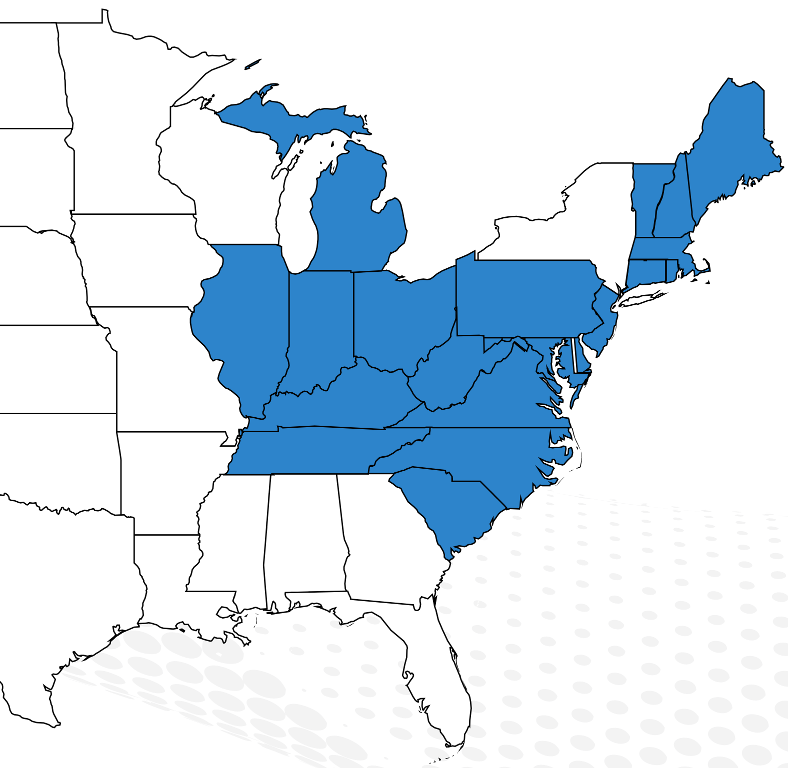
Executive Summary

Winter Storm Elliott was more than a catastrophic weather event that affected millions of people across the U.S. The storm — which popularized the phrase "bomb cyclone" — brought record-breaking frigid temperatures and impassable mountains of snow, caused more than 72 deaths, and inflicted billions of dollars of damage from coast to coast.

Beyond its tangible effects, Elliott starkly illustrated the shortcomings of our nation's current energy infrastructure. From New England to the Carolinas and as far west as West Virginia and Ohio, the storm clearly demonstrated that the buildout of new natural gas infrastructure has not kept pace with the increase in power demand from constraints in the coal markets, a shift toward electrification and the need for natural gas as a baseload and backstop to intermittent renewable energy sources. The inadequacy of natural gas infrastructure to meet power needs on days of peak demand is largely due to the inability to permit new, major infrastructure projects. Elliott also definitively proved that renewable power sources such as wind and solar do not provide enough reliable energy in times of need and that we still rely too heavily on carbon-intensive fuels such as coal and fuel oil to meet current peak demand.



Although Winter Storm Elliott impacted most of the country, this map represents only regions highlighted in this document.

The primary issue is a lack of new infrastructure that enables the storage and transportation of natural gas in impacted regions. This deficiency forced electric utilities to increase their usage of coal and fuel oil during Elliot, which are 2.5x and 2.3x more carbon intensive than natural gas, respectively. Relying on these carbon intensive fuels for power generation not only conflicts with state, federal and global decarbonization efforts, but also brought excessively high costs to residential and commercial consumers who are not located near adequate natural gas infrastructure.

To avoid such problems and move toward our clean energy future, we must enhance our nation's natural gas infrastructure to support the integration of more renewables into the energy grid to ensure resilience, reliability, and resource adequacy to meet electric generation demand — which will continue to increase as electrification takes hold in our society. Expanding this infrastructure will benefit Americans by providing greater access to low-cost, low-carbon, and reliable natural gas at home. Beyond that, enhancing the nation's natural gas infrastructure could support other critical industrial users as well. Natural gas infrastructure growth could support economic growth by helping to meet the tremendous energy needs of the manufacturing rebirth across the country. Additional infrastructure could also provide stability for the U.S. chemicals industry where there is massive demand for reliable, affordable natural gas as a fuel for operations and as a feedstock of certain fertilizers.[1]

Obstacles to achieving this promising future include outdated policies that do not require grid operators to have enough energy supply to meet demand. This is further complicated by an obsolete regulatory permitting process. In the case of Winter Storm Elliott, operators counted on spare capacity, which does not exist, largely because of an infrastructure deficiency.

