Powering Tennessee:

Landscape, Challenges, and Opportunities for Tennessee's Energy Future

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TENNESSEE BUSINESS LEADERSHIP COUNCIL

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BAKER SCHOOL OF PUBLIC POLICY AND PUBLIC AFFAIRS

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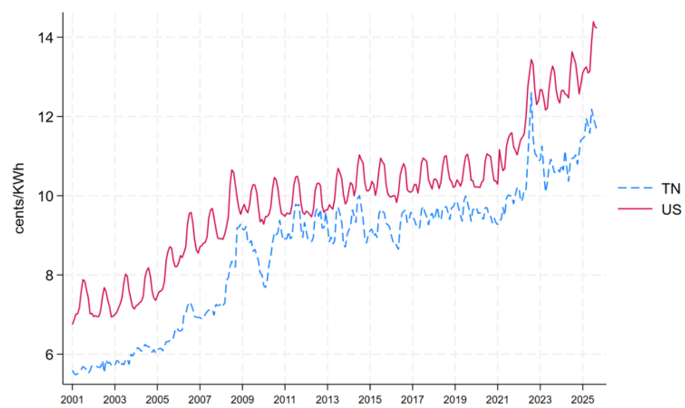
Executive Summary

Tennessee's energy system is diverse, relying on a portfolio of sources to supply many uses.

This system has served residents well. Over much of the past 15 years, Tennessee residents and businesses have enjoyed low and stable energy prices, fueling the state's economic and population growth. Tennessee enjoys the **8th lowest state-level residential electricity prices** and the **5th lowest state-level industrial electricity prices** (EIA). But prices have been trending higher in recent years, both nationally and in Tennessee. *(See Figure ES-1)*

Today the state faces a possible inflection point that puts **energy at the forefront of economic policy**. Going forward, Tennessee faces four important energy challenges.

Figure ES-1: **Tennessee and U.S. Monthly Nominal Average Retail Electricity Prices, 2001-2025**



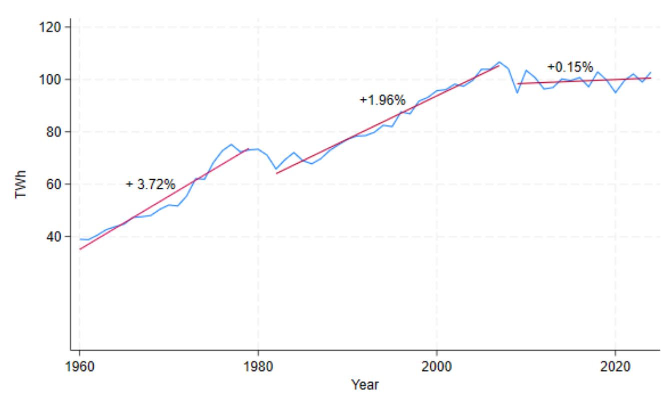
Source: Baker School calculations using EIA data

Four Energy Challenges

1. Electricity load growth

For a variety of reasons, including new energy-intensive general use technologies (e.g., artificial intelligence), **electricity demand growth is positive after decades of being close to zero**. The load growth is concentrated in certain parts of the state, amounting to 1.9 percent over the past year. This realized growth in Tennessee is slower than in other parts of the country, but much faster than over the preceding 15 years. *(See Figure ES-2, which does not include 2024 load growth of 1.9 percent.)*

Figure ES-2: **Tennessee Annual Electricity Load Growth, 1960-2023**



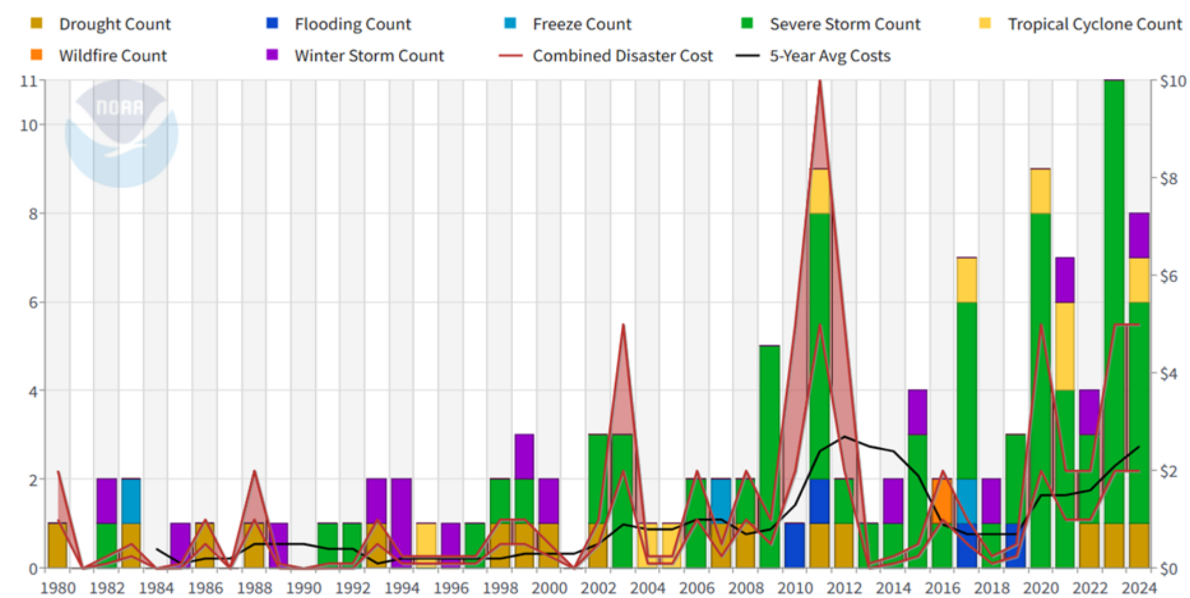
Source: Baker School calculations using EIA data

Looking forward, anticipation of continued load growth at rates not seen since before the financial crisis contributes to thinking about energy policy. Recent upward revisions in forecasts contribute to the urgency around serving growing demand.[1] Forecasts are uncertain, but supporting additional electricity use growing at annual rates of 2-3 percent would **require doubling the scale of the electricity system in coming decades**.

2. Physical shocks

Disruptions from weather and other sources affect both energy demand and supply and have arrived with increasing frequency in Tennessee. (See Figure ES-3.) These shocks can lead to critical peak demands for energy services and simultaneously interrupt the supply system. Shocks beyond weather affecting the state itself, including from cyberattacks and supply interruptions elsewhere, have also affected the state in recent years. The future energy system needs to be prepared for future disruption, including by diversifying sources of energy and providing for redundancies that increase both the robustness and resilience of the system.

Figure ES-3: **Tennessee Billion-Dollar Disaster Events 1980-2024 (CPI-Adjusted)**



Source: National Centers for Environmental Information, National Oceanic and Atmospheric Administration

3. Fuels Volatility

Tennessee is an energy importer and is connected to distant markets in ways that present both physical and financial risks to state residents. The reliance on fuels is one example. As the electricity system grows more reliant on natural gas, the ability to ensure timely delivery of fuel is a paramount concern. Recent disruptions in natural gas supply have raised consciousness of the cost of interruption. Similarly, price fluctuations due to distant causes pose cost risks for the state. Tennessee energy users must compete for fuels in an increasingly connected global marketplace.

4. Affordability and competitiveness

Maintaining affordable energy supplies is important for residents and businesses. The Tennessee economy has built a strong manufacturing base in part thanks to affordable and reliable energy supplies. Maintaining that base through a period of growth will require careful attention to balancing the costs of new infrastructure that will ultimately be paid by end users.

To meet the challenges facing the state, Tennessee's leaders may consider **three main strategies to support a secure and affordable energy future**.

Future Energy Strategies

Facilitate Growth

Tennessee's energy system will need to expand, including the construction of additional generation and transmission assets. Efforts to increase efficiency can bend the curve on needed supply additions, but efficiency alone cannot meet the energy challenge. Permitting is mostly possible, but navigating the process of winning local acceptance and managing financial risks of long-lived capital-intensive investments can be aided by policymakers.

Embrace Innovation

Embracing innovation locally and beyond the borders of Tennessee is a second important strategy. While innovative technologies are not well-suited for immediate challenges, in the long run they are essential. Opportunities exist in advanced nuclear technology, critical minerals, hydrogen technology, and batteries. Immediate solutions must rely on demonstrated technology, but prospects of new efficiencies and markets depend on continued investment in research and development today. Like infrastructure costs, the costs of successful innovations will ultimately be paid by end users. The ability for Tennessee to export energy technology to other parts of the country and other parts of the world increases the customer base that can pay for successful innovations.

Minimize Policy Uncertainty

Providing clear and certain energy policy will help attract investment and ultimately lower the cost of delivering energy. New construction costs will ultimately be borne by end users. Acceptance of those costs depends on effective engagement. Policy incentives for particular supply options, whether renewables or nuclear or fossil, impact relative prices and lead investors to make different choices. Unanticipated changes in the policy menu can contribute to uncertainty about the future, deterring investment and leading to higher-cost decisions. Whipsawing policy raises construction costs and the costs of meeting the energy challenge. Policy continuity across political cycles reduces adjustment costs and facilitates the lowest possible cost.

Tennessee's Energy System

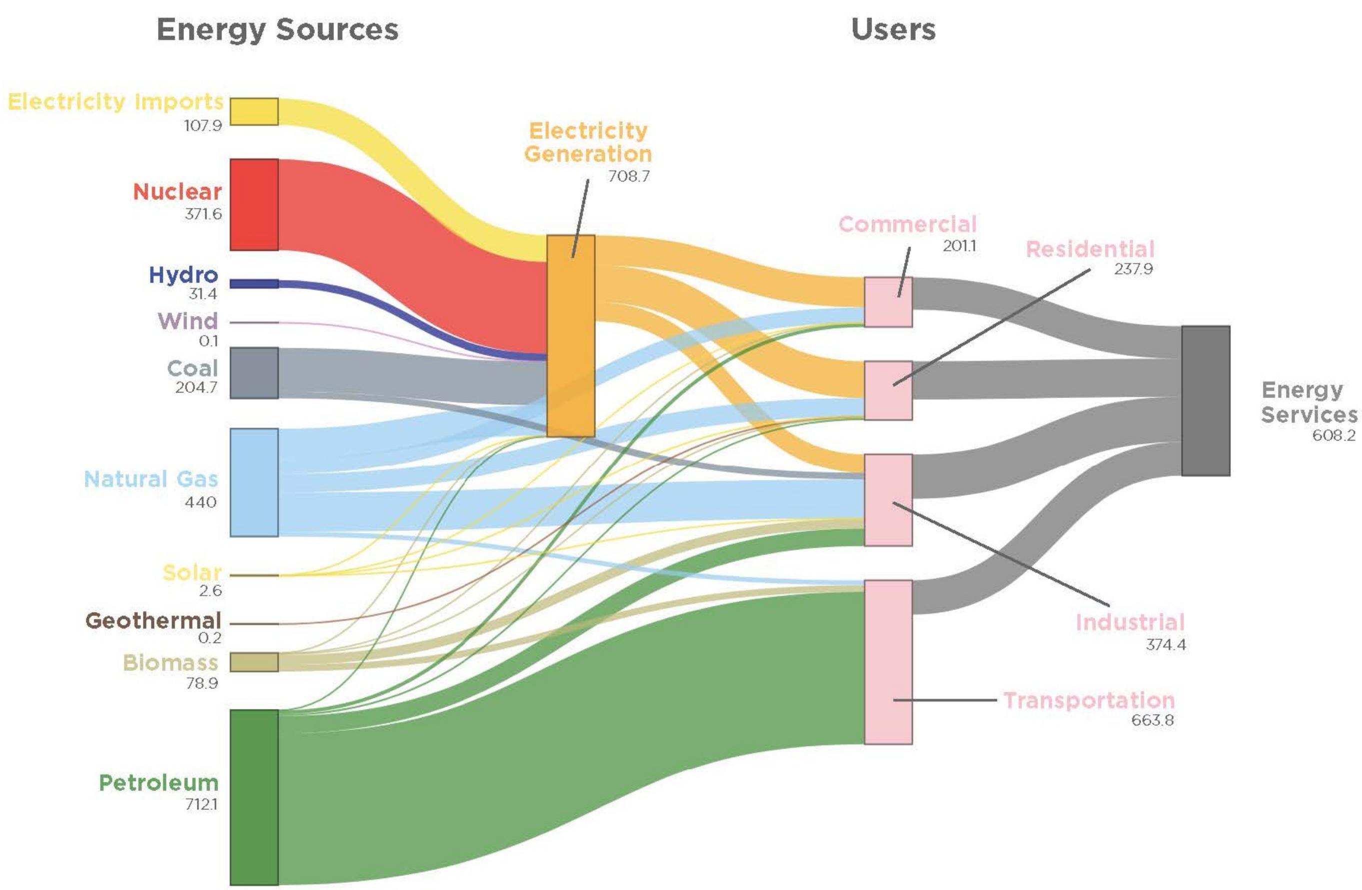
The first step towards meeting Tennessee's energy challenge is understanding the status quo.

