NPA (2023), Load and Capability Report

Nebraska has little natural gas production. Domestic production totaled 0.32 billion cubic feet (BCF) in 2022,[27] compared with about 182 BCF delivered to customers in the state.[28] There is one natural gas storage field in the state with a total capacity of 35 BCF (i.e., less than 20% of deliveries).[29] Nearly all gas is imported from other states and regions.

There are several significant gas pipelines that bring gas across and into Nebraska, including the Rockies Express Pipeline (REX), Tallgrass Interstate Gas Transmission (TIGT), and Northern Natural Gas Pipeline. The REX pipeline is a 1,700-mile pipeline that extends from the Colorado mountains east to Ohio, running across the southern portion of Nebraska. It can bring gas from basins in Wyoming and Colorado east as well as bring Appalachian shale gas west from Ohio. Movement from one direction vs. another depends upon capacity, operations, and relative price attractiveness between east or west regions. REX interconnects with the TIGT system to move gas north across the eastern part of the state.[30]

[27] NDEE, at https://neo.ne.gov/programs/stats/inf/30.html
[28] EIA, Nebraska Natural Gas Summary, at http://www.eia.gov/dnav/ng/ng_sum_lsum_dcu_sne_a.htm (released July 31, 2024)
[29] EIA Profile
[30] Tallgrass company information; interviews

NEBRASKA PUBLIC POWER AND PRIVATE DEVELOPERS

Nebraska is unique in the United States in that all the entities (districts, cooperatives, and publicly owned utilities) that provide electricity to customers in the state are publicly held. These entities are not-for-profit and are supported by customer revenues. The largest public power utilities (LES, NPPD, and OPPD) are vertically integrated, meaning that they own generation, transmission, and distribution assets. Numerous other municipal utilities, rural electric cooperatives, and smaller public power utilities are distribution utilities responsible for delivery of energy to their customers. The governance of these organizations may differ entity to entity, but they are typically governed by a board of elected or appointed officials, ultimately accountable to customers.

Rates for electric service are set by these governing bodies, which typically have very close ties to the communities they serve. Public power rates are based upon the cost of service to customers. Vertically integrated investor-owned utility (IOU) ratemaking is also based upon cost of service. However, IOUs earn a return on equity for capital investment (and included in “rate base”), as set by the state regulator, creating a natural bias toward capital investment over operating and maintenance expense that may not exist in public power entities. The combination of the lack of profit motive and close alignment with communities has been cited as at least part of the reason that the state’s electricity rates are so low (see section on affordability).

Public power entities in Nebraska must go through an approval process with the Nebraska Power Review Board (PRB) for the development of electric infrastructure. The PRB serves as the state’s regulatory authority, ensuring that all new infrastructure projects meet public need and necessity standards and do not lead to unnecessary duplication of facilities. This process of proving convenience, necessity, economic and feasible supply, and no unnecessary duplication[31] can be arduous. Once entities receive PRB approval, the siting and permitting of infrastructure are relatively straightforward. These entities have rights of eminent domain granted by the state.

In contrast, private renewable generation developers, which are for-profit entities typically developing wind or solar facilities, operate under a different set of rules. They do not have eminent domain authority and must also obtain PRB approval for their projects. However, the approval process for these developers was significantly streamlined by LB 824, signed in 2016, which deregulated the development of renewables in the state. This law provided a simplified approval process through the PRB and removed the requirement for a power purchase agreement to be in place before construction could begin. This regulatory change has fostered a more competitive and diverse energy landscape in Nebraska, spurring renewable development over the past several years.

In 2010 (LB1048),[32] the state instituted a nameplate capacity tax, further amended in 2016 and 2020, that streamlined the costs and replaced the previous property tax being applied to renewable energy projects. This flat rate tax, set at $3,518 per megawatt of nameplate capacity for renewables with a capacity greater than 0.1 MW,[33] was designed to make renewable energy development more financially attractive to localities and to facilitate better cash flow planning for local governments.

[31] Nebraska Revised Statute 70-1014(1)(a), at https://nebraskalegislature.gov/laws/statutes.php?statute=70-1014
[32] See https://nebraskalegislature.gov/FloorDocs/101/PDF/Slip/LB1048.pdf
[33] https://www.cfra.org/sites/default/files/publications/nebraska-nameplate-capacity-tax-1.pdf

This tax is in addition to the real property taxes paid by these facilities and landowners, with solar and wind facilities typically generating around $4,000 and $5,000 respectively in additional revenue per MW nameplate capacity per year.[34] These tax payments are in addition to the lease payments made to landowners for the use of their land.

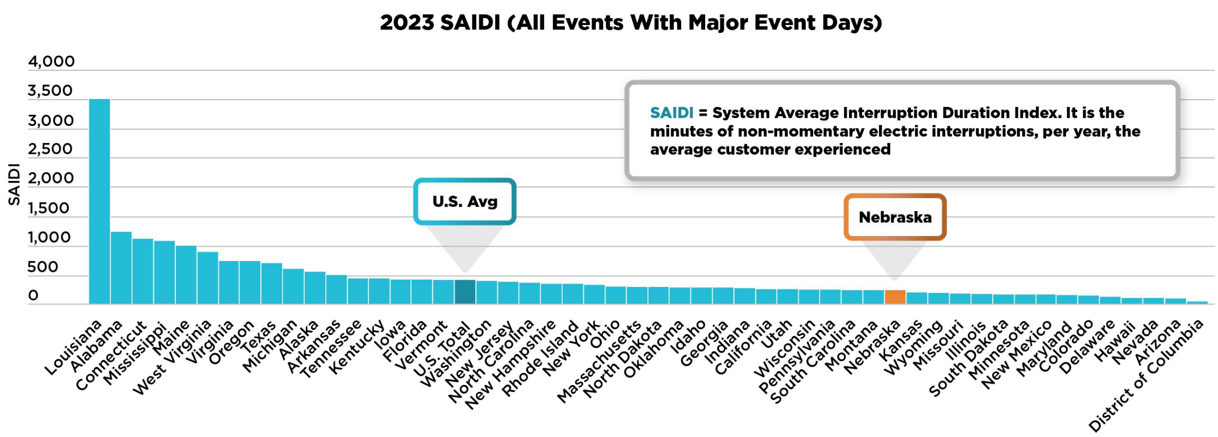
34 Interviews

RELIABILITY AND AFFORDABILITY OF ENERGY IN NEBRASKA

There are several metrics by which the reliability of an electric system is assessed. This report will focus on two. System average interruption duration index (SAIDI) measures the total time, on average, that a customer experiences non-momentary power interruptions in a one-year period. System average interruption frequency index (SAIFI) measures the frequency of those non-momentary interruptions."[35] Taken together, these metrics provide a perspective on the performance of an electric system.

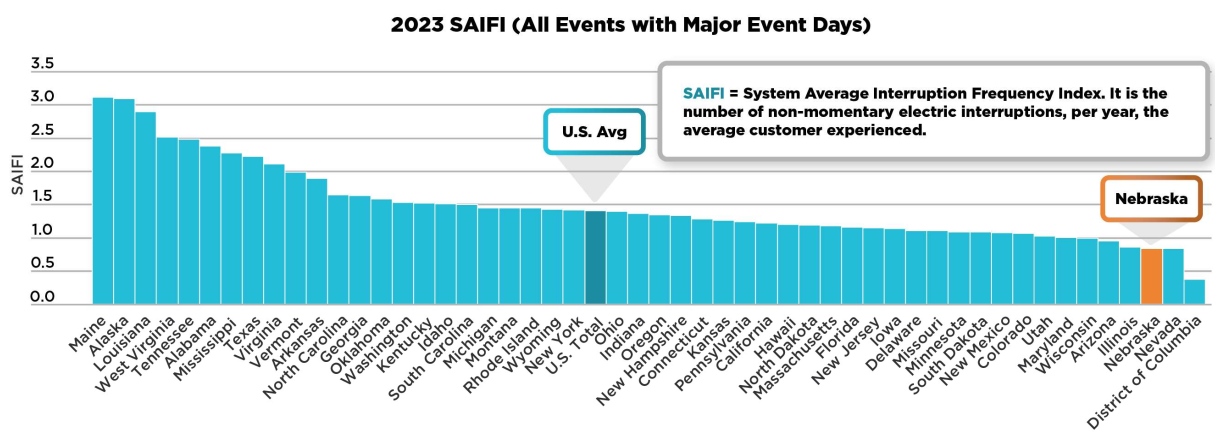
In Nebraska, the metrics for both SAIDI and SAIFI compare favorably to other states.

Figure 5: SAIDI with Major Event Days (2023)



Source: U.S. Energy Information Administration (2023)

Figure 6: SAIFI with Major Event Days (2023)



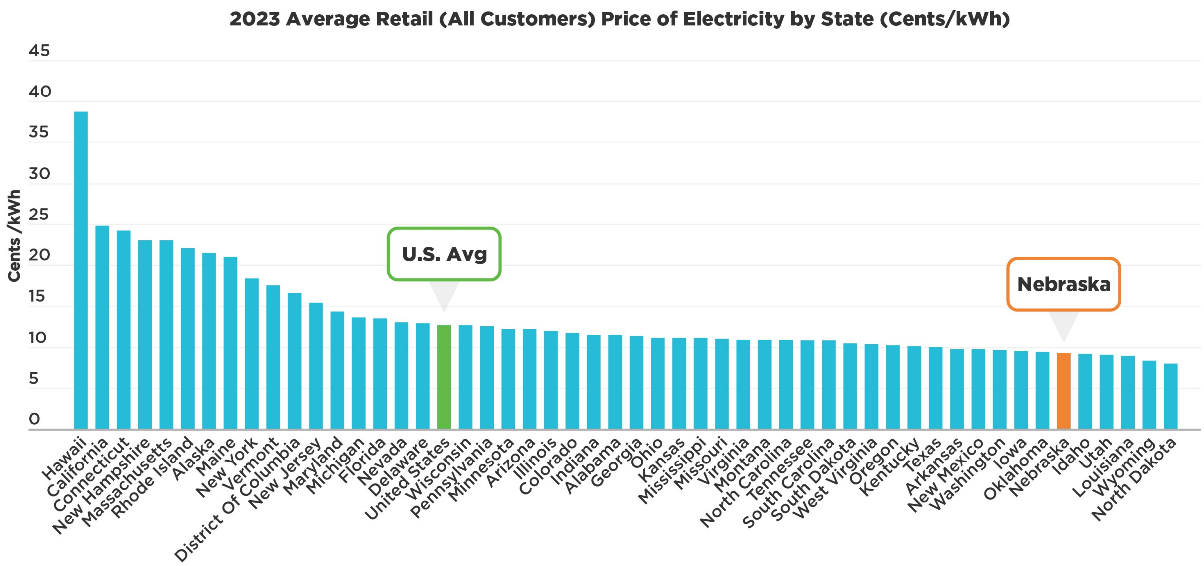
Source: U.S. Energy Information Administration (2023)

[35] EIA, at https://www.eia.gov/todayinenergy/detail.php?id=54639

In terms of the cost of energy, there are a number of metrics that the industry uses to assess how affordable it is to various types of customers.

One source of comparison is the average cost per kilowatt-hour (kWh) of electricity to customers. When compared on this metric, Nebraska's average retail electricity cost of 9 cents/kWh in 2023 placed it among the six lowest in the nation.[36] This includes all customer classes and provides an average for the entire state. A number of the electricity providers in the state tout their records in keeping costs to customers low and at least one has made public commitments to keep these in the lowest quartile nationally.

Figure 7: Average Retail (All Customers) Price of Electricity by State (Cents/kWh) (2023)



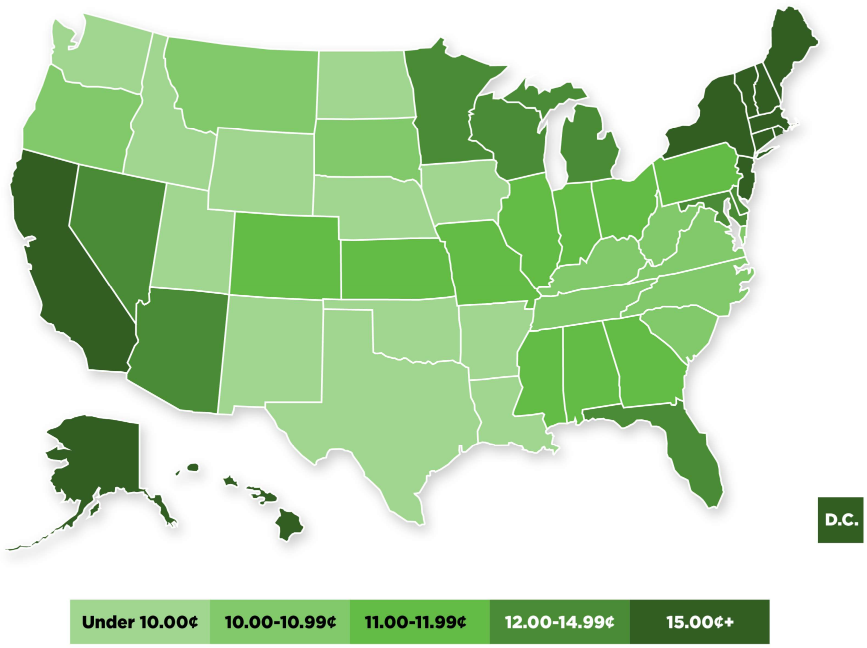
Affordability and reliability remain the primary motivators for each of the top three utilities in Nebraska. NPPD has stated that its "goal is to maintain a total retail base rate position among the lowest 15% of providers," providing retail customers 11 consecutive years of stable rates as of 2024.[37] OPPD recently increased rates to cover costs like grid modernization, and these new rates, up by 1.6%–2.5%[38], remain lower than the national average.[39] LES, too, has kept rates low and stable for the past decade, and recently proposed an increase of 3.3% (around $3.50 on residential customers' monthly bills) to reflect costs of system improvements and inflation, To keep rates affordable, it has adjusted its budget by cutting non-critical capital projects and operating expenses.[40]

It is important to note that several factors contribute to the affordability of electricity in Nebraska. The state has low-cost energy resources such as coal, nuclear, hydro, and wind generation as well as access to SPP market resources. In addition, the state's utilities have made prudent investments in transmission and distribution infrastructure. As shown above on Figure 3, coal continues to comprise a significant

[36] EIA (2022), at https://www.eia.gov/electricity/state/
[37] NPPD (2023), NPPD Board Approves Steady Rates for 2024
[38] Public Power (2024), OPPD Board Approves $2.1 Billion Operating Plan for 2024
[39] OPPD (2024), OPPD's Rates among Lowest in Region and Country
[40] LES ((Sept. 20,2024), LES Proposes Rate Adjustment

portion of baseload resources in the state. As the utilities look to retire or implement carbon capture and storage at these facilities, the generation mix for the state may become more expensive.

Figure 8: Average Electricity Cost per kWh by State (2023)



Source: U.S. Chamber of Commerce, Global Energy Institute (2023)[41]

[41] https://www.uschamber.com/energy/2023-average-u-s-electricity-retail-prices

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DEMAND TRENDS IN NEBRASKA

Nebraska's demand drivers reflect, to some degree, national trends summarized in the appendix of this paper. For example, the national trend shown at Figure 19 at Appendix F, showing relatively flat energy consumption growth from 2008 to increasing load growth beginning in 2021, is also reflected in Nebraska's electricity demand trend. However, because of the state's mix of businesses, agricultural base, demographics, and policies, some demand drivers are different than other regions of the country.

As further detailed below, Nebraska economic growth has been strong since the COVID-19 pandemic.[42] Consistent with increased manufacturing given reshoring, federal incentives, and other drivers seen nationally, several Nebraska industries have shown interest in increasing output at existing facilities and expanding operations in the state.

Data centers and cryptocurrency miners (discussed later), which have driven significant recent electric load growth in various regions of the country, have had a presence in the state and are looking to expand as the demand for advanced cloud computing, Internet of Things applications, web-based commerce, and artificial intelligence applications increases and cryptocurrency values remain high (albeit volatile). Nebraska's low power prices are attractive to these customers.

The ethanol industry, unique to a handful of states, including Nebraska, and thus not part of the national demand trend, continues to see steady demand and is looking to expand its product mix, grow production, and reduce its carbon intensity.

Companies are also pursuing manufacturing of products such as hydrogen, ammonia, and sustainable aviation fuels.

Electrification and population growth appear to be smaller factors in driving growth in power demand in Nebraska as compared with other parts of the United States. Vehicle electrification lags most other states because of the lack of charging infrastructure and limited state incentives.[43] End-use electrification has not been significant nor mandated by policy, although selected applications, such as irrigation, have been moving from diesel and other power sources to electricity. Nebraska's population growth has been approximately 0.5% per year for the past three years, and housing has lagged that growth, so new connections and end-use demand in the residential sector has not driven significant load growth.[44]

This section summarizes by customer segment, and anecdotally for some subsegments, the drivers of energy demand growth in Nebraska.

Economic Growth

Economic growth in Nebraska has been strong since the COVID-19 pandemic. Manufacturing (particularly in goods-producing industries) and construction have continued to increase at a steady pace.