That is why we need to undertake a multi-faceted approach to create a streamlined regulatory environment and evolved oversight that can help energy generators meet peak demand. This effort would allow everyone along the energy supply chain — from natural gas producers to large consumers like utilities and industrial users — to make business decisions to efficiently expend capital, mitigate the risks of climate change, ensure energy reliability, and stimulate the technological growth needed to meet clean energy goals.

[1] Natural Gas Weekly Update (eia.gov)

A Storm That Exceeded the Worst Predictions

Winter Storm Elliott began on Dec. 21, 2022, and its devastating effects spread quickly across more than two-thirds of the U.S. On the storm's first day, Denver's temperature dropped 37 degrees in just one hour and fell more than 70 degrees in 18 hours. Parts of New York received more than 50 inches of snow in just three days. Over the next five days, the storm left more than 72 dead and caused an estimated $5.4 billion in damage.

Elliott also profoundly taxed our nation's energy supply, including natural gas transported by the Transco pipeline, a 10,000-mile transmission system that alone transports roughly 15% of the nation's natural gas and runs from Texas to New York City.

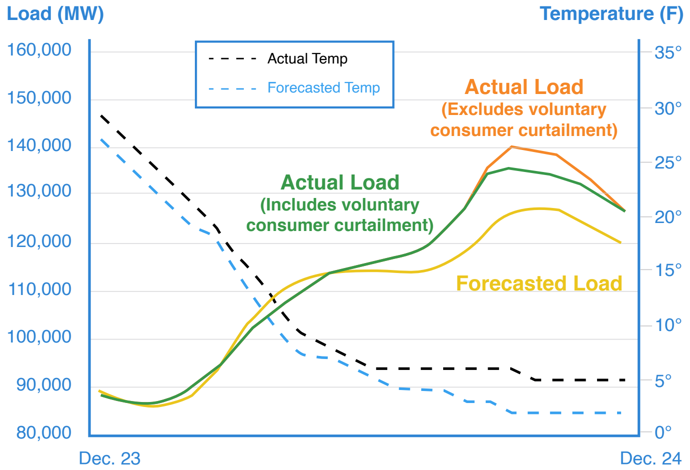
Transco assets performed well during Elliott, meeting all contractual obligations despite the massive storm. However, pipeline pressures at several delivery points in the Southeast fell below normal levels due to utility customers taking quantities of gas at delivery locations at a significantly greater rate than the gas supplies that were being received into Transco's system. Even though Transco took steps with customers to reduce receipt and delivery imbalances and engaged system storage resources to help make up the difference, the pipeline still lost 2.0 Bcf of natural gas line pack in one day because utilities and electric generators took more gas to meet demand — including a demand for electricity — that was higher than originally predicted. Losing line pack is not unusual on a high-demand day and is one of a pipeline's primary tools to cope with short-term imbalances in system flows, but the rate of loss during Elliott was unprecedented and was the cause of lower-than-expected pipeline pressures. For context, 2.0 Bcf per day of line pack gas could provide electric power for 10.7 million American homes.[2] It is enough gas to supply a mid-sized US state (like Virginia) on an average day, and it is also the proposed daily design capacity of the long-stalled Mountain Valley Pipeline that would have delivered gas supplies to Transco in western Virginia during Elliott had it been in service when originally projected rather than massively stalled by environmental opposition taking advantage of the circuitous permitting process in the U.S.

While forecasts predicted Elliott would be an intense storm, what eventually arrived was far worse in many places — the average temperature was roughly five degrees below initial estimates. Similarly, the forecasted load usage estimate stood at about 127,000 MW, when the actual load was about 10% higher. For this reason, electricity market participants (RTOs, utilities, and independent operators) found themselves with less natural gas for electric generation than they planned, which forced them to use more fuel oil and coal to meet the demand.