Two main categories constitute Tennessee's energy supply: fuels like petroleum and natural gas that are used directly and electric power delivered through the electric grid. The combined energy supply is used in many different ways, including for transportation and by commercial, industrial, and residential end users.

Figure 1 shows a depiction of the entire energy system in Tennessee in 2022, measured in trillions of British thermal units (Btu). For context, 1000 Btu has about the same energy content as a Snickers bar, so a single Btu is about the same as one quarter of a calorie familiar to those who watch their dietary intake. In a single year the Tennessee energy system involves about 2 quadrillion Btu ($2x10^{15}$ Btu).

The left side of the figure shows sources of primary energy. The right side of the figure shows final disposition of energy. The figure illustrates how primary energy flows through the system to final disposition.

Figure 1: **Tennessee's Energy System (trillion Btu per year)**



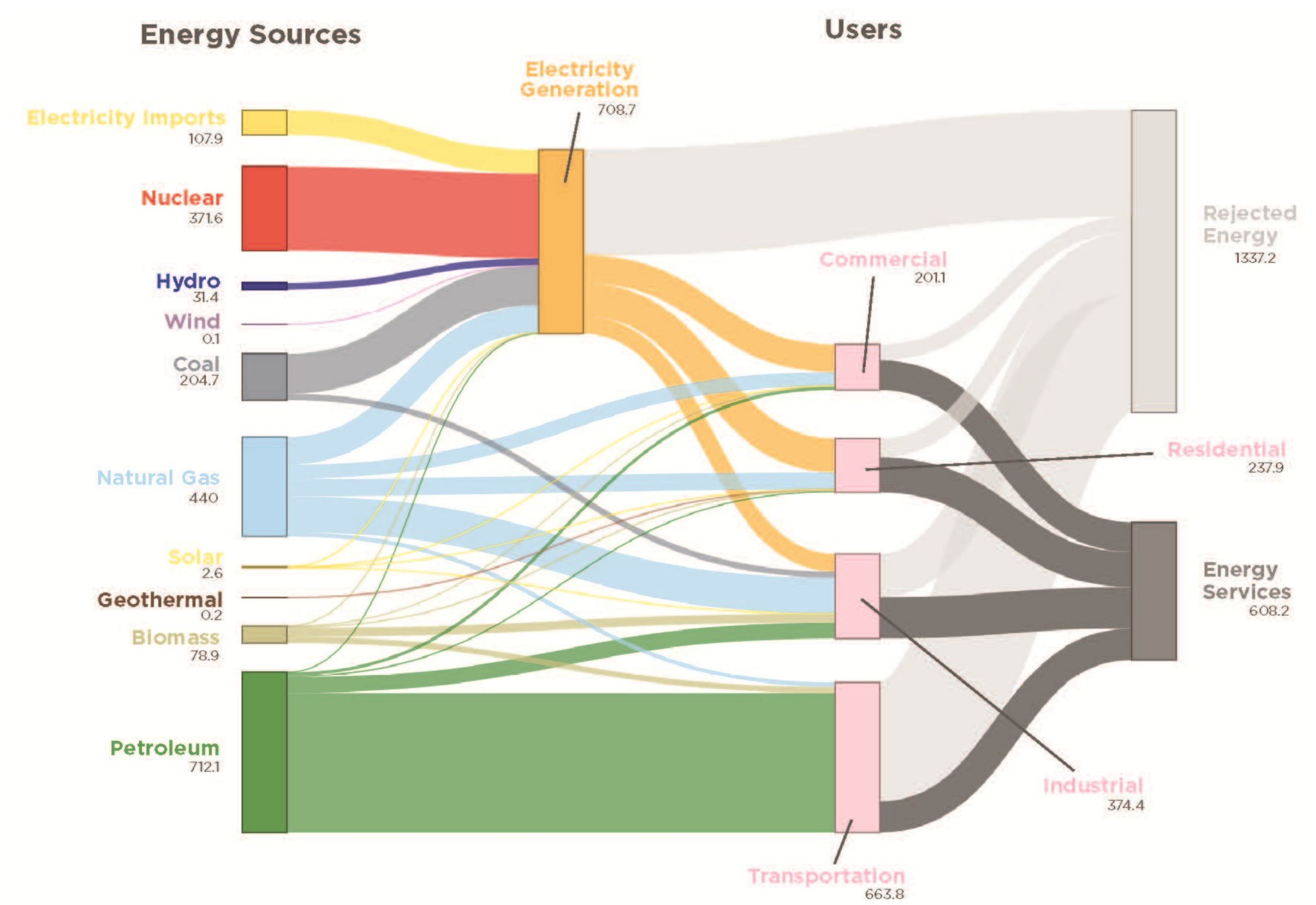
Source: Baker School using U.S. Energy Information Administration (EIA) data

There are many pathways. For example, most coal is burned to generate electricity, which is then used by residential, commercial, and industrial users to generate a particular energy service such as lighting. But a small percentage of coal is used directly by industrial users.

Figure 1 also provides compositional information, such as the mix of energy sources employed by industrial users: about 42 percent natural gas, 21 percent electricity (which itself is derived from multiple energy sources), 19 percent petroleum products, 10 percent biomass, 7 percent coal, and a fractional share from solar.

Figure 2 augments Figure 1 by displaying "rejected" energy – the amount of energy that is consumed but does not deliver energy services to end users. Examples include heat that escapes during combustion, electrical line losses, and other ways that energy escapes from the system without doing work. Most of the primary energy that is used in the state does not directly deliver energy services but is a side effect of the existing processes needed to deliver those energy services. Put another way, lost energy is necessary for the system to function, but reducing those losses is an area of opportunity discussed below.

Figure 2: **Tennessee's Energy System, Including Rejected Energy**



Source: Baker School using U.S. Energy Information Administration (EIA) data

Additional focus on Figure 1 illustrates a number of important realities.

- **The energy industry in Tennessee operates 24/7/365 with astounding reliability**, in part because many sources of energy are exploited to deliver to many different types of end uses.

- **Nearly two-thirds of the state's energy comes from petroleum and natural gas.** Tennessee is a negligible producer of both crude oil and natural gas. Ensuring delivery to the state in an efficient and reliable way is a primary concern. The United States is the world's leading producer of both and a net exporter of both products to the world market. This means that the marginal gallon of gasoline or diesel fuel, or unit of natural gas, consumed in Tennessee competes with a global buyer willing to purchase the same product.

- **The transport sector is the largest of the four final uses of energy**, by a factor of more than two. The transportation sector is almost entirely dependent on petroleum, which has limited use in other sectors. (For all the attention and excitement attracted by electric vehicles, penetration is modest today and limited to light passenger vehicles.) This poses a pair of challenges: one is the struggle to maintain the critical supply chain for a petroleum-fueled transportation system; the second is to project how transport might evolve and supplant the current system.

- **Transportation is also the least efficient sector**, if we compare the amount of energy services proportional to the rejected energy. About 21 percent of transportation energy delivers services, implying about 79 percent does not directly do the work that is needed. By contrast, the industrial sector captures about 37 percent of primary energy, and residential and commercial sectors are both around 65 percent.

- **Industrial energy users, which includes Tennessee's manufacturers, have a diverse portfolio of energy inputs** – the most diverse aside from the electricity sector. The industrial sector gets about twice as much energy from natural gas as from electricity. In fact, industrial users use more natural gas directly than is used for electricity generation in the state and represent about one-third of the total natural gas usage for the state.

- **Almost 39 percent of primary energy supply in Tennessee flows through the electricity system**. That may belie the salience of electricity, because it certainly seems that more than 39 percent of the energy policy debate centers on electricity. Looking forward, the return of electric load growth could increase the relative importance. Increasing electrification, which could happen through addition of new uses of electricity and switching existing uses to electricity, stands to increase the relative importance of this sector.

- As with the fossil fuel sector, **Tennessee's electricity sector depends on some imports from out of state**. About two-thirds of the electricity imports come from within the TVA system, which has a footprint across seven states and has been designed to operate without distinction for state lines. The ability to reliably import energy during the highest-demand periods is an asset that avoids having idle generation capacity that is infrequently used.
- **Electricity is a more diverse and substitutable form of energy than any of the other options**. Many sources are used to generate electricity, including nuclear, coal, gas, and hydro. In 2024, Tennessee generated 1.6 TWh, or 2.1 percent of annual generation, from wind, solar, and biomass. By contrast, some neighboring states (with similar endowments) achieved higher percentages: North Carolina hit 10.2 percent while Georgia made 10.4 percent. Texas and California generated 29.6 and 37.0 percent, respectively. *(Calculated from EIA state annual generation data, not accounting for imports/exports)*

