

ECONOMIC AND SITE ASSESSMENT

The Invisible Gap in the Texas Power System

A documentary analysis of curtailment, preventive non-activation and economically unused generation capacity – with NRG4NOW as a potential utilization pathway

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Evidence base: ERCOT/Modo datasets 2020–2024, S&P Global 2025/2026, Lazard LCOS 2026, EIA-860M, SB6 materials, NRG4NOW patent summary and TSTM concept data.

Purpose: decision support for an NRG4NOW pilot project in ERCOT.

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Independent NRG4NOW system analysis prepared using OpenAI ChatGPT for data preparation, calculation support and editorial assistance.

Content responsibility and conclusions: Ryszard Dzikowski.

Status: Pre-FEED / screening. No investment, legal or permitting commitment.

Executive Summary

Texas is a credible location for an NRG4NOW pilot because large volumes of renewable generation are curtailed at specific times and behind specific transmission constraints. The evaluated MODO data indicate approximately 8.34 TWh in 2024; S&P Global estimates 9.8 TWh for 2025 using a different methodology. This is not a homogeneous pool of surplus electricity. Curtailment is concentrated at particular resources, hours and grid areas, creating a potential role for a modular and directly controllable load.

Key finding	Implication for NRG4NOW
1. Location precedes volume	Compressor capacity must be matched to the five-minute curtailment profile of a specific Resource Node; statewide averages are insufficient.
2. Value arises upstream of the constraint	A load electrically located behind the same binding constraint may absorb curtailed output and defer selected network upgrades.
3. Modular system architecture	Compressors and TSTM are application modules within an open standard for storage, transport, conversion, grid, hub and control modules.
4. BESS and TSTM serve different functions	BESS provides fast electrical response; TSTM provides gas logistics, long holding periods, movable inventory, cooling and expansion work.
5. A 40–50 MW pilot is plausible	LV2_LV2 lost about 196 GWh over 4,430 hours in 2024, equal to roughly 44 MW of average unavailable injection during affected hours.
6. Brownfields can reduce project cost	Existing high-voltage connections, switchyards, roads, rail access and industrial land may reduce schedule and CAPEX, subject to verification.
7. SB6 rewards genuine flexibility	Large loads face stricter study, security and curtailment requirements. An interruptible compressor load can be designed to support the grid.
8. Bankability remains unproven	The €5 million TSTM estimate is a concept value and omits material EPC, safety, pipeline, interconnection and permitting costs.

Recommendation: conduct a two-track Pre-FEED study: (A) direct coupling to a highly curtailed wind or solar resource; and (B) a brownfield hub at Rio Pecos. No investment decision should precede five-minute ERCOT data, confirmed pipeline pressure/capacity, a grid study and binding vendor quotations.

1. Scope and Decision Question

The analysis first examines the system gap: how much technically available wind and solar capacity cannot be used economically, where these losses occur, and which parts are not fully captured by public datasets. It then assesses whether NRG4NOW can utilize part of this output through compression, stationary or mobile high-pressure storage, transport and later use as gas, pressure work, cooling, heat, reserve capacity or electricity after conversion.

The economic boundary includes electricity purchase, interconnection, demand charges, compressor efficiency, storage turnover, gas acquisition, revenues, availability, financing and grid impact.

- Geographic scope: ERCOT, with emphasis on 2024–2026 and pilot/brownfield screening.
- Economic lens: avoided losses, CAPEX/OPEX, stacked revenues, risks and option value.
- Excluded: final pressure-vessel design, pipeline nomination, tax advice, environmental studies and a binding ERCOT interconnection study.

1.1 Methodological Framework

The study applies a source-based documentary method. Published totals are reconciled with individual resources, weather zones, commissioning dates, transmission constraints and actual injections. Deviations, missing variables and methodological limits are stated explicitly.

Principle	Application
Source attribution	Each finding is linked to a source, calculation or clearly identified assumption.
Separate measurements	Meteorological potential, HSL, Base Point and actual injection are treated separately.
Test alternative explanations	Weather, maintenance, economic bids, negative prices and technical outages remain possible causes.
Identify data gaps	Missing variables and unsupported mappings are listed as open data requirements.
Align time and location	Capacity additions, constraints and curtailment are compared by node, zone and period.
Evaluate solution options	NRG4NOW and competing flexibility measures are assessed against the identified system gap.

2. Evidence Base and Curtailment Method

Modo approximates curtailed energy in each dispatch interval as the positive difference between the High Sustainable Limit (HSL) and the ERCOT Base Point. For a five-minute interval:

$$E_{\text{curtailed}} = \max(0, \text{HSL} - \text{Base Point}) \times 5/60.$$

$$\text{Curtailment rate} = E_{\text{curtailed}} / (E_{\text{curtailed}} + \text{actual generation}).$$

The metric combines transmission-driven redispatch and economic self-curtailment. It is useful for sizing a flexible load but cannot be treated entirely as curtailment that a transmission upgrade would eliminate. HSL is a telemetered sustainable capability, not necessarily the full meteorological potential.

Source	Use	Principal limitation
Modo/ERCOT dataset 01	Monthly and weather-zone distribution, 2020–2024	2024 total: 8.338 TWh
Modo/ERCOT resource data	Resource-level ranking	8.577 TWh total; 2.9% difference from dataset 01
ERCOT/TSP large-load forecast	Projected large loads, 2025–2031	Export unit must be verified before treating values as MW
S&P Global	2025 market context and 101 GW solar pipeline	Different curtailment method; not additive to Modo
Lazard LCOS v11	BESS cost benchmark	100 MW/4 h reference system; not directly equivalent to TSTM
EIA pipeline GIS	Pipeline routes and operators	No reliable pressure or residual-capacity data
TSTM concept data	Geometry and preliminary CAPEX assumption	No certified design or binding vendor price

2.1 The Partly Unmeasured Gap

Publicly reported curtailment is only one difference between natural-resource availability and sold electricity. A complete reconstruction requires meteorological expected output, the operator-reported HSL, the ERCOT Base Point and actual injection.