[42] Federal Reserve Bank of Kansas City, Nebraska Economic Update (Apr. 3, 2024)
[43] Associated Press (July 26, 2024), at https://apnews.com/us-news/nebraska-electric-vehicles-transportation-technology-general-news-45a1c977d9891cf9f6caa062e727b692
[44] Nebraska Examiner (May 20, 2024), at https://nebraskaexaminer.com/2024/05/20/nebraska-exurbs-outshine-suburbs-in-latest-population-growth-figures/

Demand for food and fuel (i.e., ethanol) have led to increases in agricultural commodity production, including food production.[45]

Moreover, as economic analysts have observed, there is an increasing relationship between agriculture and energy. As noted by the Kansas City Fed:

> New technologies and policy efforts to reduce emissions across the transportation sector have incentivized substantial increases in the production of biomass-based diesel, spurring heightened demand for soybean and other oils used to produce these fuels. Like changes in corn acreage due to demand for ethanol, soybean acreage has increased by about 13% since 2012.
>
> Agricultural land has also become an increasingly important source for harvesting renewable energy, and adoption of solar lease contracts has emerged as an opportunity for a modest but growing share of agricultural producers. Adding to the ag and energy intersection, environmental considerations such as carbon also appear likely to have a significant long-term effect.
>
> There is still some uncertainty about the exact path of the agriculture and energy connection, largely because of the effects of government policy. The use of biomass-based diesel in sustainable aviation fuel (SAF) may be a primary source of increased demand for soybeans, but its future production and use remains dependent on national and state subsidies.
>
> The emerging frontier of carbon collection and abatement also presents an opportunity, but many unknowns remain. Despite some lingering uncertainties, ag and energy linkages have deepened in recent years, and there might be more to come.[46]

Overall Growth in Energy Demand

Nebraska's energy consumption has nearly tripled from 1960 to 2021.[47] This includes energy in all forms—electricity, natural gas, motor fuels, propane, fuel oil, and other fuels. As of year-end 2021, industrial use comprised 45% of energy consumption followed by transportation (22%), residential (18%), and commercial (15%) sectors.[48]

Natural gas volumes delivered to consumers grew by a compound annual rate of 2.7% from 2017 to 2022, slightly declining in 2023.[49] Among Nebraska residential customers, 60% used natural gas as their primary heating fuel.[50]

Electricity consumption has been growing as well. Overall, the state's electric kWh consumption has grown on a compounded rate by more than 1.5% per year over the past five years.[51] Industrial usage

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45 Nebraska Economist, Federal Reserve Bank of Kansas City, "Producing' Growth" (July 15, 2024, at https://www.kansascityfed.org/omaha/nebraska-economist/producing-growth/

46 "The Ag and Energy Connection," *Ten* magazine, Federal Reserve Bank of Kansas City (Summer 2024), at p. 15, at https://www.kansascityfed.org/TEN/documents/10265/TEN_SUMMER_07_23_2024_pages.pdf

47 NDEE (2023), State Energy Report, at p. 15

48 NDEE (2023), State Energy Report, at p. 14

49 EIA (July 31, 2024), Nebraska Natural Gas Summary, at http://www.eia.gov/dnav/ng/ng_sum_lsum_dcu_sne_a.htm (data through 2023); ScottMadden analysis

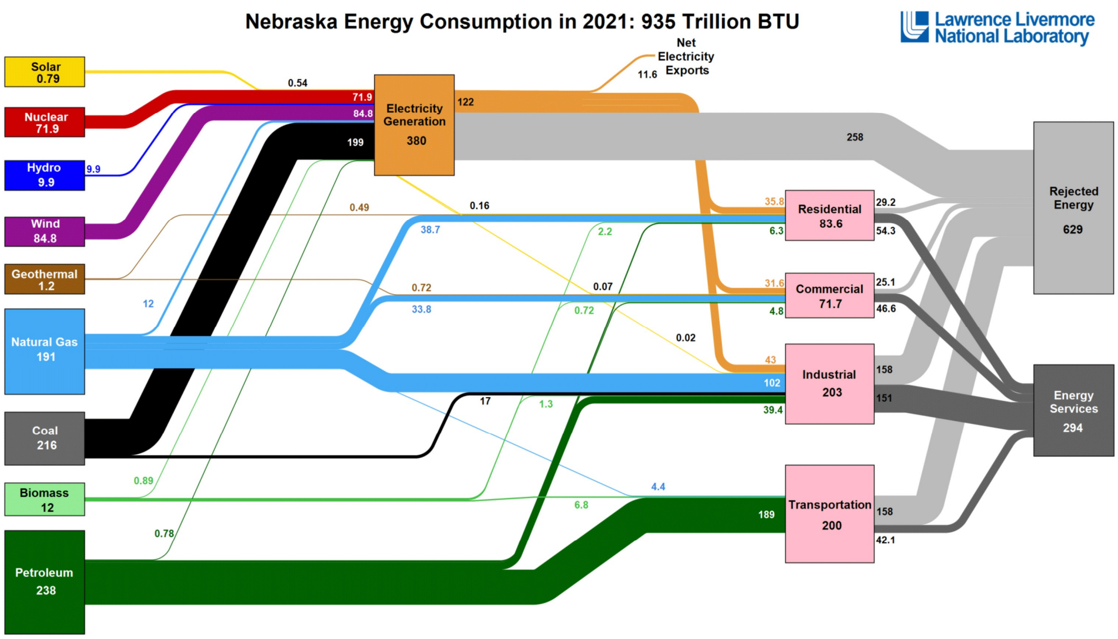
50 EIA Profile

51 EIA (Aug. 6, 2024), Retail Sales of Electricity, at https://www.eia.gov/electricity/data/browser (annual data through 2023) (EIA Retail Electric Sales data); ScottMadden analysis

accounts for a significant amount of this growth. Peak load (maximum hourly demand for a year) three-year compound annual growth for Nebraska's major public power utilities has also grown by more than 3%: NPPD (3%), OPPD (5.4%), and LES (4.6%).[52]

The chart below shows Nebraska energy consumption by source and use for 2021:[53]

Figure : Nebraska Energy Consumption by Source (2021)



Source: Lawrence Livermore National Laboratory

Residential Energy Demand Growth

Residential energy usage has been growing steadily across the state over the past several years. The sector accounted for 18% of overall state energy use in 2021. Typical residential uses are home heating and air conditioning, water heating, cooking, clothes drying, refrigeration, and lighting. Natural gas and electricity are the predominant energy sources for households, comprising 89% of energy usage, followed by petroleum (propane, fuel oil, and kerosene together comprise 7%).[54]

Natural gas consumption by residential customers in 2023 has declined by about 4% annually over the past five years.[55] NDEE has attributed that decline to price response (as residential natural gas prices have increased over that same period) and to increased energy efficiency such as furnace upgrades, conversion to heat pumps, and weatherization.[56] Weather patterns, such as generally warmer winters, also play a role in declining gas use.

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[52] S&P Capital IQ; NPPD, 2023 Financial Report, at p. 3; OPPD, 2023 Annual Report, at p. 88; LES, 2023 Annual Report, at p. 2; ScottMadden analysis
[53] Lawrence Livermore National Laboratory (July 2023), at https://flowcharts.llnl.gov/commodities/energy
[54] NDEE (2023), State Energy Report
[55] EIA data; ScottMadden analysis; NDEE (2023), State Energy Report, at p. 25
[56] NDEE (2023), State Energy Report, at p. 25

Residential electricity sales growth has been increasing but at less than 1% annually (0.5%) since 2018.[57] As of 2021, only 3 in 10 households use electricity for home heating.[58]

Commercial Energy Demand Growth and Drivers

Growth in commercial energy usage was 1.2% year-over-year from 2020 to 2021.[59] The sector accounted for 15% of overall state energy use in 2021.[60] This sector includes accommodations, restaurants, retail businesses, health and educational institutions, and government facilities. Typical energy uses are space heating and air conditioning, water heating, cooking, refrigeration, and lighting.

Growth in commercial electricity usage was low (0.2%) on a compounded annual basis since 2018, but it grew at about 1.7% per year since 2020.[61] Natural gas deliveries to commercial customers declined by 0.4% per year since 2020 and declined at a higher rate (-2.4% per year) since 2018.[62]

According to the U.S. Energy Information Administration (EIA), space heating is the largest contributor to commercial energy consumption in the United States. As such, changing weather conditions toward warmer winters may have contributed to the decline in natural gas consumption.

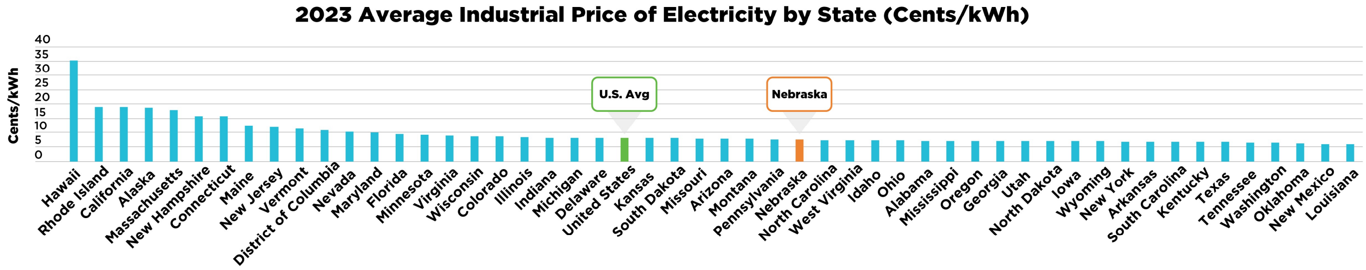
Industrial Energy Demand Growth and Drivers

Nebraska's industrial sector includes a variety of industries, including manufacturing, ethanol production, food processing, and agriculture. Sectors such as technology (including data centers) and business services are growing.[63] Industrial use comprises 45% of total energy consumed in the state.[64]

As of year-end 2023, Nebraska ranked third in the nation, after Texas and California, in its number of industrial electricity customers. About 39% of electricity sales in the state went to the industrial sector. These figures include agriculture, where electricity is used to run irrigation systems on a seasonal basis.[65] The state is attractive for new industrial customers and business expansion for many reasons—favorable business climate, central U.S. location, good infrastructure (roads, railways, river access, fiber, energy infrastructure), abundant water resources, technology-friendliness, and an educated workforce. Also attractive to industrial companies is the cost of energy, in particular electricity. Nebraska's electric rates for industrial customers are lower than the national average, despite the higher cost to serve seasonal irrigation load. As noted previously, the state also ranks well in terms of electric reliability.

57 EIA Retail Electric Sales data; ScottMadden analysis
58 EIA Profile
59 NDEE (2023), State Energy Report, at p. 22
60 Ibid.
61 EIA Retail Electric Sales data; ScottMadden analysis
62 Ibid.
63 Nebraska Chamber Foundation, Nebraska Economic Competitiveness Assessment 2024 (Jan. 2024), at p. 1
64 NDEE (2023), State Energy Report, at p. 15, Fig. 11; EIA Profile
65 EIA Profile

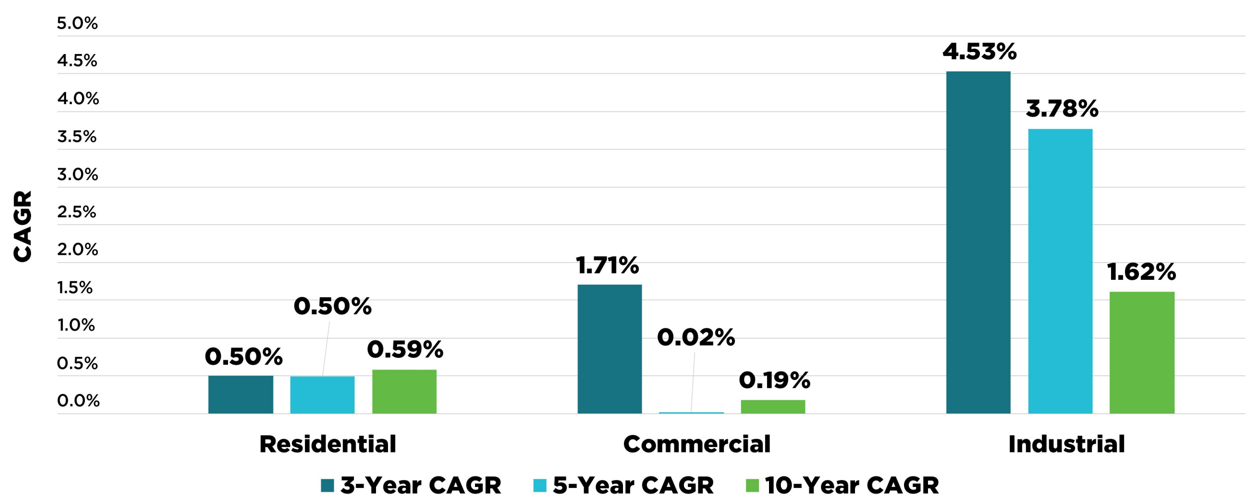
Figure 90: Average U.S. Industrial Electricity Prices by State (2023)



Source: Energy Information Administration

Industrial electricity usage has increased at an annual rate of nearly 3.8% since 2018, while annual industrial customer growth has been about 0.5% over that period.[66] This implies a long-term increase in electric-driven processes or new industrial customers or locations having higher electricity requirements.

Figure 101: Nebraska Retail Electricity Consumption Selected CAGR by Customer Type (through 2023)



Source: Energy Information Administration; ScottMadden analysis

Natural gas demand to the industrial sector was significantly lower year-over-year in 2023, declining from 98 BCF to 86 BCF. Excluding 2023, the five-year compound annual growth rate of gas consumption through 2022 was nearly 2%.[67] Industrial use comprises half of natural gas consumption in Nebraska. Gas is used for operating irrigation pumps and as a feedstock for the manufacture of fertilizer.[68]

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66 EIA data; ScottMadden analysis

67 EIA, Nebraska Natural Gas Summary, at http://www.eia.gov/dnav/ng/ng_sum_lsum_dcu_sne_a.htm (released July 31, 2024)

68 EIA Profile

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Large Loads in Nebraska

One thing that characterizes some of Nebraska's industrial demand is that several significant energy users are also energy producers and providers of energy-related products (e.g., low-carbon fuels). This is also an area where a variety of fuels are used to meet energy needs.

Agriculture

Energy needs for agriculture includes transportation of inputs and outputs from farm production, processing livestock feeds, and irrigation.[69] Electricity is a significant energy source for irrigation (powering nearly 59% of pumps as of 2018). Irrigation demand is seasonal.[70]

Diesel and biodiesel fueled nearly a quarter of irrigation pumps in 2018, while natural gas fueled 11% of pumps. There are indications that increasing digitalization of farming and replacement of labor with mechanical applications is also leading to electrification of irrigation, with farmers converting from diesel fuel and propane.[71] These conversions are facilitated by the U.S. Department of Agriculture and the Nebraska Department of Energy and Environment programs aimed at reducing air pollutants.

[69] NDEE (2023), State Energy Report, at p. 17
[70] Interviews
[71] NDEE (2023), State Energy Report, at pp. 18-19

Ethanol Production

Ethanol serves as a renewable fuel that is blended into gasoline and other liquid hydrocarbons to reduce greenhouse gas (GHG) and other emissions under the U.S. EPA's Renewable Fuel Standard.[72] Nebraska's agriculture industry provides feedstock for ethanol production: approximately 750 million bushels or 29% (net) of Nebraska's annual corn crop goes into producing ethanol.[73,] There are 24 fuel ethanol production plants in Nebraska with around 2.4 billion gallons of annual production capacity.[74] In 2022, Nebraska produced 13% of the nation's ethanol. U.S. ethanol production peaked in 2018, dipping in 2020 (with COVID), but production volumes have been rebounding.[75]

Producers are also expanding into sustainable aviation fuel (see sidebar), which, like ethanol, is derived from biomass and blended into jet fuel to reduce aircraft emissions.[76] ADM, one of the largest ethanol producers in the state, desires to produce a low-carbon intensity ethanol that could be used for the production of SAF or other renewable chemicals.

Sustainable Aviation Fuel (SAF)
SAF is a biofuel with similar properties to jet fuel but with a smaller carbon footprint. It can be produced from many sources (feedstock), including ethanol, waste fats, oils and greases, agricultural and forestry residues, and non-food crops. SAF can be blended with jet fuel with limits between 10% and 50%.

Jet fuel is a significant contributor to carbon emissions, contributing 9% to 12% of U.S. transportation GHG emissions. The international aviation industry has set a goal of net-zero CO2 emissions by 2050. The U.S. government estimates that 35 billion gallons of annual SAF production will be required by 2050 to meet that goal, and three billion gallons annually will be needed to meet an interim 2030 goal of 50% emissions reduction.

The Inflation Reduction Act of 2022 established a tax credit (Section 40B) starting at $1.25 per gallon of qualifying SAF produced. To qualify under 40B, SAF must have at least 50% less emissions when compared to petroleum-based jet fuels. Lifecycle GHG emissions—GHG emissions in production, transportation, and combustion of SAF—are important for qualification for the credit. The tax credit increases as lifecycle carbon intensity decreases. The IRA does allow for renewable energy credits to be used to qualify for low-carbon electricity use. SAF presents a potentially lucrative market for ethanol producers as major airlines like American, Delta, and Southwest have pledged net-zero emissions by 2050.

Other Energy-Intensive Industries

Nebraska is home to other process industries, such as steelmaking, carbon black and hydrogen production, cylinders for energy products (natural gas and renewable natural gas) in transportation applications, as well as chemical manufacturing (pharmaceuticals, pesticides, and fertilizers), food processing, and machinery manufacturing.[77] Some example industries and representative participants are detailed below.

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[72] EIA, at https://www.eia.gov/energyexplained/biofuels/ethanol-supply.php; EPA, at https://www.epa.gov/renewable-fuel-standard-program
[73] Nebraska Corn Board, at https://nebraskacorn.gov/cornstalk/sustainability/ethanol-simplified/ and https://nebraskacorn.gov/corn-101/corn-uses/
[74] EIA, as of Aug. 7, 2023, at https://www.eia.gov/petroleum/ethanolcapacity/
[75] EIA, at https://www.eia.gov/energyexplained/biofuels/ethanol-supply.php
[76] https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuels
[77] Interviews; EIA Profile

Monolith

Monolith, an industrial customer, produces carbon black at its Olive Creek 1 facility. It seeks to expand their current manufacturing facility, Olive Creek 1, to produce additional carbon black and hydrogen through a proprietary, energy-intensive pyrolysis process. It plans to use the hydrogen to produce clean ammonia. The Olive Creek 2 expansion will add approximately 2 million MWh of carbon-free electricity demand to the NPPD system.[78] Monolith is interested in sourcing carbon-free electricity (solar, wind, and energy storage) and renewable energy credits and is working with NPPD for the purchase of those resources. Expansion of the transmission system will also be required to serve this load.[79]

ADM and Tallgrass

ADM has committed to reducing their GHG emissions by 25% by 2035. To advance progress toward that goal, the company has entered into an agreement with Tallgrass to capture CO2 from ADM's corn-processing complex in Columbus, Nebraska, and transport the CO2 to Tallgrass's Eastern Wyoming Sequestration Hub for permanent underground storage.[80] Other ethanol producers are similarly interested in reducing their carbon intensity, including that of their energy sources, to satisfy purchasers' and state and national requirements for products sold to them or into those jurisdictions. Some U.S. states (such as California), Canada, and the European Union have or plan to have such carbon content regulations (see nearby sidebar on Low-Carbon Fuel Standard, for example).

Tallgrass is developing a project to convert its Trailblazer natural gas pipeline to a CO2 transportation service, establishing an approximately 400-mile CO2 pipeline to serve as the backbone of a regional CO2 transportation system. This project will allow for the capture, transport, and sequestration of CO2 to aid communities and customers in carbon capture and sequestration (CCS) projects to meet their own decarbonization goals.[81]

Low-Carbon Fuel Standard:
An Example of Customer Requirements

The Low-Carbon Fuel Standard (LCFS) was designed by the California Air Resource Board as an early measure to reduce carbon emissions in the transportation sector. It was estimated that transportation emissions accounted for 50% of GHG emissions in California.

The LCFS set a carbon intensity (CI) requirement for transportation fuels, including gasoline, diesel, SAF, and other alternative fuels, based on the carbon intensity of gasoline and diesel and equated to a 20% reduction in emissions. Importantly when calculating CI scores, emissions across the entire lifecycle of the fuel are counted, including power source emissions. This results in producers looking to have direct connections with low CI generation to meet the requirements.

The standard gives credit for use of renewable hydrogen in refineries and for use of CCS in alternative fuels production facilities. The LCFS has been adopted in California, Oregon, and British Columbia, with Washington and other regions considering similar standards.

[78] Monolith Corp (2021), at https://monolith-corp.com/news/monolith-seeking-2-million-megawatt-hours-of-renewable-energy-annually-for-planned-expansion
[79] NPPD, Financial Report 2023, at p. 21
[80] Tallgrass (2022), at https://tallgrass.com/newsroom/press-releases/tallgrass-to-capture-and-sequester-co2-emissions-from-adm-corn-processing-complex-in-nebraska
[81] Ibid.

The Trailblazer CO2 pipeline represents an opportunity to improve carbon capture and sequestration capabilities in Nebraska. This does not consider the energy required to capture carbon which will also represent new loads. ADM has already signed on as a partner to utilize the pipeline to capture and transport carbon from their corn-processing plant in Columbus, Nebraska.

Nucor

Nucor is one of the first diversified steelmakers to announce net-zero, science-based GHG emissions intensity targets for 2050. Nucor seeks to meet this target through a comprehensive carbon reduction strategy that includes increased use of clean electricity, CCS, and near-zero GHG ironmaking.[82]

As the above examples demonstrate, the clean energy transition is creating opportunities for Nebraska companies to develop fuels and products that both meet clean energy objectives and take advantage of federal subsidies. The facilities needed to produce these fuels and products also consume energy, often with clean energy requirements. As such, these types of large loads are driving both increased energy demand and the need for more generation and, specifically, non-carbon-emitting energy.

Data Centers

Nebraska is seeing the same influx of data centers as other parts of the country. The large tech companies have either established data centers or are planning facilities in the state, generally in the Omaha and Lincoln metropolitan areas.

There are 10 data centers in Nebraska, all located in the Omaha or Lincoln metropolitan areas.[83] Tech giants Meta and Google have large data centers in and around the Omaha metro area.[84] Meta's data center broke ground in 2017. Google broke ground on its Papillion data center in October 2019. While data centers differ in size, number of servers, function, and efficiency, typical data center electricity demand can range from one MW to hundreds of megawatts.[85]

One benefit of data center demand is that it provides steady, stable, around-the-clock demand. This predictable load profile[86] allows for relatively lower cost to serve and can make these customers financially attractive to an energy supplier or utility.