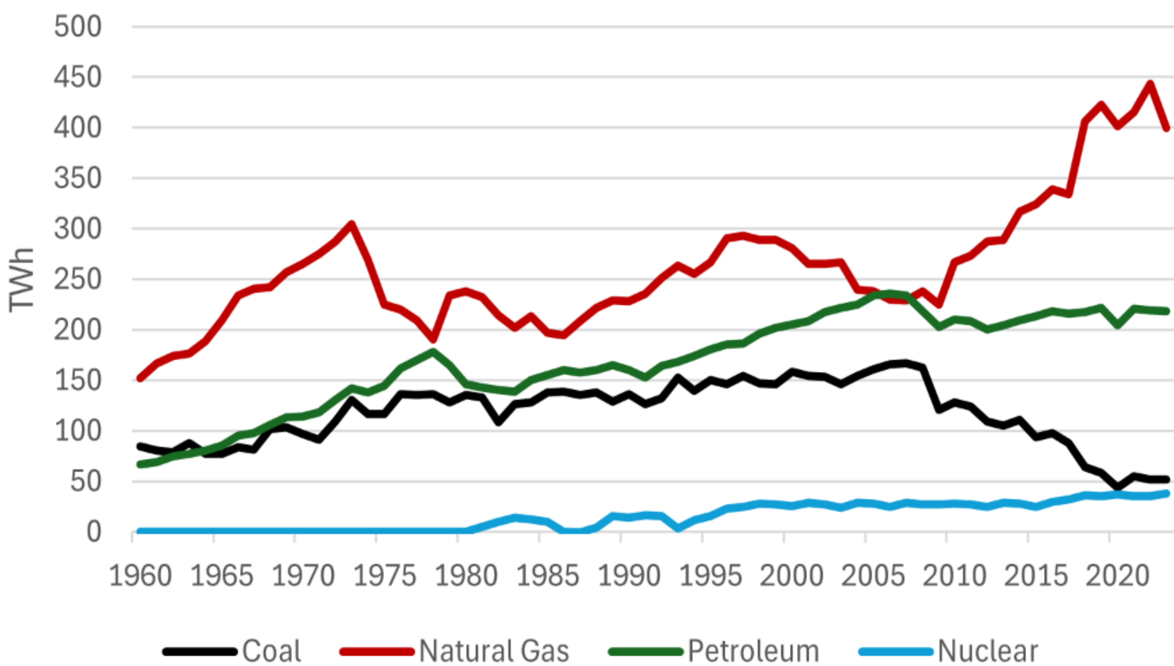
The renewable resource that is abundantly available in Tennessee is water, and hydroelectric power makes a substantial and perhaps undervalued contribution. Pumped storage, when excess power is used to pump water back up into a reservoir from which it can later be released, is a very cost-effective way to store energy and provides balancing benefits not reflected by the primary energy flows in Figure 1.

While the electricity generated by renewable sources is the same as from fossil or other sources from a customer's perspective, each type of generation offers its own strengths and weaknesses for the system. Two high-level concepts are important. First, wind and solar resources are intermittent rather than dispatchable. When the wind is blowing or the sun is shining, power is generated. Windless or sunless times mean the resources cannot be used. Second, the marginal cost of wind or solar generation is effectively zero. Other resources generally use some costly fuel that contributes to marginal cost, but when the wind and sun are available, power can be generated at no additional cost. Intermittency and zero marginal cost are system characteristics that are not observed directly by electricity customers but are important to utilities because dispatchable resources must be substituted when intermittent generation falls off and demand does not.

Some customers, including some data centers, prefer electricity with lower or zero emissions. With its strong base of nuclear power sources, Tennessee can offer nuclear power as a zero emissions alternative to renewables at a very high capacity factor. Finding a way to accommodate customers willing to pay a premium for zero emissions electricity is in the best interest of all and may be an increasingly important competitive advantage for the state going forward if demand for zero emissions energy sources continues to rise.

While Figure 1 provides a detailed look at the entire energy system in a single year, Figure 3 provides important context for how the primary sources of energy have changed over time. Since the financial crisis, a dramatic switch has taken place as natural gas consumption has grown substantially and has effectively substituted for coal's steady decline. Petroleum has seen minimal change over the same period.

Figure 3: **Tennessee's Primary Energy Sources, 1960-2023**



Source: Baker School using U.S. Energy Information Administration (EIA) data

Tennessee's Energy Geography

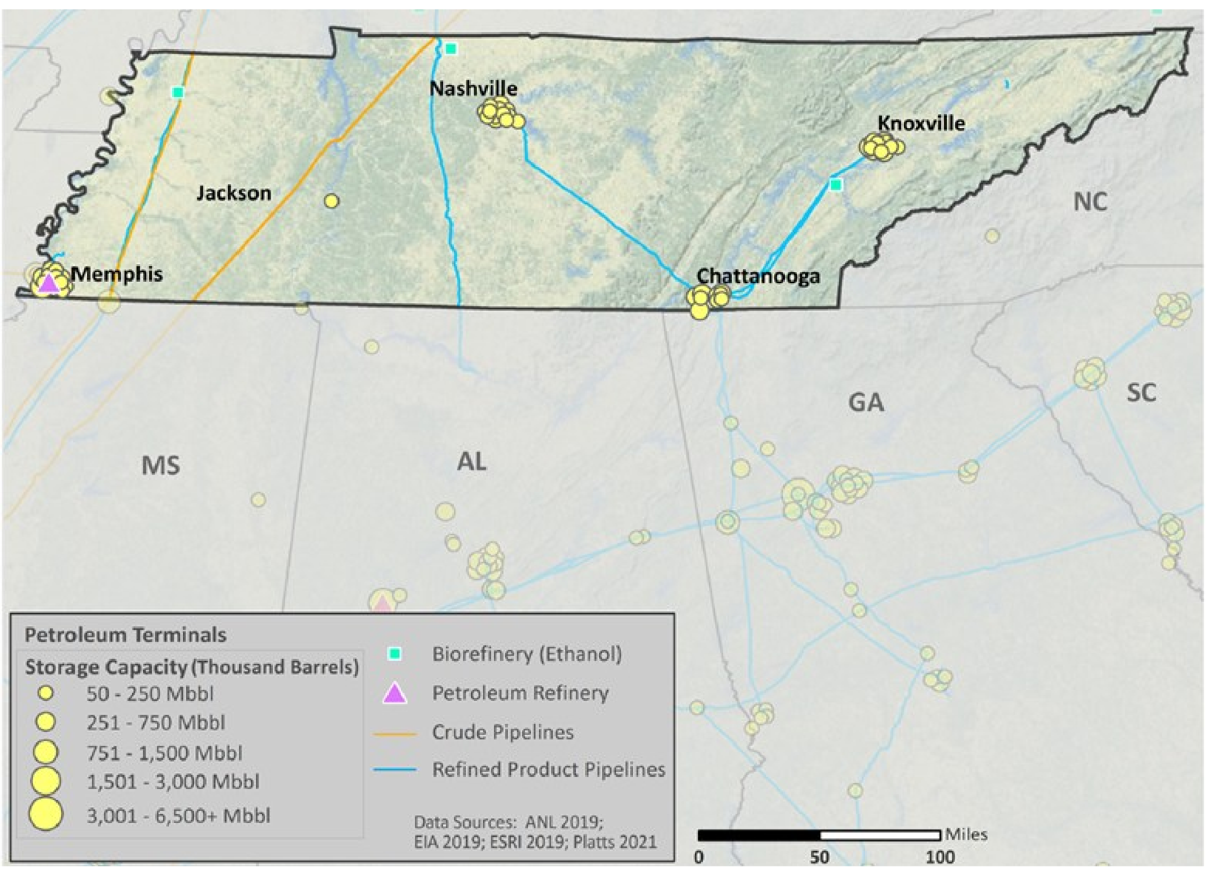
Examining the particular geography of Tennessee's energy system also provides some important insights.

Petroleum

Figure 4 shows the main infrastructure for petroleum across the state. Because petroleum products can be transported in a variety of ways, including pipeline, barge, rail, and truck, there are several pathways. The state's only oil refinery, located in Memphis, has a throughput capacity of 195,000 barrels per day. That capacity is sufficient to serve about half of the consumption in the state. Crude oil is delivered primarily by pipeline but also by barge. Delivery of refined products is by barge and truck.

Petroleum pipelines transit the western part of the state. Further east, delivery terminals from the Colonial and Plantation Pipeline systems in Chattanooga, Knoxville, and Nashville (Colonial only) are an important part of the petroleum product supply chain. These locations represent the end points of pipelines that begin on the Gulf Coast and are crucial transfer points for supplying the approximately 4,000 public gasoline fueling stations around the state.

Figure 4: **Tennessee's Primary Energy Sources, 1960-2023**



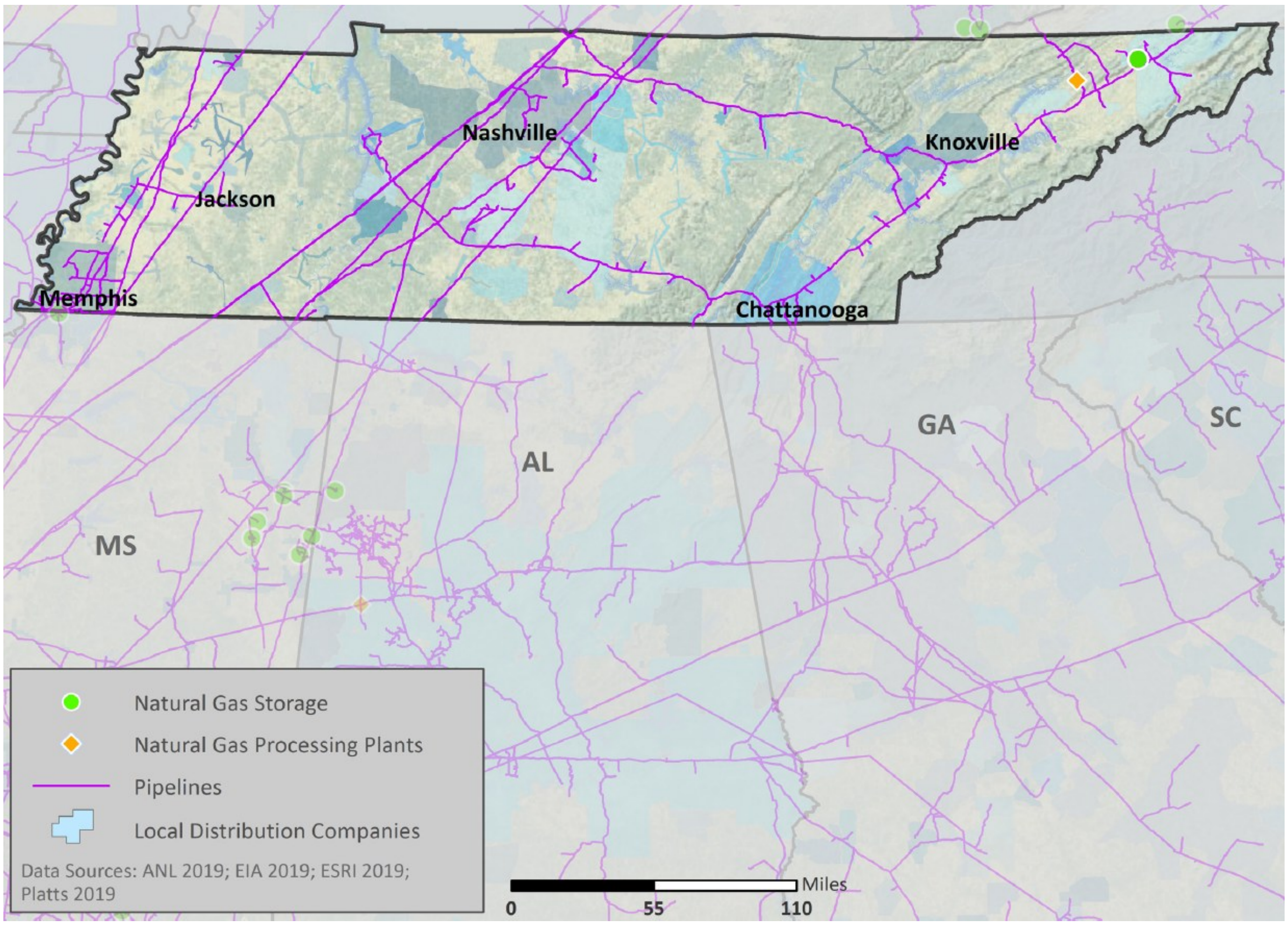
Source: U.S. Department of Energy's Office of Cybersecurity, Energy Security, and Emergency Response (CESER).

