Public Service Company of New Mexico

Gas Volatility Analysis

January 27th, 2026

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Situation

Stakeholders Expressed Concern Regarding PNM's IRP (Edited)

A significant issue that remains unaddressed in the regionalization discussion is the significant and unaddressed risk of gas price volatility. Even if a gas generating unit is able to serve load at peak times, it may not be able to do so economically. Gas price spikes carry a significant economic risk to consumers, and there are tools that can quantify the economic value of the risk reduction provided by greater use of renewable resources and storage elative to gas generation. Lawrence Berkeley National Laboratory (LBNL) has developed more than one such tool that PNM could use to account for gas price risk. Stakeholders recommends that PNM use tools such as these to evaluate the exposure of portfolios to natural gas fuel price risk to consumers in future IRP analysis. Stakeholders recommends the Commission order PNM to include a detailed, regional study of gas price volatility and the risk of gas price spikes during peak times, to align the cost assumptions more closely with its expected gas generator usage.

PNM's Response:

Perform detailed study for natural gas volatility and price exposure.

PNM agrees with Stakeholders to perform a study on natural gas volatility and price exposure in its next IRP. PNM will work with interested stakeholders, including Stakeholders, to reasonably scope and perform a study on natural gas volatility and price exposure as part of its next IRP.

Siemens approach

Quantify the impact of natural gas price volatility on PNM's annual fuel expense

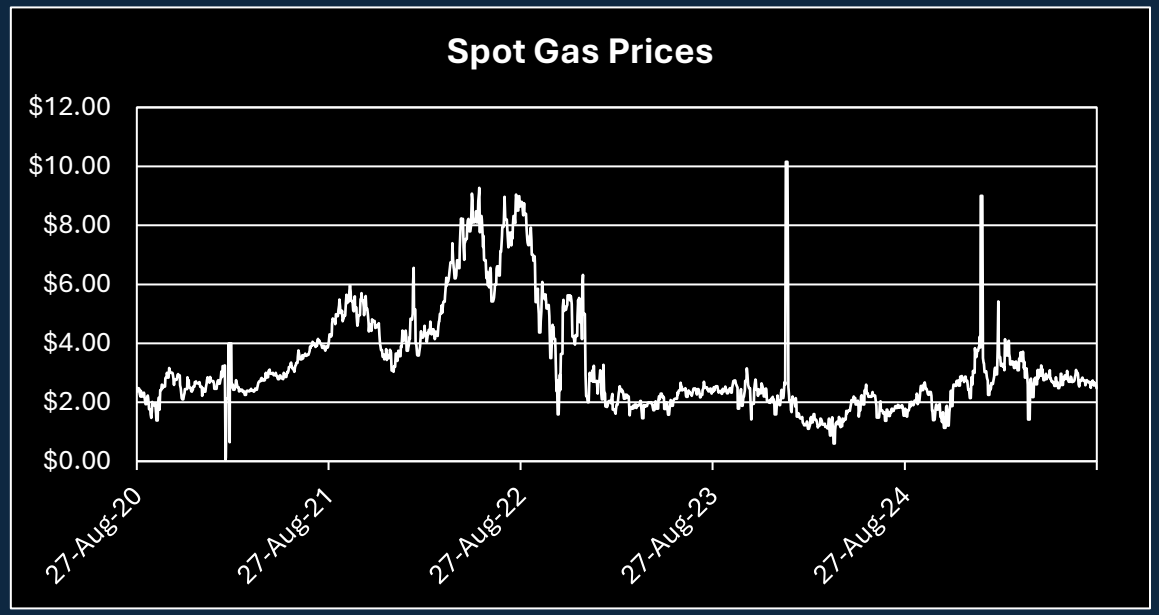
Using a simulation-based Value at Risk (VaR) framework, Siemens PTI will:

- Analyze historical spot pricing data to calculate volatility including short duration market disruptions that create pricing anomalies
- Apply this volatility to the forward curve
- Generate thousands of potential price paths via Monte Carlo simulation using a GBM methodology
- Organize these into standard deviation bands around the forward curve
- Apply these paths to forecasted monthly gas consumption (from IRP dispatch) to quantify cost exposure
- Estimate the variance between expected and unfavorable outcomes to assess risk potentially passed on to ratepayers

The volatility study will inform PNM of the potential favorable and unfavorable variances on an mmbtu and total dollar basis for the incremental and total gas supply requirement. The potential variances will then be factored into the IRP

Understanding volatility σ

Volatility is the degree of variability in the price or return of an asset over time, usually quantified as the statistical dispersion (standard deviation) of its returns over a given period. Higher volatility means prices move up and down more sharply and frequently, and is therefore often associated with higher risk, while lower volatility indicates more stable, less dramatic price movements.