Meta

Meta, previously known as Facebook, broke ground on its Sarpy Data Center in 2017. Meta has announced plans to expand this data center to nine total buildings, creating a roughly 3.6 million square-

[82] Nucor (2024), at https://nucor.com/sustainability
[83] https://www.datacenters.com/locations/united-states/nebraska
[84] NDEE (2023), State Energy Report, at p. 19; Nebraska Examiner (Aug. 22, 2023), "Google Confirms Lincoln's $600M Data Center, Touts This Year's $1.2B Spend on NE Infrastructure"; Meta, at https://datacenters.atmeta.com/all-locations/#united-states and https://datacenters.atmeta.com/wp-content/uploads/2024/07/Nebraska-Sarpy.pdf; Google, at https://www.google.com/about/datacenters/locations/papillion/
[85] https://dgtlinfra.com/data-center-power/
[86] See Appendix A regarding customer and load types.

foot campus.[87] Meta's data center represents an investment of more than $1.5 billion in Nebraska. Since joining the Nebraska community, they have provided more than $3.8 million in direct funding to schools and nonprofits in the area.

Since 2020, Meta has supported its operations with 100% renewable energy by bringing online new renewable energy resources that equate on an annualized basis to the energy their data centers use. It has already brought online 320 MW of wind energy in Nebraska in addition to other new renewable energy resources within the same regional grid (SPP) to support its operations in the region.[88]

Google

Google broke ground on its first data center in Sarpy County, Nebraska. Google has plans to expand in Nebraska by developing data centers in both Lincoln and Omaha.[89] To reach its net-zero goal, Google contracts via renewable power purchase agreements and also purchases bundled renewable energy credits from renewable energy sources located in Nebraska's regional power market (SPP). It recently announced the Pierce County Energy Center, a subsidiary of NextEra Energy Resources, LLC—a 420-MW solar and 170-MW battery energy storage system—in northeast Nebraska that is expected to come online in 2027. This facility along with the High Banks Wind Energy Center, also a subsidiary of NextEra Energy Resources, was deployed in collaboration with OPPD under a new procurement framework as a way to expedite energy procurement and address increasing electricity demand. OPPD and its customers will benefit from the clean capacity attributes of these facilities.

Figure 112: Selected Large Customer Clean Energy Goals

Company	Commitment	Time Frame
Google	Net-zero emissions across all operations and value chain	2030
Meta	100% renewable energy and net-zero operational emissions Net-zero emissions across whole value chain	Since 2020 2030
ADM	25% reduction in GHG emissions	2035
Nucor	Net-zero emissions	2050

Source: Interviews, company disclosures

Cryptocurrency Mining

The state is also seeing cryptocurrency mining loads looking to interconnect to the system. Those operations—creating cryptocurrency such as Bitcoin—are computationally intense and have significant power requirements. Typically, these customers seek inexpensive power, potentially without regard for its source.[90] These loads are flexible, depending upon energy costs and cryptocurrency values, and they can ramp up and down operations accordingly.

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[87] Meta (July 28, 2022), at https://www.facebook.com/SarpyDataCenter/posts/pfbid02wGy6wFfKbqgXLouRvrLRSgnQNonyv85coDbF1oCeaQ8ouiXC8Ub8ZXS8GFRsvXCSl

[88] Meta (2022), Economic Impact of Meta-supported U.S. Renewable Energy Projects; interviews

[89] Nebraska Examiner (2022), Google Announces Nebraska Growth Plan that Includes New Northwest Omaha Data Center; Nebraska Examiner (2023), Google Confirms Lincoln's $600M Data Center, Touts This Year's $1.2B Spend on NE Infrastructure

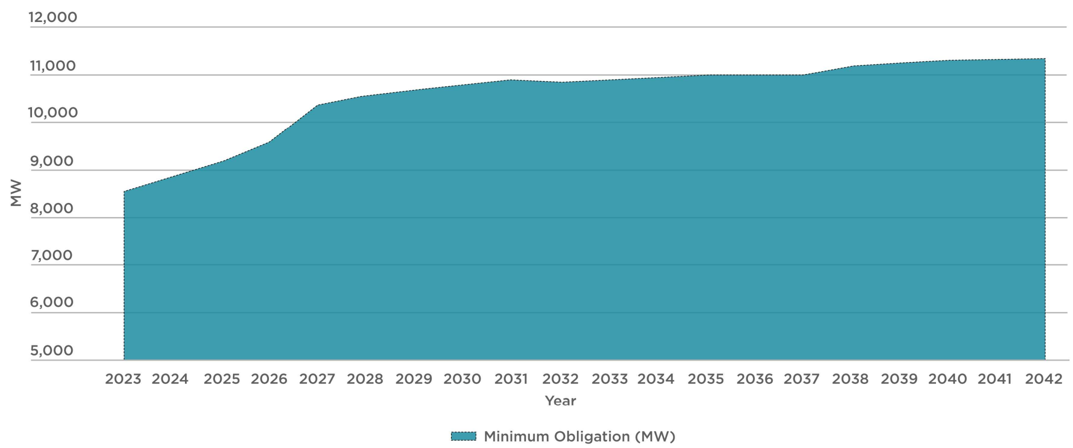
[90] White House Office of Science and Technology Policy (Sept. 2022), Climate and Energy Implications of Crypto-Assets in the United States, at https://www.whitehouse.gov/wp-content/uploads/2022/09/09-2022-Crypto-Assets-and-Climate-Report.pdf

Power Demand

The proposed location of new, large spot loads in Nebraska and expansion of existing operations of current large energy consumers are leading to significant increases in energy demand in the state.

Nebraska Power Association (NPA) studied the growing demand in Nebraska in their load and capability report. One metric is the minimum obligation which represents the minimum amount of energy the utilities need to be able to provide to support Nebraska and is calculated by adding the net reserve capacity obligation to the forecasted annual system demand. NPA estimates that the minimum obligation for Nebraska would increase from around 8,500 MW in 2023 to nearly 11,000 MW in the next 10 years.[91]

Figure 12: Nebraska Summer Minimum Capacity Obligation (MW) for Resource Adequacy (as of August 2023)



Source: 2023 NPA Load and Capability Report

Both NPPD and OPPD state in their integrated resource plans (IRPs) that they have updated their load forecasts with known large loads. These large loads were indicated to be primarily industrial customers, including data centers, and increased the load forecasts by hundreds of MWs. These load forecasts are used in their IRPs to plan future resources, as well as used in the Nebraska Load and Capability report to understand minimum load obligations.

When considering the customers either expanding operations or requesting new connections to the Nebraska grid, as described above, many have net-zero commitments or specific requirements for the use of non-carbon-emitting generation to produce their products. As such, this combination of requirements adds complexity in resource planning by the utilities and will drive additional clean resources in the state (or contracts through SPP). Please see Load Growth and Clean Energy Demand section below.

Natural Gas Demand

Several generating stations in Nebraska are considering repowering from coal to natural gas to improve their emissions profile and position the generating resource portfolio for Nebraska utilities' net-zero objectives. These conversions could increase natural gas demand in the state. While natural gas demand

[91] NPA (2023), Load and Capability Report

for power generation is relatively small compared with other fuels (natural gas-fired power production consists of about 3% of Nebraska's total MWh power production in 2023),[92] repowered facilities and new gas-fired facilities may increase gas's share in the fuel mix. A few examples of potential new gas-fired power generation are:

- **Sheldon Station:** In its latest IRP, NPPD indicated that it is investigating potential restoration of the 216 MW Sheldon site to natural gas operation.[93] No studies have been completed nor decisions made on this resource.
- **Standing Bear Lake and Turtle Creek Stations:** OPPD is constructing these stations, which will add 150 MW of gas-fired reciprocating engines (Standing Bear) and 450 MW of dual-fueled gas-fired combustion turbines (Turtle Creek) to meet growth in energy demand. The units are expected to be operational in 2024/2025.[94]
- **North Omaha Station Units 4 and 5:** OPPD plans to repower these units (nameplate 278 MW)95 with natural gas but will await operation of Standing Bear Lake and Turtle Creek Stations before doing so to maintain reliability.[96]
- **900-MW Natural Gas Capacity Expansion:** OPPD has contracted for four 225-MW Siemens dual fuel combustion turbines. Three are to be sited at its Cass County Station; one is to be sited at its Turtle Creek Station.[97]

Black Hills Energy, the largest natural gas distribution company in Nebraska, has seen its number of customers growing by more than twice the rate of the state's population growth since 2018 (3.6% annually vs. 1.7%).[98] The company is planning to invest $513 million in its Nebraska assets 2024-2028.[99]

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[92] Ibid.
[93] NPPD (2023), Financial Report, at p.9
[94] OPPD 2023 Annual Report, at pp. 25-26
[95] OPPD 2021 IRP, at p. 92
[96] Ibid.
[97] OPPD (June 18, 2024), at https://www.oppd.com/media/319925/2024-6-june-new-generation-and-transmission-update.pdf
[98] Black Hills Energy, Presentation at the AGA Financial Forum (May 2024), at p. 6
[99] Black Hills Energy, Presentation at the AGA Financial Forum (May 2024), at p.31, ScottMadden analysis

PATH FORWARD

Nebraska's energy landscape is experiencing a significant transformation driven by unprecedented load growth and an increasing demand for clean energy. This section explores the key drivers behind this shift, the strategic responses from the state's major utilities, and the common themes shaping Nebraska's energy future.

Key Drivers

Load Growth and Clean Energy Demand

As described in this paper, load is growing at a rate not seen in generations. The shift that the electric sector is undergoing with the rapid emergence of large loads across the country and the electrification of transportation and heating is unprecedented.[100] Nebraska itself is experiencing substantial load growth, driven by large-scale industrial customers, including industrial agriculture, data centers, and cryptocurrency mining operations. The rapid deployment of new generation and grid investment are critical to meeting the growing needs of these large-load customers—specifically data centers and manufacturing companies—who are making load interconnection requests of hundreds of MWs, something the industry has never seen before.

However, electric infrastructure, particularly certain types of generation and greenfield transmission, can take a decade or more to build. As a result, the rate at which electric infrastructure investments can be made in Nebraska will, at least partially, determine the degree to which the state can take advantage of the influx of new customers and industry.

The degree to which the pace of change in the industry has accelerated cannot be overstated. In mid-2023, the industry was only just beginning to talk about large loads, and the first major industry report on the topic was published in December 2023.[101] The fact that load forecasts are showing significant increases year to year is also new and, importantly, was not anticipated. As such, frequent revisions to load forecasts and required generation and grid infrastructure should be expected through this period.

As sustainability becomes a priority for industries and consumers, the demand for clean energy sources is intensifying. Major customers, such as tech giants and industrial agricultural companies like ADM, are setting ambitious net-zero-carbon goals. For example, Google aims to achieve net-zero emissions across its operations and value chain by 2030[102], and ADM targets a 25% reduction in absolute Scopes 1 and 2 emissions[103] by 2035.[104] This demand is prompting utilities to transform their generation mix, integrating more renewable resources like wind, solar, and energy storage.

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[100] See Appendix F: Factors Driving Power Needs Across the United States

[101] Grid Strategies 2023 Report, at https://gridstrategiesllc.com/wp-content/uploads/2023/12/National-Load-Growth-Report-2023.pdf

[102] Google (2024), Net Zero Carbon

[103] Scope 1 emissions are direct emissions from owned and controlled facilities by the company. Scope 2 emissions are indirect emissions from energy purchased from utilities. Source: GHG Protocol

[104] ADM (2022), ADM's Net Zero Aspirations

Regulatory Landscape and Its Impact on Infrastructure Development

It is also important to note that Nebraska is not isolated from national or regional regulation that will impact the development of generation and transmission infrastructure. In the case of generation, EPA's recent revisions of emissions regulation under §111 of the federal Clean Air Act, if implemented in its current form, will dramatically change the parameters within which both coal and natural gas plants must operate. In the case of coal and high-capacity new gas plants, it will require carbon capture and storage. In addition, the generation queue in SPP directly impacts the ability to get generation projects approved for deployment in Nebraska. Developments at the EPA on GHG emission regulation and at FERC and SPP on generation queue reform will have significant implications for the nature and speed at which resources can be deployed within the state.

Utility Near-Term Responses

Nebraska utilities are responding to this load growth by expanding their generation resources to ensure reliability while integrating greater amounts of renewables into their system to meet the goals of their customers. These actions reflect the utilities' commitments to aligning their development of infrastructure with the pace of customer demand for both generation and grid investments.

Integration of New Resources

LES, OPPD, and NPPD are increasingly integrating a variety of resources into their portfolios to meet growing demand and achieve their emissions-reduction targets (to meet both their own goals and those of their customers). These resources are being developed through both independent project development and strategic collaborations. While the utilities continue to build out projects to meet load growth, they are using a variety of energy sources, both traditional and renewable, to continue providing reliable energy.

To meet the short-term increase in demand growth, the utilities are taking several steps:

- **OPPD** plans to add 2.5 GW of generation over the next decade to meet the anticipated annual load growth of 100 MW,[105] which includes 1,100 MW of solar, 500 MW of wind,

NPPD Load Queue Process

In 2024, the NPPD established a new process to manage the growing demand of large-load customers. This process was developed to manage customer expectations around timelines and enable NPPD to plan capacity to ensure reliability for existing customers. It applies to any project greater than or equal to 5 MW for new and expanding customers.

The process follows several milestones before customers are given an in-service date. The "New Load Queue Process" requires an application, a signed memorandum, and two security deposits amounting to $12,000/MW. Once the application is submitted, two studies are conducted to assess the feasibility of the project. If transmission upgrades are required, customers are responsible for the added construction costs related to potential stranded assets, outlined in the Transmission Facilities Construction Agreement. New load projects are then added to the project queue in the order they were received. The queue is reviewed twice a year to determine if certain projects can be brought online sooner than anticipated if other projects fall through.

[105] OPPD (2024), Generation Expansion

and 150 MW of energy storage by 2030.[106]

- **NPPD** approved a budget[107] in early 2024 for new generation resources to meet growing demand, including 50 MW of battery storage near the Ainsworth Wind Facility, 50 MW of battery storage capacity purchased from an existing, privately owned wind facility, 216 MW of dual-fuel reciprocating internal combustion engines, and 420 MW of dual-fuel combustion turbines.
- **LES** continues to expand its renewable energy portfolio as outlined in its IRP.

Innovative Partnerships and Rates

OPPD has collaborated with NextEra Energy Resources and Google to access 600 MW of wind capacity at the High Banks Wind Energy Center. In this arrangement, OPPD benefits from increased renewable energy resources, NextEra Energy Resources gains a committed customer, and Google retains the energy and environmental attributes to support its climate goals. These partnerships create mutual benefits by aligning the interests of utilities, developers, and companies pursuing sustainability targets.[108]

Utilities are developing innovative rates to manage demand and support the integration of renewable resources. These rates are designed to provide flexibility and incentivize customers to shift their usage to periods of high renewable generation, thereby improving the overall efficiency and sustainability of the grid. For example, LES's dynamic pricing structure encourages energy efficiency and aligns consumption with renewable energy availability, helping to reduce peak demand and integrate more renewables into the grid.

Rate Innovation: OPPD's 261M Rate

In 2017, OPPD was the first U.S. utility to offer a green rate through its 261M rate, a program that lets customers buy large-scale renewable energy through its system. The rates are market based and cover the utility's fixed costs. This program was developed and approved within three months to address growing demand from Fortune 500 companies for renewable energy to meet their energy and climate goals.

These new rates are only applicable to commercial- and industrial-size customers with a demand of 20 MW at 161,000 volts or 200 MW for 345,000 volts (transmission levels). The rate allows customers 18 months to ramp up to the minimum energy demand which is then billed a monthly service charge of $10,000, a demand charge of $18.36/kW, an energy charge which covers the cost of energy purchases from SPP, and a 5% gross revenue charge in lieu of taxes.

The structure provides a mechanism to pay for grid upgrades specific to these customers and enables them to access energy through the SPP market.

Technological Advancements

The exploration of new, or emerging, technologies, such as energy storage, hydrogen, and carbon capture and storage, is critical for achieving long-term sustainability goals while maintaining system reliability. Nebraska utilities are investigating and investing in these resources to support their transition to cleaner energy. However, technology readiness is an important consideration. Several non-emitting energy technologies, such as long-duration storage and advanced nuclear generation (including small

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[106] OPPD 2021 Integrated Resource Plan, at p. 87
[107] NPPD (2024), New Generation for Future Growth
[108] OPPD, at https://www.oppdcommunityconnect.com/generation (accessed Sept. 13, 2024)

modular nuclear reactors), are years away from commercialization and, while promising, are not available in the time frame required to meet currently anticipated, near-term load growth. Many of these technologies require further demonstration, technology improvements, cost improvements (that come with learning curve improvements), and in some cases new regulatory frameworks.

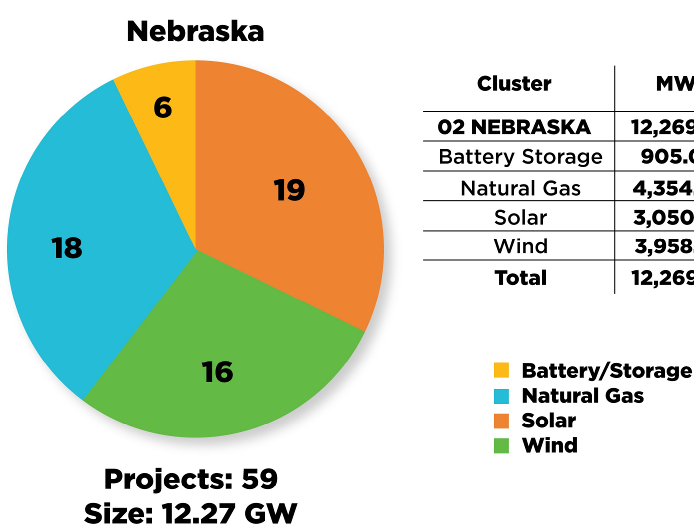
Interconnection for Private Renewables

Private renewable energy developers are a growing part of Nebraska's energy landscape. The state has rich wind and solar resources, and federal subsidies under the IRA are driving the development of these facilities.

Nebraska offers a streamlined approval process through the PRB for private renewable developers, which helps expedite project development once the project has cleared the SPP interconnection queue. This streamlined process is described in more detail in the Nebraska Public Power and Private Developers section. It is important to note that while the PRB approval process is streamlined, zoning and permitting is done at the county level and can prove very challenging.

In addition, the SPP generation interconnection queue, through which new generation resources seeking to connect to the grid are studied, has become increasingly congested. As of 2024, there were more than 80,000 MW of generation capacity in the queue with significant portions allocated to wind, solar, and energy storage projects.[109] The long wait times in the SPP queue—averaging over five years—pose a significant barrier to the timely development of all new generation projects.

Figure 13: SPP Generation Interconnection Queue for Nebraska Subregion (as of Late August 2024)



Cluster	MW	Projects
02 NEBRASKA	**12,269.10**	**59**
Battery Storage	**905.00**	**6**
Natural Gas	**4,354.96**	**18**
Solar	**3,050.87**	**19**
Wind	**3,958.27**	**16**
Total	**12,269.10**	**59**

Sources: SPP Generation Interconnection Queue Dashboard, accessed Aug. 2024

[109] SPP Generation Interconnection Queue, link from https://www.spp.org/engineering/generator-interconnection/

Black Hills Energy: Delivering Natural Gas to Support Nebraska's Economy

Black Hills Energy conducts annual gas supply planning to forecast peak demands and ensure supply. According to their annual report, Black Hills Energy has deployed $590 million to support their infrastructure, including improving risk detection and replacing leaking or damaged pipes.[110] The company has also seen customer growth in the agricultural sector from soybean, beef, and ethanol producers who have been looking for renewable natural gas (RNG) sources. Black Hills Energy currently has four RNG interconnection sites in Nebraska and has plans for a fifth interconnection site.[111] The company is planning to spend around $513 million through 2028 on its infrastructure in the state.[112]

Utility Long-Term Responses

Nebraska's major utilities develop long-term IRPs that outline their strategies for meeting future energy needs while transitioning to cleaner energy sources. These plans reflect each utility's approach to balancing reliability, affordability, and sustainability in the context of Nebraska's unique energy landscape. Each of the utilities emphasizes the need for flexibility in planning, particularly in the face of load growth, clean energy demands, and regulatory changes. Ensuring reliability while transitioning to cleaner energy sources is a key priority for all of them.