Natural Gas

Figure 5 presents a similar map for natural gas infrastructure. The physical properties of natural gas largely restrict its infrastructure to pipelines, without the benefit of rail or over-the-road transport. Several pipelines run through West and Middle Tennessee. Some of the gas transported in these pipelines is "fly-by" gas on its way to other places and is inaccessible. Still, West and Middle Tennessee are relatively well-supplied by the network of Texas Gas, Texas Eastern, and Tennessee Gas pipelines.

Further east the pipeline network is less dense, and East Tennessee is often capacity strained on the East Tennessee Gas pipeline system.[2]

Figure 5: **Natural Gas Map of Tennessee**

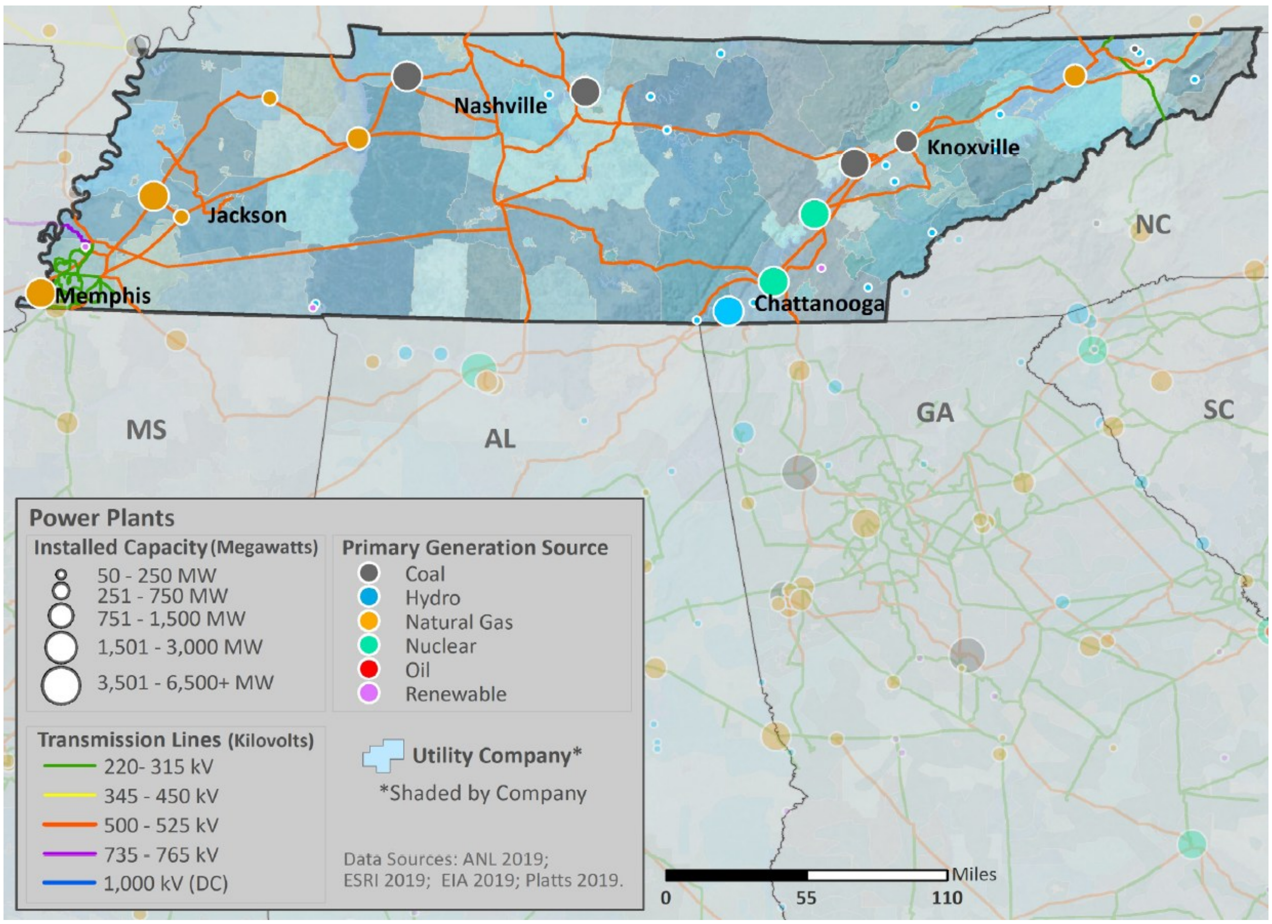


Source: U.S. Department of Energy's Office of Cybersecurity, Energy Security, and Emergency Response (CESER).

Electricity

Figure 6 presents a high-level depiction of the electricity system serving the state. Electricity generating stations are located throughout the state, most of which are part of the TVA system that is built to serve its entire region, and not just Tennessee. Operating nuclear reactors at Watts Bar and Sequoyah in East Tennessee are highlights of the generation fleet, but there are generation facilities located across the state. Both coal and natural gas are used to fuel power plants. The Tennessee and Cumberland Rivers (and their tributaries) provide several hydroelectric facilities. Though not shown in Figure 6, the greatest density of utility-scale solar generation facilities in the state is in West Tennessee.

Figure 6: **Electricity Map of Tennessee**



Source: U.S. Department of Energy's Office of Cybersecurity, Energy Security, and Emergency Response (CESER).

Customer Interface

Tennessee has more than 80 local electric companies that deliver to customers in dedicated service areas, including municipal utilities and rural electric cooperatives. Behind all of them is the Tennessee Valley Authority, which is a unique federal utility. TVA generates power and owns transmission lines but is not a retailer to regular customers. TVA sells electricity to local electric companies that sell to retail customers. In other states, a collage of investor-owned and public utilities ensures the delivery of power on a nondiscriminatory basis.

TVA serves parts of seven states without regard to the state borders. [3] Chartered by an act of Congress, TVA has a mandate to promote economic development and environmental quality, along with providing energy. By virtue of its Federal charter, TVA has electric rate-setting authority typically reserved for state regulators at a public utility commission. Members of TVA's board are confirmed by Congress, providing similar opportunity for public oversight afforded by directly elected or appointed commissioners in other state commissions. Local utilities in Tennessee follow the rates TVA elects, giving the TVA board an unusual amount of influence for a bulk electricity provider. In other states, retail utilities need rate approval from state regulators. Regulators in other states often take other actions beyond setting rates, whereas the focus on rate-setting ignores other avenues that could be available.

Natural gas does not have the overarching coordination that TVA provides in electricity markets, instead relying on contracting to ensure supplies are available when and where they are needed. The natural gas network does have dedicated local sellers similar to local power companies – in many cases the local utility provides both electricity and natural gas. In most of Tennessee, local distribution companies are also local utilities, though some localities are served by specialized natural gas providers. Although natural gas was historically regulated at the federal level, those restrictions have been relaxed for decades, and market transactions for supply and transportation shape the market. Natural gas is produced by hundreds of companies, transported along dozens of interstate transportation pipelines, and then delivered by local distribution companies with specific service areas.

Petroleum is the most competitive energy sector, with thousands of producers of crude, dozens of refiners around the country, active international trade in crude oil and refined products, and thousands of retailers within the state. The fungibility of petroleum makes transportation across modes feasible and competitive, with pipeline, barge (or other vessel), rail, and truck all competing to deliver products. A mix of large and small firms compete as suppliers and retailers without the geographic exclusivity that characterizes electricity and natural gas. In contrast to electricity and natural gas that a customer can usually only buy from a single provider, the market for petroleum sales is therefore highly competitive and lightly regulated.

Defining the Energy Challenge in Tennessee

Over the past 13 years, electricity demand in Tennessee has grown by 0.15 percent per year. As a result, concerns about keeping up with load growth have rarely been the focus of public discussion, and investments in Tennessee's electricity grid have been the result of replacing old assets more than adding new capacity.

But there are reasons to think accelerating demand will make maintaining the high level of performance in Tennessee's electricity system more challenging in the coming years. These concerns mirror a national policy debate, including a national "energy emergency" declared by President Trump on January 20, 2025.

Four elements define the contours of the energy challenge for Tennessee.

First, **expectations of strong and persistent electricity demand growth** pose a challenge that has not been faced in decades. Forecasts are uncertain and load growth may ultimately deviate from forecasts, but the latest TVA resource plan showed growth rates from 0-2.3 percent per year until 2050. Recent load growth has been about 1.9 percent per year, near the upper end of the range, with an updated resource plan expected in 2026.

Tennessee currently has lower observed and forecasted load growth than other states – the official ERCOT (the grid that covers most of Texas) forecast for annual energy anticipates 8.9 percent compound annual growth (CAGR) until 2035. Accelerating energy demand in Tennessee will present a challenge for maintaining the high levels of performance the system currently provides.

Second, **physical shocks to the system** are an important consideration. Dominated by weather events, physical shocks can manifest in a variety of ways. Winter Storm Elliott in December 2022 crippled the state's electricity system and is an instructive lesson about how weather events pose a challenge. The remnants of Hurricane Helene are a different example of a physical shock to the region it affected, resulting in weeks of lost service for some Tennesseans. Heat domes and weather patterns of unusual intensity relative to historical norms also require considering the robustness of the energy system. In a non-weather example, the 2021 one-week shutdown of the Colonial Pipeline in response to a cyberattack highlighted the vulnerability inherent in dependence on a single, congested infrastructure for liquid fuel supply.

Third, Tennessee is an energy importer, particularly of fossil fuels. Fortunately, reliable and affordable supplies are available from other states. However, producers of petroleum and natural gas in other states have many other market options. The United States is a net exporter of natural gas and petroleum products, implying that the options for producers are global. **The tendency of markets to equalize prices across regions implies that distant markets may affect prices and quantities available in Tennessee**.

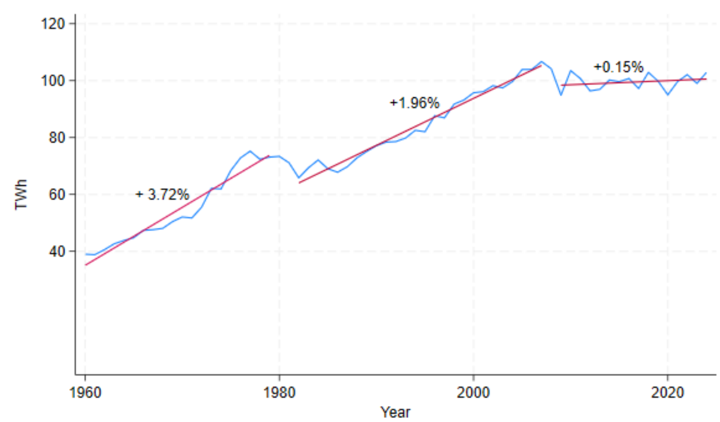
A secondary dimension of this is the competition for infrastructure investment. Petroleum products are easily transported by a number of transport modes, whereas natural gas is almost exclusively moved by pipeline.