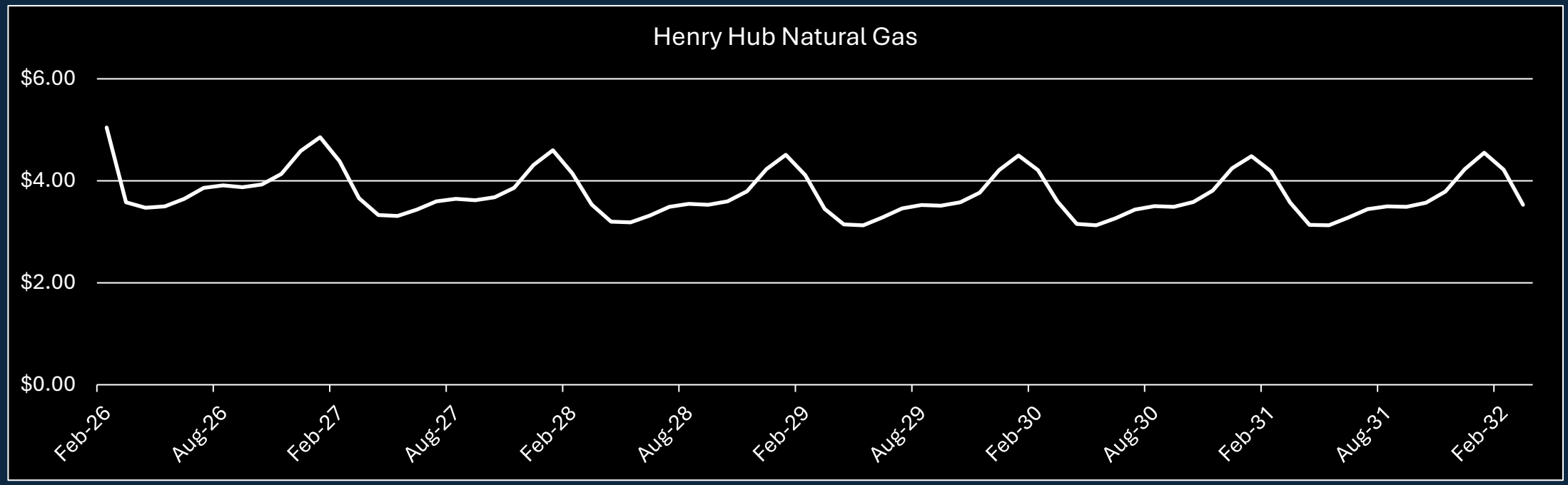


Volatility is the standard deviation of returns over the lookback window, scaled monthly using the square-root-of-time.

Using daily closing prices P_t:

- Compute daily log returns
- Compute the sample standard deviation of those returns (daily volatility)
- Calculate monthly volatility, multiply by $\sqrt{22}$) the number of trading days in a month

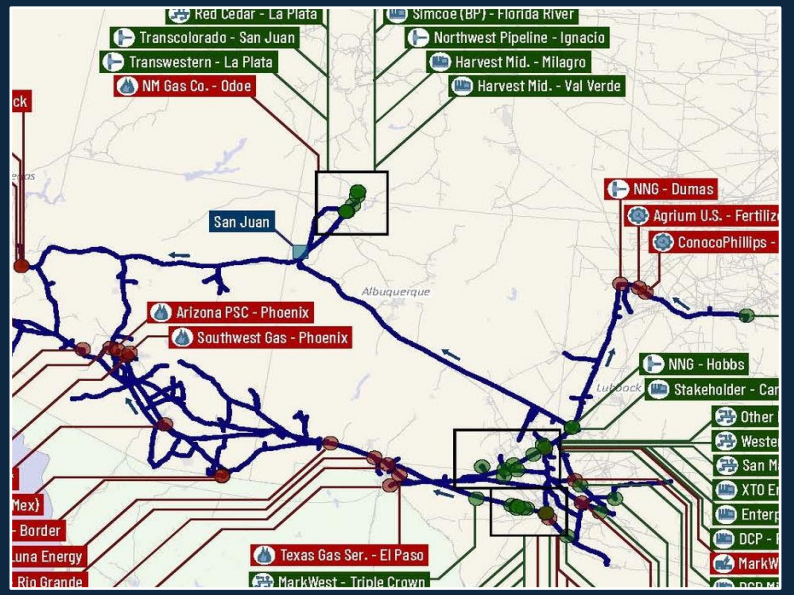
Understanding the forward curve



The forward curve represents the price of gas going out into the future. It is created by linking the individual forward monthly gas prices into a continuous chart and is the baseline for market simulations.

Market data to be used for the analysis

- Delivered gas prices are based on Henry Hub + the location differential (basis)
- The basis differential is the difference between the Henry Hub benchmark and the local delivery market
- Basis differentials are usually fairly stable however weather and operational disruptions can cause sever, short term price spikes
- To ensure a robust analysis capturing several markets, Siemens overlayed the PNM service territory with the available, liquid Platt's Gas Daily Daily pricing points



- Henry Hub
- Waha
- El Paso San Juan
- El Paso Permian
- Houston Ship Channel

Simulating the market

GBM market simulation

Calculate a series of forward prices paths using a Geometric Brownian Motion (GBM) price simulation