All three major utilities have set net-zero targets, with LES setting the most ambitious target to be achieved by 2040 and NPPD and OPPD by 2050. The IRPs provide a roadmap for achieving these goals through a combination of renewable energy expansion, fossil fuel transition strategies, and the integration of new technologies such as energy storage. Summaries of the IRPs and selected updates for each utility are provided below:

Example Trend: Rapid Update of Resource Plans—Georgia Power Company (GPC)

GPC updated its 2022 IRP in October 2023 when its projected load growth increased from 400 MW to 6,600 MW through 2030, driven primarily by data center load growth in its service territory. Importantly, this need has emerged as the company just added approximately 2,200 MW of generation capacity with the completion of Vogtle Units 3 and 4.

GPC's revised IRP was filed to request approval for power purchase agreements, contracted resources, and planned resource investments. GPC will invest in new battery energy storage systems, develop solar capacity, build new simple-cycle combustion turbines, and expand distributed energy resources and demand response programs. In addition, the company expects to add 10,000 MW of new renewables by 2035.

To address flexibility concerns it established a framework within which the company can procure additional capacity ("flex capacity") ahead of its 2025 IRP filing.

OPPD IRP and Generation Updates

- **Power with Purpose Initiative**: OPPD's strategy prioritizes carbon reduction by ceasing coal operations at the North Omaha Station. This involves retiring Units 1-3 (241 MW) in 2026 and converting Units 4-5 (278 MW) to natural gas in the same year.

[110] Black Hills (2023), Annual Report
[111] S&P Global (2024), Gas utilities continue to line up new pipeline links to RNG projects
[112] Black Hills Energy, Presentation at the AGA Financial Forum (May 2024), at p.31

Smart. Focused. Done Right.®

- **Renewable Expansion**: OPPD began operations of 81-MW Platteview solar project in May 2024[113] and plans to add 1,000 – 1,500 MW of renewable generation through 2030, and 125 MW of energy storage by the end of 2027. By 2050, these targets expand to 3,000 MW of solar, 3,800 MW of wind, and 800 MW of energy storage. This significant increase in renewable capacity is central to OPPD's plan to achieve its net-zero goals.
- **Planned Projects**: OPPD expects to bring natural gas generation, totaling 600 MW, online in 2024/2025 and is pursuing an additional 900 MW of gas-fired generation.[114] These projects are part of OPPD's broader strategy to meet growing energy demand, particularly from large industrial customers and data centers, while transitioning to cleaner energy sources.
- **Flexibility in Near-Term Planning**: In response to unprecedented load growth, OPPD has shown flexibility in its planning processes, delaying some retirements and conversions while adding new natural gas turbines to ensure reliability.

Growing Importance of Gas-Fired Generation and Natural Gas Supply

One of the trends that the electric industry has witnessed in recent years is an increasing reliance on natural gas for both base-load generation, as coal has retired, and balancing a growing portfolio of renewables. While natural gas-fired generation represents a relatively small portion of the generation fleet today in Nebraska, it is forecasted to play a larger role as coal plants retire and more renewables are integrated into the system. Recent winter events (such as Winter Storms Uri and Elliott) have demonstrated the outsized role that natural gas can play in extreme winter weather.

Developing natural gas-fired plants (and the pipelines that supply them) is not without challenges. New gas-fired generation in the state will be subject to the same interconnection challenges facing all new generation in SPP. In addition, incremental gas supply to the state may also be required as usage of the fuel expands. Fortunately, there are several pipelines that run through Nebraska today, which could ease access to supply. Lastly, new gas plants will also be subject to EPA's §111 GHG emissions rule, depending on what happens with myriad legal challenges currently underway. If implemented in its current form, the rule will dictate the amount of CO_2 that can be emitted as they operate.

NPPD

- **Natural Gas Conversion at Sheldon Station**: NPPD is exploring the restoration of natural gas as the primary fuel at Sheldon Station beginning in 2028. This is part of a broader strategy to maintain a diverse energy portfolio while reducing carbon emissions.
- **Nuclear License Extension:** NPPD is pursuing a 20-year license extension for Cooper Nuclear Station, which would allow it to continue providing emission-free electricity until 2054.[115]
- **Renewable Energy and Energy Storage**: NPPD plans to maintain and expand its Tier 1 wind and solar resources as part of its commitment to sustainable energy. NPPD is also

[113] OPPD, https://www.oppdcommunityconnect.com/power-with-purpose-solar
[114] OPPD (2024), at https://www.oppd.com/media/319925/2024-6-june-new-generation-and-transmission-update.pdf and https://www.oppd.com/media/320139/2024-9-sept-sd-9-integrated-system-planning-monitoring-report.pdf
[115] NPPD, "Cooper Nuclear Station Celebrates 50 Years of Reliability" (August 2024)

focusing on energy storage technologies, recognizing their importance in balancing intermittent renewable energy with reliable grid operations.

- **Coal Plant Retirements and Carbon Capture**: By summer 2026, NPPD plans to evaluate an expanded energy mix, including the potential for retiring or upgrading existing coal resources with carbon-capture technology. This aligns with the utility's longer-term goals of reducing reliance on coal while ensuring grid reliability.
- **Demand Response Programs:** NPPD has pilot demand response programs[116] for both wholesale and retail customers, which supports resource adequacy requirements.[117]

LES

- **Renewable Energy Development**: LES plans to maintain its Tier 1 wind resources and develop Tier 1 solar resources. These efforts are part of LES's broader strategy to increase the share of renewables in its energy mix.
- **Energy Storage and Microgrids:** LES is actively exploring energy storage technologies, including a battery storage pilot project. Additionally, LES is expanding its community microgrid solar initiatives, which are designed to enhance grid resilience and support local energy needs.
- **Dynamic Pricing and Demand Response**: To better manage demand and integrate renewable energy, LES is implementing a dynamic pricing rate structure for its customers. This approach aims to incentivize energy efficiency and align consumption with periods of high renewable generation.

Role of Rural Electric Cooperatives, Public Power, and Municipal Utilities

The state's rural electric cooperatives, municipal utilities, and smaller public power districts are key players in meeting customer demand and serving communities throughout the state. In looking at utility responses and plans to meet changing energy demands in the state, we have focused in this paper on the larger public power districts, which supply most of the power to distribution utilities and municipalities as well as end-use customers.

Takeaways

Nebraska's energy landscape is undergoing significant transformation driven by rapid load growth and demands for clean energy. The state's utilities are responding with comprehensive plans that balance immediate needs with long-term sustainability goals. Through strategic investments in new generation, renewable energy, streamlined regulatory processes, and innovative rates, Nebraska is positioning itself to meet future challenges while continuing to provide reliable, affordable energy to its residents and industrial customers.

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[116] Demand response programs encourage customers to voluntarily curtail usage at times of high prices or system stress in exchange for compensation or reduction in electricity charges.
[117] NPPD, at https://docs.nppd.com/Board/2023/October7.pdf

SUPPORTING ENERGY INFRASTRUCTURE IN NEBRASKA: AREAS FOR CONSIDERATION

Stakeholder Education

On the whole, the average American citizen is relatively uninformed about the energy industry, infrastructure development, energy costs, and the industry's fundamental role in our economy. There is also significant misinformation available about the health and environmental effects of certain types of energy infrastructure. In Nebraska, there is often community pushback about the appearance of infrastructure, the proximity of farmland to renewable installations, or the use of farmland for renewables development. In addition, these arguments both for and against various types of projects have become highly contentious. Unfortunately, energy is a complex and multifaceted subject that does not lend itself to easy answers or sound bites.

Because energy is such an important enabler of economic growth in Nebraska, the state has an opportunity to educate its myriad stakeholders and policy makers about the industry and its benefits. This education should include:

- The basics of energy infrastructure (electric and gas)
- The critical role energy plays in the broader Nebraska economy
- How the cost and reliability of electricity in the state compares to its neighbors
- Facts about various types of generation in Nebraska and their health impacts (or lack thereof)
- The benefits of a diverse portfolio of generation for both cost and reliability, including the role of natural gas and fuel flexibility in ensuring reliability
- Nebraska's approach to clean energy and its importance to companies moving to the state or looking to grow
- The economic benefits of renewables to the counties where they are located (e.g., nameplate tax revenue)

Creating a base of educational materials that can be used by utilities, developers, economic development offices, state and local officials, and companies looking to invest in the state could both align the parties on key facts and dispel some of the misinformation that is available.

It is critical that policymakers lead the way in becoming educated about these topics. Making sure that their own positions are both well informed and grounded in fact can guide the state in making decisions that both preserve reliability and affordability while enabling economic development. Understanding the role that clean energy will play as the state's energy ecosystem evolves to meet the needs of a changing customer base will be critical.

Permitting and Zoning

The permitting and zoning processes to build generation are different for public power entities and private developers. Public power entities go through a review process with the PRB that assesses questions of need, cost effectiveness, and public benefit. However, once those thresholds are met, the utilities have relatively little difficulty in siting and permitting.

Private developers go through a streamlined approval process for projects (which does not include meeting the same thresholds as public utilities); however, they must then go through a zoning and permitting process that may be unique to each county in the state. As with the siting of any type of infrastructure, stakeholder opposition can be extensive. As such, the process can take significant time and effort and yield very different results from county to county.

The state might consider a “model rule” approach to permitting and zoning to streamline the process and provide a consistent approach and set of requirements to developers. This could include identifying leading practices from projects considered successful by both communities and developers. Based on these leading practices, a “standard” process could be introduced to counties grappling with these challenges.

Private developers pay a combination of real and personal property taxes and nameplate capacity taxes to the counties within which they operate. The nameplate tax was designed to provide a stream of income to the county roughly aligned with the life of the asset; 26 years was used to calculate the nameplate capacity tax. Some counties have touted the benefits of these funds to their communities. There may be an opportunity to align the receipt of this tax revenue, or a portion of it, to the use of the model rule described above. These funds could also be earmarked for particular county programs or funds.

Large Loads

As the role of technology in our modern economy continues to grow, data center developers are searching for optimal locations. Access to affordable, reliable electricity is a key criterion in their evaluations of potential locations. Given the size and quantity of these load interconnection requests, utilities across the country are grappling with how to assess and then plan for the infrastructure needed to support these customers. Importantly, this is true across the country; Nebraska is not unique in this challenge.

In considering the build of infrastructure to support large loads, particularly from data centers (because of how quickly they can come online) but also for other types of facilities, it is important to recognize that utilities typically build infrastructure when they have a clear line of sight to load coming online. To the extent that a load is “speculative” or “uncertain,” the utility typically does not build grid or generation facilities, as there is no clear path to recovery of the costs of those assets. As such, gaining clarity on the development plans of large-load customers and aligning their commitments to locate in the state with the utility’s requirements to build infrastructure are important.

This approach is not unlike recent FERC reforms to the generation interconnection process that require generation (primarily renewables) developers to meet certain thresholds or criteria before they advance in the regional “queue” to be studied as a new generator on the system.

As Nebraska’s utilities work to bring on these new loads, mechanisms that enable both line of sight to load being connected and financial commitments to support the needed infrastructure are critical. In addition, given the amount of infrastructure that may be required to connect these loads, it is important that these customers pay their portion of incurred costs and that the utility is able to hold its other customers harmless to the degree that is appropriate. To the extent that infrastructure initially needed to meet large loads benefits customers more broadly (i.e., transmission investments), those costs can and should be borne by all beneficiaries.

A combination of creative contracting and rate structures can enable utilities to gain lines of sight to interconnection and customers to provide financial commitments to the service territory. Utilizing SPP to provide energy to these large loads provides a mechanism by which to procure energy but not necessarily require the build of all additional generation by utilities within Nebraska. Of course, Nebraska utilities must provide sufficient additional generation deliverable to meet resource adequacy requirements under regional reliability rules.

Given the significant need for generation resources to meet the loads coming to the state, “all hands on deck” will be needed to meet these needs. This includes both electric and gas utilities as well as public and private entities. Public power entities generally have the flexibility to enter into partnerships with both customers and their peers to site generation or other infrastructure. There may be options to expand natural gas offerings to certain types of customers. Expanding these creative structures and contracting could benefit both utilities and their customers as the state looks to support both new load and customers.

CONCLUSION

Nebraska has reliable, affordable energy. The state has maintained a portfolio of energy resources that have served it well in keeping energy costs low and reliably meeting demand. Access to low-cost, reliable energy underpins a very successful agriculture sector and has attracted a variety of other industries to the state. These include agriculture-adjacent industries like ethanol production, as well as steel manufacturing and data centers.

In recent years, the United States has seen a significant increase in requests by large customers to interconnect to the grid. This has been driven by the onshoring of manufacturing, the expansion of data centers to support advanced cloud computing, Internet of Things applications, web-based commerce and growth in artificial intelligence applications, and growth in cryptocurrency mining. Favorable federal policy for products like ethanol has also driven demand for agriculture-adjacent industry. As a result, the number and size of load interconnection requests has ballooned across the country and within Nebraska. Many of these large customers have net-zero or carbon-emissions-reduction targets and are trying to procure clean energy to help meet these goals. Some customers produce products that have a requirement to use only "clean," "zero-emitting," and/or low-carbon-intensity resources in their production.

Federal and state policies supporting clean energy and renewables is driving a wholesale shift in the types of generation available across the country. The system is moving away from baseload fossil power plants and integrating increasing amounts of renewable resources in quantities that are twice the amount of currently installed power plants. Generous federal subsidies to renewable energy and the availability of rich wind and solar resources in Nebraska are bringing renewable developers to the state. However, local resistance to these projects can be significant. These developers follow different processes to develop projects from public power entities; however, they have a role to play in meeting the energy needs of the state.

Natural gas also plays an important role in delivering affordable, reliable energy to Nebraska customers. It provides end-use customers both heating and energy for industrial processes as well as fueling 26% of the accredited generation capacity in the state. Given the significant gas infrastructure in the state, its role in meeting customer needs for energy and heating is critical. The commodity has the potential to play an even larger role as the state looks to meet the new customer load described above and gas-fired power remains a key, proven, and dispatchable energy resource.

Nebraska is generally well positioned to support increased load; however, infrastructure planning and development have never been easy. In addition, the time frame within which new customers are looking to connect is challenging the processes and time frames within which energy systems have traditionally been planned and built. The utilities in the state are responding to these needs but doing so in a way that continues to prioritize low-cost, reliable energy. The development of *clean* energy, however, is increasingly important as customers bring their requirements to the state.

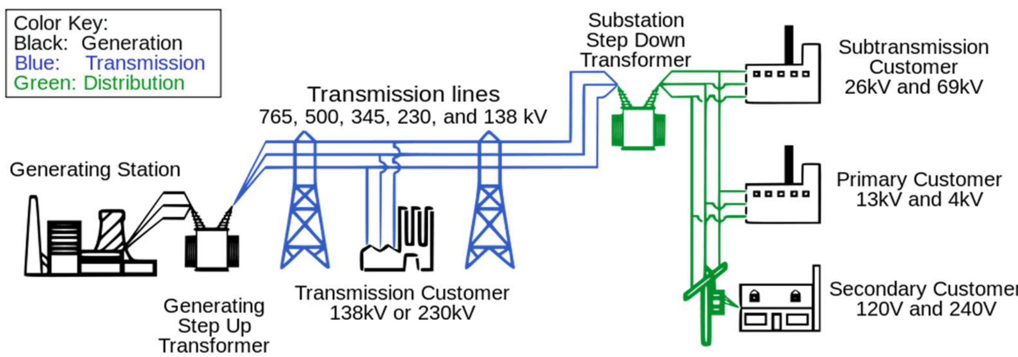
Given these needs and drivers, the time is ripe for all participants in and customers of Nebraska's energy systems to work together to develop innovative, constructive models to support infrastructure development. Stakeholders and customers would benefit from being better informed about the critical role this industry plays in the economic success of the state and how different types of resources can contribute to that success. Regarding the development of renewables in the state, there are opportunities to create a standard or "model" zoning and permitting process that could facilitate the interconnection of renewables developed by private developers. In working with customers who want to connect significant loads to the system, there may be an opportunity for creative partnerships across public power, private developers, and natural gas utilities to provide the energy needed.

APPENDIX A: KEY PRINCIPLES – ELECTRICITY 101

Segments of the Electric System

An electric utility system is a multifaceted structure responsible for generating, transmitting, distributing, and delivering electricity to consumers. An electric system is broadly divided into three parts: generation, transmission, and distribution. Distributed energy resources such as rooftop solar are sometimes considered part of this system when on the customer's side of the meter.

Figure 145: Centralized Electric System Model



Generation is the production of electrical energy from another primary source. These primary sources may be coal, natural gas, oil, nuclear power, and other natural sources such as water, wind, or solar energy. Generators typically have different operating schedules based upon their technology and anticipated electricity demand:

- **Baseload:** Operates much of the day and night with limited fluctuation. Often, these units are thermal (coal, nuclear, or gas fired), involve the production of steam, and have lower fuel costs but higher fixed costs. These units are inefficient when cycled (i.e., ramped up and down). Renewables, including hydropower, do not technically operate as baseload but are run with baseload when available because their marginal cost (sun, wind, water) is zero.
- **Intermediate:** More flexible than baseload, output of these units can be increased and decreased, depending upon demand. Sometimes referred to as load-following, they may be turned off at night or on weekends, depending upon actual and expected demand.
- **Peaking:** Very flexible plants that can be started and stopped quickly. Typically, these units have low fixed costs but high variable (operating) costs, in part because frequent startups consume large amounts of fuel. As the name implies, these units are called upon at times of day and seasons when demand is highest. Energy storage is increasingly used as a peaking resource.

The transmission and distribution system is responsible for transporting electricity from generation facilities to consumers. Generation typically produces electricity with a voltage range from 11 kV to 25 kV. Transmission lines are then used to carry electricity over long distances but can be subject to some energy loss in the form of heat due to resistance as electricity flows through the conductor (or lines). To reduce losses, "step up" transformers are placed at the interconnection of generation facilities and transmission lines, which increase the voltage to between 110 kV to 765 kV. Substations are then used to "step down" voltages from the transmission lines to distribution lines to between 4 kV and 69 kV (primary voltages).

Distribution lines deliver power from substations to consumers through primary lines and secondary lines. Line transformers and pad-mounted transformers then "step down" the primary voltages to secondary voltages (120V to 240V) used by small commercial businesses and residential customers.

Thermal Generation

Electricity is a secondary source of energy, as it requires the conversion of other sources of energy into electrical power. Thermal generation is responsible for converting heat energy into electrical energy, typically using sources such as natural gas, coal, oil, or nuclear reactors (in which controlled fission generates heat). Thermal generation involves burning these fuels at high temperatures to heat water in a boiler. The water is converted into high-pressure steam, thus transforming it into kinetic energy to spin a turbine. This kinetic energy turns the generator to produce electricity. A condenser then cools the steam back into water which is recycled back to the boiler. Gas turbines do not use steam but, like a jet engine, take in air, compress and heat it, and use the force of exhaust to rotate blades and turn a generator.

For thermal generation, there are environmental considerations of emissions from combustion of fuels, which produce sulfur dioxide, nitrous oxides, mercury, and particulate matter. Plants typically have emissions control systems that capture or reduce those emissions. Carbon dioxide, also emitted during fuel combustion, is typically uncontrolled unless it is captured and sequestered underground.

