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Gas-Electric Coordination and Winter Reliability

Two systems, one cold snap: fuel assurance and grid reliability in a high-demand era

WHITEPAPER



SCAN TO EXPLORE

VedeniEnergy

- +1 463-266-4496
- www.vedeni.energy
- info@vedeni.energy
- North Vernon, IN 47265, US.

Abstract

Natural gas now produces roughly two-fifths of U.S. electricity and is the fuel the grid leans on hardest during extreme cold, yet the gas and power systems are still scheduled, priced and regulated as if they were separate industries. This paper examines **gas-electric coordination** and **winter reliability** through the record of Winter Storms Uri, Elliott and Fern, the structural mismatch between the gas day and the power day, the economics of **firm fuel** and **pipeline capacity**, the market and regulatory tools now in place, and the specific exposure of the Western Interconnection as new day-ahead markets take shape. It concludes that the industry has made measurable progress on generator winterization, but that fuel assurance, scheduling alignment and shared visibility remain the binding constraints on **natural gas reliability** for power generation.

About this Paper

This white paper was prepared by Vedeni Energy as part of its Vedeni.Insights series. It draws on federal and regional event reviews, NERC reliability assessments, EIA data, market operator publications and recent regulatory orders through early November 2026. The analysis is descriptive and neutral; it does not advocate for any specific market design, fuel or company.

Audience and Use Cases

The paper is written for utility and independent power producer executives, market participants, regulators, pipeline and local distribution company staff, investors and stakeholders engaged in ISO/RTO and Western market processes who need a concise, current view of how fuel supply risk shapes electric reliability in winter.

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Executive Summary

The most serious threats to the North American power grid over the past five winters have not come from a lack of generating capacity on paper. They have come from the moment the gas system and the power system both reach their limits at the same time, in the same cold.

Winter Storm Uri in February 2021 forced ERCOT to shed 20,000 MW of load, the largest controlled load shed in U.S. history, and left more than 4.5 million Texans without power. Natural gas units made up 58% of the generators that failed, and gas accounted for 87% of fuel-related outages. Twenty-two months later, Winter Storm Elliott produced 90,500 MW of coincident unplanned generation outages across the Eastern Interconnection and 5,400 MW of firm load shed, with gas-fired units again the largest category and Marcellus and Utica production falling 23% and 54% respectively.

The record since then is more encouraging. Joint FERC and NERC reviews found that both systems operated without major incident or manual load shed during the January 2025 arctic events and without significant disruption during Winter Storm Fern in January 2026, crediting new cold weather standards, earlier unit commitment and better situational awareness. Yet Fern also cut gas production by as much as 18.3 Bcf/d at its peak, drove a record 360 Bcf weekly storage withdrawal, set record day-ahead power prices in PJM, New York and New England, and required federal emergency orders to keep units running. NERC's chief executive called Fern a near-miss, and the joint review found that several reliability challenges brought the system close to its limits.

The underlying problem is structural. Gas is scheduled on a day that begins at 9 a.m. Central time with a nomination deadline before most power awards are known; electricity is dispatched every five minutes on a midnight-to-midnight day. Many gas generators rely on interruptible transportation that disappears precisely when heating demand peaks. Capacity markets are now discounting gas units for correlated winter risk, and pipeline expansion is concentrated in Texas and Louisiana rather than in the constrained regions that need it most.

For the West, the issue is becoming more pressing. NERC and WECC rate the Northwest and Basin at elevated risk in extreme cold, the December 2022 Western gas price spike showed how quickly pipeline and storage limits feed into power prices, and the launch of EDAM in 2026 and Markets+ in 2027 will change how day-ahead commitments interact with gas nominations across the region. Utilities, generators and market operators that treat fuel assurance as a first-order reliability input will be better positioned for the winters ahead.

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01 Two Systems, One Peak

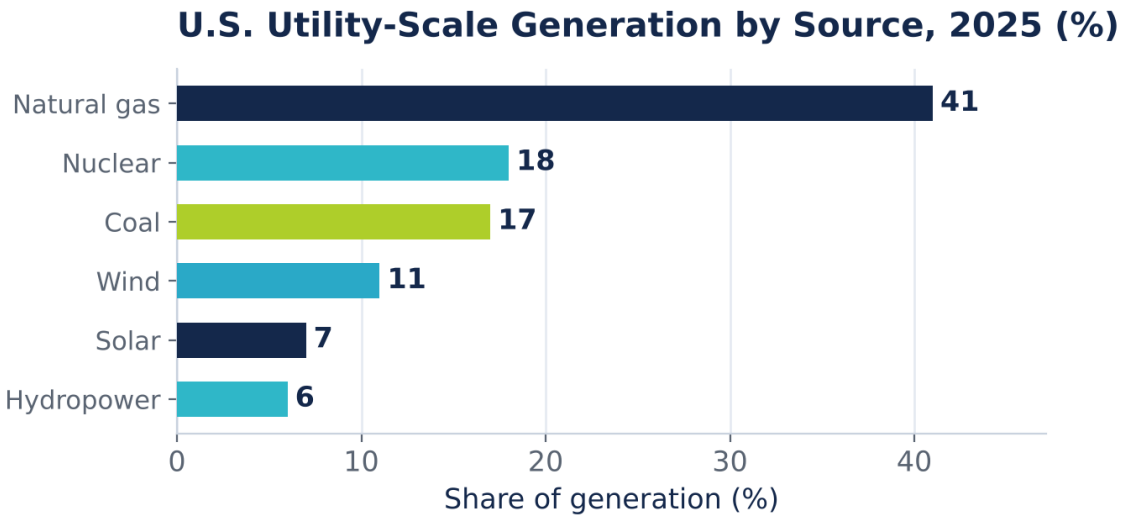
Gas and electricity have become a single reliability system in practice, even though they remain two systems in regulation, scheduling and commerce.