Fourth, given the demand (load growth) and supply (physical and market shocks) factors outlined above, **the affordability of energy in Tennessee is an ongoing challenge to manage**. Some energy product prices are determined almost exclusively by market forces, while other user charges are determined by regulatory processes that may be affected by policy choices. Maintaining affordability for existing customers, and the ability to offer attractive pricing to draw new businesses and residents to the state, are important challenges. More broadly, affordability is a balancing act. More infrastructure can help deliver more energy more reliably, but it comes at a cost that is ultimately borne by final users. How costs of improvements are shared across groups of customers is a contentious issue.

Electricity Demand Growth

Figure 7 shows electricity demand in Tennessee from 1960-2023. The chart illustrates three distinct epochs of electricity load growth. During the 1960s and 1970s, when economic growth and the penetration of air conditioning was rapid, electricity demand growth averaged 3.72% per year. After the energy shocks of the 1970s and the recession-triggering measures to control inflation in the early 1980s, electricity demand growth resumed at a healthy rate of 1.96% per year, with little deviation until the financial crisis. This was a period of population and manufacturing growth in the state. Since 2009, electricity demand growth has been close to zero on average, with some years of decline. This period did see a turnover in manufacturing and industrial composition in the state, and also a substantial effect from efficiency enhancements including the transition from incandescent to fluorescent lighting.

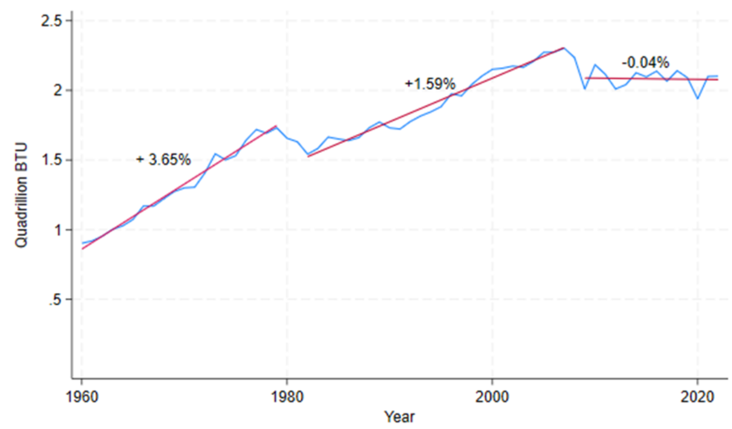
Figure 7: **Tennessee's Electricity Demand, 1960-2023**



Source: Baker School calculations using EIA data

Very similar trends are evident in total energy use across all sources, depicted in Figure 8. The flattening of total energy growth is explained in part by the plateau in gasoline and diesel demand growth since the financial crisis, even as natural gas consumption has increased by approximately 50 percent. The rise of gas has effectively offset the fall of coal.

Figure 8: **Tennessee's Total Energy Usage, 1960-2022**



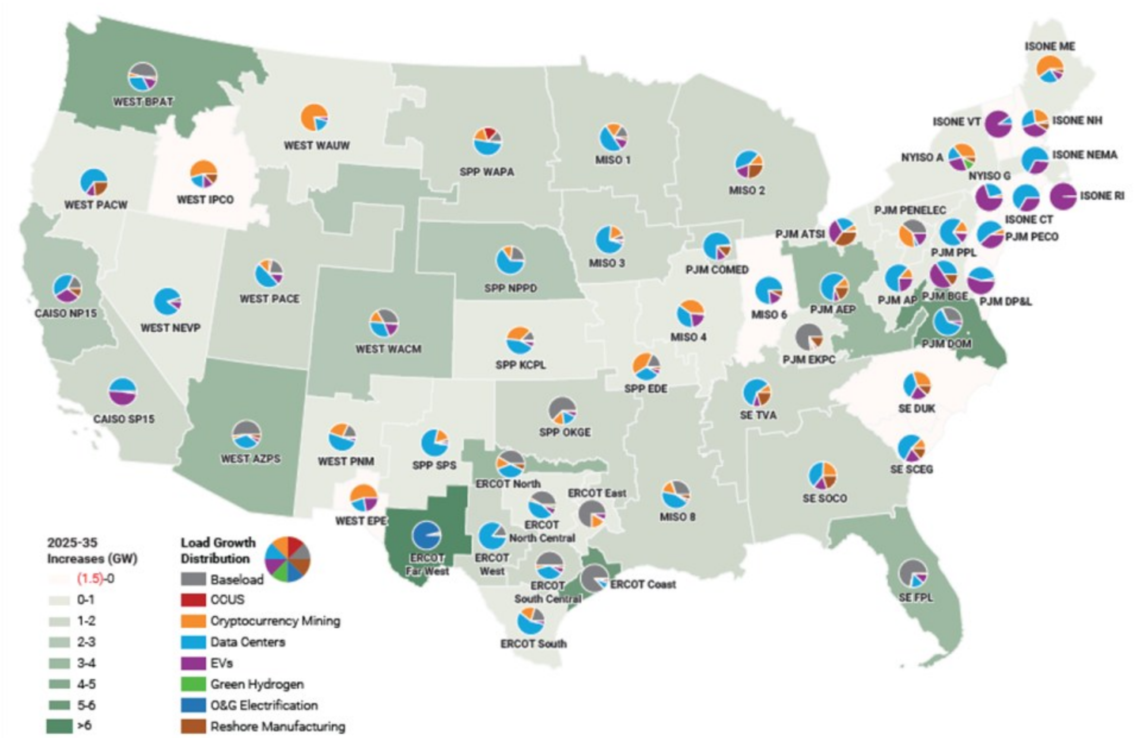
Source: Baker School calculations using EIA data

Part of today's energy challenge is that electricity load growth is expected to return to levels not seen in decades. In contrast to the similarity in historical electricity and overall energy use evident in Figure 7 and Figure 8, current forecasts anticipate growth being concentrated in electricity. Renewed load growth has two important dimensions: where the demand is coming from and how it will be served.

Figure 9 illustrates the distribution of projected load growth by load regions across the country. Regions are shaded from light to dark based on expected additions to peak electric demand over the next decade. Each region then features a pie chart to decompose estimates of load growth into component sources. The blue portion of pie charts is data centers; when added with the prominent amount of cryptocurrency mining in orange, novel new loads dominate most regions. Electric vehicles are expected to be major factors in the Northeast and the West Coast, whereas prevailing growth of the prevailing load mix is substantial in fast-growing parts of the Sunbelt including Arizona, Texas, and Florida.

Across the TVA service area, data centers and cryptocurrency mining are the largest source of expected load growth, but manufacturing demand and electric vehicles also play an important role. Population growth and expanding residential power usage is not expected to meaningfully contribute to the region's future load growth. While the prominence of data centers is common to many regions, the importance of manufacturing for Tennessee load growth is more unusual and concentrated in specific

Figure 9: Load Growth by Region, 2025-2035



Source: Enverus as presented at Federal Reserve Energy Conference, November 2025.

Note: Among the load growth types, CCUS is carbon capture utilization and storage; EVs are electric vehicles; O&G Electrification is electrification of oil & gas extraction operations, including hydraulic fracturing.

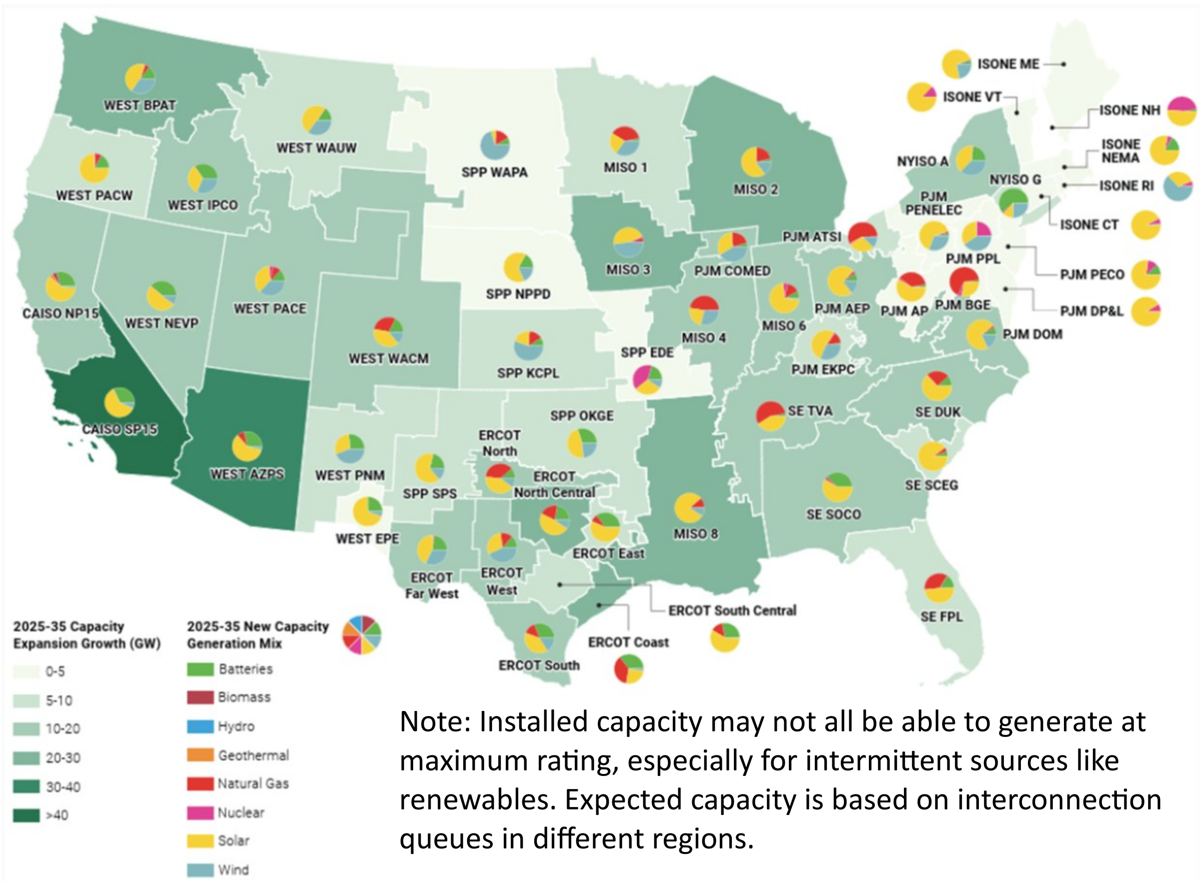
locations. For all but the smallest data centers, the distinction between them and manufacturing is more subtle because both are industrial customers. This contrasts with other regions where commercial and residential customer classes are expected to grow more.

The fact that load growth in our region is expected to come from industrial classes has important pricing and policy implications. As discussed below, industrial customers have historically paid a lower rate than residential and commercial users. Bearing or sharing the costs of load growth is a crucial issue.

While the TVA service area is expected to experience load growth, TVA itself need not supply all of the additional power with its own native generation assets. Indeed, a feature of the current expansion of generation capacity nationwide is the adoption of new models of electricity generation and financing.

As of 2020, TVA allows retail utilities to purchase up to 5 percent of their power from independent (often renewable) power providers other than TVA. This model is most commonly used in solar, where private electricity providers build larger-scale solar farms and sell power directly to local utilities. For most peak hours, the state can obtain power imports at lower cost than building and maintaining extra capacity that operates only a few hours each year.