The capacity factor of a generation facility is the ratio of actual electric generation produced by a generating unit over a period of time to the maximum electric generation that could have been produced if the generation unit operated at continuous full power. Thermal plants run more efficiently when operated much of the time. Illustrative capacity factors for fossil fuel sources are a function of how often they are called to operate. Coal plants in 2023 averaged 42% nationally; natural gas combined cycle averaged near 59%.[118]

Solar and Wind Generation

Solar and wind generation have become favored resources due to technological improvements, federal tax credits, interest in non-emitting energy resources, and decreases in installed cost. Solar photovoltaic technology can convert radiation from the sun into electrical current. Wind power utilizes the natural wind currents to spin a turbine to generate electricity.[119] These renewable sources of energy, unlike fossil fuel generation, do not require fuel, and the electricity they produce varies with wind currents and availability of sunlight, respectively.[120]

One key difference between renewable energy sources and fossil fuel energy sources is that renewable generation may not align with peak demand times. Solar is plentiful during summer afternoons with high air conditioning demand but less so in early winter mornings with high electric heat demand. Wind can be plentiful in low demand times such as overnight hours but also in winter. Thermal generation, by

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118 https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a
119 U.S. Dept. of Energy (July 2015), United States Electric Industry Primer
120 Congressional Research Service (Apr. 25, 2023), Electricity: Overview and Issues for Congress

comparison, is considered dispatchable; that is, it can be ramped up and down to produce more or less energy on demand.

Average nationwide capacity factors for wind plants in 2023 was 34% and 23% for utility-scale solar.[121]

Construction Time for Various Energy Resources

As mentioned elsewhere, generation interconnection can add a significant amount of time to development of new generation resources. Time to develop, permit, engineer, and construct are also key factors. Those time frames can vary by technology, region, and myriad other factors. To understand "typical" time frames, the table below summarizes selected technologies and the construction and total lead times that the U.S. Energy Information Administration uses in its analyses:

Figure 15: Typical Generic Lead Times for Selected Technologies (Months), Excluding Interconnection Queue

Technology	Construction Time (Months)	Total Lead Time (Months)
Battery energy storage system (4-hour duration)	12	18
Combustion turbine – simple cycle (4 x 54 MW)	22-24	40
Combined cycle (1 x 1 x 1)	22	40
Advanced nuclear (brownfield) (2 x AP1000)	52	84
Small modular reactor (6 x 80 MW)	42	66
Wind (200 MW)	9	21
Solar PV (150 MW-ac, single-axis tracking)	12	36

Source: EIA (Jan. 2024), Capital Cost and Performance Characteristics for Utility-Scale Electric Power Generating Technologies

Permitting of thermal resources often involves considerations of water usage, effluents, and air emissions which can affect development timelines. The estimates above assume technology readiness. Nuclear may take longer than indicated above given the technology developments that must still occur.

Transmission and Distribution Planning

In addition to generation resources, transmission and distribution facilities need to be planned, designed, and built to replace obsolete and aging facilities and to accommodate increasing demand from customers. As customer demands increase (load growth) the capacity of transmission and distribution system needs to increase to accommodate this demand.

Local utilities have significant autonomy over improvements on their distribution systems, but also coordinate with transmission providers when upgrading or constructing new facilities. Transmission owners must propose projects through the RTO's (i.e., SPP) regional transmission planning process. The RTO assesses needs in collaboration with transmission owners, studies the impact of proposed transmission projects on the region, and develops a long-term transmission plan that is refreshed annually.

The time required for these studies and the approval process, as with new generation, is a consideration in expanding the bulk power grid in Nebraska.

[121] Federal Reserve Bank of Dallas, at https://www.dallasfed.org/research/energy/indicators/2024/en2404

System Balancing

Electricity is a physical commodity where supply and demand must be always in balance. This balancing is required to ensure frequency and voltage levels within the system are stable and within a narrow range of tolerances. One can think of an electric grid like a bathtub, for which the water level must be kept the same at all times—as some is drained, more must be added.

Resource Adequacy

Reliability of the bulk power grid depends in large part on having adequate resources at all times to serve demand (or load). Resource adequacy is defined as the ability of the electric system to supply the aggregate electric power and energy requirements of the electricity consumers at all times, taking into account scheduled and expected unscheduled outages of system components.[122]

Resource adequacy requires maintaining sufficient capacity above forecasted peak demand to serve peak load. This margin (reserve margin) is intended to account for potential weather events or loss of a large generator or transmission line. The margin does not require "never out" but is usually based upon a probabilistic 1-in-10 years loss of load standard.[123]

System operators and planners require demonstration of sufficient capacity to meet this reserve margin. As more variable (solar and wind) resources are integrated into the grid, those operators calculate capacity, accounting for its availability at peak demand times. This is termed effective load carrying capability (or ELCC), which is the ability of a generation unit to produce electricity to reliably meet demand, especially during electricity shortfalls. ELCC is usually less than nameplate capacity for solar and wind resources because of their variable nature. But other resources may have lower ELCC (less than 100% of nameplate capacity) due to unit performance (from unit breakdown and outage history).

Kilowatts, Kilowatt-hours, and Pricing of Electricity

A key measure of electricity used in industry is the rate at which it is produced, transferred, or consumed at an instant, with the units of electricity called watts. Similar measures are kilowatts (kW) (=1,000 watts) and megawatts (MW) (=1,000 kilowatts). How much energy per unit of time (typically an hour) a generator produces or a consumer uses is called a watt-hour. Similar measures are kilowatt-hours (kWh) (=1,000 watt-hours) and megawatt-hours (MWh) (=1,000 kilowatt-hours). For example, an incandescent bulb may be rated at 60 watts (instantaneous power required to illuminate it) or .06 kilowatts. If you operate the bulb for 16-2/3 hours, it consumes 1 kilowatt-hour of electricity (.06 kW x 16-2/3 hours = 1 kWh).

Electricity prices for retail customers are a function of the rate schedule (sometimes called a tariff) of the customer's class, e.g., residential, commercial, lighting, and industrial. The schedule sets forth the charges for the customer's service. These charges may include fixed charges (to pay for infrastructure like wires that do not vary with customer usage), customer charges (for billing and other services), societal charges (for low income and other programs), taxes, and volumetric charges based upon energy used.

Volumetric charges are typically based upon energy consumption (typically in kilowatt-hours) over a billing period measured in kilowatt-hours. A rate (in cents per kilowatt-hour) will be set at which the customer's energy charge will be calculated.

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[122] NERC (Dec. 2023), 2023 Long-Term Reliability Assessment, at p. 130
[123] Ibid., at p. 129

Some larger customers may incur demand charges. Those charges are to help pay for resources and other costs of supplying peak demand. Utilities apply demand charges based upon the maximum amount of power that customer used over a billing period. Demand is typically measured in kilowatts. Typically, the customer's rate schedule will specify the maximum power demand the customer may have. If the customer exceeds that demand over several months, it may be moved to another rate schedule with a higher demand charge.[124]

Customer and Load Types

Retail electricity end-use customers are customarily divided into three types: residential, commercial, and industrial. Residential customers typically use electricity for climate control, lighting, refrigeration, and operating appliances and equipment such as computers. Air conditioning is the largest use of electricity in homes.[125] The average U.S. household uses about 10,500 kWh per year.[126]

Commercial customers range from service-providing facilities and commercial establishments to office and government buildings to warehouses. Typical commercial uses of electricity are for operating computers and office equipment (combined), refrigeration, space heating and cooling, lighting, and ventilation. The average usage can vary widely based upon the building, alternative energy sources such as gas, and nature of the establishment.

Industrial customers are larger, energy-intensive customers that use electricity for operating machinery: generating process heat; and cooling, freezing, and refrigeration. They also use electricity for space heating and cooling and lighting of their facilities. Agriculture is included in the industrial use category; as mentioned elsewhere, irrigation is another end use among industrial customers.

A load profile is the shape of a load versus time curve over a defined period (e.g., hours). Depending on the shape of that curve, the cost to the utility to supply power could be higher or lower. Some utility rates can be based on averages of many load profiles for customers within a given class. Residential customers tend to have "peakier" consumption, with higher demand at the beginning and end of the day, while lower during the workday and at night. Customers with long operating schedules (e.g., hospitals, data centers, round-the-clock manufacturing) tend to have flatter customer load profiles.

Flatter load profiles tend to be less expensive to serve because their continuous steady demand can be served with a set of baseload resources at high-capacity factors without ramping up and down. Peakier loads tend to be more expensive to serve because resources must be reserved to meet the higher demand parts of the day but may be less utilized during the day and night. Load profile data is used for determining cost of service, planning the utility system, as well as evaluating energy management and peak load reduction and efficiency opportunities.

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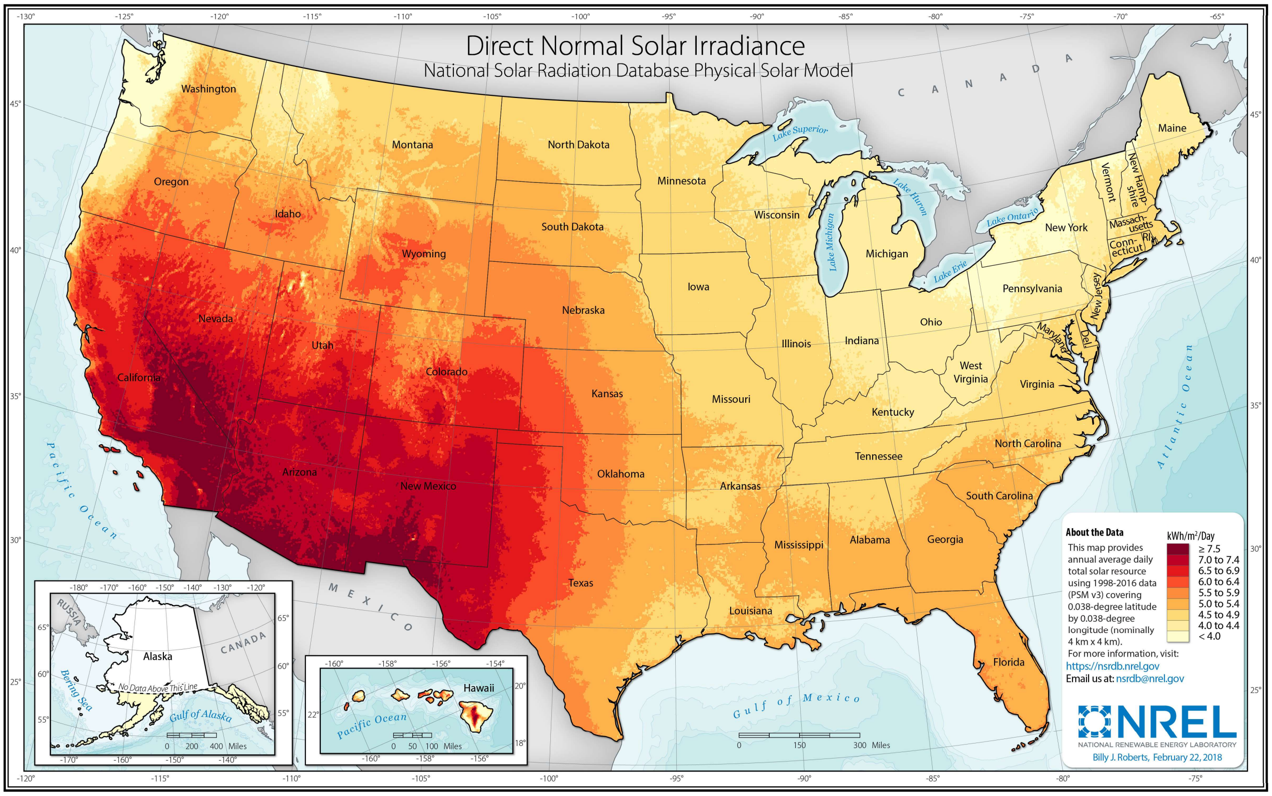
[124] See Renewable Energy World (June 6, 2017), "Making Sense of Demand Charges: What Are They and How Do They Work?"
[125] https://www.eia.gov/energyexplained/electricity/use-of-electricity.php
[126] https://www.eia.gov/energyexplained/use-of-energy/electricity-use-in-homes.php

APPENDIX B: SOLAR RESOURCES IN THE UNITED STATES

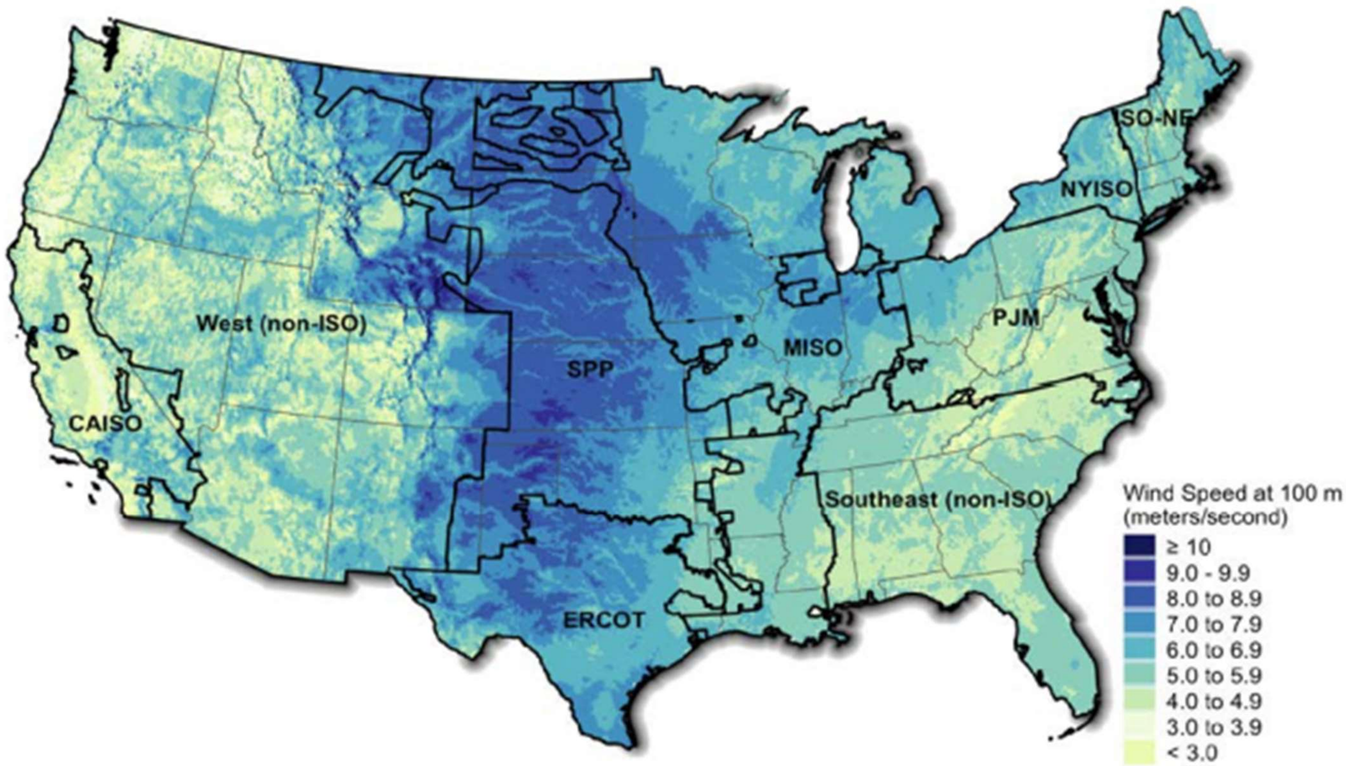
The following map shows solar irradiance in terms of annual average daily total solar resource, using 1998-2016 data, presented in kilowatt-hours per square meter per day.



Source: National Renewable Energy Laboratory, at https://www.nrel.gov/gis/assets/images/solar-annual-dni-2018-01.jpg (accessed Sept. 13, 2024)

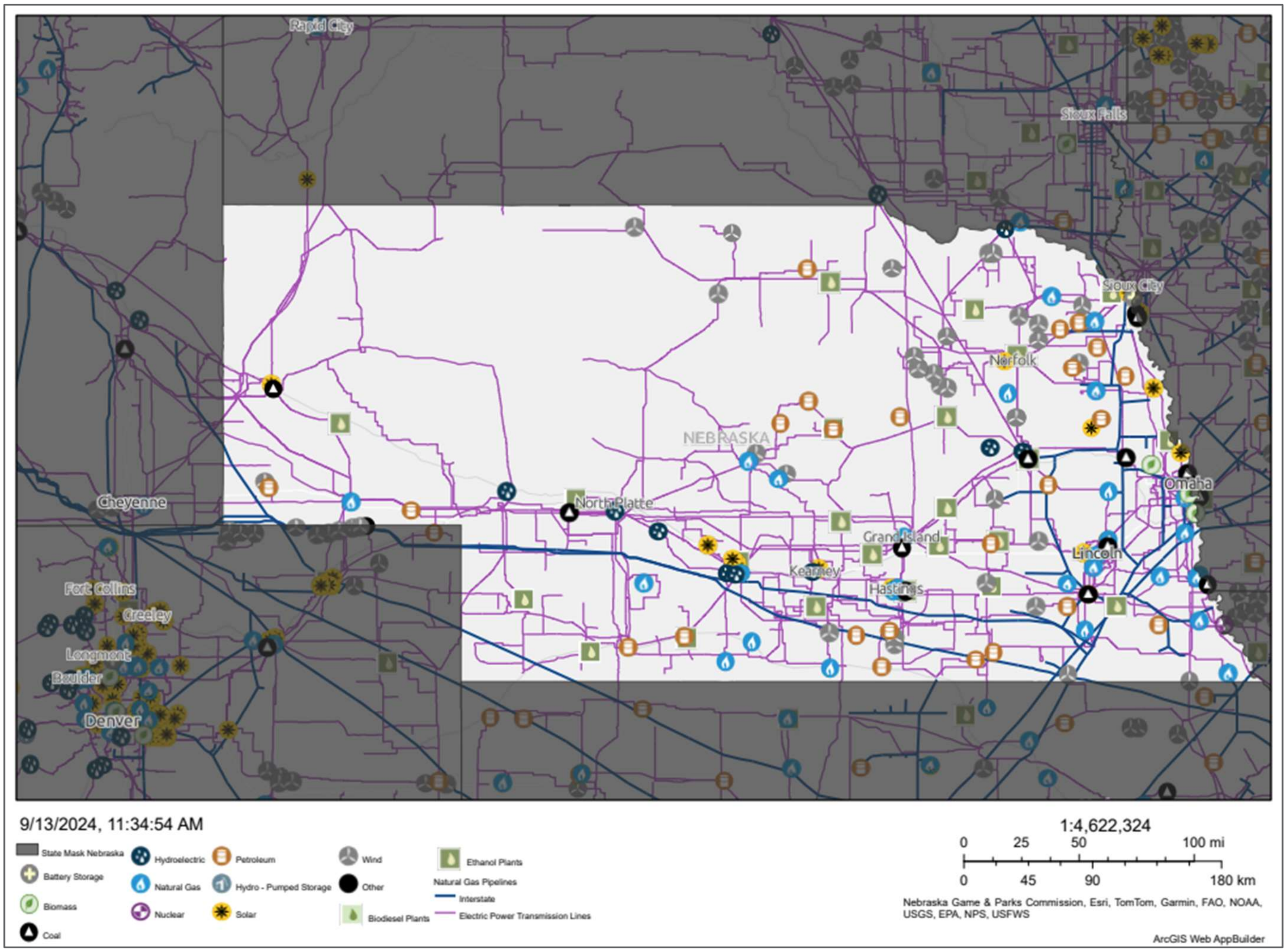
APPENDIX C: WIND RESOURCES IN THE UNITED STATES

The following map shows wind resource in terms of annual average U.S. wind speed at 100 meters above the ground. The map also shows the boundaries of nine regions, seven of which align with organized wholesale power markets (i.e., independent system operators).