Natural gas supplied about 41% of U.S. utility-scale electricity in 2025, more than nuclear and coal combined. Gas-fired plants provide most of the flexible, dispatchable capacity that balances variable wind and solar output and that system operators call on when load climbs during the coldest hours of the year. The same pipelines, however, also serve residential and commercial heating load, which local distribution companies are obligated to protect and which rises sharply as temperatures fall. During Winter Storm Fern, residential and commercial gas use ran 29% above the five-year average for several days in a row.

That overlap produces a correlated risk that does not exist for most other inputs to the grid. When a cold air mass settles over a large region, electric demand and gas heating demand peak together, wellheads and gathering lines freeze, and processing plants lose power. Generators without firm fuel arrangements compete for the remaining gas on a spot market that can move from single digits to more than $50/MMBtu in a day. Outages that would be independent events in mild weather become simultaneous ones.

Demand growth is adding pressure to both sides of the relationship. NERC's 2025-2026 Winter Reliability Assessment found that winter peak demand across the bulk power system had grown by about 20 GW, or 2.5%, in a single year, while resources available at peak grew by only 9.4 GW. The West, Southeast and Mid-Atlantic posted the fastest growth, driven in large part by data center development, with some areas forecasting increases near 10%. Much of the new firm capacity proposed to meet that demand is gas-fired, and turbine manufacturers have been quoting delivery dates of 2028 and beyond, so the existing fleet and its fuel supply will carry the winter peak for several more years.

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Natural gas remained the largest source of U.S. utility-scale generation in 2025.

41%
U.S. generation from gas, 2025

+20 GW
winter peak growth in one year

9.4 GW
resource growth at peak

The policy response has followed a familiar pattern. Each major winter event produces a joint FERC and NERC inquiry, a set of recommendations and a new round of reliability standards for electric generators. Far less of that machinery reaches the gas production and gathering sector, which sits largely outside federal reliability jurisdiction. The remainder of this paper examines what the recent storms revealed, why the two systems remain misaligned, and which tools are now available to close the gap.

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KEY TAKEAWAY

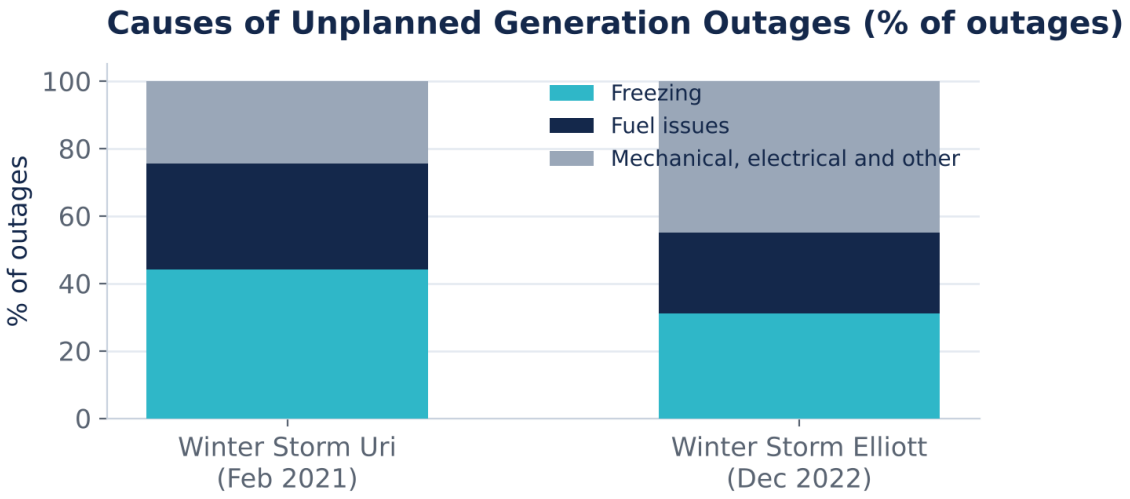
Winter reliability is now a fuel-supply question as much as a capacity question; the risk lies where gas heating demand, gas production losses and electric peak load coincide.

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02 Lessons from Uri, Elliott and Fern

Three major storms in five years have produced a consistent diagnosis, and a measurable but incomplete recovery.

Winter Storm Uri remains the reference event. The final FERC-NERC report attributed 44.2% of unplanned generating unit outages, derates and failures to start to freezing and 31.4% to fuel issues, with natural gas responsible for 87% of the fuel-related outages. On the supply side, freezing temperatures accounted for 43.3% of gas production declines and losses of electric power to wellheads, gathering and midstream facilities for another 21.5%. The interdependence ran in both directions: gas shortfalls took generators offline, and rotating outages then cut power to the facilities that produce and move gas. The report made 28 recommendations, which led directly to NERC's mandatory cold weather standards.