Figure 10: Planned Capacity Growth by Region, 2025-2035



Source: Enverus as presented at Federal Reserve Energy Conference, November 2025.

This context is important for understanding Figure 10, the supply-side analogue to Figure 9. Regions are shaded from light to dark based on how much capacity is planned to be added to the grid. This does not include behind-the-meter resources that are not grid connected, which might include industrial users with their own energy sources. Each region has a pie chart showing the composition of generation technologies that will be added.

The figure reflects the queue of new generation assets currently planned. It does not indicate what entity plans to build the assets. Within the TVA region, solar is expected to be an equal partner to natural gas-sourced electricity in meeting our rising electricity demand, even if it is built by private companies contracting with local utilities rather than TVA itself.

Several additional items deserve mention. First, on a nationwide basis, capacity increases in nominal terms exceed the expected load additions shown in Figure 10, in some cases by an order of magnitude. Second, nationwide, the most popular form of capacity to be added is solar, represented by the yellow portions of the pie charts. The relatively low capacity factor of solar generation helps explain why so much needs to be installed. It also relates to the third observation, which is the high share of capacity additions in the form of batteries, albeit not in Tennessee. Batteries are often being paired with solar to prevent curtailment during daytime hours and allow discharge when the sun has set. The benefit of this pairing depends on the details of demand, but it is a popular choice today as storage is more widely available in electricity markets. Fourth, in terms of dispatchable resources, natural gas is the clear favorite.

Finally, it is worth noting that, at this time, nuclear energy is not a major part of energy supply planning across the country over the next decade. Interconnection queues do not currently have active applications to add nuclear capacity to the grid before 2035. Expected construction times for conventional nuclear reactors suggest that new commitments today would likely begin producing power after 2035. A shift in policy priorities towards nuclear, and financing commitments to support nuclear energy investment, would spark an adjustment in these projections.

Turning to Tennessee, across the TVA system the capacity additions are natural gas and solar. Reliance on natural gas contrasts with some neighboring regions (see Figure 10) and underscores the importance of reliable gas supplies to the electricity system. How loads evolve and when they matriculate has important implications for the choice of generation technology, as natural gas can expand and adjust quickly, but nuclear can provide low-cost baseload power if afforded time for construction.

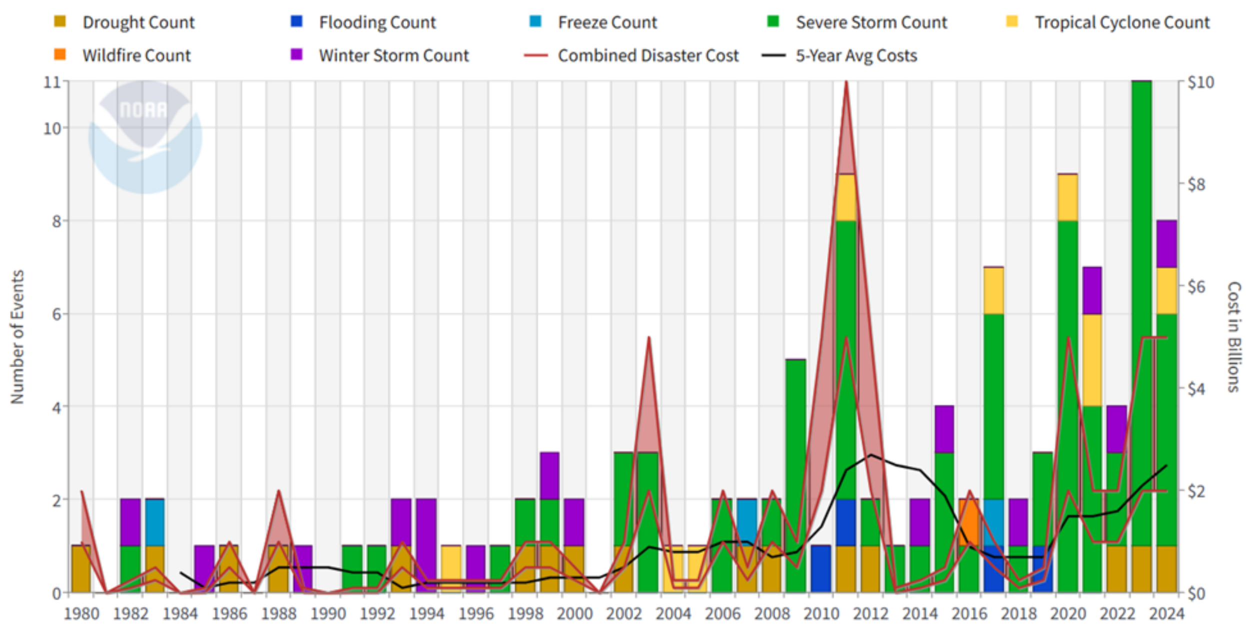
Demand Growth Beyond Electricity

Tennessee's increasing reliance on natural gas for electricity generation underscores the direct linkages within the energy system between fuels and power. Without long distance electricity transmission, increases in the demand for electricity will also raise local demand for natural gas. Natural gas is delivered largely by just-in-time delivery. If electricity demand increases during a weather event that also makes delivering fuel more difficult, such as during a major winter storm event, then supply constraints in natural gas can become binding. And alternative sources of energy without fuel delivery constraints suddenly become more attractive. This could include generation with fuel stored on site, such as coal or nuclear, or it could be renewables that do not require fuel.

Physical Shocks

An important challenge is physical shocks that elevate demand and strain the ability of the system to deliver energy services. Electricity demand varies seasonally and peaks during seasonal weather abnormalities, including both winter storms or summer heat waves. The system is acclimatized to normal weather patterns, but extreme weather is an important form of physical shock.

Figure 11: **Tennessee's Billion-Dollar Disaster Events 1980-2024 (CPI-Adjusted)**



Source: National Centers for Environmental Information, National Oceanic and Atmospheric Administration

Figure 11 reports a 45-year history of major weather events in Tennessee, with a noticeably higher incidence later in the period. The figure includes events with at least $1 billion (2024 $) in damages, using the consumer price index to adjust across years.

Weather shocks raise concerns around robustness, reliability, and resilience. Robustness refers to the ability of the system to endure greater extremes without being affected. Reliability is the ability of the system to maintain energy services despite challenges. Resilience is the ability of the system to recover full performance when an outage does occur.

Robustness to interruption can be increased with greater investment. The leading cause of electric outages in Tennessee and nationwide is falling trees. Undergrounding electric lines reduces that threat but increases the investment cost in new infrastructure. Similarly, fuels infrastructure can be hardened, or built more expensively, to ensure that interruptions are less frequent.

System redundancy can be created to ensure reliability. This also increases system cost by requiring more capital investment and reducing utilization rates as some redundant capacity is idle during normal circumstances. But during a crisis, as resources become unavailable, others are standing by to supply energy.

The converse to system redundancy is demand response by end users. Electricity providers have formal demand response programs, particularly for large users, wherein customers agree to reduce their consumption when asked. In exchange, responsive customers receive favorable rates or other financial incentives. The natural gas system has evolved with ways for some users to express their willingness to be interrupted in exchange for lower transportation charges. One important advantage to demand response is that it can help reduce demand when it is highest, sometimes called "peak shaving," thereby reducing the need for building additional supply that would only be used infrequently.

Investments can also improve resilience by dedicating resources to timely restoration of supply. Because the system is highly reliable, these investments are unlikely to be called upon frequently. Some customers, from individuals purchasing backup generators to firms storing fuel supplies, make their own investments in resilience. Data centers that co-locate generation assets to augment retail power and may sell some of their co-located generation back to the grid are a recent high-profile example.

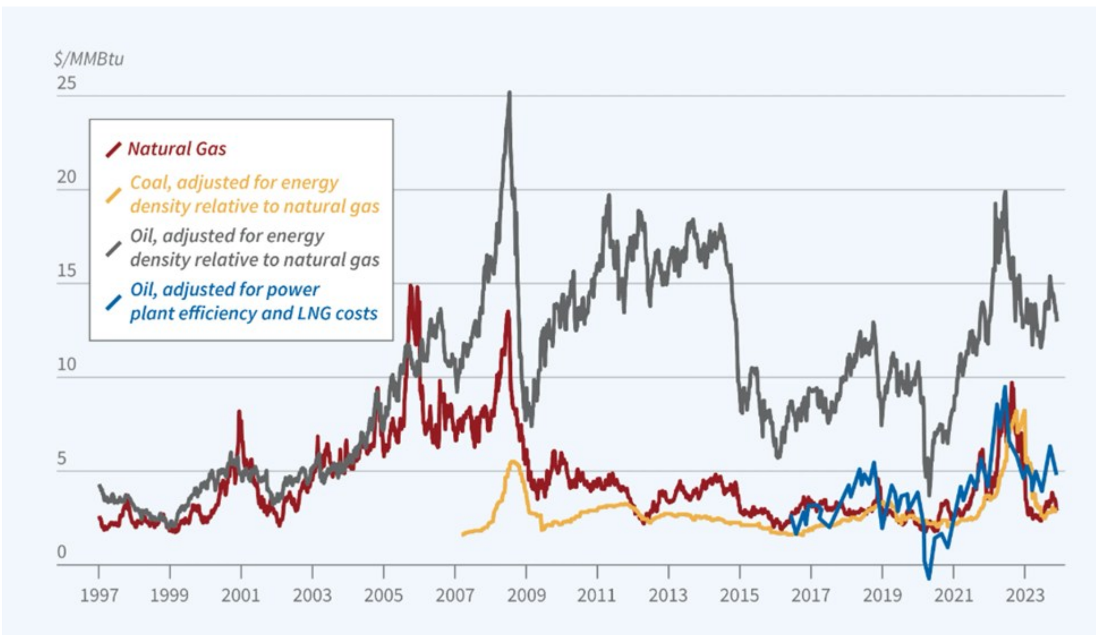
Reliance on distant supplies, particularly for fuels, means even weather shocks that do not directly impact Tennessee can test the energy system. This is even more true in a world of sole-source supply, e.g., in 2021 when Winter Storm Uri in Texas interrupted natural gas supplies. This risk can be managed through supply diversification. Diversification may not fully resolve problems from especially widespread weather systems such as Winter Storm Elliott, which affected Tennessee and much of the eastern U.S. in 2022.

While weather is a primary factor in fluctuating energy demand and causes many important physical shocks, it is not the only concern. Reliance on distant supplies also underscores the importance of critical infrastructure links. The May 2021 cyberattack on Colonial Pipeline resulted in a shutdown and disrupted fuel supplies to the southeastern U.S., highlighting how novel and unexpected threats can affect energy supply. The outage lasted only a few days but contributed to higher fuel prices at the pump for weeks, compounding seasonal price increases. The unfortunate timing resulted in stacking seasonal trends on top of a physical shock and highlights the challenge that physical shocks of all kinds can pose.

Connected markets

Connection to distant markets creates opportunities but also introduces new risks. Historically, concern about dependence on foreign supplies has shaped U.S. energy policy and advocates for energy independence. In the last decade the emergence of the U.S. role as net energy exporter has assuaged some of those long-time fears, but net exporter status certainly does not eliminate all risk. Petroleum markets remain global, meaning domestic consumers must compete with exports for the marginal barrel. The net export position is created in refined products, though both crude oil and refined products are exported. With substantial investment in liquefied natural gas (LNG) export capacity, and still more under construction, the United States is also a net exporter of natural gas, a notable change from decades of regional marketing. Price spikes in distant parts of the world now draw more exports from the U.S. market. Energy markets have also matured in recent years so that substitutability between fuel sources has resulted in the price parity evident in Figure 12.