Difference	Potential meaning	Limit of proof
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Difference	Potential meaning	Limit of proof
Weather potential minus HSL	Preventive non-activation, technical unavailability or conservative HSL declaration	No unique cause without plant status and a weather model
HSL minus Base Point	Visible dispatch reduction	Includes both grid and economic curtailment
Base Point minus actual injection	Technical deviation, response lag or metering difference	Requires high-resolution telemetry
New capacity without proportional generation growth	Possible absorption or transmission limit	Weather, COD timing and outages may also explain the result

Evidence of preventive non-activation would be strongest where several indicators coincide: high wind or irradiance, repeatedly low HSL, a saturated export corridor, increasing connected capacity, clipped generation curves and stronger output from comparable neighboring plants. No single indicator is sufficient by itself.

3. Scale and Spatial Pattern of Curtailment

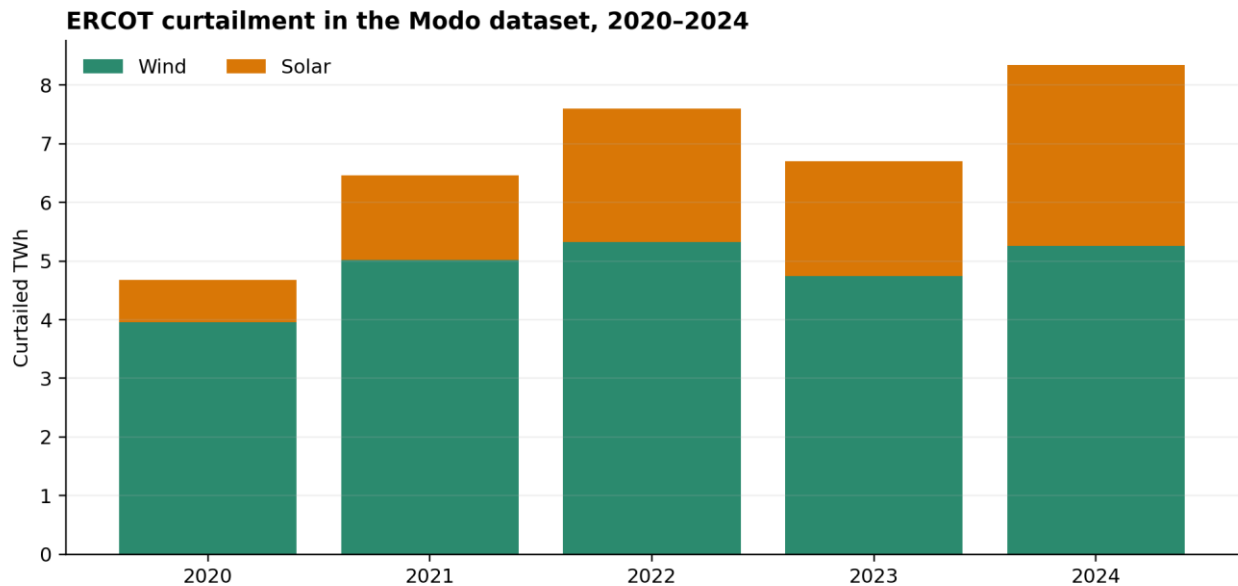


Figure 1. Modo dataset 01, sum of weather zones. 2024: 5.26 TWh wind and 3.08 TWh solar.

Curtailment increased from 4.68 TWh in 2020 to 8.34 TWh in 2024. Solar curtailment rose much faster than wind curtailment. S&P Global reports 9.8 TWh for 2025, while Reuters reports 9.2 TWh. The difference demonstrates that definitions, HSL treatment and aggregation must be fixed before project valuation.

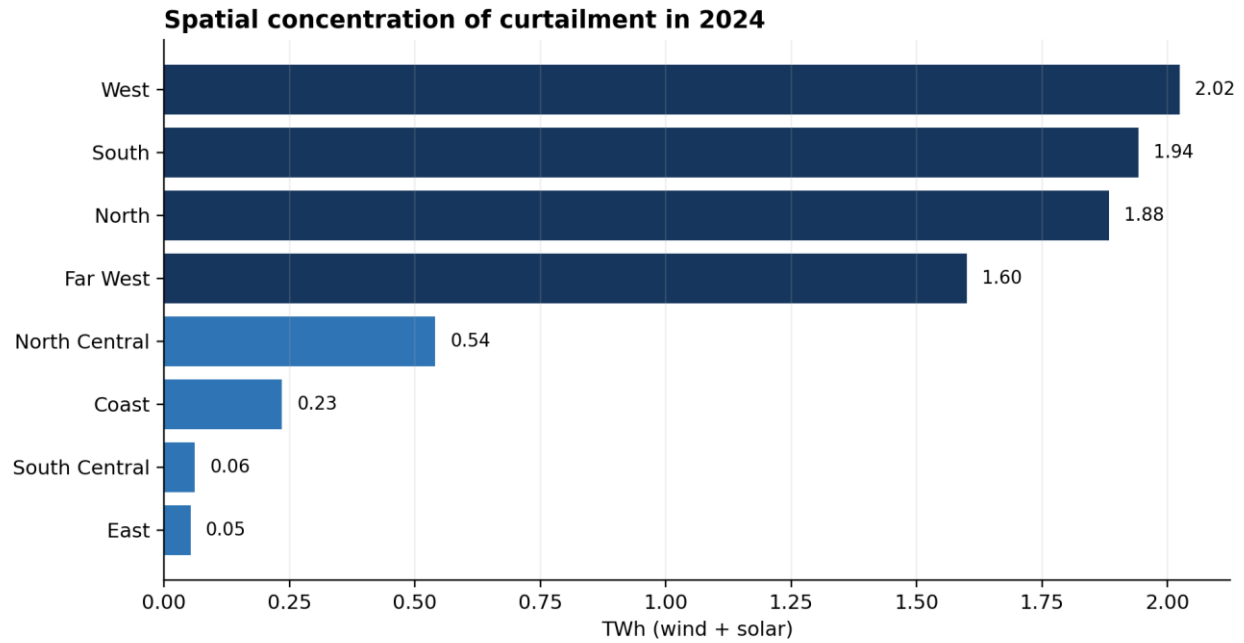


Figure 2. West, South, North and Far West accounted for about 89.3% of the 2024 total.