Source: Dept. of Energy, Land-Based Wind Market Report: 2023 Edition (Aug. 2023), at https://www.energy.gov/sites/default/files/2023-08/land-based-wind-market-report-2023-edition.pdf (citing AWS Truepower and National Renewable Energy Laboratory)

APPENDIX D: NEBRASKA POWER, GAS, ETHANOL, AND BIODIESEL FACILITIES

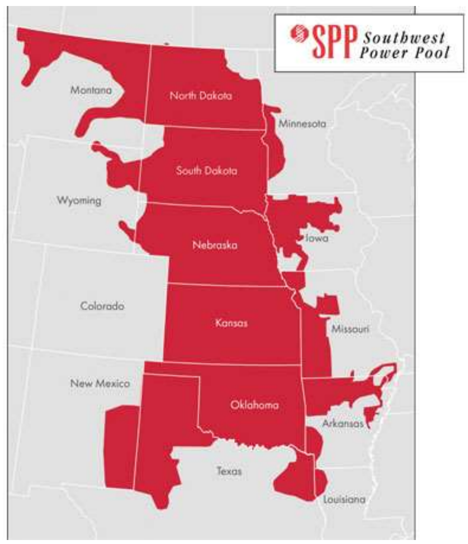


Source: EIA, U.S. Energy Atlas, available at https://atlas.eia.gov/apps/5039a1a01ec34b6bbf0ab4fd57da5eb4/explore

APPENDIX E: OVERVIEW OF THE SOUTHWEST POWER POOL

Nebraska is part of the Southwest Power Pool (SPP). SPP is one of the nine regional grid operators in the United States, covering part or all of 14 states from Oklahoma to North Dakota. SPP serves as "air traffic control" for the high-voltage regional grid, balances supply and demand across the region, maintains reliable grid operations, operates the wholesale energy market, and performs regional transmission planning. As the regional transmission expansion planning authority, SPP works with its members and stakeholders to develop transmission projects needed to meet reliability, economic, and public policy needs. SPP is made up of 111 members, including utilities, power producers, marketers, customers, and state agencies.

Figure 16: Geographic Footprint of the Southwest Power Pool



Source: LES, SPP Market Workshop (2022)

Role of SPP as an Energy Market and for Transmission Planning and Development

SPP provides a market for buying and selling wholesale electricity within its footprint and balancing supply and demand. It is responsible for setting resource adequacy accreditation and managing the day-ahead and real-time markets. Essentially, SPP ensures that supply and demand are balanced so that customers within its territory are supplied with electricity. In this role, it also manages financial transactions that underpin the movement of energy across its footprint.

One advantage of RTO membership is the ability to import and export energy when it is needed or in surplus, respectively. Nebraska is a net exporter of energy in the region, having exported about 10% of the state's generation to the regional grid in 2021.[127]

In terms of transmission planning, SPP is responsible for developing a regional transmission plan that complies with FERC's standards for planning and cost allocation. FERC Orders 1000 and 1920 (which was issued in 2024) establish the rules under which regional planning and cost allocation are to be performed by the region. Given the recent promulgation of Order 1920, each regional planning

[127] EIA, Nebraska State Energy Profile (updated July 20, 2023) (accessed Aug. 7, 2024); EIA Profile

organization in the United States will be required to submit compliance filings describing how its revised processes comply with that order. Depending on the success (or failure) of challenges to that order, new processes for transmission planning and cost allocation may be implemented in 2025 or 2026 for the region.

Through SPP's regional planning and cost allocation processes, the need for transmission is identified and costs for those projects are allocated to the transmission owners. The cost allocation is determined based on the attributes of the project. For instance, for projects greater than 300KV, 100% of those costs are allocated across the footprint as a "postage stamp" rate. For projects at lower voltages, their costs are allocated partially across the footprint, and a share is allocated to a smaller region within SPP (depending on the location of the project).

Generator Interconnection Queue

Part of SPP's role is to manage the generation interconnection queue for generation developers that want to interconnect to the transmission system. The generator interconnection queue process provides a means for generation planners and developers to submit new generation requests into the queue for validation, study, analysis, and ultimately, execution of a generator interconnection agreement. The purpose of these studies is to determine the effect on the grid of newly sited generation, identifying any transmission or substation upgrades needed, and assess other system impacts that new resources might present.

As of August 18, SPP had more than 85,000 MW of generation in its interconnection queue. In recent years, generation interconnection queues have become extremely congested. These interconnection processes were originally designed to accommodate a relatively small number of large generator requests. In recent years, as renewables have become the dominant resources requesting interconnection, these queues have become congested due to the volume of requests from relatively small resources. While FERC Order 2023 may, over time, improve RTO processes related to these queues, it is likely that delays in interconnection will remain a reality for the foreseeable future.

Per a study by Lawrence Berkeley National Lab, the time from entering the interconnection queue to commercial operation date takes on average more than six years.[128] SPP itself has stated that any new generation requests will take at least five years.[129]

[128] Lawrence Berkeley National Lab (2024), Queued Up
[129] Interviews

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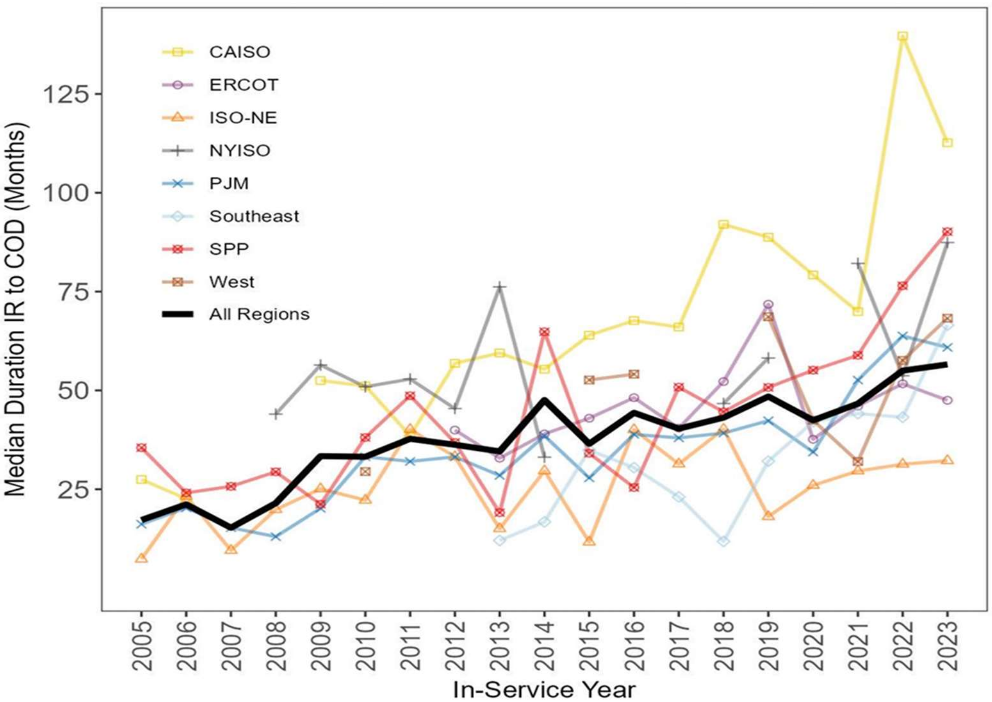
Figure 17: Interconnection Queue Operational Timeline[130]



Source: Lawrence Berkely National Lab, Queued Up report (2023)

This matters for Nebraska because, as we describe in this paper, the need for generation in the state is increasing. Both utilities and private developers are looking to interconnect generation in the state, and this queue is a potential barrier to all parties.

Governance and SPP's Regional State Committee

The Regional State Committee at SPP is comprised of state utility commissioners from each of the participating states and has primary responsibility over electric resource adequacy, coordination with neighboring systems, cost allocation for transmission upgrades, and allocation of financial transmission rights assets. [131] This governance feature is unique to SPP, as it grants authority to state representatives on an equal voting basis, giving them more collective state regulatory agency input on matters of regional importance as compared to other RTOs/ISOs.

Resource Adequacy and Capacity Accreditation

The question of capacity accreditation is another example of how the changing generation resource mix is causing the industry to reassess how to measure and assure reliability. Given the different operating characteristics of renewables (as opposed to coal, natural gas, or nuclear resources), there is an ongoing need to assess their performance on the grid and their ability to meet demand under all conditions, including extreme weather.

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[130] IR means interconnection request. COD means commercial operation date. RTO/ISO acronyms are defined in Appendix G.

[131] SPP (2019), 2019 and Beyond Operational Objectives, Regional State Committee

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For reliability, load-serving entities in SPP must demonstrate adequate accredited capacity to meet projected peak load with a reserve margin in the event of non-performance of a significant generation or transmission resource. That reserve margin has historically been 15%. SPP is now considering increasing seasonal planning reserve margins to 16% in summer and 36% in winter, beginning in 2026.[132]

To more adequately represent resource adequacy, SPP proposed an effective load carrying capability (ELCC) accreditation methodology for wind, solar, and energy storage resources and a performance-based accreditation (PBA) for thermal and other conventional resources. The ELCC is designed to account for the reduction in reliability with increased number of renewable resources and is based around wind, solar, hybrid, and storage resources' collective ability to perform during the highest-risk hours. The PBA, which is designed around improving performance, would be based on a power plant's "equivalent forced outage rate" during times the resources are needed[133].

There have been challenges to the new accreditation approach and it has not yet been approved by FERC. Some parties have urged FERC to reject the proposal, as it does not treat wind, solar, and battery storage resources the same as thermal resources. Others contend that the proposal will increase ratepayer costs because SPP will have to buy high-priced power when power plants that have been given unrealistically high accreditation fail to perform and represents an over-accreditation of thermal causing a long-term risk to reliability.[134]

In Nebraska, the question of capacity accreditation will matter, as the resource mix is poised to change along with the rest of the industry. In addition, as different resources receive different accreditations, generation planning by the utilities in the state will have to take into account the needs of the system against a more diverse and variable portfolio of resources.

[132] SPP, at https://www.spp.org/documents/71928/prm%20recommendation%207-2-24.pdf
[133] Utility Dive (2024), SPP Proposes Renewable, Thermal Resource Accreditation Reforms Aimed at Bolstering Reliability
[134] Utility Dive (2024), SPP Capacity Accreditation Plan Disadvantages Clean Power, Threatens Reliability, ACP, Others Say

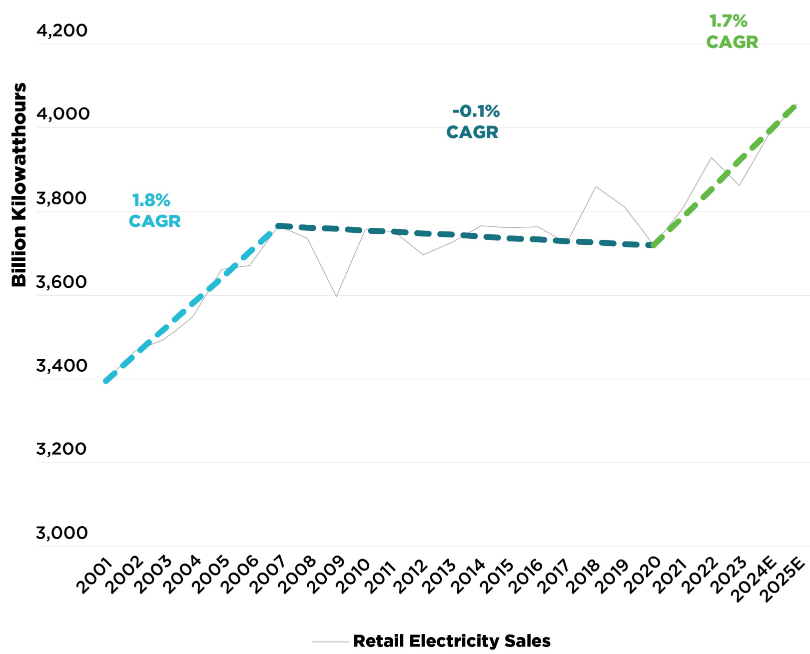
APPENDIX F: FACTORS DRIVING POWER NEEDS ACROSS THE UNITED STATES

In considering Nebraska's energy infrastructure, and particularly the challenges emerging in terms of growth, it is necessary to put these in the context of the rest of the United States. This section describes key national trends in load growth, new demand, and clean energy that are also impacting the state.

Historical and Current Forecast Consumption and Peak Demand Growth

The demand for electricity in the United States is increasing at a pace not seen in decades. The Great Recession, which lasted from December 2007 to June 2009, marked a turning point for retail electricity sales. Prior to the economic downturn, annual electricity sales increased at a compound annual growth rate (CAGR) of 1.8%. Following the Great Recession, retail electricity sales remained essentially flat for well over a decade. Retail electricity sales resumed growth following the COVID-19 pandemic. From 2020 to 2025, retail electricity sales are expected to grow an average of 1.7% per year (see Figure 19).

Figure 18: Historical and Projected U.S. Retail Electricity Sales (2001-2025)

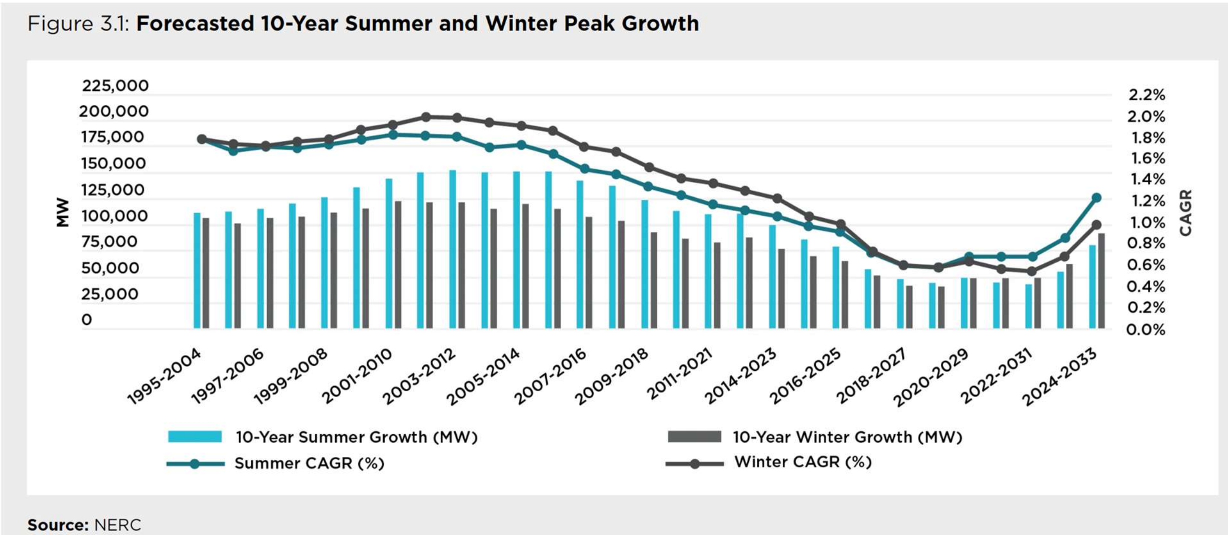


Sources: EIA Electricity Data Browser; EIA Short-Term Energy Outlook; ScottMadden analysis

Similar trends are seen in summer and winter peak demand forecasts. Peak demand refers to the predicted maximum level of electricity demand within a specific time period. Long-term forecasts produced by the North American Electric Reliability Corporation (NERC) show a sharp reversal in declining or flat growth rates. In their most recent analysis, NERC forecasts aggregated summer peak demand will rise by 80,000 MW and aggregated winter peak demand will rise by 91,000 MW from 2024 to 2033 (see Figure 20).[135]

[135] NERC (2023), 2023 Long-Term Reliability Assessment

Figure 19: Forecasted 10-year Summer and Winter Peaks Growth



Source: NERC (2023), Long-Term Reliability Assessment

The increasing demand for electricity can be attributed to a combination of secular long-term changes—notably the electrification of buildings and transportation—and the emergence of large loads, such as new data centers. Each trend is discussed in more detail below.

Long-Term Changes: Electrification

A major trend underway in the United States is the electrification of transportation, building, and industrial sectors. The term electrification refers to the shift away from non-electric sources of energy to electricity at the point of final consumption.[136] In the building sector, electric heat pumps offer an alternative to natural gas furnaces and oil-based space heating. Electrification opportunities in the industrial sector include boilers, space heating, and process heating service demand.[137]

In the transportation sector, more than 1.4 million plug-in electric vehicles (PEVs) were sold in 2023; 80% of the vehicles were fully battery electric.[138] The PEV sales accounted for 9.3% light-duty sales, up from 6.8% in 2022.[139] Vehicle electrification also extends to medium- and heavy-duty vehicles used in fleet operations. The increased adoption of electric vehicles will result in increasing electricity consumption. In 2023, light-duty PEVs consumed an estimated 7.6 million MWhs in 2023—surpassing the amount of electricity consumed by the rail systems for the first time.[140] Incremental annual growth in electricity consumption is expected but will vary significantly by state and region.

A robust analysis conducted by the National Renewable Energy Laboratory (NREL) illustrates the potential scale and scope of electrification through 2050 (see Figure 21). The shift toward electrification may provide an array of benefits, including lower costs, reduced emissions, and less energy consumption

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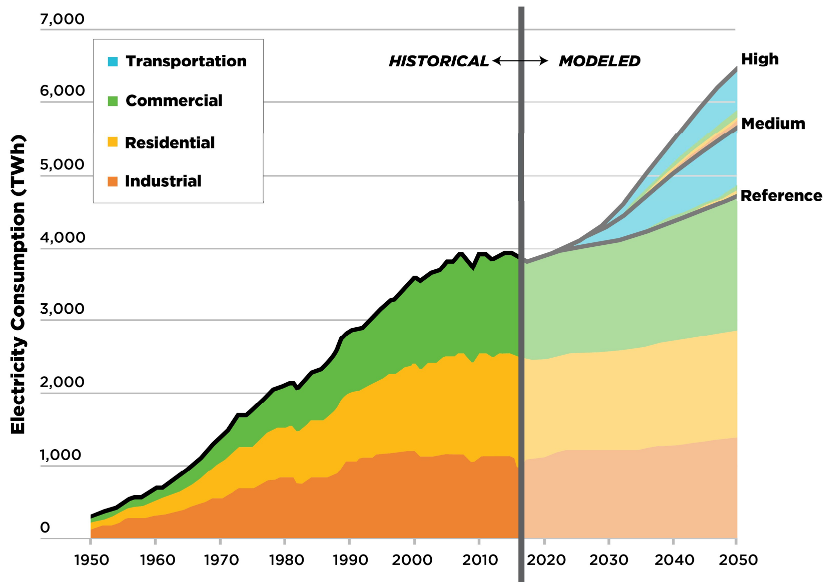
[136] NREL (2018), Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States
[137] Ibid.
[138] Argonne National Laboratory (September 2024), Light Duty Electric Drive Vehicles Monthly Sales Updates
[139] ScottMadden calculations using historical sales data published by Argonne National Laboratory
[140] EIA (May 20, 2024), U.S. Electricity Consumption by Light-duty Vehicles Likely Surpassed Rail in 2023

while providing equal or better service.[141] However, the impact for electric grid operators will be an increasing demand for electricity, shifts in peak loads (e.g., higher winter peaks due to electric heat pumps), and changes in load shapes (e.g., timing or size of expected electricity demand).

Figure 20: Impact of Electrification on Projected Annual Electricity Consumption



Source: NREL (2018), U.S. National Electrification Assessment

Emerging Large Loads and Drivers

Advanced cloud computing, Internet of Things applications, web-based commerce, and growth in artificial intelligence applications are driving the need for new data centers and increased electricity demand. The Electric Power Research Institute (EPRI) reports AI-driven data requests require 10 times the electricity needed for traditional Google data inquiry.[142] Forecasting future data center growth, EPRI estimates data center load could grow to consume 4.6% to 9.1% of U.S. electricity generation by 2040—up from an estimated 4% today.[143]

In addition, data centers are often highly concentrated in specific geographic regions. Data center developers are often drawn to similar regions due to favorable infrastructure or economic development policies. Therefore, 80% of the national data center load in 2023 was concentrated in 15 states, led by Virginia and Texas.[144] This trend is expected to continue as most planned data centers are in existing clusters (see Figure 22).