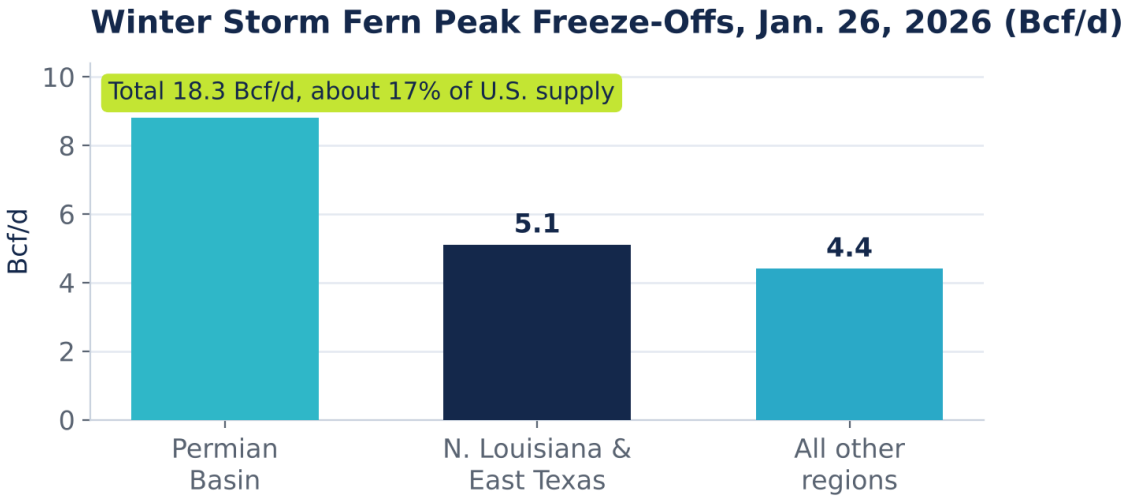


Freezing and fuel problems dominated outages in Uri; Elliott shifted the mix toward mechanical failures.

Winter Storm Elliott in December 2022 tested those reforms across a much larger footprint. Coincident unplanned outages peaked at 90,500 MW, and more than 127,000 MW of capacity, about 18% of anticipated Eastern Interconnection resources, was unavailable at the worst point. Of the 1,702 units that experienced problems, 47% were gas-fired. Freezing caused 31% of outages, fuel issues 24% and mechanical or electrical failures 41%, and gas fuel issues alone represented 83% of fuel-related outages. Production from the Marcellus and Utica shales fell 23% and 54%, and operators shed 5,400 MW of firm load. In PJM, non-performance charges under the capacity performance rules were initially estimated at $1.8 billion before a FERC-approved settlement reduced them to about $1.25 billion.

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The January 2025 arctic events and Winter Storm Fern in January 2026 tell a better story. The joint FERC, NERC and Regional Entity review of the winter 2026 cold period, published in September 2026, found no significant disruptions in either system. Generator outages were similar in size to January 2025 and improved over earlier storms, and the reviewers credited lessons applied from prior reports, advance commitment of generators before the cold arrived, NERC's cold weather standards and additional resources made available through Department of Energy emergency orders.



Fern's freeze-offs were concentrated in the Permian and in northern Louisiana and East Texas.

Fern was nonetheless a severe stress test. Wood Mackenzie estimated that freeze-offs peaked at 18.3 Bcf/d on January 26, about 17% of U.S. supply, and removed roughly 120 Bcf of production over the event, placing the winter among the three worst freeze-off seasons of the past decade. The Lower 48 drew a record 360 Bcf from storage in the week ending January 30. Henry Hub's daily spot price reached an all-time high above $30/MMBtu, with intraday trades reported as high as $53.75/MMBtu, and dozens of North American hubs set record average spot prices. The Department of Energy issued orders under Section 202(c) of the Federal Power Act allowing units in PJM, New York, the Carolinas and elsewhere to run notwithstanding permit limits, and PJM worked with data center customers that had volunteered to move to backup generation in an emergency.

Event	Dates	Electric impact	Gas system impact
Winter Storm Uri	Feb. 2021	20,000 MW load shed in ERCOT; 4.5 million people without power	Freezing caused 43.3% of production declines
Winter Storm Elliott	Dec. 2022	90,500 MW coincident outages; 5,400 MW load shed	Marcellus -23%, Utica -54%
January 2025 arctic events	Jan. 2025	Outages contained; PJM winter peak record	No major gas-electric performance failures
Winter Storms Fern and Gianna	Jan.-Feb. 2026	No significant disruptions; record power prices	Peak freeze-offs 18.3 Bcf/d; record 360 Bcf withdrawal

Table 1. Major winter events and their gas and electric impacts.

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“We cannot let this be the new norm of operating the grid.” NERC CEO Jim Robb, on the joint review of the winter 2026 cold period.

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KEY TAKEAWAY

Generator winterization is working; what has not changed is the gas system's vulnerability to freeze-offs and the grid's dependence on emergency measures to bridge the gap.



Freeze-offs at the wellhead remain the gas system's weak point.