2024 zone	TWh	Share
West	2.024	24.3%
South	1.941	23.3%
North	1.883	22.6%
Far West	1.600	19.2%
North Central	0.540	6.5%
Coast	0.235	2.8%
South Central	0.062	0.7%
East	0.053	0.6%

Zone totals do not determine site economics. A plant in a heavily affected zone may experience little curtailment, while an individual facility may lose 100–200 GWh per year. Recurring binding constraints at the specific node are the decisive signal.

4. Individual Resources and Pilot Sizing

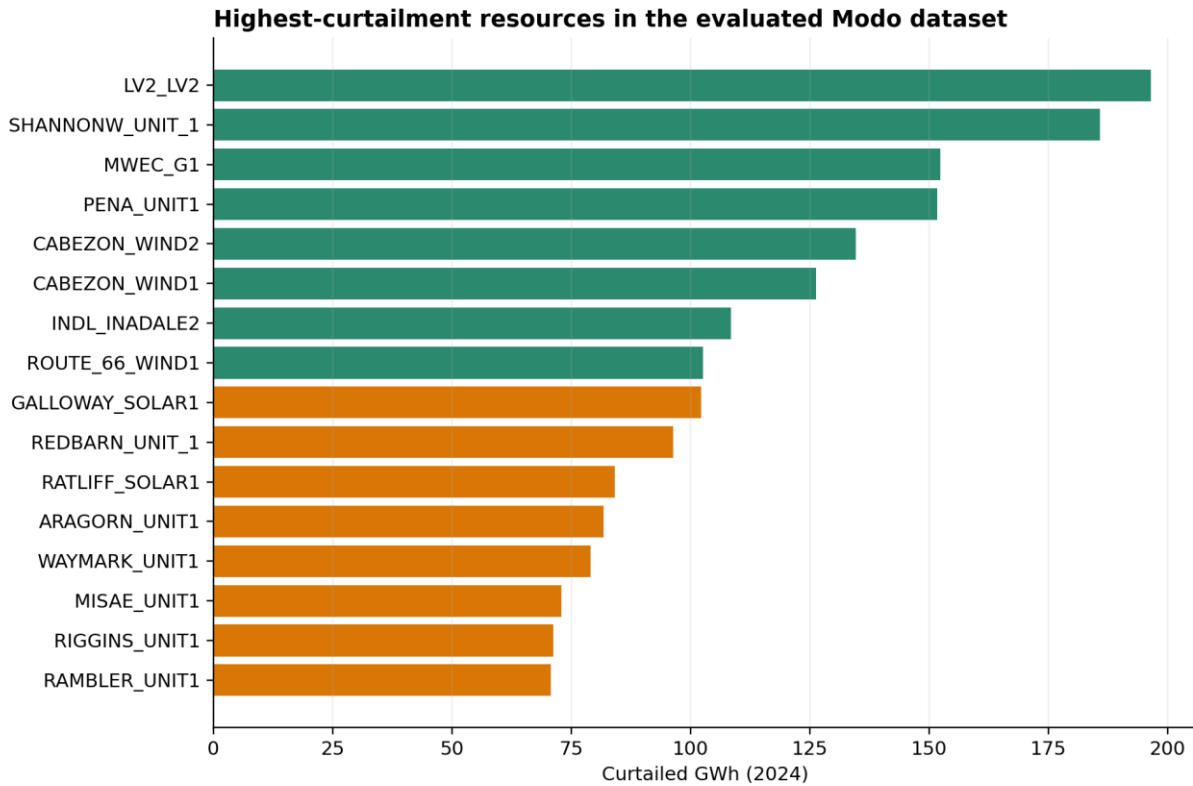


Figure 3. Highest 2024 values in the evaluated resource-level dataset.

Wind Resource ID	Curtailed GWh
LV2_LV2	196.5
SHANNONW_UNIT_1	185.8
MWEC_G1	152.3
PENA_UNIT1	151.7
CABEZON_WIND2	134.6
CABEZON_WIND1	126.3
INDL_INADALE2	108.5
ROUTE_66_WIND1	102.7
INDL_INADALE1	101.4
CSEC_CSECG1	100.3

Solar Resource ID	Curtailed GWh
GALLOWAY_SOLAR1	102.2
REDBARN_UNIT_1	96.4
RATLIFF_SOLAR1	84.1
ARAGORN_UNIT1	81.8
WAYMARK_UNIT1	79.0
MISAE_UNIT1	73.0

Solar Resource ID	Curtailed GWh
RIGGINS_UNIT1	71.3
RAMBLER_UNIT1	70.7
MISAE_UNIT2	69.8
SPTX12B_UNIT1	67.1

4.1 LV2_LV2 / Los Vientos Example

Modo identifies 4,430 affected hours and a 38% average power reduction for the most-curtailed Los Vientos unit. With 196.45 GWh curtailed, the average unavailable injection during affected hours was 44.35 MW. This does not represent a continuous 44 MW supply, but it is a credible starting point for a modular 40–50 MW compressor station.

Metric	Calculated value	Interpretation
Curtailed energy	196.45 GWh/year	Maximum gross addressable energy before losses
Affected hours	4,430 h/year	High temporal incidence, but intermittent
Average unavailable output	44.35 MW	196,450 MWh / 4,430 h
Average reduction when curtailed	38%	Actual peaks are above and below the mean
Illustrative utilization of 50 MW load	≈39%	Actual capture is lower because of profile, minimum load and storage state

The five-minute series must be simulated before contracting. Annual GWh overstate absorbable energy where compressors have minimum load, startup time or a full TSTM inventory.