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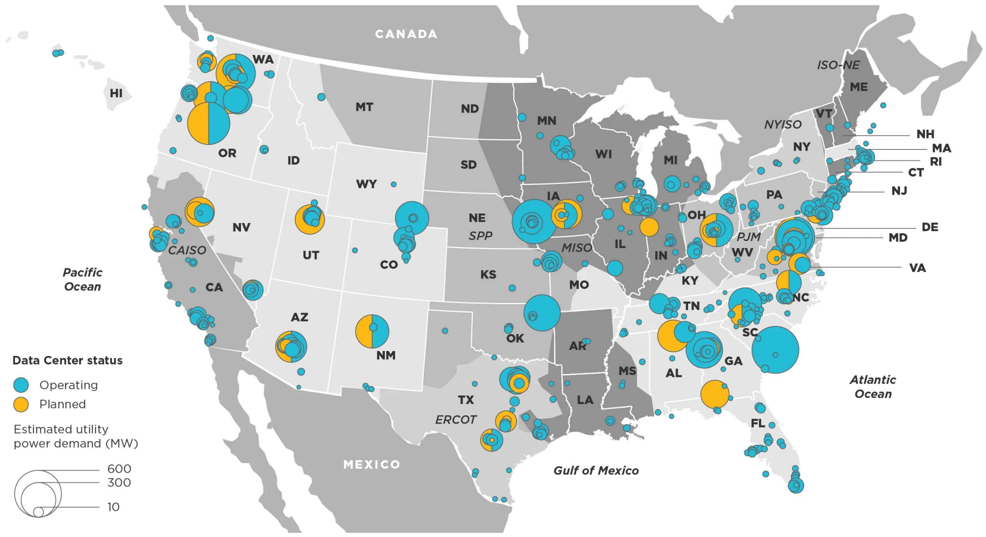
141 EPRI (2018), U.S. National Electrification Assessment
142 EPRI (2024), Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption
143 Ibid.
144 Ibid.

Figure 21: Operating and Planned Data Centers in the United States



Sources: S&P Global Market Intelligence; 451 Research; S&P Global Commodity Insights

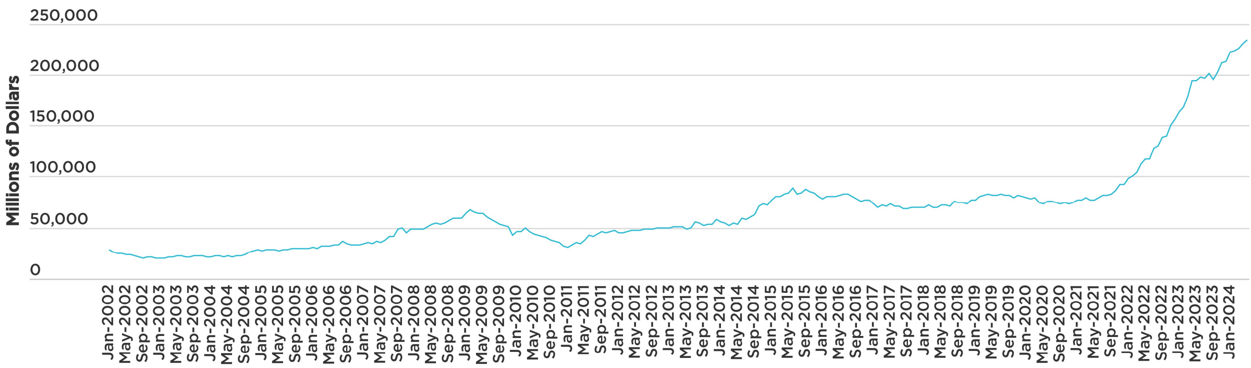
Two additional emerging sources of large loads are cryptocurrency mining and growth in domestic manufacturing. Cryptocurrency mining involves computationally intensive processes to create digital assets such as Bitcoin.[145] The scope of the industry is not well known, but cryptocurrency mining may account for up to 2.3% of annual electricity sales.[146]

Cryptocurrency mining differs from other types of data centers in that the loads can be flexible as crypto miners can cease “production” of crypto and reduce or stop operations (and the associated electricity use). Traditional data centers typically run 24/7 and have limited flexibility in terms of demand, which is tied to global internet demand. Depending on the price of energy and interruptible rates available, cryptocurrency mining facilities may adjust operations based on the price of energy and what they can earn through demand response or interruptible rates.

Meanwhile, monthly construction spending on manufacturing has more than tripled since the end of 2020 (see Figure 23). This trend is bolstered by onshoring interests following COVID-related supply chain disruptions and incentives to expand domestic manufacturing following the passage of the CHIPS and Science Act and Inflation Reduction Act of 2022 (IRA).

[145] The White House, Climate and Energy Implications of Crypto-Assets in the United States (Sept. 2022), at p. 10
[146] EIA (2024), Tracking Electricity Consumption from U.S. Cryptocurrency Mining Operations

Figure 22: Value of Manufacturing Construction (January 2002–March 2024)

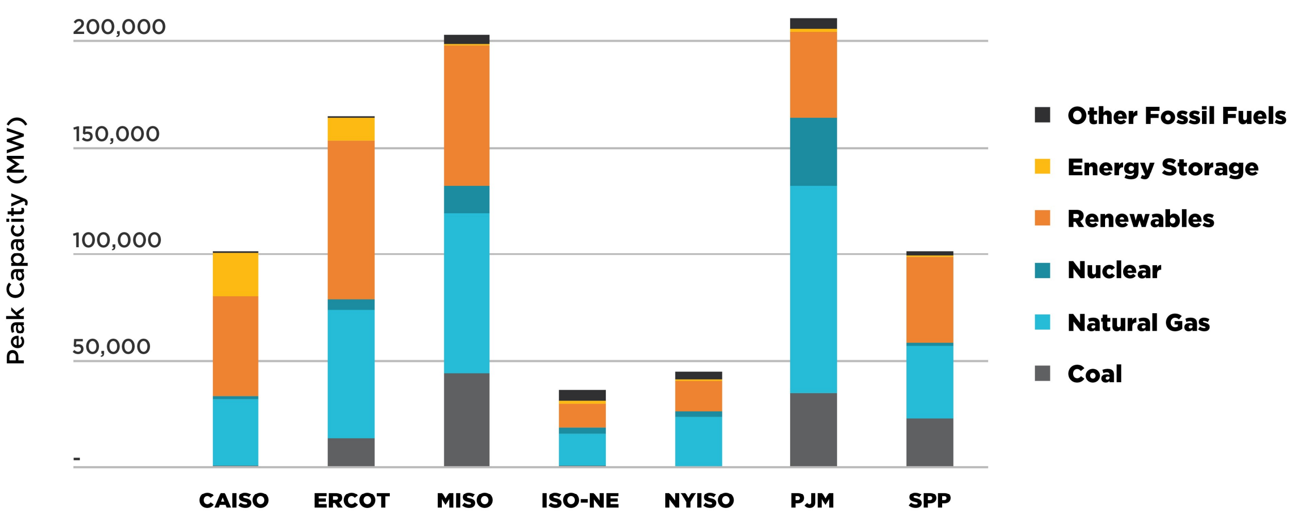


Source: U.S. Census Bureau (2024)

Electricity Supply Mix Varies by Region

The supply of electricity and pace of the energy transition varies dramatically by region (see Figure 24). Notable drivers influencing regional electricity supply include the availability of energy resources (e.g., fossil fuels or renewable resources), existing energy infrastructure (e.g., natural gas pipelines and transmission networks), and public policy. These factors have led some regions to transition more quickly from coal to natural gas (i.e., PJM). Elsewhere, regions with abundant renewable resources have seen a significant uptick in wind and solar (i.e., SPP and ERCOT).

Figure 23: Installed Summer Peak Capacity by ISO (MW) (2024)



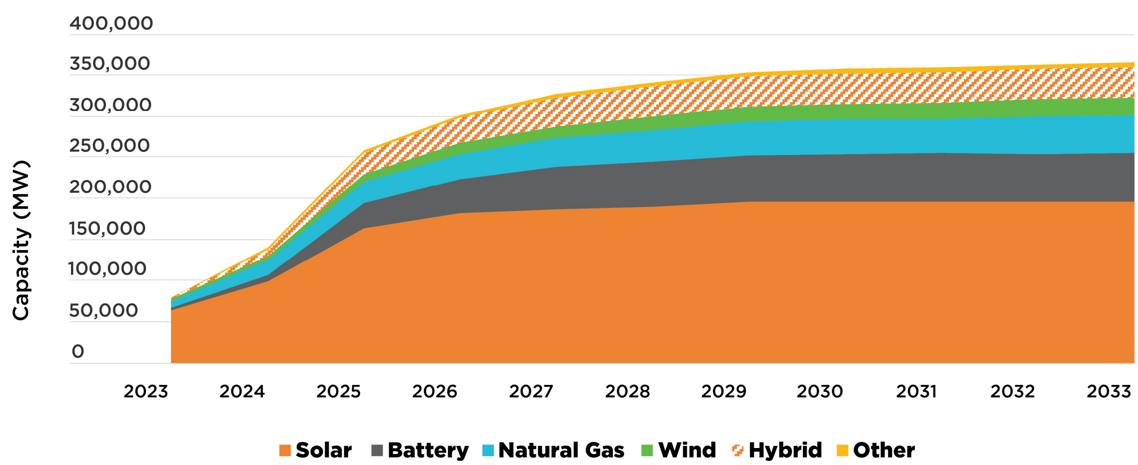
Source: Bloomberg NEF & Business Council for Sustainable Energy (2024), Sustainable Energy in America 2024 Factbook

Power plant retirements have been dominated by the closure of coal-fired capacity in recent years. The decline of coal has been precipitated by increasing environmental regulations and competition from natural gas plants. According to the EIA, operators have closed about 37,000 MW of coal capacity—or 17% of the coal-fired fleet—since the beginning of 2021 primarily due to increased costs of older plants and competition with natural gas and renewables.[147] Coal retirements are expected to slow in 2024 with just 2,300 MW of capacity retirements this year but accelerate again in 2025 with more than 10,000 MW of capacity retirements.[148]

As for the addition of new generation, more than 60,000 MW of new capacity is expected to come online in 2024. More than half of the new capacity (36,000 MW) is expected to be utility-scale solar. Three states—Texas, California, and Florida—will account for more than half of the solar capacity installed in 2024. Meanwhile, 14,000 MW of battery storage is expected in 2024, nearly doubling the capacity operating on the grid at the end of 2023. Wind, natural gas, and nuclear will account for the remaining new capacity anticipated to come online in 2024.[149]

Similar trends exist over longer-term projections. According to forecasts from NERC, solar photovoltaic will be the dominant source of new generation—accounting for more than half of new generation forecasted through 2030. Battery storage, natural gas, wind, and hybrid generation systems (i.e., solar or wind plus storage) are also expected to be key capacity additions during this time frame (see Figure 25).

Figure 245: Planned Generation Capacity Additions (2023–2033)[150]



Source: NERC (2023), Long-Term Reliability Assessment

[147] EIA (2024), U.S. Coal-Fired Electricity Generation Decreased in 2022 and 2023
[148] EIA (2024), Retirements of U.S. Electric Generating Capacity to Slow in 2024
[149] EIA (2024), Solar and Battery Storage to Make up 81% of New U.S. Electric-generating Capacity in 2024
[150] Hybrid facilities are wind or solar plus storage.

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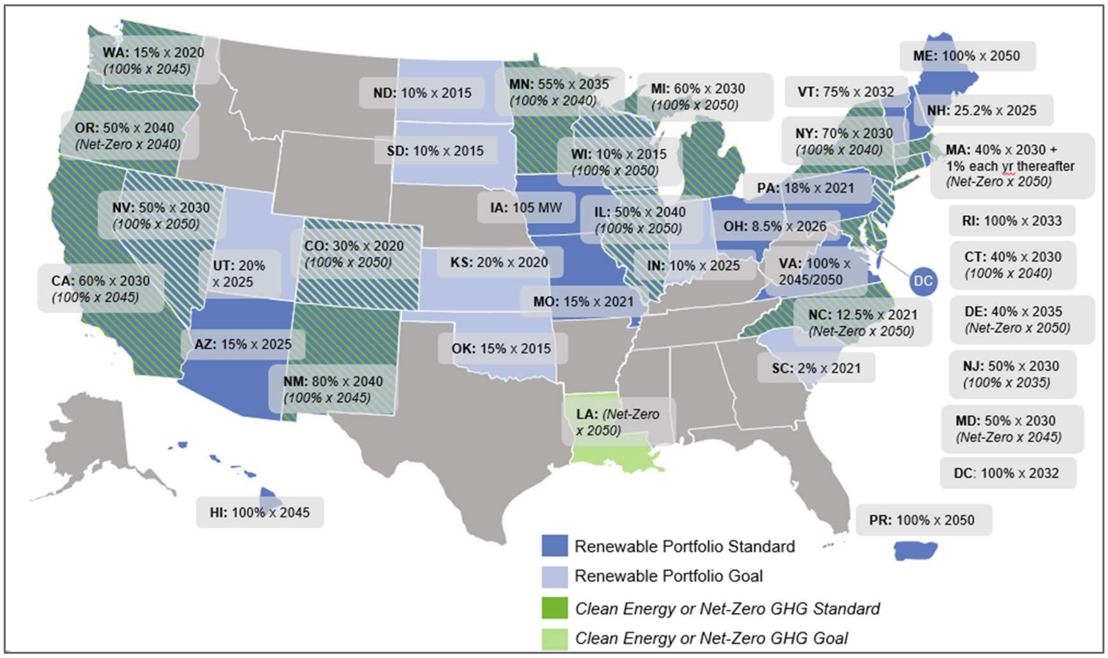
Drivers Shaping Electricity Supply

Renewable Portfolio Standards and Clean Energy Goals

A host of state and federal policies will impact the development of electricity supply. Renewable portfolio standards (RPS) are a common policy used by states to drive renewable energy adoption. In most cases, RPS policies require utilities to procure a percentage of electricity sales from renewable resources. More recently, a growing number of states have adopted "clean energy" standards or goals. These requirements often focus on a broader set of carbon-free generation resources (see Figure 26).

Figure 25: State Renewable and Clean Energy Standards and Goals (December 2023)



Source: DSIRE Insight (2023), Top State Clean Energy Policy Trends of 2023

Growing numbers of states, utilities, and corporations are establishing clean energy goals such as 100% clean energy commitments. In December 2018, Xcel Energy was the first major utility to announce plans to pursue a 100% clean energy goal by 2045. As of 2023, 24 states have 100% clean energy commitments either through government action or utility action.[151] California, as part of its decarbonization efforts, set the low-carbon fuel standard to limit transportation fuel emissions. Some municipalities in New York and Massachusetts have also proposed outright bans on natural gas systems either in government buildings or as part of the municipalities' permitting processes. Electric utilities in Hawaii have become "postcards from the future" with the rapid expansions of solar energy and ambitious 100% renewables requirements by 2045.[152]

Eighty percent of U.S. customers are currently being served by a utility with a 100% carbon-reduction target.[153] Utilities acknowledge the importance of clean being done in a reliable and cost-effective way

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[151] CESA (2024), Table of 100% Clean Energy States - Clean Energy States Alliance (cesa.org)
[152] ScottMadden (2019), EIU Volume 20 – Issue 1 and Issue 2
[153] Smart Electric Power Alliance (2024), Utilities' Path to a Carbon-free Energy System

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and have set their goals decades into the future to accommodate. Net-zero will require greater resource investments and changes in resources, including renewables, battery storage, and demand-side alternatives. While carbon emissions have declined, much of the progress to date has been the gradual migration from coal- to gas-fired power generation.[154] New and expected advancements in CCS, battery storage, and hydrogen generation are being watched for their potential benefits to the clean energy infrastructure.[155]

Federal Public Policy, Particularly the Inflation Reduction Act

At the federal level, the most impactful piece of legislation in the energy sector is the 2022 Inflation Reduction Act (IRA). The IRA represents an unprecedented investment of $369 billion to ensure energy security, reduce GHG emissions, and increase energy innovation in the United States. The last significant federal legislation was the Infrastructure Investment and Jobs Act (IIJA) in 2021, which provided $1.2 trillion in funding for transportation and infrastructure investment.[156]

The IRA provides incentives and investments across the entire energy supply chain (i.e., raw materials, manufacturing, deployment, and consumer adoption) for both existing technologies (e.g., new wind, solar, nuclear, and storage) and more nascent technologies (e.g., small modular reactors, hydrogen, carbon capture). Tax incentives from the IRA provide a base credit and a bonus rate. The bonus rate is equal to five times the base amount and is available only when prevailing wage and apprenticeship requirements are met.

The law provides extensive funding for the deployment of clean energy technologies through numerous tax credits and direct appropriations.

One major provision was the extension and modification of the renewable energy investment tax credit (ITC) and production tax credit (PTC). Most notably, the IRA added bonus credits for applications that use domestic content (steel or iron manufactured in the United States), meet low-income community requirements, or have placement in defined energy communities[157]. The law also expanded monetization opportunities by allowing tax credits to be transferred and tax-exempt entities to seek direct pay.

In 2025, the renewable energy ITC and PTC will be replaced by a clean electricity ITC and PTC. The new tax credits expand eligibility to any technology generating electricity without emitting GHG. The clean electricity tax credits remain in place until electric generation GHG emissions are reduced 75% below 2022 levels. Achieving this phase-out trigger may take decades.

The 45Q, 45V, and 45Z tax credits can greatly impact energy development. The IRA extends the timeline for the carbon sequestration credit (45Q), which provides credit for CO_2 capture, utilization, and storage for industrial facilities and power plants. The new hydrogen tax credit (45V) encompasses clean production of hydrogen primarily through natural gas reforming and electrolysis. The clean fuels production credit (45Z) replaces existing incentives for biodiesel, renewable diesel, and alternative fuels.[158]

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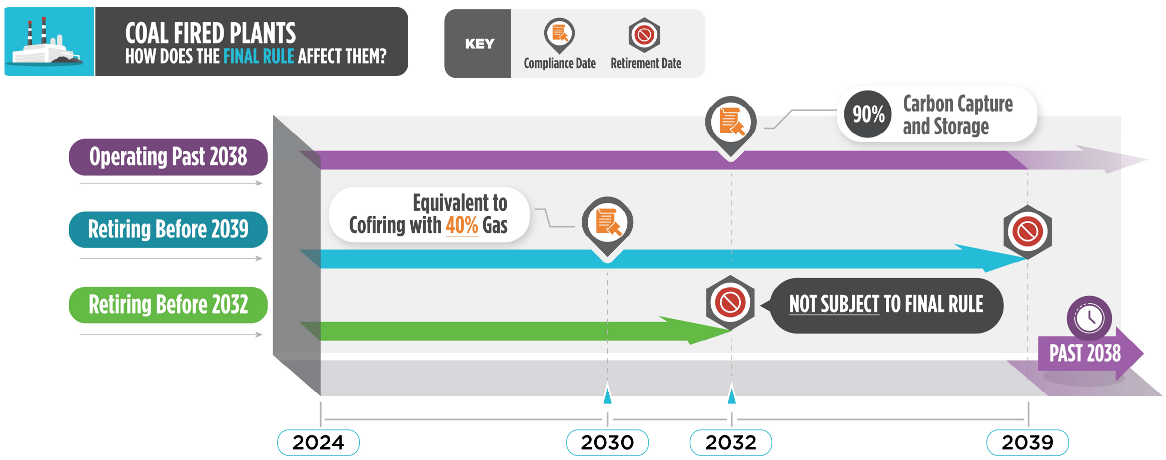
[154] ScottMadden (2019), EIU Volume 20 – Issue 1 and Issue 2
[155] Interviews
[156] U.S. Dept. of Transportation, at https://www.phmsa.dot.gov/legislative-mandates/bipartisan-infrastructure-law-bil-infrastructure-investment-and-jobs-act-iija
[157] IRS (2022), at https://www.irs.gov/credits-and-deductions-under-the-inflation-reduction-act-of-2022
[158] Public Law No. 117-169, at https://www.congress.gov/bill/117th-congress/house-bill/5376/text

In May 2023, EPA proposed a GHG rule for fossil-fired power plants and finalized their rule in April 2024. The new rule applies to new or reconstructed fossil-fired combustion turbines (CTs), existing fossil-fired units, and coal plants modified after May 2023.[159]

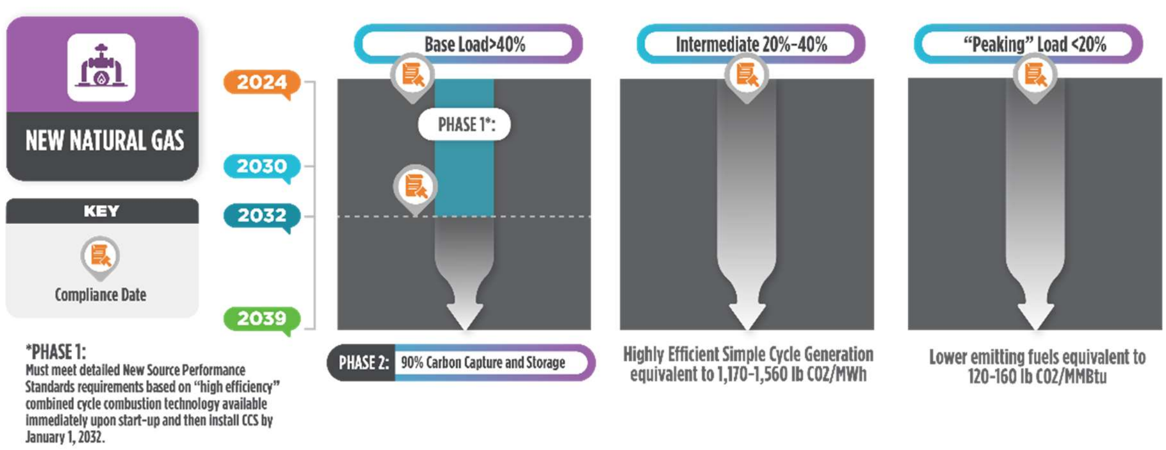
Figure 26: EPA Greenhouse Gas Final Rule – Coal



Source: EPA (2024), Final Carbon Pollution Standards to Reduce Greenhouse Gas Emissions from Power Plants

The rule set a performance standard for existing coal and new baseload CTs based upon a "best system of emissions reduction." Coal plants that will operate after 2038 must implement the equivalent of 90% carbon capture and storage or an 88.4% reduction in annual CO2 emissions. For those retiring before 2039, CO2 emissions must be equivalent to cofiring 40% with natural gas. Plants retiring before 2032 are not subject to the rule. These standards have a deadline of January 1, 2032.