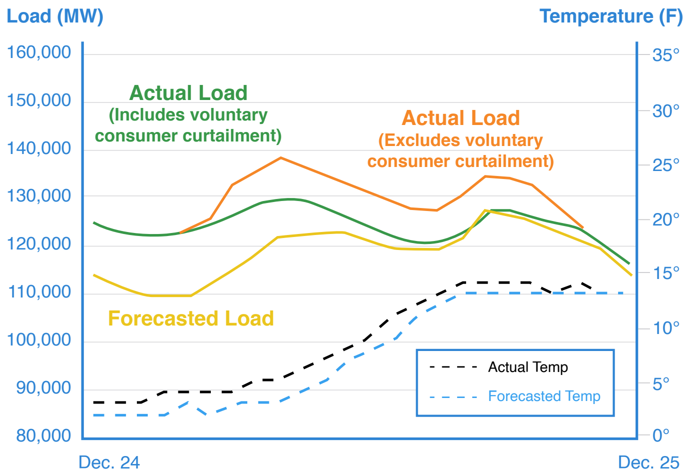
PJM Hourly Power Load and Temperature on December 23 and 24, 2022

These charts illustrate that both the forecasted temperature and power demand deviated from what actually occurred. A lower temperature drove up energy demand requiring more fuel to support increased electricity.

Dec. 23



Dec. 24



Graphic and Data from PJM Winter Storm Elliott Overview[3]

PJM Demand Response is a voluntary PJM program that compensates end-use (retail) customers for reducing their electricity use (load), when requested by PJM, during periods of high power prices or when reliability of the grid is threatened. These customers receive payments from PJM members called Curtailment Service Providers.

[2] Calculation by Williams using EIA assumptions [3] PJM Winter Storm Elliott Overview

The main reason for this shortcoming in meeting peak demand is that energy demand has increased over the years, but the infrastructure to support demand has not kept pace. This has been most prevalent in New England, the Northeast, the Mid-Atlantic, and the Carolinas, where a series of recent natural gas projects have been denied.

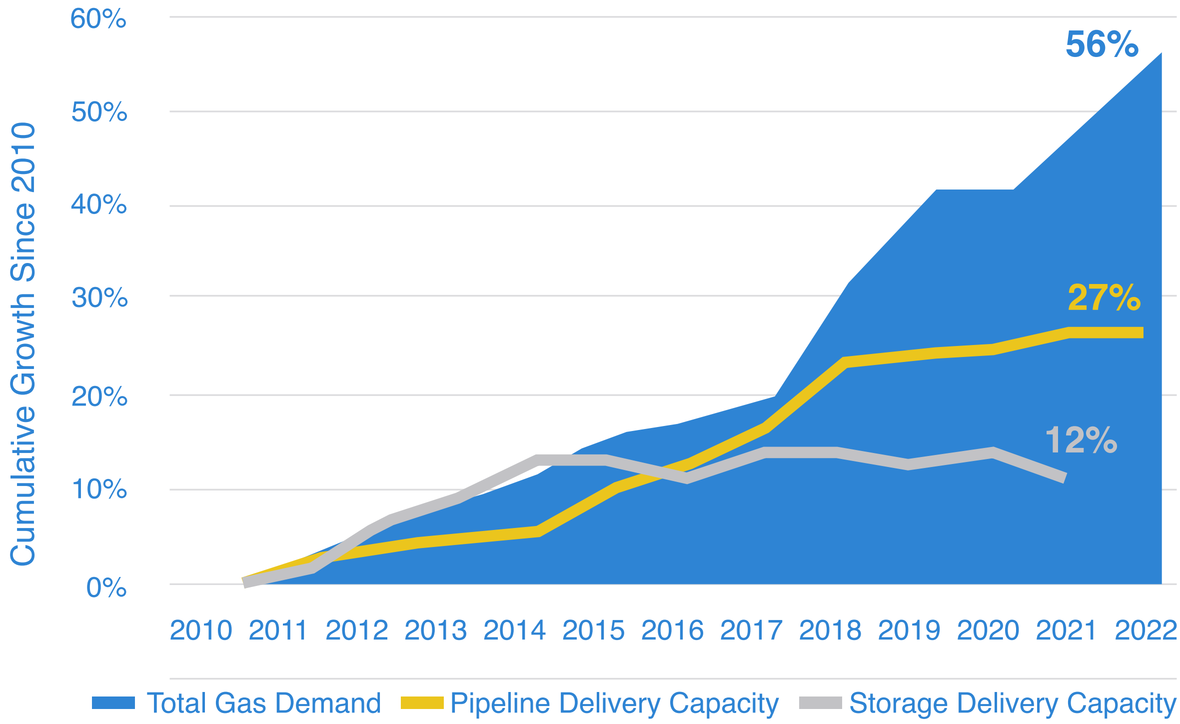
For example, North Carolina and Tennessee experienced unprecedented rolling blackouts during Elliott. Relatedly, the number of homes using electric heat increased by roughly 20% in the Carolinas and 22% in Tennessee between 2009 and 2020. Meanwhile, total generating design capacity in the Carolinas grew by only 4% in the period between 2009 and 2020, and in Tennessee capacity grew only 3%.