5. Revenue Loss and Electricity Procurement

The revenue effect of curtailment depends on the market and contract structure. Under as-produced PPAs and pure energy-merchant exposure, energy that is not generated or delivered generally produces no energy-sale revenue. Deemed-energy provisions, hedges, tax incentives, negative bids, congestion rights and project-specific curtailment clauses can reallocate the economic effect.

A dedicated offtake or service agreement for usable curtailment MWh can create incremental generator revenue and a calculable electricity input for NRG4NOW. A financeable arrangement requires clear rules for the meter, dispatch rights, price formula, non-availability and priority of ERCOT instructions.

Contract model	Generator	NRG4NOW	Main risk
Pay-as-used behind common POI	Revenue only when energy is absorbed	Low energy price	Volume risk
Floor plus upside sharing	Minimum value per usable MWh	Predictable spread	Price formula / negative LMP
Compression service	Retains gas/product value	Fee per Nm ³ or MWh of compression work	Gas quality and throughput
Capacity/tolling agreement	Secures flexible load capacity	Fixed availability revenue	Performance guarantees
Multi-generator brownfield hub	Diversifies curtailment profile	Higher utilization	Private wires and grid charges

6. NRG4NOW as an Energy-Logistics Architecture

NRG4NOW is treated as an open, standardized energy-logistics architecture. According to the summary of patent application DE 10 2026 003 523.6 of 22 June 2026, it extends beyond a single storage or conversion technology to the identification, coupling, storage, transport, conversion, management and demand-oriented deployment of modular energy units.

Core proposition: energy is managed as a standardized logistics flow with identity, interfaces, operating states, routes, hubs, conversion and automated orchestration—not only as generated MWh.

Architecture layer	Elements	System function
Energy sources	Wind, solar, grid/redispach power, molecular carriers	Provides energy available at a specific time and location
Storage modules	Stationary and mobile pressure, gas or other storage	Decouples generation, transport and demand
Transport modules	Road, rail, inland/seagoing vessel, offshore routes	Moves energy beyond the electrical constraint
Conversion modules	Compressors, SOFC, gas engines, micro/expansion turbines, flywheels	Adapts energy form, pressure, power and end use
Grid modules	Electrical coupling, metering, protection, load shedding and settlement	Controls flexible consumption and return delivery
Energy hubs	Inspect, fill, empty, distribute and combine modules	Creates physical nodes in the logistics network
Identity and data	Module, carrier, pressure, power and safety class; operating/maintenance state	Makes compatibility and status machine-readable
Orchestration	Source, storage, route, hub and priority decisions	Optimizes supply by price, constraint, need and resilience

6.1 Interoperability, Rotation and Strategic Reserve

Standard mechanical, fluid, electrical and digital interfaces allow compatible modules from different suppliers to be identified and safely connected. Mobile units may temporarily become part of a stationary system, then be returned, inspected, maintained and refilled. This creates movable inventory and a strategic reserve that can be redirected when a line, port, rail route, terminal or hub fails.

Texas application	Architectural effect
Curtailment hub at a renewable cluster	Absorbs electricity, compresses gas and fills modules behind the constraint
Brownfield hub	Reuses high voltage, industrial land, road/rail and potentially water/gas assets
Consumer hub	Provides gas, pressure/cooling services, SOFC/engine output or reserve energy
Mobile reserve pool	Redirects modules to critical consumers during grid or transport disruption
Multiple transport paths	Pipeline, road and rail reduce dependence on one corridor

6.2 Adaptive Orchestration and Electrical Hybridization

The orchestration layer combines SCED and price signals, local curtailment forecasts, compressor ramps, BESS/flywheel state, TSTM fill level, pipeline nomination and customer demand. BESS can provide startup, black start, minute-scale bridging and safe compressor shutdown. A flywheel can smooth high-frequency power changes, reduce BESS micro-cycling and recover braking energy. TSTM provides long-duration molecular inventory.

Module	Primary role	Time horizon
Flywheel	Power smoothing, frequency support, very short interruptions	Milliseconds to minutes
BESS	Startup, bridging, black start and controlled shutdown	Seconds to hours
Compressor	Productive use of absorbed electricity	Minutes to operating hours
TSTM/mobile module	Gas inventory, transport and time shifting	Hours to months
Hub/orchestration	Coordination of energy and logistics paths	Continuous

7. TSTM Energy and Mass Balance

Methane contains approximately 10 kWh of chemical energy per normal cubic metre. Compression to 250 bar does not increase molecular chemical energy; it increases energy per physical vessel volume. An idealized first estimate is about 2.5 MWhth per m³ of vessel volume. Real design must account for compressibility factor Z, temperature, composition, minimum and maximum operating pressure and residual/cushion gas.

Configuration	Geometric volume	Idealized gross gas energy at 250 bar
Concept: 36 pipes plus connectors	≈883 m ³	≈2.21 GWhth
Current scale: 192 pipes	≈5,310 m ³	≈13.28 GWhth

The 13.28 GWhth value is the heating value of stored methane. It is not 13.28 GWh of stored curtailment electricity and must not be presented as an electrical round-trip efficiency.

7.1 Expansion Cooling

Pressure reduction can generate useful cooling through the Joule–Thomson effect or recoverable exergy in a turboexpander. Potential users include data centres, cold stores, gas processing and industrial refrigeration. Cooling is a genuine co-product, but not newly created energy. Pressure work, temperature, mass flow and auxiliary electricity must be accounted for together; icing, hydrates, condensate and dew point are design constraints.