Figure 27: EPA Greenhouse Gas Final Rule – New Fossil-fired Combustion Turbines



Source: EPA (2024), Final Carbon Pollution Standards to Reduce Greenhouse Gas Emissions from Power Plants

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[159] U.S. Environmental Protection Agency, Docket No. EPA-HQ-OAR-2023-0072, at https://www.epa.gov/stationary-sources-air-pollution/greenhouse-gas-standards-and-guidelines-fossil-fuel-fired-power

For new or reconstructed fossil-fired units, the rule set the following requirements based on capacity factor:[160]

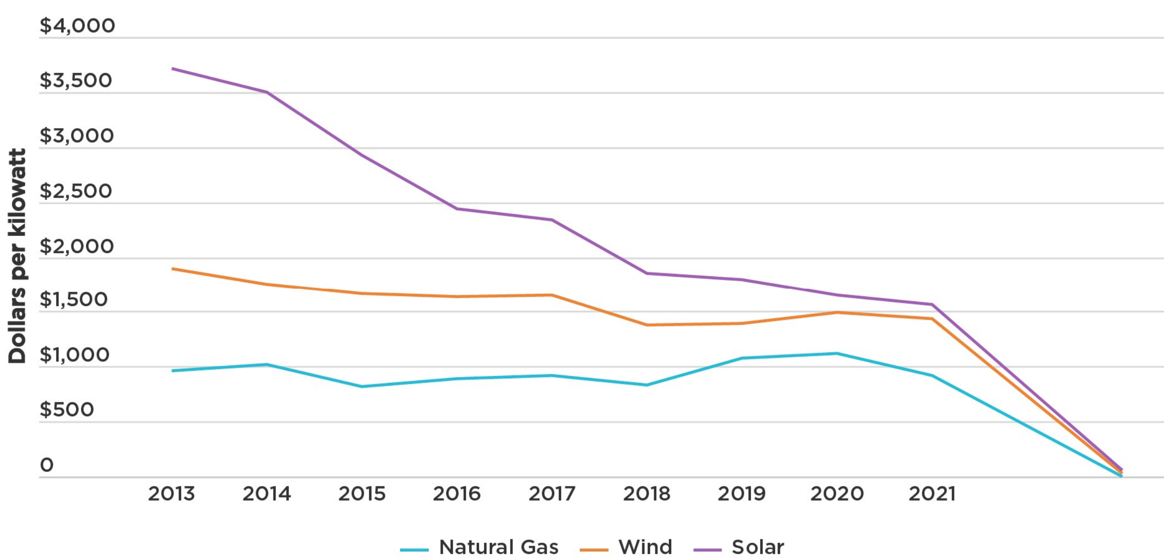
- >40% (baseload) units: Through 2031, units can comply by operating with emissions levels equivalent to a highly efficient combined-cycle unit; beginning 2032, units must achieve equivalent of highly efficient combined cycle with 90% reduction in CO2 emissions through CCS
- 20%-40% (intermediate): Units must achieve “highly efficient operations”
- <20% (peaking): Units can continue to operate with “low-emitting fuels” (natural gas or Nos. 1 or 2 fuel oil)

No standard has been set for existing natural gas plants.[161] This rule is being challenged in the courts and may also face headwinds, depending on the outcome of the November election. As such, the ultimate requirements of the rule and the timeline for implementation remain unclear.

Technology and Fuel Costs

In addition to the tax incentives described above, a major driver in the changing energy mix is the rapid decline in capital costs for new solar and wind generation. The trend is illustrated by the average construction cost incurred by solar, wind, and natural gas. Since 2013, solar construction costs declined nearly 60%, wind declined 25%, and natural gas declined only 5% (see Figure 29).

Figure 28: U.S. Capacity-Weighted Average Construction Cost by Technology (2013-2021)



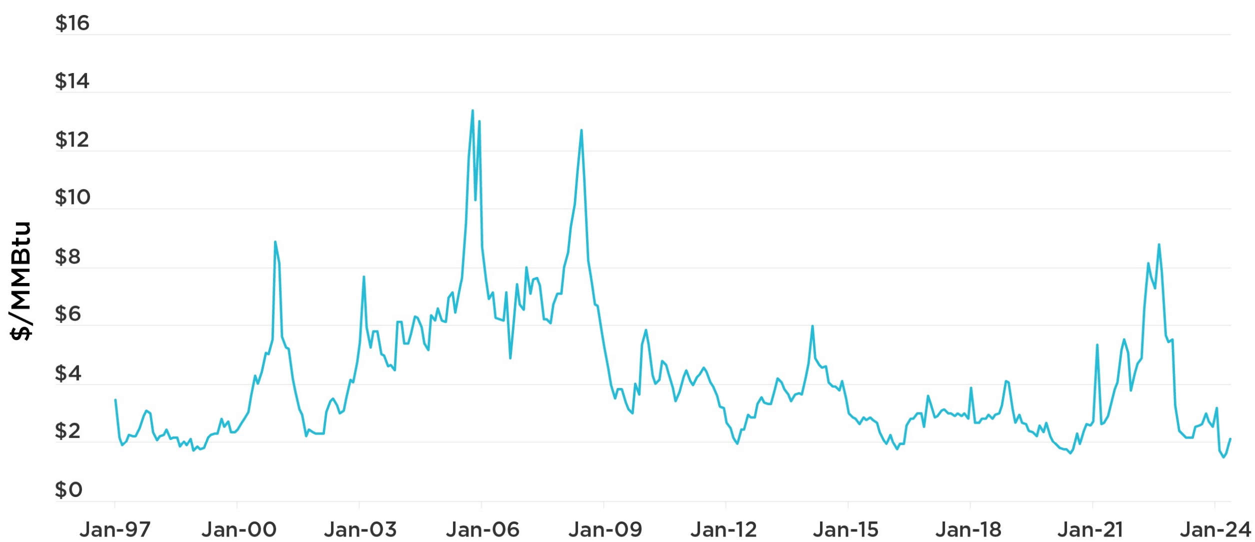
Source: EIA (2024), Electric Generator Construction Costs

Despite limited declines in capital costs, natural gas has benefited from declining fuel costs. With advancements in hydraulic fracking and horizontal drilling, the United States has increased natural gas

[160] Capacity factor is the percentage of annual hours a power generating unit operates.
[161] EPA (2024), at https://www.epa.gov/system/files/documents/2024-04/cps-presentation-final-rule-4-24-2024.pdf

production, resulting in lower spot prices. In 2022, the Russian invasion of Ukraine resulted in a spike in natural gas prices; however, prices have since fallen back below $3.00 per million Btu (see Figure 30).

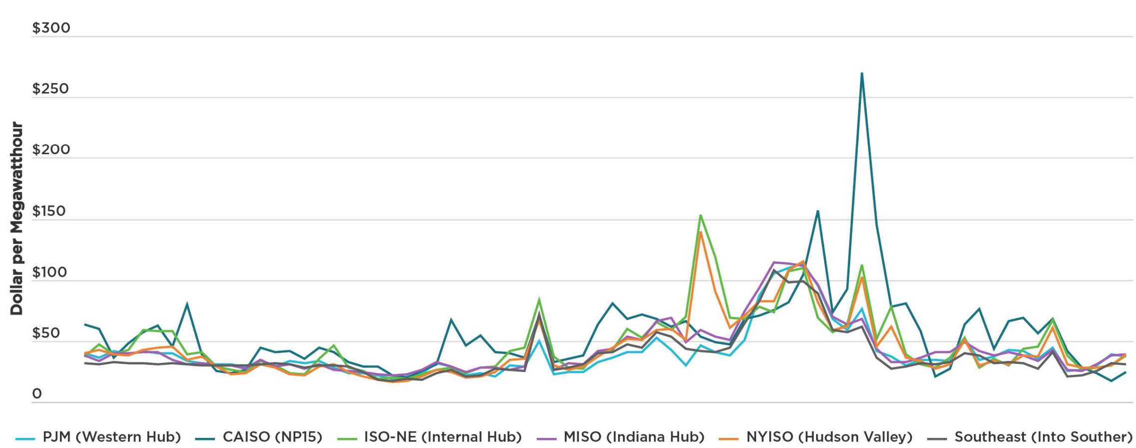
Figure 29: Henry Hub Natural Gas Spot Prices ($/MMBtu) (1997-2024)



Source: EIA (2024), Henry Hub Natural Gas Spot Prices

The price of natural gas is often a key driver of wholesale electricity prices. In deregulated markets, natural gas power plants are often the resource that sets the marginal cost of electricity (e.g., market clearing price). Therefore, changes in natural gas prices often influence wholesale electricity prices. Following the Russian invasion of Ukraine, spiking natural gas prices resulted in a corresponding increase in wholesale electricity prices (see Figure 30).

Figure 30: Monthly On-Peak, Day-Ahead Power Prices in Select Markets (July 2018-June 2024)



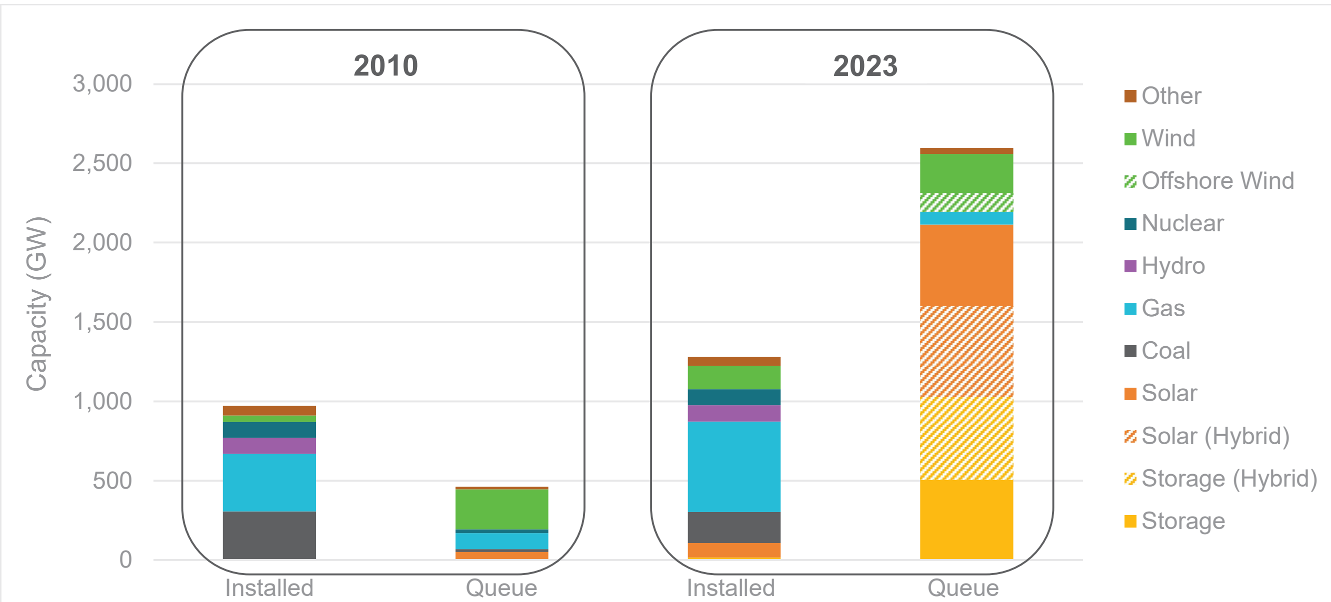
Source: S&P Capital IQ, SNL Day-Ahead Power Prices

Generator Interconnection Queues: A Key Barrier to Power Generation Development

Navigating interconnection queues is a substantial challenge facing new electricity supply. Proposed generation must undergo studies to determine if system upgrades are necessary. Projects applying for interconnection and undergoing the study process are considered in the interconnection queue.

Interconnection queue requests have surged in recent years—both in terms of capacity and number of projects. In 2023, the active capacity in the interconnection queue was more than twice the installed capacity in the United States. The existence of such a large interconnection queue is a new phenomenon. In 2010, the interconnection queue was roughly half of installed capacity (see Figure 31).

Figure 31: Installed Generation Capacity vs. Interconnection Queue Requests (2010 and 2023)



Source: LBNL (2024), Queued Up: 2024 Edition. Characteristics of Power Plants Seeking Transmission Interconnection as of the End of 2023

Proposed generation projects are challenged by low completion rates and increasing wait times. In recent years, roughly 20% of projects entering the interconnection queue achieve commercial operation.[162] Meanwhile, the average wait time spent in interconnection queues has grown from three years to five years.[163] New rules implemented by FERC—most notably FERC Order 2023—are designed to improve the effectiveness of interconnection queues, but reforms will take several years to be fully implemented.

System Reliability Concerns: Impacts of a Transitioning Portfolio

Ensuring the reliability of the electric system is a core responsibility and top priority for regulators, electric utilities, and grid operators. However, multiple trends are posing increased risks to the reliability and resilience of the electric system.

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[162] LBNL (2024), Queued Up: 2024 Edition. Characteristics of Power Plants Seeking Transmission Interconnection as of the End of 2023
[163] Ibid.

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The changing generation mix poses new challenges and reliability concerns to the grid. Energy policy is prompting significant changes in generation resources (from traditional baseload to variable resources, such as wind and solar) and encouraging electrification of end-use appliances and space heating. Longer term, there is hope that long-duration storage and perhaps hydrogen may provide “on demand” clean power, but those technologies are years away from commercial availability. The rapid pace of change poses a challenge to grid planning and resource adequacy. In addition, the growth of weather-dependent resources and storage adds new operational complexities. Key concerns include ensuring both energy sufficiency during all hours (not only at times of peak demand) and essential reliability services (e.g., frequency and voltage) are available at all times. The combination of rising peak demand and the retirement of 83,000 MWs of generation over the next 10 years “creates blackout risks for most of the United States.”[164]

The impact of extreme weather events is increasingly important, with the most striking examples being recent winter storms. In February 2021, Winter Storm Uri hit Texas and other south-central U.S. states. More than 4.5 million electric customers lost power, some for as long as four days, and the death toll is estimated at 246 people in Texas alone.[165] As the largest firm load-shedding event (e.g., rotating outages) in U.S. history, the event resulted in an estimated $80 to $130 billion in economic losses in Texas.[166]

In December 2022, Winter Storm Elliott overtook much of the Eastern Interconnection. The extreme cold resulted in more than 1,700 generating units experiencing unplanned outages, derates, or failures to start. At one point, 90,500 MW of generation capacity was unavailable. According to NERC, Winter Storm Elliott was the fifth time in just 11 years that cold weather-related outages jeopardized grid reliability.[167]

During both storms, the performance of natural gas resources was a notable concern. In some cases, natural gas plants experienced operational challenges related to freezing instruments and equipment. In other cases, fuel availability was the problem as production, transportation, and distribution infrastructure was disrupted by freezing conditions and equipment failures.

The winter storms also highlight the growing interdependence between the electric and natural gas sectors. In recent years, the electric industry has become more dependent on natural gas generation. Widespread and extended electric outages can result in natural gas delivery issues, thereby impacting electric generation and home heating.[168]

In summary, the United States is experiencing tremendous load growth from a variety of sources while transitioning the generation mix to include significantly more renewable, intermittent resources. This is happening at a time when extreme weather events are occurring more frequently. NERC, FERC, and several of the regional grid operators have expressed concern about the ongoing reliability of the grid in the face of these challenges.

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164 Utility Dive (2024), NERC Wary of 100 GW in Possible Plant Retirements and Other Takeaways from CEO Jim Robb
165 Texas Tribune (2022), at https://www.texastribune.org/2022/01/02/texas-winter-storm-final-death-toll-246/
166 FERC and NERC (2023), Inquiry into Bulk-Power System Operations During Winter Storm Elliott
167 Ibid.
168 NERC (2023), 2023 ERO Reliability Risk Priorities Report

APPENDIX G: GLOSSARY OF ACRONYMS

AI – artificial intelligence

BCF – billion cubic feet

BTU – British thermal units

CAGR – compound annual growth rate

CAISO – California Independent System Operator

CCS – carbon capture and sequestration (or storage)

CI – carbon intensity

CO2 – carbon dioxide

CT – combustion turbine

DOE – Department of Energy

EIA – Energy Information Administration

ELCC – effective load-carrying capability

EPRI – Electric Power Research Institute

ERCOT – Electric Reliability Council of Texas

FERC – Federal Energy Regulatory Commission

GHG – greenhouse gas

IOU – investor-owned utility

IRA – Inflation Reduction Act of 2022

IRP – integrated resource plan

ISO – independent system operator

ISO-NE – ISO New England

ITC – investment tax credit

kV – kilovolt

kW – kilowatt

kWh – kilowatt-hour

LCFS – Low-Carbon Fuel Standard

LES – Lincoln Electric System

MISO – Midcontinent Independent System Operator

MMBtu – million British thermal units

MW – megawatt

MWh – megawatt-hour

NDEE – Nebraska Department of Environment and Energy

NERC – North American Electric Reliability Corporation

NPA – Nebraska Power Association

NPPD – Nebraska Public Power District

NREL – National Renewable Energy Laboratory

NYISO – New York Independent System Operator

OPPD – Omaha Public Power District

PEV – plug-in electric vehicles

PJM – PJM Interconnection LLC

PRB – Nebraska Power Review Board

PTC – production tax credit

RNG – renewable natural gas

RPS – renewable portfolio standards

RTO – regional transmission organization

SAF – sustainable aviation fuel

SAIDI – system average interruption duration index

SAIFI – system average interruption frequency index

SPP – Southwest Power Pool

V – volt

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