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03 Two Clocks: The Scheduling Mismatch

Gas and power are bought, scheduled and settled on different days, at different granularity and against different deadlines, and the seams are widest exactly when conditions are most volatile.

The interstate gas day begins at 9 a.m. Central Clock Time and runs for 24 hours. Under the NAESB standards adopted by FERC in Order No. 809 in 2015, the Timely nomination for the next gas day is due at 1 p.m. Central, followed by an Evening cycle and three intraday cycles, the last of which closes at 7 p.m. Central. The electric day, by contrast, runs from midnight to midnight in local market time, with day-ahead awards that typically post after the Timely gas deadline and real-time dispatch that changes every five minutes in most organized markets.

Dimension	Natural gas	Electricity
Operating day	9 a.m. to 9 a.m. Central Clock Time	Midnight to midnight, local market time
Key deadline	Timely nomination, 1 p.m. Central, day before flow	Day-ahead offers, morning of the day before
Schedule changes	Five nomination cycles; last intraday cycle 7 p.m. Central	Hourly and five-minute real-time dispatch
Pricing	Daily or monthly hub index	Nodal, every market interval
Settlement	Daily, trued up monthly; imbalance cash-out penalties	Hourly or sub-hourly

Table 2. How the gas and power operating days differ.

The practical consequence is that a generator must commit to gas before it knows whether it will run. A unit that buys and nominates gas for a day-ahead award it does not receive is left holding volumes it must resell or absorb as an imbalance. A unit that waits for the award risks finding that pipeline capacity has been fully scheduled by the Timely cycle, particularly when local distribution companies have nominated their full firm rights for heating load. The morning hours of the electric day fall in the previous gas day, so a cold-morning ramp straddles two sets of gas nominations.

The problem compounds on weekends and holidays. Gas for Saturday, Sunday and Monday is usually traded as a package on Friday, before weekend weather and power awards are known, and liquidity thins out in the days that follow. Elliott struck over the Christmas weekend, and NERC's 2025-2026 Winter Reliability Assessment again identified the coincidence of severe cold and holiday

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weekends as a specific procurement risk for generators.

FERC considered moving the start of the gas day to 4 a.m. Central in the proceeding that produced Order No. 809 and declined, finding that the record did not justify a nationwide change. The industry instead relies on regional workarounds: earlier day-ahead market timelines in some ISOs, multi-day unit commitment ahead of forecast cold, operator-initiated commitments that give generators time to procure fuel, and better information exchange between pipelines and grid operators. The joint review of the January 2025 events concluded that cold weather performance had improved, but that incompatible market time frames and limited electric-side visibility into gas conditions remained persistent gaps.

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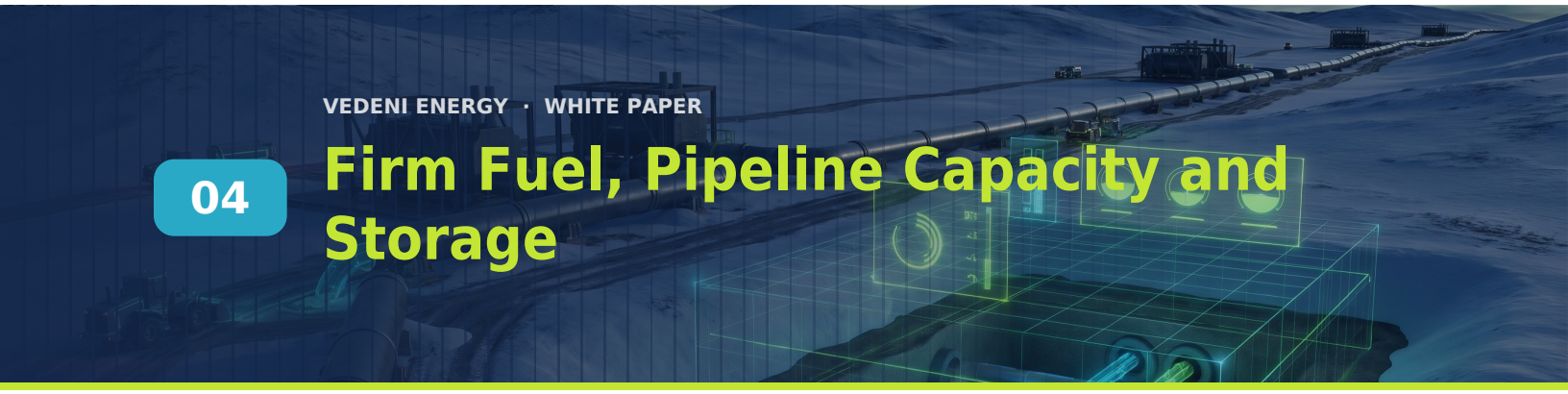
KEY TAKEAWAY

Generators bear the risk of the gap between the gas and power days; the closer a cold event falls to a weekend or holiday, the larger that risk becomes.



Gas is committed before the power day is known.

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04 Firm Fuel, Pipeline Capacity and Storage

The single most reliable predictor of whether a gas generator runs in extreme cold is the firmness of its fuel and transportation arrangements.