8. BESS Compared with Compression and TSTM

Feature	BESS (Li-ion, 2–4 h)	NRG4NOW + TSTM/high-pressure gas
Stored quantity	Electrical energy	Chemical gas energy; electricity provides compression work
Response	Milliseconds to seconds	Seconds to minutes, depending on compressor train
Typical duration	1–4 h	Hours to seasonal with very low self-discharge
Electrical round-trip efficiency	High; Lazard assumption 86–92%	Relevant only if gas is reconverted to electricity

Feature	BESS (Li-ion, 2–4 h)	NRG4NOW + TSTM/high-pressure gas
Primary value	Arbitrage, ancillary services and peak shifting	Curtailement sink, gas logistics, inventory, cooling and reserve
Mobility	Electricity remains grid-bound	Gas can move by pipeline, vehicle or rail
Primary risk	Thermal runaway and cell aging	High pressure, methane leakage and explosion protection
Expansion	Additional battery racks	Additional pressure modules; compressor power scales separately
Best role	Intraday electrical shifting	Longer-duration sector coupling and brownfield hubs
Substitution	Partial	Complementary rather than universal replacement

ERCOT BESS reached a record 11.98 GW discharge in July 2026 according to GridStatus, but generally serve short peaks. Electricity Maps' monthly stored-energy figure of 0.37% is an energy-flow metric, not a complete measure of system value. BESS can deliver high power and control value with a limited monthly energy volume.

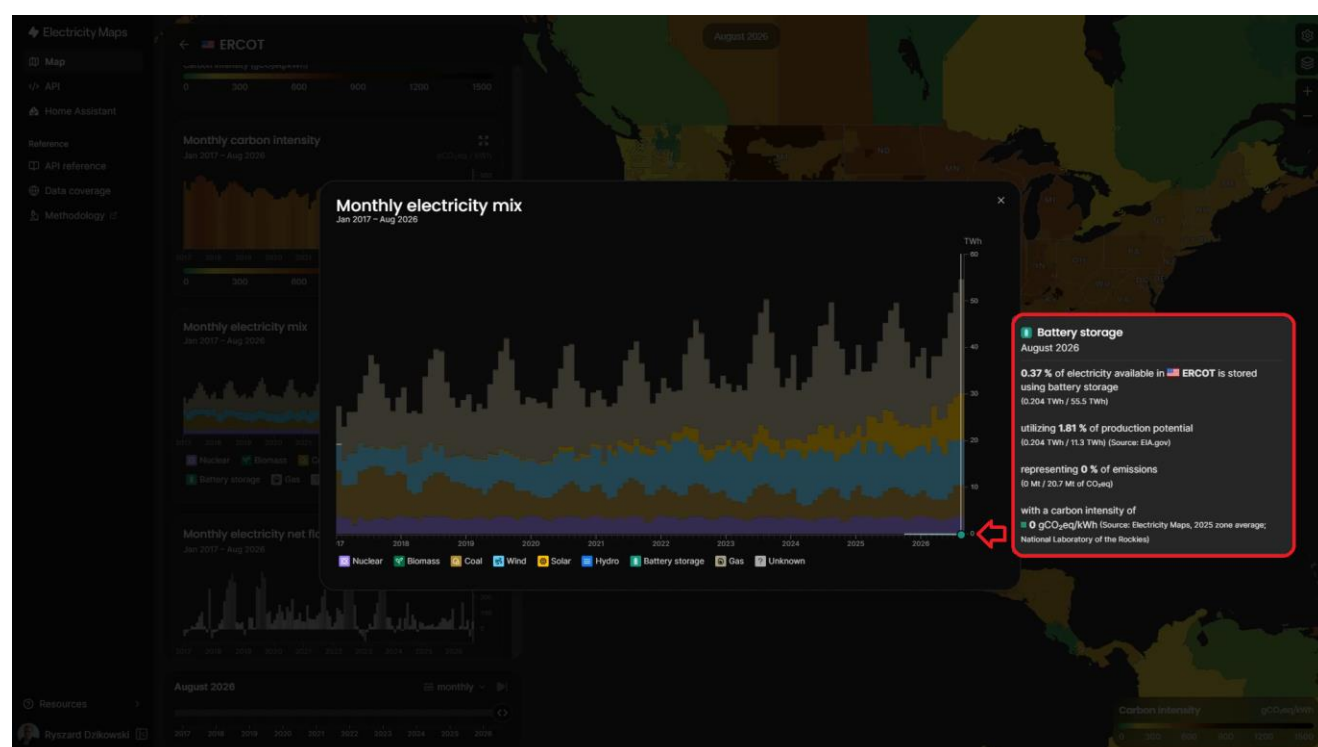


Figure 4. ERCOT monthly electricity mix and battery-storage energy-flow indicator. Source: Electricity Maps; screenshot by the author.

9. Cost Comparison and Levelized Economics

9.1 BESS Benchmark

Lazard LCOS v11 (2026) gives 270–365 US\$/kWh of investment cost and 210–292 US\$/MWh of unsubsidized LCOS for a 100 MW/400 MWh lithium-ion system; with ITC, 148–209 US\$/MWh. Assumptions include 20 years, one cycle per day, 350 days per year, 90% depth of discharge and 86–92% round-trip efficiency.

BESS scale	Usable energy	CAPEX benchmark
100 MW / 4 h (Lazard)	400 MWh	US\$108–146 million
Hypothetical 2.2 GWh / 4 h	2,200 MWh	US\$594–803 million
Hypothetical 13.28 GWh / 4 h	13,280 MWh	US\$3.59–4.85 billion

These are order-of-magnitude scalings, not sensible project designs. A 13.28 GWh four-hour battery would imply more than 3.3 GW of discharge power, whereas TSTM separates gas inventory from compressor power.

9.2 TSTM Concept Value and Missing Costs

The TSTM paper assumes approximately €5 million for 2.2 GWhth: €1.5 million for pipes, €1.6 million for compressors, €0.3 million for controls and €1.5 million for microturbines. This equals €2.27/kWhth of nominal gas capacity. The ratio is not equivalent to battery \$/kWh because the input and output energy forms differ.