While the example is specific to this region, it illustrates a critical point: increased demand from electrification across the country will continue to strain the nation's electric grid and investing in more renewables without also investing in reliable reserve capacity will exacerbate the issue.

The graph at the bottom of this page shows the growth rates in natural gas consumption, gas pipeline capacity and gas storage delivery capacity from 2010 to 2022. During this period, gas consumption increased 56%, primarily from electricity demand growth, while at the same time, pipeline capacity grew only 27% and gas storage delivery capacity grew only 12%.

Storage delivery capacity is particularly important in seasonal high demand as it is the source of the line pack that is used to help balance differing rates of supply and demand on a peak day. The graph shows that storage delivery capacity in the U.S. has been steady or declining since 2014, while consumption of gas has grown over 40% during that period[4].

Natural Gas Annual Demand, Pipeline Capacity & Storage Delivery Capacity Cumulative Growth Percentage 2010-2022



Since 2010 demand for gas has grown by 56% while infrastructure to deliver gas has increased 27%.

Sources: S&P Global Commodity Insights and U.S. Energy Information Administration (EIA)

[4] Calculations based on Energy Information Administration data.

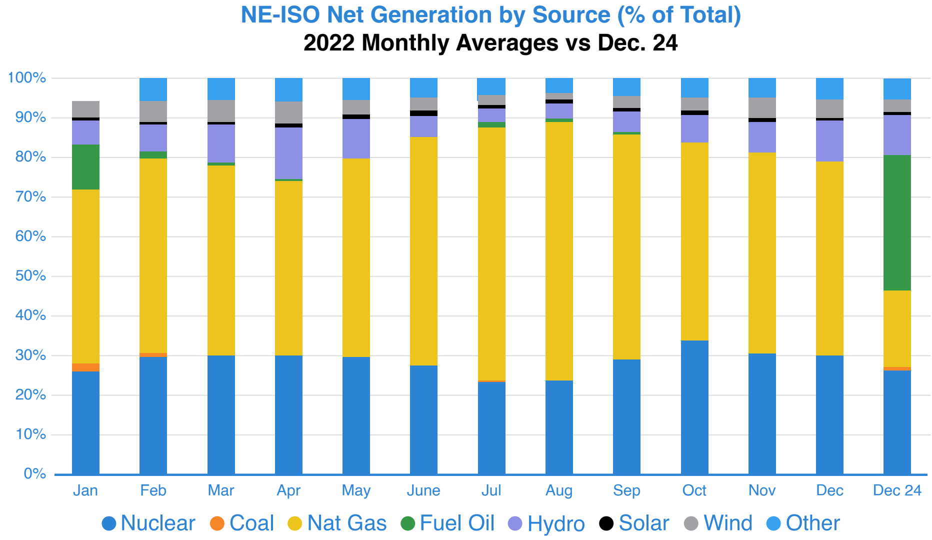
What Worked in Supplying Energy During Elliott — and What Didn't

Despite Elliott's unprecedented effects, Transco safely and reliably delivered natural gas to all of its markets and customers, meeting its contractual obligations. In addition, Transco further aided its markets with more natural gas than was initially contracted. This was possible in part due to recent system expansions such as the Leidy South and Southeastern Trail Projects, which increased the pipeline's capacity by 878,000 Dth of natural gas per day — enough to power roughly 4.5 million American homes while substantially reducing our reliance on carbon-heavy fuels.[5]

But in the bigger picture, Elliott exposed several shortcomings within our country's energy system. For starters, the supply shortage due to a lack of natural gas infrastructure led utilities to generate electricity from more carbon-intensive coal and fuel oil — or fail to generate enough electricity altogether. This was the primary factor that led to conservation notices and rolling blackouts.