Firm transportation gives a shipper priority access to pipeline capacity every day of the year, at a demand charge paid whether or not the capacity is used. Local distribution companies hold firm rights because their customers' heating load is predictable and protected. Many merchant and peaking generators do not, because a plant that runs a few hundred hours a year cannot easily recover a year-round demand charge through energy margins. Those units rely on interruptible service, released capacity or delivered supply, all of which become scarce or expensive when the pipeline is full.

Alternatives exist but carry their own costs. Dual-fuel capability allows a combustion turbine or combined cycle to switch to distillate oil, provided it maintains on-site inventory, has air permits that allow extended oil operation and has tested the switch. ISO New England, the most pipeline-constrained region in the country, surveys oil inventories weekly through winter and asks dual-fuel units to prepare to switch when it issues a Cold Weather Watch; switching remains voluntary. Liquefied natural gas imports, satellite storage and trucked supply provide additional margin in New England, and ISO New England lists disruptions at those facilities among the triggers for an energy emergency.

Storage is the other buffer. Underground storage and market area storage close to load allow pipelines to meet peak-day deliveries well above their transmission capacity from producing basins. The record 360 Bcf withdrawal during Fern shows how heavily the system relies on that inventory when production falls. Storage levels entering winter therefore matter: the Western price spike of December 2022 began with Pacific region storage roughly 30% below its five-year average.

New pipeline capacity is arriving, but mostly where supply is produced rather than where winter constraints bind. EIA reported in May 2026 that about 44.9 Bcf/d of new pipeline capacity is planned for 2026 and 2027, with roughly 70% already under construction. More than two-thirds of it, 29.7 Bcf/d, is in Texas, and another 19% is in Louisiana, largely to move Permian gas to Gulf Coast markets and LNG export terminals. Among projects outside those states, the 1.6 Bcf/d Southeast Supply Enhancement expansion of the Transco system is expected in 2027. The joint review of the 2026 cold period listed further gas infrastructure buildout as a priority for future cold events.

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44.9 Bcf/d
planned pipeline capacity, 2026-2027

66%
of it located in Texas

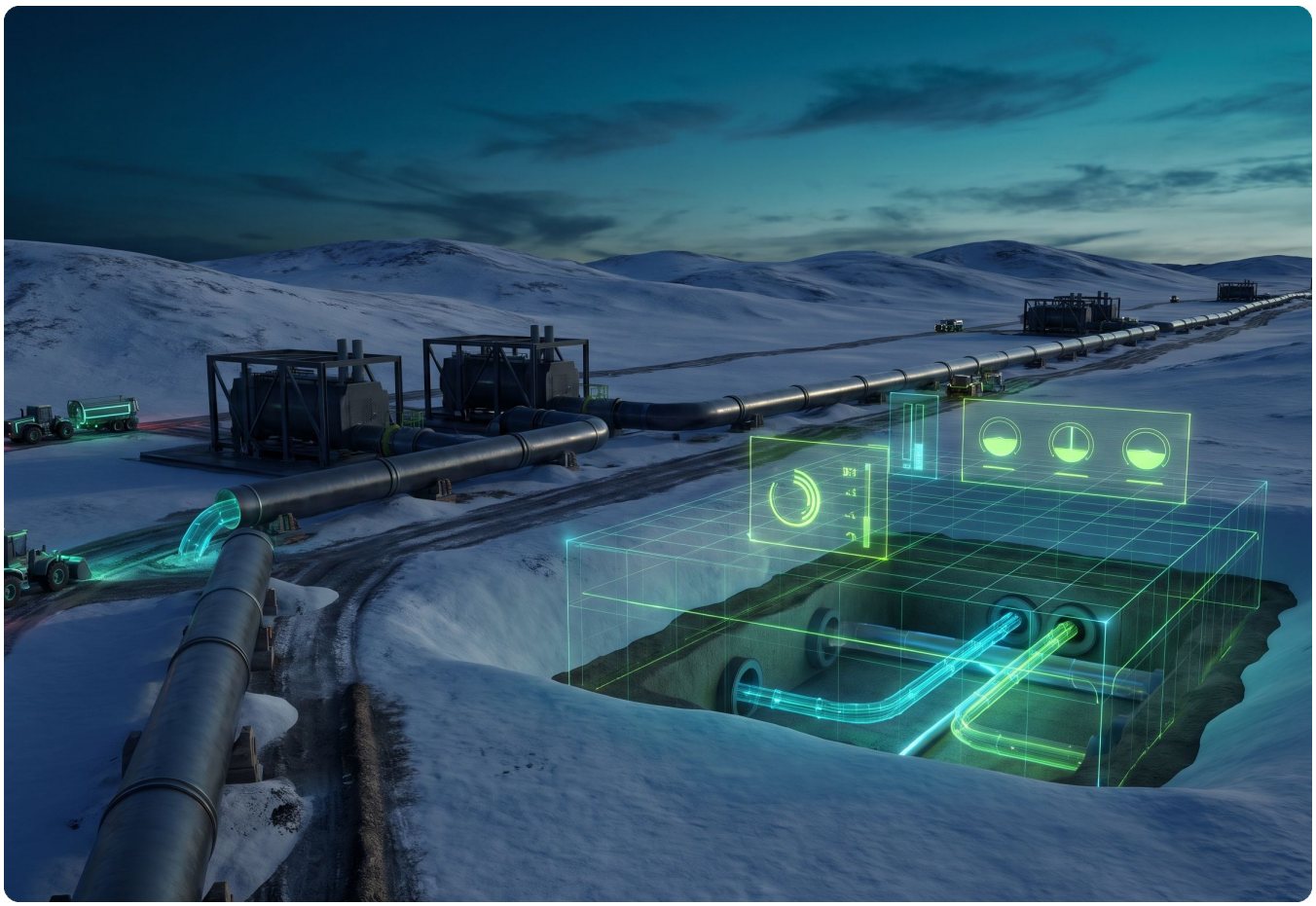
360 Bcf
record weekly storage withdrawal