Additional cost item	Why material
Foundations, pipe ends, connectors, valves and manifolds	Pressure-bearing components and installation
Certification, pressure testing, gas detection and fire protection	Permitting and insurability
Interconnection, transformer, switchgear and protection	Potentially several million
Pipeline lateral, metering/regulation or loading facility	Determines market access and throughput
Redundancy, heat rejection, drying and O&M	Availability and gas quality
EPC, engineering, owner's cost and contingency	Concept price is not total installed cost
Residual gas, finance, insurance and decommissioning	Complete life-cycle cost

9.3 Illustrative Levelization

At €5 million CAPEX, 20 years and an 8% discount rate, annualized capital is approximately €0.509 million. Based on 2,207.5 MWh of gross capacity, the following capital-only costs result before OPEX, electricity, gas, losses and omitted scope:

Full inventory turns/year	Throughput GWhth/year	Annualized CAPEX only, €/MWhth
1	2.21	230.7
4	8.83	57.7
8	17.66	28.8
15	33.11	15.4
30	66.22	7.7

Economics depend more on annual turnover than nominal GWh capacity. Low €/kWh does not make an infrequently used store inexpensive; a frequently cycled buffer can be economical.

10. Economic Value of Avoided Network Infrastructure

NRG4NOW cannot replace transmission and substation expansion in general. Deferral value exists only where the load is electrically upstream of the binding constraint, absorbs power during the relevant hours and can be shed during system stress.

Benefit	Mechanism	Monetization/evidence
Lower curtailment	Local consumption behind the constraint	Incremental MWh revenue / lower PPA loss
Higher use of existing interconnections	Common POI, submetering and coordinated dispatch	Avoided duplicate interconnection CAPEX
Deferred line upgrade	Lower flow over the binding element	Requires a grid study or non-wires contract
Lower redispatch	Fewer countermeasures during recurring hours	System benefit, not automatic project revenue
Energy relocation	Gas leaves the electrical bottleneck	Gas and transport margin
Reserve and resilience	Stored gas supplies heat, generators or industry	Capacity, availability or supply payment
Cooling/expansion work	Use of pressure exergy at the consumer	Cooling contract or process-cost saving
Brownfield reuse	Grid, road, rail, water and industrial land	Shorter development schedule and lower site CAPEX

The full 8–10 TWh cannot be multiplied by an average transmission cost. A nodal counterfactual is required: which line or transformer loading falls, during which hours, and by how many MW? Only then can avoided-wires value be substantiated.

11. Future Market Development and SB6

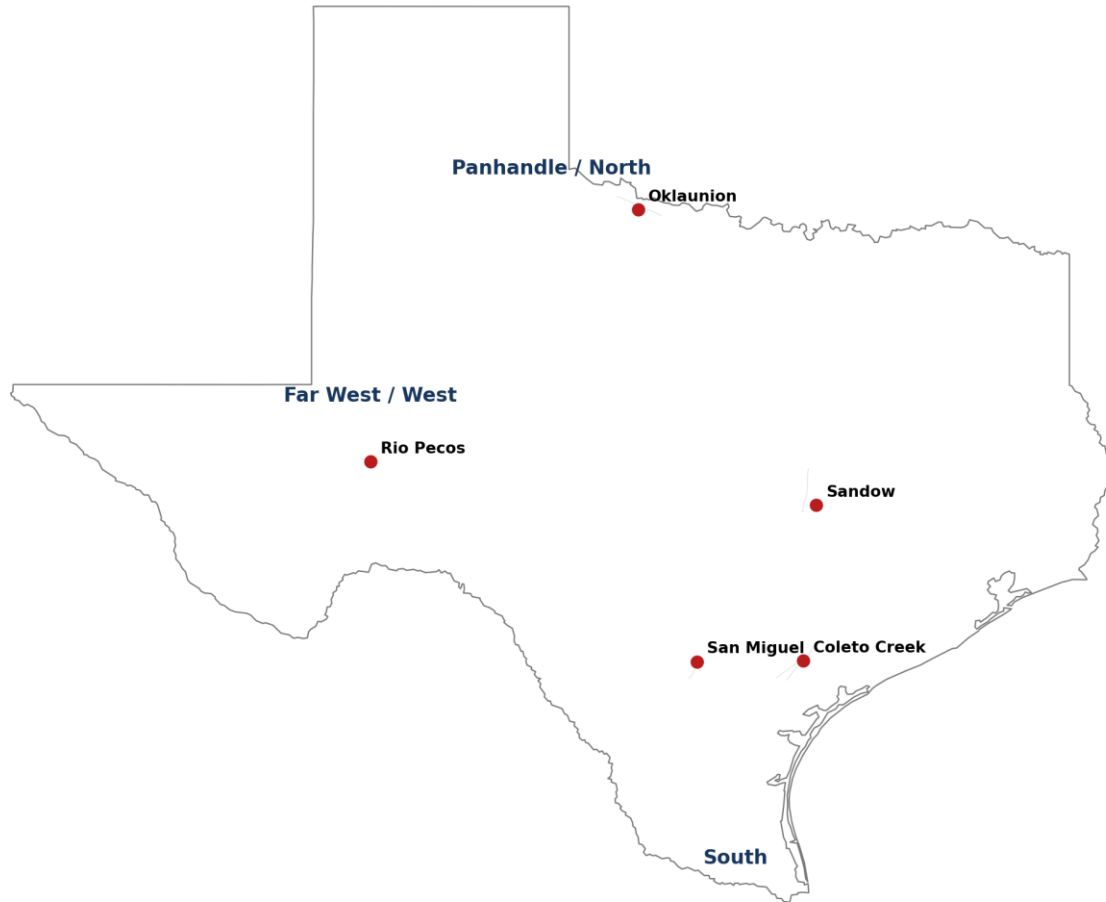
S&P Global reported 101 GW of additional solar capacity in planning at the end of Q1 2026. The evaluated TSP dataset also shows rapidly growing large-load demand, led by data centres. New generation can increase curtailment, while new loads can absorb it or move the hotspot. Historical curtailment locations are therefore not permanent.