Figure 12: **U.S. Natural Gas, Coal, and Oil Prices**



Source: Stock & Zaragoza-Watkins (2024)

What is novel in the last 10 years is the co-movement of prices across fuels. Petroleum, natural gas, and coal prices historically evolved with their own dynamics. Today, with net export positions, arbitrage across exports of different fuels means that global price shocks are transmitted back to domestic markets. For example, a global shock to LNG prices makes exports rise and drives domestic users to switch to coal. This, in turn, drives up coal prices. In 2022, global energy markets experienced a coordinated shock that affected domestic prices substantially. The same events ten years earlier would not have affected domestic natural gas markets because there was no LNG export channel to link domestic U.S. prices to global energy prices.

Tennessee relies on petroleum and natural gas and must endure greater price volatility from increasingly connected markets. New U.S. LNG export capacity currently under construction is expected to double export capacity by the end of 2028. This will open a greater channel to distant price shocks. Recent infrastructure investment for natural gas has fixated on facilitating LNG exports, including bringing southbound gas through Tennessee. Some of this LNG is delivered to Europe, where seasonal fluctuations in demand mirror those in the U.S. and exacerbate concerns about potential price spikes driven by weather or other physical shocks elsewhere in the world.

Affordability and Prices

The final challenge for Tennessee is to keep energy prices manageable for residents and businesses. Figure 13 shows a history of average retail electricity rates for Tennessee and the United States. It is clear that Tennessee energy consumers have paid lower prices than the average elsewhere in the country.

When it comes to electricity pricing, not all customers are treated the same. Commercial, industrial, and residential rate classes exist to provide different pricing to different types of customers. Figure 14 shows how these different rate classes have experienced electricity pricing in Tennessee over time.

While residential and commercial rates are very similar, industrial rates are lower and have followed a different trend for the past 15 years. Industrial customers often use large amounts of electricity in a steady and predictable way that makes it relatively simple for utilities to know what to expect. In this sense, lower industrial rates are akin to the price discounts consumers often receive for buying in bulk. Industrial customers may also engage in activities like demand response that are valuable to utilities and allow their needs to be served at lower prices.

Figure 13: **U.S. vs Tennessee's Retail Electricity Prices**

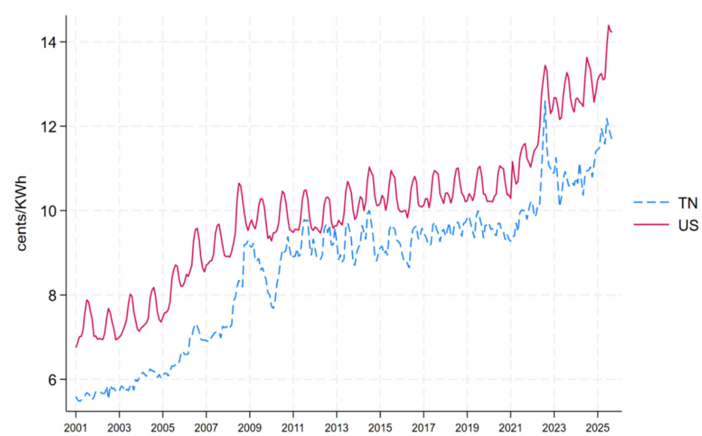
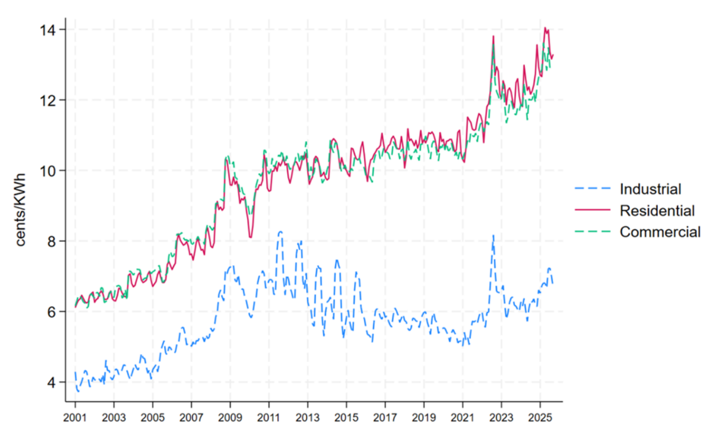
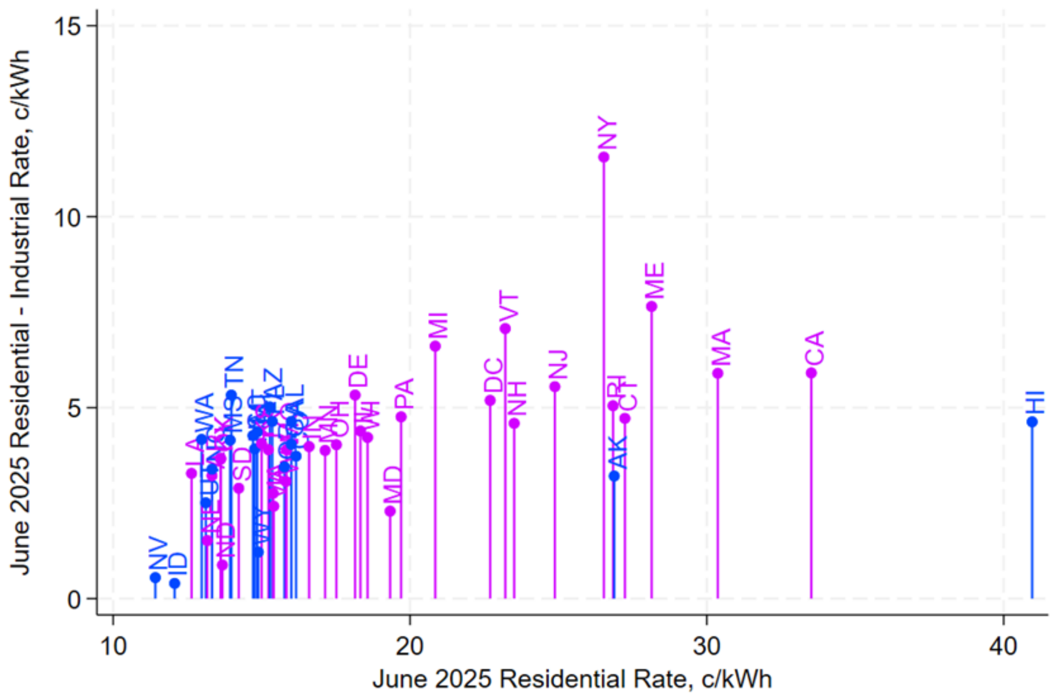


Figure 14: **Tennessee's Retail Electricity Prices by Customer Class**



Tennessee's relatively low industrial rates have helped attract large industrial users, including manufacturers and data centers, to the state. The competitiveness of Tennessee in this regard is shown in Figure 15, which compares average residential and industrial rates across states in a single month, June 2025. The horizontal axis tracks the average residential rate by state, from the lowest (Nevada) to the highest (Hawaii). The vertical distance of the spike represents the difference between average industrial and residential rates in each state; a taller spike means that there is a larger difference between residential and industrial rates. It is notable that all states offer lower rates to industrial than residential customers. Tennessee is visible to the top left of the states, suggesting that it has among the lowest residential rates and the largest discounts for industrial customers.

Figure 15: **Residential vs. Industrial Electricity Rates by State, June 2025**

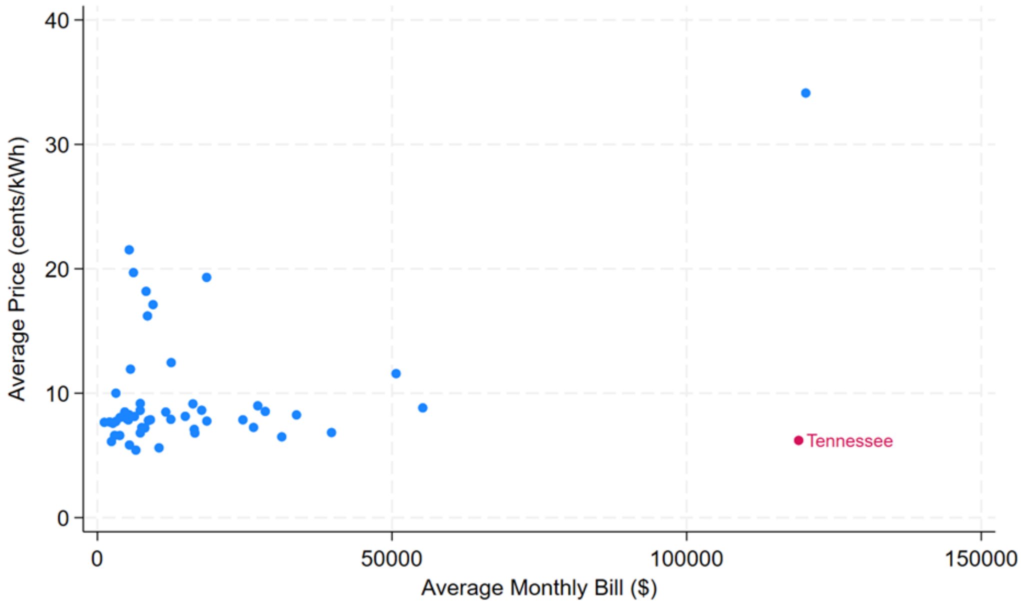


Source: Baker School calculations using EIA data

Note: Figure shows average monthly residential rate on horizontal axis and difference between average residential rate and average industrial rate on vertical axis. Colors indicate states with predominantly traditional (blue) and restructured (pink) electricity markets.

Low industrial electricity prices in Tennessee have been a successful recruitment tool and industrial electricity usage in the state is very high. Despite the relatively low rates, the average monthly electricity bill for industrial customers in Tennessee is the highest of any state in the country (see Figure 16). This is attributable to the high usage by industrial customers. Tennessee's comparative advantage in affordable electricity for industrial users will require an ongoing effort to maintain competitive pricing.

Figure 16: **Average Industrial Electricity Rates and Bills by State, 2024**



Source: Baker School calculations using EIA data

Meeting the Energy Challenge in Tennessee

Meeting the energy challenge will require Tennessee leaders to keep long-term goals in mind while thinking flexibly to ensure residents and businesses have access to affordable and reliable energy.

State and local actors have a role to play in at least three ways.

First, the system that supplies Tennessee's energy needs will need to grow, and additional generation and transmission assets will need to be built inside Tennessee's borders. Tennessee's leaders help determine the speed with which private and public power producers and transmission owners get the permissions and local buy-in they need to build new infrastructure. Efforts to increase efficiency can bend the curve on needed supply additions, but efficiency efforts alone cannot meet the energy challenge.

Second, Tennessee's leaders can embrace innovation both within its own footprint and as an opportunity for economic development as Tennessee supplies the energy needs of other regions. The East Tennessee/Oak Ridge nuclear industry is an example of a strategic investment allowing the state to benefit from energy innovation both in Tennessee and around the world. Opportunities also exist in critical minerals, hydrogen technology, and batteries.