On the production side, Texas has moved furthest. The Railroad Commission's weather emergency preparedness rule, adopted in August 2022 under Senate Bill 3, requires critical gas wells, processing plants, underground storage and pipelines that serve generators to weatherize, report weather-related forced stoppages and correct known problems, with penalties of up to $1 million. Outside Texas, NERC has repeatedly reported little evidence that upstream producers, gatherers and processors have improved winterization, and the federal reliability framework does not extend to them.

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KEY TAKEAWAY

Firm transportation, dual-fuel capability and storage are the proven tools for winter fuel assurance; the question is who pays for them and how markets value them.



Pipeline and storage capacity set the limits of winter deliverability.

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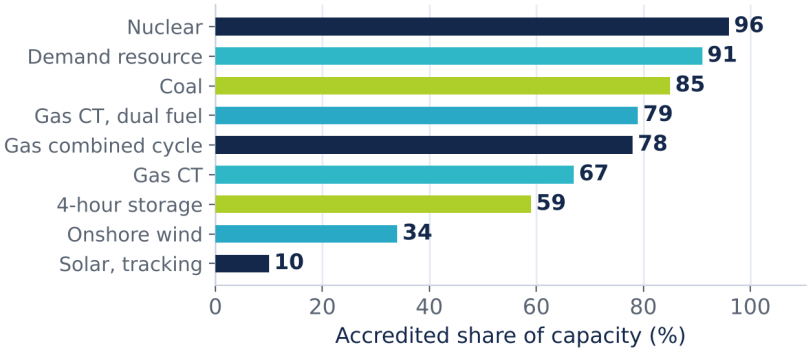


05 Market Design: Pricing Fuel Risk

Organized markets are moving from treating all gas capacity as equivalent toward pricing the specific winter risk that fuel arrangements create.

Capacity accreditation is the most consequential change. PJM and other operators now rate resources using effective load carrying capability, a probabilistic measure of how much each resource class contributes when the system is most likely to be short. Because PJM's risk has shifted toward winter, gas units are discounted for correlated cold weather outages and fuel interruptions. In the 2028/2029 Base Residual Auction, gas combined cycles were accredited at 78% and single-fuel combustion turbines at 67%, while dual-fuel combustion turbines received 79%. The 12-point gap between dual-fuel and single-fuel turbines is, in effect, a market price on fuel assurance.

PJM ELCC Class Ratings, 2028/2029 Base Residual Auction (%)

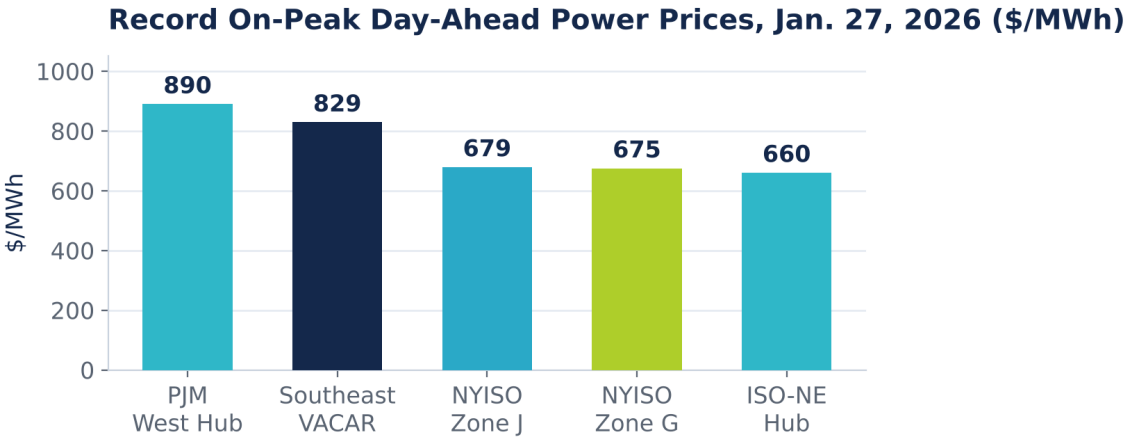


Accreditation rewards dual-fuel capability and discounts single-fuel gas turbines for winter risk.

Performance penalties provide the second signal. PJM's capacity performance construct charges resources that fail to deliver during emergency intervals and pays those that over-perform. Elliott produced the largest test of the design to date, and the resulting disputes and settlement led PJM to revisit penalty levels and the definition of excused non-performance. Strong penalties encourage investment in firm fuel and winterization, but they also expose generators to large, sudden liabilities for events that partly originate upstream in the gas system.