Texas SB6 and subsequent PUCT/ERCOT rules tighten studies, financial security and emergency curtailment for large loads. NRG4NOW can be designed as a genuinely interruptible load, but mandatory emergency shedding must not be counted again as paid demand response.

SB6 issue	Project consequence
Current 75 MW large-load threshold	A 40–50 MW pilot is below it, but the threshold can change; this is not an avoidance strategy
Site control and screening fees	Resolve brownfield ownership and grid rights early
Security and direct connection costs	Include in development budget and CAPEX
Direct curtailability	Automatic load shedding and safe-shutdown design
Co-location study	Allow for ERCOT and PUCT process in the schedule
No duplicate DR payment	Do not book mandatory shedding as a separate revenue

12. Brownfield Screening

Brownfield candidates and proximity to gas pipelines



Screening map only. Pipeline pressure, available interconnection capacity and property boundaries require verification.

Figure 5. Five brownfield candidates and EIA pipeline routes. Pressure and available capacity are not contained in the GIS.

Site	Strengths	Weaknesses	Priority
Rio Pecos (inactive AEP site)	West/Far West proximity; historic 136 MW; 138 kV infrastructure; pipelines 1.4–1.9 mi	Ownership, capacity, water and contamination unresolved	1 – capture pilot
Oklaunion	69/138/345 kV; up to 500 MW marketed; about 1,000 acres; rail; 14 MGD water	Nearest line about 3.4 mi; far from reference top resources; CCR	2 – logistics hub
Coletto Creek	622 MW site; pipeline about 1.3 mi; reservoir; existing POI	Visra plans 600–630 MW gas repowering; site/POI committed	Partnership
San Miguel	345 kV infrastructure; transition project; gas 6–7 mi	USDA solar/BESS transition; mine/environment; distant from reference plants	Partnership
Sandow	Three 345 kV lines marketed; large area; private rail; gas about 3.2 mi	Data centre/1.2 GW CCGT planned; legacy liabilities; not a capture hotspot	Lower-priority hub

12.1 Minimum Brownfield Due Diligence

Screening item	Required evidence	Go/no-go indicator
Distance to curtailed plants	Coordinates, Resource Node and 24–36 months of 5-minute data	Recurring and correlated MW profile
Interconnection power and voltage	TSP/utility study, POI rights, fault and protection data	Firm import capability with flexible operation
Pipeline distance and pressure	Operator letter, MAOP, diameter, nomination and residual capacity	Technically and contractually feasible injection/withdrawal
Substation and transformers	Asset register, condition, ownership and spares	Usable without major rebuild
Rail, road and water	Load classes, spur, loading area and water rights	Year-round heavy transport and secure process water
Available land	Survey, setbacks and pressure/explosion zones	Space for compressor, TSTM, M&R and expansion
Ownership and reuse status	Title report, easements, retirement and option agreement	Site control and exclusive operating rights
Contamination and permits	Phase I/II ESA, CCR, methane, noise and air permits	Financeable remediation and schedule risk
Direct line to wind/solar	Route, rights of way, voltage drop and private-wire law	The relevant constraint is genuinely bypassed
Local demand	Gas users, cooling/heat load, reserve power and industry	At least two independent offtake paths

13. Business Model and Revenue Stack

A robust pilot should not rely on a single spread. At least three partly independent revenue or avoided-cost streams should be combined.

Component	Unit	Valuation basis
Curtailed electricity	\$/MWh absorbed	Node price, PPA loss and availability
Compression service	\$/MWhth or \$/Nm ³	Throughput multiplied by service fee
Storage capacity	\$/MWhth-month	Reserved pressure-storage inventory
Gas transport/logistics	\$/MMBtu or \$/delivery	Basis differential between constraint and market
Cooling	\$/MWhcooling	Avoided electrical refrigeration cost
Expansion/electricity	\$/MWhel	Net after pressure regulation and auxiliaries
Reserve/resilience	\$/MW-month	Availability to industry, heat or generation
Avoided wires	Project-specific	Utility/ERCOT contract or demonstrable CAPEX avoidance

Annual project value = avoided curtailment losses + compression/storage revenue + gas/cooling/expansion margin + demonstrable grid value – electricity – gas – O&M – transport – insurance – grid charges – annualized CAPEX.

14. Sensitivities and Principal Risks

Variable	Why dominant	Required stress test
Absorbable rather than reported curtailed MWh	Profile, minimum load and full inventory limit capture	P10/P50/P90 from five-minute data
Compressor MW and specific work	Determines electricity use and interconnection	Vendor curves over operating pressure
TSTM total installed cost	Concept estimate is incomplete	Budget quotes $\pm 30\%$ and EPC contingency
Inventory turnover	Primary driver of capital cost per MWh	1/4/8/15/30 turns per year
Gas basis and offtake	Storage fills without a market	Take-or-pay and pipeline nomination
Grid expansion and load growth	Can reduce or relocate curtailment	2030 transmission cases and data centres
Regulation/SB6	Studies, security and shedding	Schedule/cost plan with PUCT counsel
Methane emissions	Climate and permitting exposure	LDAR, metering and closed venting
Safety	High pressure and large inventories	QRA, HAZOP, setbacks and emergency depressurization
Water and legacy liabilities	Brownfield schedule and liability	Phase I/II and water balance

15. Pilot Development Plan

Phase	Indicative duration	Decision output
0. Data room	4–6 weeks	ERCOT IDs, coordinates, five-minute data, ownership and pipeline/grid letters
1. Dispatch and mass balance	6–8 weeks	Capture curves for 10/25/40/50/75 MW, storage state and offtake
2. Dual site screen	8–12 weeks	Direct Los Vientos/top-solar site versus Rio Pecos brownfield
3. Pre-FEED	3–5 months	PFD/P&ID, compressor quote, TSTM code, HAZID, metering and $\pm 30\%$ CAPEX
4. Commercial structure	Parallel	Curtailment PPA/tolling, gas offtake and cooling/reserve customer
5. FEED and permitting	6–12 months	Class 3 estimate, HAZOP/QRA and SB6/PUCT/ERCOT approvals
6. Modular construction	Project-specific	First 10–20 MW, expansion to 40–50 MW after performance validation

The first stage should be smaller than the calculated 44 MW average curtailed output and expand modularly. A small parallel BESS can support startup, fast regulation, ramp smoothing and safe shutdown. Flywheel integration should be tested against observed high-frequency cycling rather than assumed in advance.