The North American Electric Reliability Corporation (NERC) released a study just one month before Elliott that foresaw this exact situation, stating:

> "A large portion of North American BPS (Bulk Power System) is at risk of insufficient electricity supplies during peak weather conditions. Higher peak-demand projections, inadequate generator weatherization, fuel supply risks, and natural gas infrastructure are contributing to risks.… Winter weather conditions that exceed predictions could expose power system generation and fuel delivery infrastructure vulnerabilities. Increased demand caused by frigid temperatures, coupled with higher than anticipated generator-forced outages and derates, could result in energy deficiencies that require system operators to take emergency operating actions, up to and including firm load shedding."



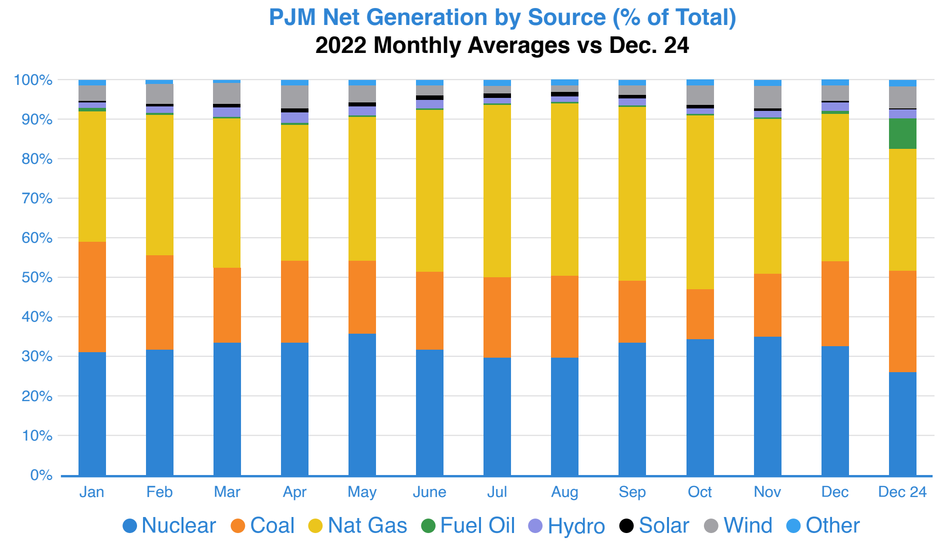
Source: Energy Information Administration

As predicted, renewable energy sources simply weren't up to the task of providing critical power during peak demand, according to NE-ISO energy generation figures (see above). Wind played a small role as a baseload source, while the impact of solar was nearly non-existent. The insignificant contribution of renewables illustrates why we must increase reliable and flexible natural gas capacity as a backup source of energy to renewables. Further, as coal capacity continues to retire, dispatchable natural gas capacity will increase in importance to maintain grid reliability.

[5] Calculation by Williams using EIA assumptions

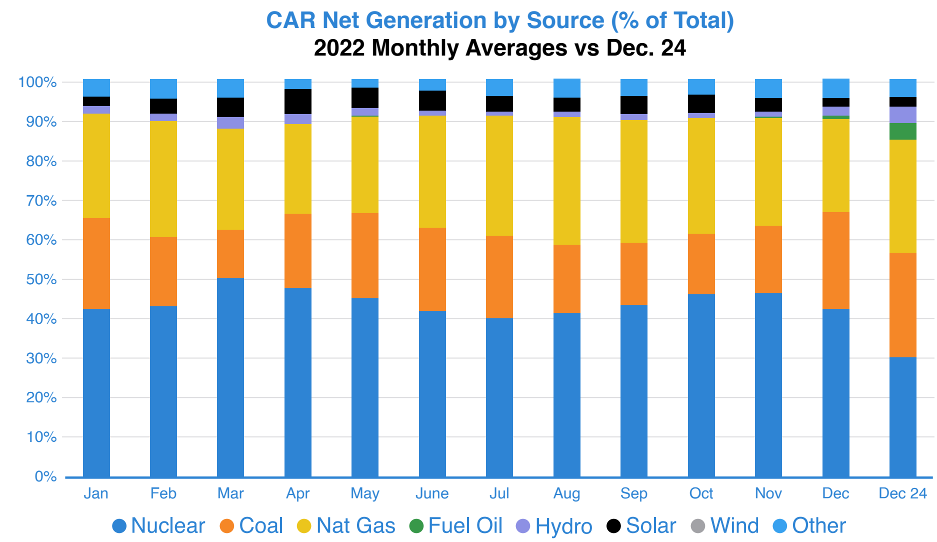
More troubling was the dramatic switch from natural gas to fuel oil — note the high percentage of NE-ISO natural gas usage in August (roughly 60% of total output) compared to the figure for December 24, which totaled less than 20% of energy output. Output from natural gas-fired plants declined because the region's limited natural gas pipeline capacity was increasingly used to supply natural gas to residential and commercial heating customers, making less natural gas available for power plants. Conversely, usage of fuel oil skyrocketed from a negligible amount in August to roughly 35% of output on December 24.