Third, Tennessee leaders can work to provide policy certainty in energy, thereby attracting investment and lowering the cost of delivering energy. Costs of new infrastructure investments fall on end users – ratepayers in the case of electricity. Policy incentives for various supply options (renewable subsidies, nuclear subsidies, moratoria on coal plants, etc.) impact relative prices and lead power producers to make different choices. Unanticipated changes in the policy menu can contribute to uncertainty about the future, deterring investment and leading to higher-cost decisions. Ultimately, when policy whiplash at the local, state, or federal level happens, it raises construction costs and the electricity rates paid by ratepayers. A continuous policy environment that transcends political cycles can reduce policy adjustment costs and facilitate additional energy generation at the lowest possible cost.

Finally, although there is little public policy implication, increasing efficiency is a valuable tool to help meet Tennessee's energy challenge.

We examine each of these solutions in turn.

Facilitating Growth in Tennessee's Energy Supply

Energy is a capital-intensive sector with long-lived assets, and today's stock of infrastructure has accumulated over many years. To meet growing energy demand, retiring assets will need to be replaced, but new capacity will also be required.

New generation assets will need to join the grid. **Natural gas power plants are the quickest to build and are the focus of TVA's short-term generation expansion**. Private power producers are adding solar capacity to the grid and, as a substitute for TVA direct construction, this private construction protects TVA ratepayers from risks associated with additional infrastructure costs. In both cases, additional transmission lines from power generation sources to end users will be required.

In addition to electricity generation and power transmission, the state will likely see the **addition of interstate natural gas transmission capacity**, which is privately provided and federally permitted, for at least three reasons. First, natural gas power plants need a supply source. Adding transmission and storage means more natural gas generation can be used, taking the variability in draw into account when electricity needs are highest. Second, diversification of natural gas supply beyond the current set of sources would improve the reliability of the system and limit potential for power generation disruptions, but additional pipeline construction is needed to source gas from different regions. Finally, East Tennessee is particularly limited in natural gas pipeline capacity amid a boom in population and economic activity. Without additional capacity, the pipeline capacity constraint in East Tennessee is likely to become a binding constraint in the years ahead.

Finally, consistent with trends across the country, the state may also see the addition of **batteries for energy storage** into the energy grid. Chemical batteries, which offer the prospect of reselling low-cost power that would otherwise be wasted, are being deployed at breakneck pace in other markets. Tennessee's relatively low reliance on renewables makes battery deployment less important than in other states. But a shifting supply of renewables in the Tennessee energy market may provide new opportunities for their deployment. Pumped storage is a mechanical battery and already a valuable asset in Tennessee, though much more limited in terms of number of potential locations.

Additional infrastructure will add costs to the system that are ultimately borne by ratepayers (electricity) and customers (fuels). The prices of key inputs into electricity and fuels infrastructure (labor, concrete, steel) have all risen at an accelerated rate in the last several years, making it likely that additional infrastructure will raise the average cost of generating and delivering energy to Tennesseans and, therefore, raise average prices paid.

Tennessee leaders have a role to play in facilitating the additional infrastructure that will be needed to meet Tennessee's energy challenge. This does not imply that leaders should be blindly supportive of any new infrastructure project. But **engaging and communicating with affected communities is essential** to timely and successful infrastructure buildout and requires leadership that is aware of the broader context in which infrastructure needs are emerging.

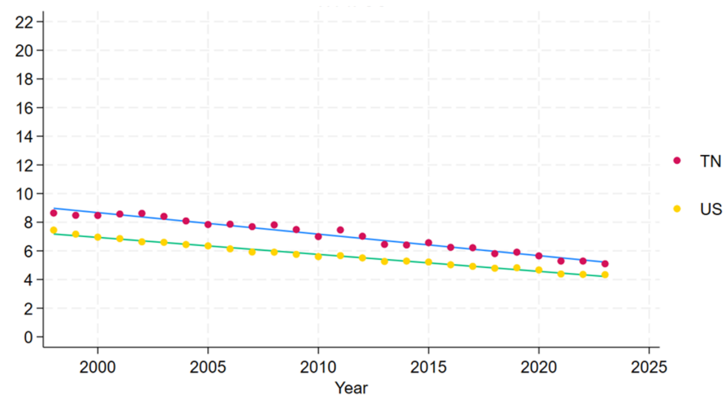
Where impacts are localized but benefits are spread across the entire state or region, leaders can help communicate how investments are needed while addressing concerns about local effects.

Improving Energy Efficiency

Building infrastructure without concern for the use of energy is no guarantee of increasing value from the energy system. Discipline in terms of energy use is also necessary.

Energy efficiency in Tennessee has been increasing over time. Figure 17 shows the energy intensity of GDP (measured in thousand Btu/ 2017$) for Tennessee and the United States. Tennessee's economy is slightly more energy-intensive than the nation as a whole, which is attributable to the importance of manufacturing and the climatic need for air conditioning. Both Tennessee and the United States have followed similar trends in decreasing energy intensity over the past couple decades. The trend towards lower energy intensity appears in every state. The persistence across states and over time suggests common trends are at work.

Figure 17: **Energy Intensity of GDP, U.S. and TN 1998-2023**



Source: Baker School calculations using EIA data

Increasing energy efficiency implies delivery of the same services with fewer inputs. Electricity providers have made progress in recent years to minimize the inputs needed to meet customer needs. This has led to programs for demand response and flexibility on the customer side. Such strategies **shift energy demand to shave demand from peak periods and therefore reduce the need for expensive infrastructure capacity** that would otherwise be used only during high demand periods.

Two major types of programs are used in electricity markets: **demand-side management programs** include direct load control, interruptible service contracts, emergency demand response, and **buyback programs**. Dynamic pricing programs are similar but rely on time-varying prices to achieve behavioral adjustments rather than more direct interventions. Examples of dynamic pricing programs include time-of-use pricing programs including real-time pricing or variable peak or critical peak pricing.

Efficiency gains are not limited to the customer side. A mechanism for increasing systemic efficiency from the supply side is virtual power plants (VPPs) that are emerging as a critical solution for strengthening electrical grid reliability. VPPs aggregate small, distributed energy resources such as rooftop solar and demand response capabilities into blocks of power that grid operators, including TVA, can deploy. With wider adoption, it is possible that VPPs could aggregate to gigawatt scale and preclude having to build additional generation assets. VPPs could also provide peaking capacity at roughly half the cost of alternatives and could address 10-20 percent of peak load while saving $10 billion in annual grid costs.

Embracing Innovation

An important part of meeting the energy challenge is innovation. The energy sources and delivery mechanisms of tomorrow will not be the same as today's. And because it is not obvious *ex ante* which future technologies will be most successful, a portfolio approach to innovation investment is useful. Long lead times and capital intensity for new technologies create problems of how to finance research and development, but most of these considerations play out in federal energy policy.

Tennessee's innovation opportunities are both about harnessing this innovation to meet future demand but also about economic development and the opportunity to meet the needs of other energy consumers worldwide.

Tennessee is uniquely positioned to embrace energy innovation as home to one of the country's largest federal energy research & development facilities: Oak Ridge National Laboratory (ORNL). ORNL has a $2.6B annual budget and a mandate to advance scientific knowledge in the areas of "supercomputing, advanced manufacturing, materials research, neutron science, clean energy, and national security." With the ORNL asset and the performance of its higher education institutions, Tennessee ranks 8th among all states in public and nonprofit expenditures on R&D (not specific to energy).[4]

Nuclear energy has a special place in the collective psyche of Tennessee and advanced nuclear technology offers great scope for innovation.[5] After decades of stasis, the U.S. nuclear industry has completed three reactors in the last 10 years. Simultaneously, new reactor designs have been proposed to avoid past safety problems.

One example of how nuclear technology is being explored in Tennessee is Kairos Power, which has a **novel reactor design and is constructing two prototypes**. To facilitate the experimentation, Kairos has contracted future commercial power from its prototypes for consumption in datacenters owned by Google, using the transmission network owned by TVA. This innovative contracting allows for experimentation with new technology without committing TVA financial resources, which would preclude the pursuit of other alternatives.

Given the large number of advanced nuclear designs, it is not clear if Kairos will ultimately have a superior design. That will be determined by research and experimentation, which can be fostered in a decentralized and permissive environment. The proliferation of designs for small modular reactors, optimism about breakthroughs in fusion, and connections to national security issues are all feeding the current enthusiasm and potential future innovation that could occur in just the nuclear energy space. Fostering work on new technologies, including but not limited to nuclear, is important to long-term success.

One promising technology that has seen recent breakthroughs in other parts of the country is advanced geothermal. Unfortunately for Tennessee, the assessed potential in the state is low. This effectively removes one alternative for clean baseload electricity generation from the set of possibilities.

The state has more to offer for innovation in emerging technologies like hydrogen. Like natural gas, hydrogen fuel travels in pipelines. The state's relatively low regulations on intrastate pipeline construction may facilitate a quicker buildout for future hydrogen generation and distribution.

The state may also contribute to emerging battery technologies and battery proliferation through innovation in critical minerals. In December 2025, the state announced the arrival of Korea Zinc, including a rare earth extraction operation that will take advantage of Smith County's gallium and germanium deposits. In addition, new innovations in the extraction of rare earth elements from coal ash imply that the state's coal-burning (or previously coal-burning) power plants may have additional economic development uses.[6] In all cases, economic development incentives from state and local governments are likely to be part of bringing opportunities to full fruition.

Embracing a portfolio across the options preserves the greatest future flexibility alongside opportunities for local economic windfalls.

Reducing Policy Uncertainty to Lower Costs of Expansion

In Tennessee, public entities are not likely to invest directly in energy infrastructure. Tennessee leaders can, however, help create a stable and predictable policy environment. The emphasis here is on policy *predictability*, not on the content of the policy *per se*.

Major swings in energy policy can create uncertainty that undermines incentives to make long-term investments. And those same swings increase the probability that private sector players make investments that are *ex post* costly to ratepayers and customers. For example, fluctuations in federal policy with respect to renewables (wind, solar) means that some planned projects are no longer the lowest cost option and will unnecessarily raise the average cost of power production and rates paid by Tennessee users. Similarly, uncertainty regarding the federal policy on nuclear energy subsidies slowed progress in the financing of new nuclear projects earlier in 2025 and raised the estimated costs of construction.

Much of energy policy is federal, but state and local governments have a role to play as well. In Tennessee, the General Assembly tackled issues related to solar energy in 2022, ultimately resulting in a new state law related to decommissioning solar assets. The state has a role, though not exclusive, in permitting pipeline construction. Local governments still regulate the deployment of some assets (including solar) through zoning and land use rules. And although the state has influence over pipeline authorization, local governments retain the right to challenge private pipeline construction on certain grounds.

Again, the emphasis here is on predictability and continuity. Policy stability and alignment at the local, state, and federal level is a complement to addressing the State's energy challenge in a timely and cost-effective manner.

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[3] This includes nearly all of the state of Tennessee, except Bristol and a small area in the southeastern corner of the state.

[4] National Science Foundation, Science & Engineering State Indicators

[5] See chapter 3 in Kessler, Lawrence M., Donald J. Bruce, Tim Kuhn, Seth Neller, Edward Taylor, and Alex S. Norwood. 2025. An Economic Report to the Governor of the State of Tennessee, 2026.

[6] Center for Energy, Transportation, and Environmental Policy. Southern Appalachia Rare Earth Element Ecosystem.