Energy prices provide the third. During Fern, on-peak day-ahead prices set records of $890/MWh at PJM West Hub, about $679/MWh in New York City (Zone J) and $660/MWh at the ISO-NE Internal Hub, with several Southeast bilateral hubs above $780/MWh. High scarcity prices reward units that secured fuel in advance, but they arrive only after the gas has already been scheduled and offer little help to a generator that could not get supply at any price.

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Fern set record day-ahead power prices across the East.

Some markets therefore pay for fuel assurance directly. ERCOT's Firm Fuel Supply Service, created after Uri, procures resources that maintain on-site or otherwise firm fuel for the November 15 to March 15 season and can be deployed when gas supply is threatened. ISO New England paid resources to hold fuel inventory through its Inventoried Energy Program in the winters of 2023/24 and 2024/25, and since March 2025 has procured day-ahead reserves that reward units able to deliver energy on short notice. Each approach adds cost to consumers, and each requires a judgment about how much firm fuel the system needs and which resources should hold it.

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KEY TAKEAWAY

Accreditation, penalties, scarcity pricing and fuel programs all point in the same direction: firm fuel is becoming a priced attribute rather than an assumed one.

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06 Standards, Communication and Shared Visibility

Most of the regulatory progress since Uri has been on the electric side of the seam; the newest measures focus on what each industry can see of the other.

NERC's cold weather reliability standards are now in their third generation. EOP-012-3, approved by FERC on September 18, 2025 with an implementation date of October 1, 2025, requires generator owners to prepare units for extreme cold, implement freeze protection, train staff and correct the causes of cold weather outages. It also allows NERC to review and confirm Generator Cold Weather Constraint declarations, under which an owner claims a unit cannot meet the standard's temperature requirements, and FERC directed NERC to file biennial informational reports on how the standard is working. The standard applies to roughly 1,300 generator owners.

On the gas side, the NAESB Gas Electric Harmonization Forum, convened at FERC and NERC's request in 2022 and continued in the wake of Winter Storm Elliott, issued its report in July 2023. Its recommendations led to revised NAESB Wholesale Gas Quadrant standards, which FERC incorporated by reference in Order No. 587-AB in May 2026. Pipelines must now post scheduled quantities for power plants directly connected to their systems, publish a dedicated gas-electric coordination category of operational information, and include geographic detail on affected areas and facilities in critical notices. Compliance is required by January 1, 2027.

These are modest changes in cost, estimated by FERC at about $2.1 million across some 193 pipelines, but they address one of the gaps that event reviews have identified repeatedly: grid operators often cannot see in real time whether the gas needed by the units they are committing has actually been scheduled. FERC treated broader proposals, such as reliability metrics for pipelines and changes to force majeure practice, as outside the scope of that rulemaking.

> NERC recommends that balancing authorities conduct generator fuel surveys ahead of and during cold events, so that operators know which units have firm supply, which depend on interruptible service, and which hold backup fuel.

The most significant structural gap remains jurisdictional. FERC regulates interstate pipeline tariffs and approves NERC standards for electric facilities, but it has no reliability authority over gas production, gathering or processing. After Elliott, FERC and NERC staff called on Congress or the states to establish reliability rules for the gas sector. Texas has acted for its intrastate facilities; elsewhere, preparedness depends largely on voluntary practice and commercial incentives.

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KEY TAKEAWAY

Visibility is improving through new NAESB postings and fuel surveys, but no federal body yet sets reliability standards for the gas wells and gathering systems where cold weather losses begin.



Shared situational awareness is the newest coordination tool.

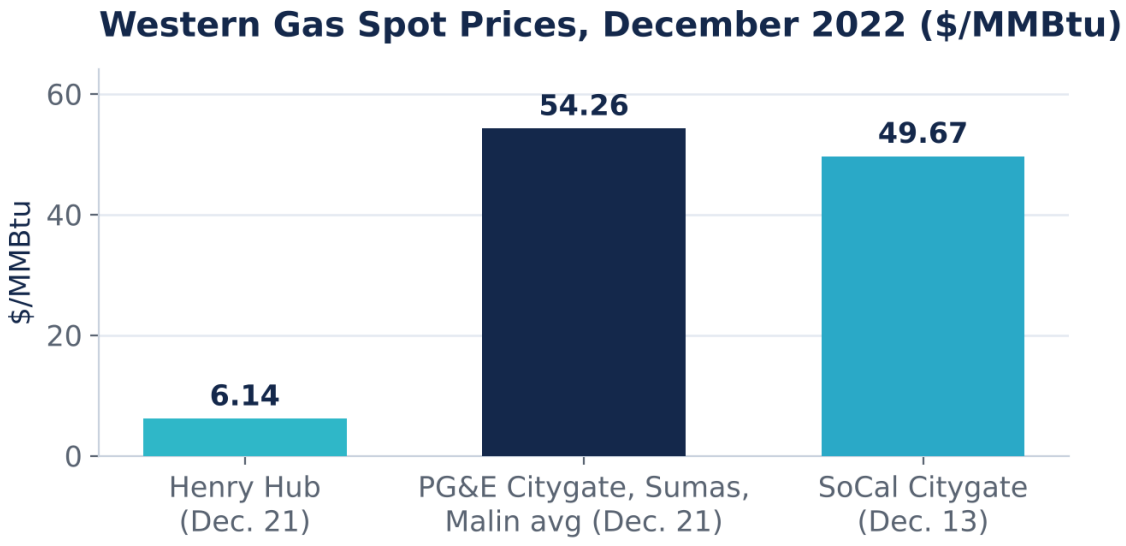
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07 Outlook and Implications for the West

The Western Interconnection faces its own version of the gas-electric problem, shaped by long pipelines, limited storage, hydro variability and the arrival of new day-ahead markets.