We see a similar trend from PJM generation data, as natural gas made up more than 40% of energy output in August 2022 but fell to roughly 28% on December 24. Meanwhile, fuel oil usage grew from roughly 1% to 8% for that same time frame, and coal usage increased as well.



Source: Energy Information Administration

We did not see such a dramatic shift in the Carolinas because the region still heavily relies on coal-fired generation year-round. That is in part because projects like Atlantic Coast Pipeline (ACP) and Mountain Valley Pipeline (MVP), which would have displaced coal-fired generation and supported natural gas power generation, have been canceled (ACP) or faced prolonged delays (MVP).[6] The lack of those projects creates a shortfall of infrastructure to deliver natural gas to meet generation demand and impacts locational pricing, which also leads to fuel oil usage to fill the gap.



Source: Energy Information Administration

This move to more CO_2-intensive fuels exacted a heavy environmental price and dramatically increased the amount of carbon emitted into the atmosphere over typical natural gas output. For instance, the CAR, NE-ISO, and PJM service areas would have produced almost one million fewer metric tons of CO_2 emissions in just one day — December 24, 2022 — if natural gas was used instead of coal and fuel oil for electric generation.[7] To put this in perspective, it would take over one million acres of U.S. forests one year to sequester one million tons of carbon, according to the EPA's Greenhouse Gas Equivalencies Calculator.

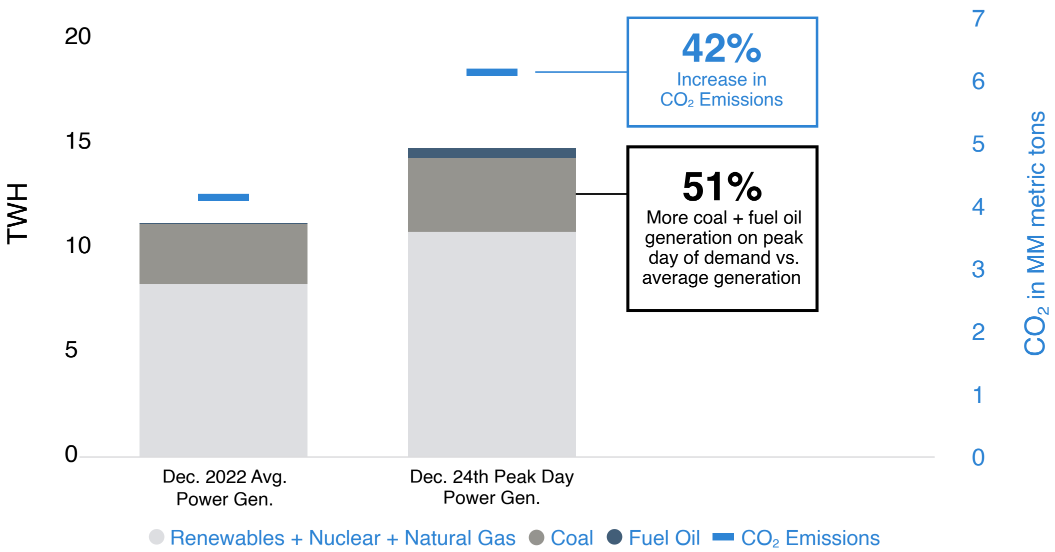
[6] https://www.eia.gov/naturalgas/data.php#pipelines
[7] Calculation by Williams using EIA assumptions