16. Conclusion

The evaluated evidence demonstrates a material and geographically concentrated utilization gap in the Texas power system. It does not yet allocate the full gap among transmission constraints, economic bidding, technical restrictions and non-activation occurring before HSL is declared. Resolving that allocation is the central task of the next investigation phase.

Texas combines high curtailment, a large renewable-development pipeline, dense gas infrastructure, industrial brownfields and increasing demand for flexible loads. NRG4NOW can create value when placed behind the relevant constraint and operated as a dispatchable load. Its value is broader than compression and TSTM: standardized module identity, automated release, energy hubs, rotation, multimodal transport, adaptive orchestration and interchangeable conversion modules form the system architecture.

The principal advantage is not the claim that NRG4NOW eliminates every transmission project. It can improve utilization of existing generation and interconnections, defer selected upgrades, move energy out of an electrical bottleneck and provide gas, cooling, pressure work, heat or reserve at a later time. BESS, flywheels and TSTM are complementary layers across different time scales.

Investment conclusion: “Go to Pre-FEED,” not “Go to Construction.” The evidence supports a pilot investigation but not a final CAPEX or return commitment.

Appendix A – Key Figures and Plausibility Checks

Metric	Value	Source/calculation
Modo 2024 total – zone dataset	8.338 TWh	Dataset 01
Modo 2024 total – resource dataset	8.577 TWh	Dataset 02
Dataset difference	0.238 TWh / 2.86%	Do not merge without audit
S&P 2025	9.8 TWh	S&P Global, May 2026
Top four zones in 2024	7.448 TWh / 89.3%	West, South, North and Far West
LV2_LV2	196.45 GWh; 4,430 h	Modo
LV2 average unavailable power	44.35 MW	196,450 MWh / 4,430 h
TSTM concept	883 m ³ / 2.21 GWhth	10 kWh/Nm ³ × 250 bar, idealized
192-pipe TSTM	5,310 m ³ / 13.28 GWhth	Same idealized approximation
TSTM concept CAPEX	€5m / €2.27/kWhth	Incomplete concept estimate
Lazard four-hour BESS	US\$270–365/kWh	100 MW/400 MWh, 2026
Lazard LCOS	US\$210–292/MWh	Unsubsidized, model assumptions apply

Appendix B – Sources

- [1] Modo Energy: The Curtailment Crisis: Saving wind and solar investments in ERCOT; CSV exports and interactive charts, 2024/2026. <https://modoenergy.com/research/en/ercot-curtailment-crisis-solar-wind-data-battery-colocated-trends-maps-texas>
- [2] S&P Global Market Intelligence: Renewable energy curtailment offers a surplus opportunity for Texas data centers, 5 May 2026. <https://www.spglobal.com/market-intelligence/en/news-insights/research/2026/05/renewable-energy-curtailment-offers-a-surplus-opportunity-for-texas-data-centers>
- [3] Lazard: Levelized Cost of Energy+ v19 / LCOS v11, 2026.
- [4] Bracewell: Texas Senate Bill 6 Ushers in Major Overhaul of Large Load Interconnection and Grid Access Rules.
- [5] Verse: Texas SB6’s Real Test: What ERCOT’s New Curtailment Order Means for Co-Located Data Centers, 2026.
- [6] GridStatus: Another Record Bites the Dust, 2026.
- [7] U.S. EIA / NETL: Natural Gas Interstate and Intrastate Pipelines GIS Feature Layer. https://arcgis.netl.doe.gov/server/rest/services/Hosted/EIA_pipeline_data/FeatureServer/3
- [8] AEP Texas: AEP Texas Central Company closes sale of Rio Pecos Power Station, 2007. <https://www.aeptexas.com/company/news/view?releaseID=988>
- [9] Frontier Companies: Oklaunion Industrial Park property materials. <https://frontier-companies.com/oklaunion-power-plant/>
- [10] Vistra: Coletto Creek repowering announcement, 29 September 2025.
- [11] NRG4NOW patent summary: Patent application summary dated 22 June 2026, file DE 10 2026 003 523.6, Standardized Energy-Logistics Architecture for Molecular Energy Carriers.
- [12] TSTM concept: A Scientific Analysis of the Tube Storage Tank Module for Methane Energy Storage, 2025.
- [13] Author’s calculations based on the listed datasets; rounding differences may occur.

Appendix C – Open Data Requirements before Pre-FEED

- ERCOT SCED Resource IDs with coordinates, Settlement Point, TSP and five-minute HSL/Base Point/LMP series for at least 24–36 months.
- Separation of economic and transmission-driven curtailment using Binding Constraints and Shift Factors.
- Compressor vendor data: MW, kg/h, stages, inlet/outlet pressure, turndown, startup time, efficiency, cooling and redundancy.
- TSTM: applicable ASME/DOT code, operating range, Z-factor model, usable volume, fatigue, inspection and certified total installed cost.
- Pipeline operator: MAOP, normal pressure, diameter, gas quality, available injection/withdrawal capacity and tariff.
- Grid operator: import capacity, voltage, transformer condition, protection, SB6 treatment and direct shedding.
- Brownfield: title, easements, Phase I/II, water rights, noise/air, flood exposure, transport loads and local users.
- Commercial term sheets: power price, curtailment priority, gas offtake, capacity payment, cooling price and availability guarantee.