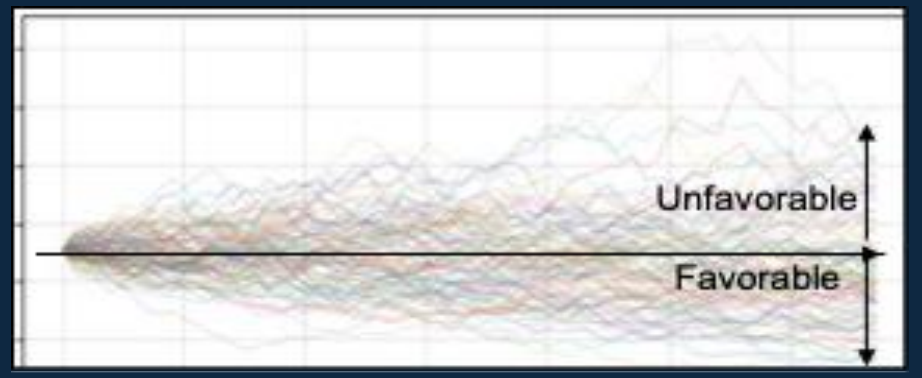
Continuous-time GBM model for price S_t:

$$dS_t = \mu S_t\, dt + \sigma S_t\, dW_t$$

where: μ is drift
σ is volatility
W_t are random shocks

The price paths are then grouped to create a distribution of forward monthly prices

The commodity risk (Henry Hub) and basis risk are evaluated independently and then combined to calculate the total volatility impact



Quantify the impact of market volatility

- Assume a three-year calculation horizon, adjusted to consider a 20-year horizon
- Multiply the simulated market price paths by the additional gas volume required to fuel new generation
- Calculate the standard deviation of the estimated gas expense
- Calculate the difference between the expected case (mean) and a two standard deviation move in either direction to quantify the impact of volatility
- Divide the unfavorable two standard deviation expense by the total forecasted gas load to calculate the system wide impact to PNM customers

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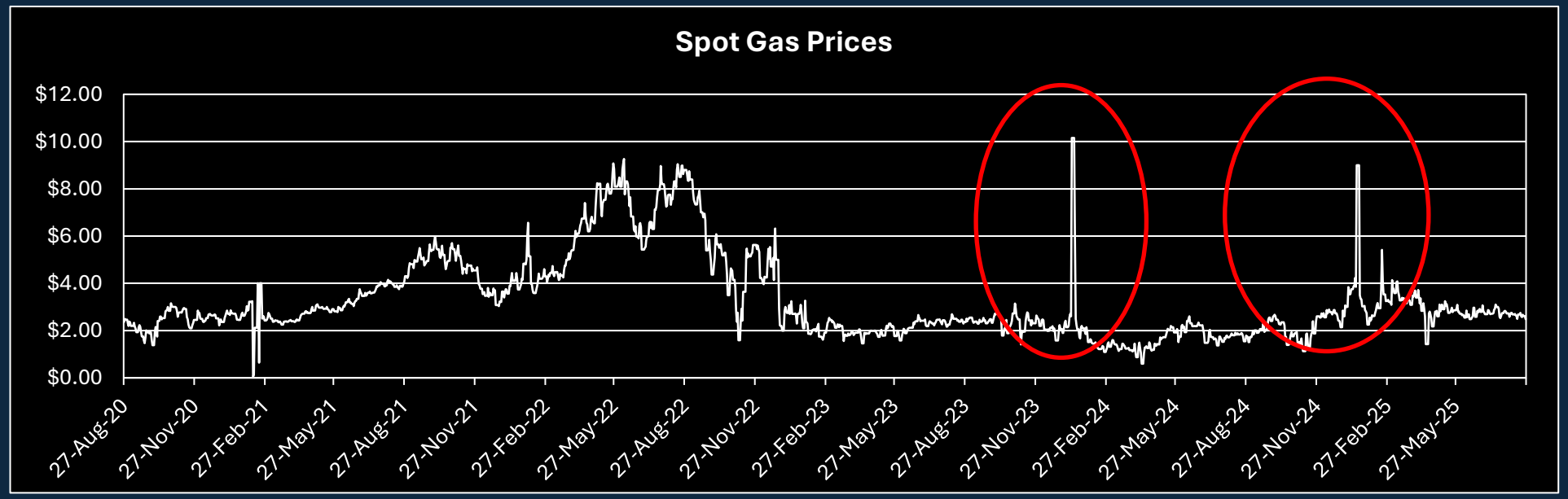
Basis risk historical scenario analysis



Basis risk scenario analysis

- Identify periods of market disruption; magnitude and duration
- Quantify incremental daily gas load
- Evaluate the impact of the price spike on the incremental gas load
- Based on price history, estimate the number of disruption events that occur annually
- Apply disruption events to the three-year unfavorable cost analysis

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Incremental considerations

In addition to the market simulation analysis Siemens will evaluate the potential impact of the following market drivers:

- Seasonality between the summer and winter strips and the impact of cooling on power demand and gas costs for fossil generation based on Gas Daily price history
- Pipeline disruptions as listed in the EIA portal
- Planned pipeline construction
- Correlations between basis markets
- Statistical validity of the analysis

Questions

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