WECC's 2025-2026 winter assessment rated most of the West at normal risk but placed the Northwest and Basin at elevated risk of shortfalls in extreme weather. It described natural gas as essential to Western winter reliability and winter as the most challenging period for gas supply, noting that generators without firm contracts may be unable to obtain fuel. Northwest demand is forecast to rise 9.3%, while coal and hydro retirements have reduced firm capacity, leaving the region dependent on imports during wide-area cold.

The January 2024 cold event showed what that dependence looks like. Over January 12 to 16, BC Hydro set an all-time peak of 11,300 MW, several U.S. balancing authorities exceeded nine-year winter peaks, and RC West placed four entities in energy emergency alert status. The Northwest imported an average of about 4,900 MW per hour across five days, much of it from the Desert Southwest and Rockies. On December 21, 2022, Western hub prices averaged about $48/MMBtu above Henry Hub ($6.14), with PG&E Citygate, Malin and Sumas exceeding $50/MMBtu after cold weather, reduced flows from Canada and the Rockies, West Texas pipeline maintenance and low storage combined.



Western gas prices in December 2022 reached more than eight times the national benchmark.

Market structure in the West is changing quickly. CAISO's Extended Day-Ahead Market began operating on May 1, 2026 with PacifiCorp; Portland General Electric joined in October 2026, and

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further entrants are planned for 2027 and 2028, which CAISO expects to bring EDAM to more than 40% of Western demand. SPP's Markets+ is scheduled to go live in October 2027. Both markets will clear day-ahead commitments across many balancing authorities, which should improve the use of diverse resources and transmission during regional cold. They will also place day-ahead awards for gas-fired units on market timelines that interact with the 1 p.m. Central Timely nomination, which falls at 11 a.m. Pacific.

Several practical questions follow for Western utilities and generators. Market rules will need to recognize fuel limitations and gas scheduling realities in commitment and bidding, including multi-day cold events. Resource adequacy programs, including the Western Resource Adequacy Program, will need accreditation methods that capture correlated fuel risk. Pipeline operators, local distribution companies and market operators will need routine information exchange across a larger footprint than any single balancing authority has managed before. And participants in both EDAM and Markets+ will need consistent practices at the seams between the two markets during wide-area cold.

+9.3%
Northwest winter demand forecast

~4,900 MW
average Northwest imports, Jan. 2024

$54
avg Western hub price, Dec. 21, 2022

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KEY TAKEAWAY

Regional day-ahead markets can make the West more resilient to cold, provided their designs account for gas scheduling, firm fuel and correlated outages from the outset.

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Key Findings

The record of recent winters supports seven findings for utilities, generators, market operators and policymakers.

- → Natural gas supplied about 41% of U.S. generation in 2025 and remains the fuel most exposed to correlated failure during extreme cold.
- → Generator winterization has improved measurably since Uri and Elliott; neither the January 2025 events nor Fern produced major disruption or manual load shed.
- → Gas production remains vulnerable: Fern freeze-offs peaked at 18.3 Bcf/d, comparable to the worst events of the past decade.
- → The gas day and power day remain misaligned, leaving generators to commit fuel before power awards are known, especially on weekends.
- → Markets increasingly price firm fuel through accreditation, penalties and dedicated fuel programs.
- → New NAESB standards effective in 2027 improve visibility, but gas production and gathering still lack federal reliability standards.
- → The West faces elevated winter risk in the Northwest and Basin, and EDAM and Markets+ designs will shape how fuel risk is managed.

Method and Scope

This paper synthesizes FERC and NERC event reports, NERC and WECC reliability assessments, EIA data and analysis, ISO/RTO publications, FERC orders and Federal Register notices, and industry reporting published through early November 2026. Figures are reported as stated by their sources; no independent modeling was performed.

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Conclusion

Winter reliability now depends on fuel assurance as much as on installed capacity

The industry has learned a great deal from Uri and Elliott. Generators are better winterized, operators commit units earlier, standards are enforceable, and the last two winters passed without the cascading failures of 2021 and 2022. That progress is real and should be recognized.

It has not, however, resolved the core vulnerability. Gas production still falls sharply in deep cold, many generators still rely on interruptible fuel, the gas and power days still run on different clocks, and the grid still relies on emergency orders to bridge the worst hours. With winter demand growing faster than resources, the margin for error is shrinking.

The organizations best placed for the winters ahead will be those that treat fuel assurance as a core reliability and commercial variable: securing firm transportation or backup fuel where it is valued, engaging in market and standards processes that define how fuel risk is priced, and building routine coordination with the pipelines and distribution companies on which their generation depends.

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+1 463-266-4496 • info@vedeni.energy • North Vernon, IN 47265, US.

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