Looking across the lower-48 states, coal and fuel oil power generation was 51% higher on December 24th, a peak day of demand, than the December 2022 average generation. This increased generation of carbon-intensive fuel sources was the primary driver of 42% higher CO_2 emissions on the peak day of demand compared to the December average. Coal is 2.5x and fuel oil is 2.3x more carbon intensive than natural gas in the current U.S. power sector. Incremental infrastructure to serve the power generation markets could help reduce emissions by meeting peak day demand needs with natural gas alongside renewables rather than coal and fuel oil.

The lack of natural gas infrastructure also affects energy affordability, as peak weather events can strongly influence local pricing. If certain locations are cut off or otherwise constrained from receiving natural gas from nearby supply sources, prices can spike significantly, ultimately translating into higher utility bills for consumers.

For example, retail electricity prices for Middle Atlantic residential consumers show that December 2022 prices were 23% higher compared to a 5-year December monthly average. Similarly, retail natural gas prices for Middle Atlantic residential consumers were 44% higher than the 5-year December monthly average.[8]

L-48 December 2022 Average Power Generation versus Peak Day Power Generation by Fuel Type and Associated CO_2 Power Emissions



Source: Energy Information Administration

As the increase in power generation spiked on December 24th, there was an increase in coal and fuel oil generation to meet the demand that renewables were unable to address. As more carbon-intensive fuels were utilized, the level of carbon emissions increased.

[8] Source: Energy Information Administration. Note: 5-year December monthly averages are for the 2017-2021 time period. Middle Atlantic region is NY, NJ and PA

Creating a Cleaner Energy Future

With the benefit of time, we can learn valuable lessons from Winter Storm Elliott. Namely, as NERC has outlined, our electric grid is ill-prepared for storms of Elliott's magnitude, and our country desperately lacks sufficient natural gas infrastructure. Essentially, the U.S. has enough natural gas to withstand such an extreme storm — but not the ability to store, transport, and supply it to the regions that need it most. This situation leads to more expensive energy and a greater use of higher-carbon fuels to meet demand.

Three factors make electric markets especially sensitive to significant weather events: increasing electric demand, constrained fast-starting electric generation, and insufficient gas infrastructure. The magnitude of this issue only increases as extreme weather events increasingly become the norm and reveal that energy markets are simply too reliant upon favorable weather to generate renewable power. Future coal-fired power plant retirements will also worsen this issue due to the electric grid operators no longer being able to rely on coal during peak days of demand and increasing the demand for natural gas and natural gas infrastructure.

If there is no change, natural gas supply and generation will continue to be the scapegoat for poor electric market planning as baseload facility capacity shrinks and renewables expand. Reliability margins will tighten to unrealistic levels, and electric consumers will experience increased rolling blackouts and brownouts with less-than-extreme cold and hot weather.

That's why we need to create a multi-pronged energy approach that partners renewable energy sources with natural gas to reliably and cleanly meet electricity demand during both peak and non-peak situations with low-carbon solutions. This effort must also include a simplified regulatory environment that supports additional infrastructure.

Our outdated regulatory permitting process for natural gas infrastructure and electric transmission is too frequently weaponized by those who oppose all infrastructure, whether natural gas pipelines or electric transmission. Infrastructure projects can and should be permitted efficiently and sustainably, as they will help us protect the environment and modernize our national energy network.

The current, broken regulatory system leads to costly delays and project cancellations, continuing our reliance on carbon-intensive fuels, such as coal and fuel oil. The lack of regulatory certainty and transparency also makes it difficult to plan new developments and hampers our ability to take advantage of the many benefits natural gas and renewables offer.

We must also take a more holistic look at our energy grid regulatory process to ensure operators create more accurate plans for incremental demand caused by electrification. This would entail putting firm fuel contracts in place so generators can meet demand, rather than relying on spare capacity that is not guaranteed to be there when it is needed most.

Developing a simple, forward-looking regulatory environment will help us support incremental natural gas pipeline and storage expansion projects. This type of work would help us create an environmentally and economically sound future to help millions of Americans stay warm and comfortable — no matter how cold it is outside.