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What Happened to Electricity in Q1 ’24?

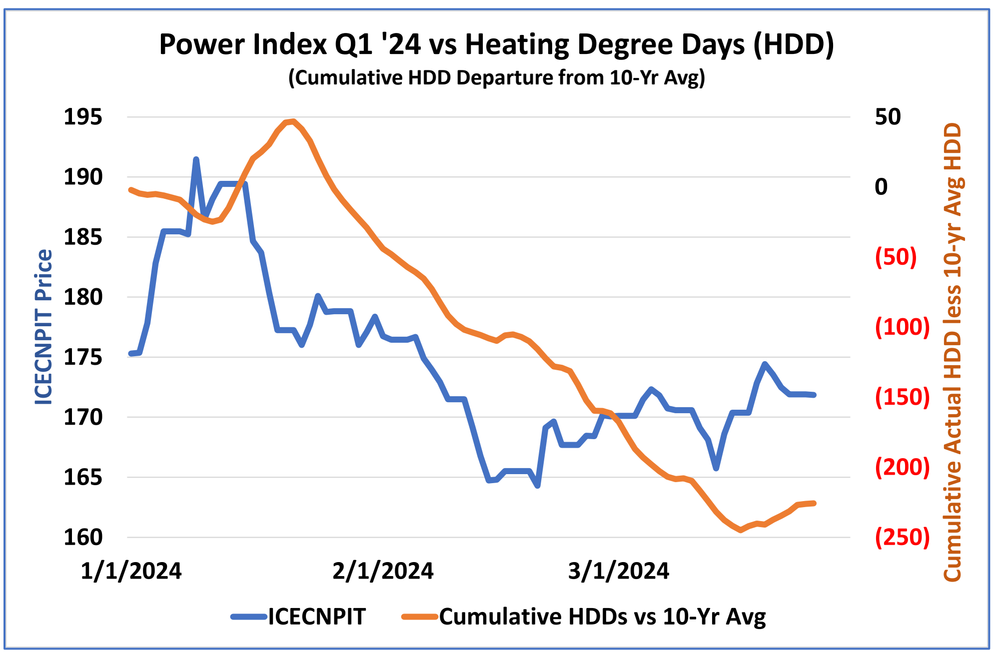
April 2024

Executive Summary

Wholesale power prices in the US, as measured by the CNIC-ICE US Carbon Neutral Power Index (ICECNPIT), fell only about half a percent (0.5%) in the first quarter of 2024. This comes after a steeper drop of 6.32% between early January and mid-February. While the quarter ended slightly negative, ICECNPIT's performance was much stronger than expected given the challenging climate. This resilience in the face of headwinds is a positive sign for power prices and demand, and should indicate bullish momentum for the remainder of the year.

Specific reasons for the negative performance in Q1 ’24 include:

1. **Minimal Winter**: The Winter ’24 (defined as Dec’23/Jan’24/Feb’24) was the warmest winter since 1893. Early forecasts in Nov ’23 for an average temperature winter were quickly replaced with consistently warmer winter forecasts in the face of an El Nino period. This was followed by the 5th warmest March in history
2. **Challenging Technicals**: Natural gas storage exceeded records (bearish); speculator positions in natural gas futures were bearish (record short open interest) and AUM in natural gas ETFs (liquidating mode) put downward pressure on natural gas and power
3. **Negative Fundamentals**: mild weather resulted in overall low power demand, low power prices and low natural gas prices. Natural gas prices are relevant to electricity during winter periods due to being the marginal fuel for power generators



Warm Winter = Low Power Prices

Heating Degree Days (HDDs) indicate temperatures below 65°F, or times when heating is needed. The warm Winter ’24 resulted in significantly less HDDs than average

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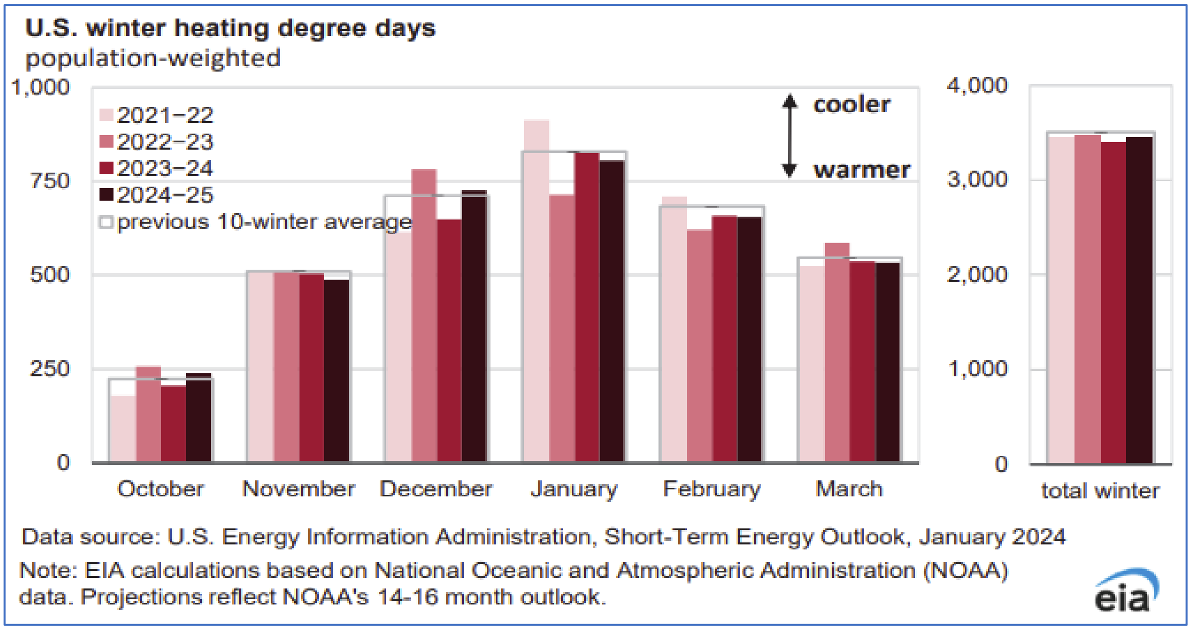
Minimal Winter

<u>**Initial Winter ‘23/’24 Forecasts**</u>:

Initial weather forecasts provided in early November ’23 for Dec/Jan/Feb ’24 were for slightly warmer average temps overall, with a few short but intense bursts of cold. This was the industry consensus, as provided by commercial weather vendors for seasonal forecasts which began being published in mid-Oct’23 to late Nov’23 and continued through to mid-Dec ‘23. It also reflected the fact that the previous winter (Dec/Jan/Feb ’23) was an El Nino event (a warmer than normal winter) and odds of back-to-back El Nino events are <9%. Given such small odds, early market sentiment matched forecasts and provided the backdrop for forecasting a normal winter.



Forecast = normal winter

From October ’23 thru early Jan ’24, US winter weather was forecasted to be average cold to slightly warmer as measured by Heating Degree Days (HDDs)

US Winter '23/'24 Actuals vs Forecasts and Averages

US HDDs ref 65F	1-Dec-23 29-Feb-24	1-Dec-23 31-Dec-23	1-Jan-24 31-Jan-24	1-Feb-24 29-Feb-24
Forecasted	2,046	636	824	544
10-Year Avg	2,291	765	874	599
30-Year Avg	2,296	781	862	599
Actuals	1,990	613	837	497

Forecasts were well below averages

Actuals were below averages and below forecasts

Revisions = warmer

As Winter progressed, forecasts continued to get warmer, and actual temperatures continued to be even warmer than the revisions

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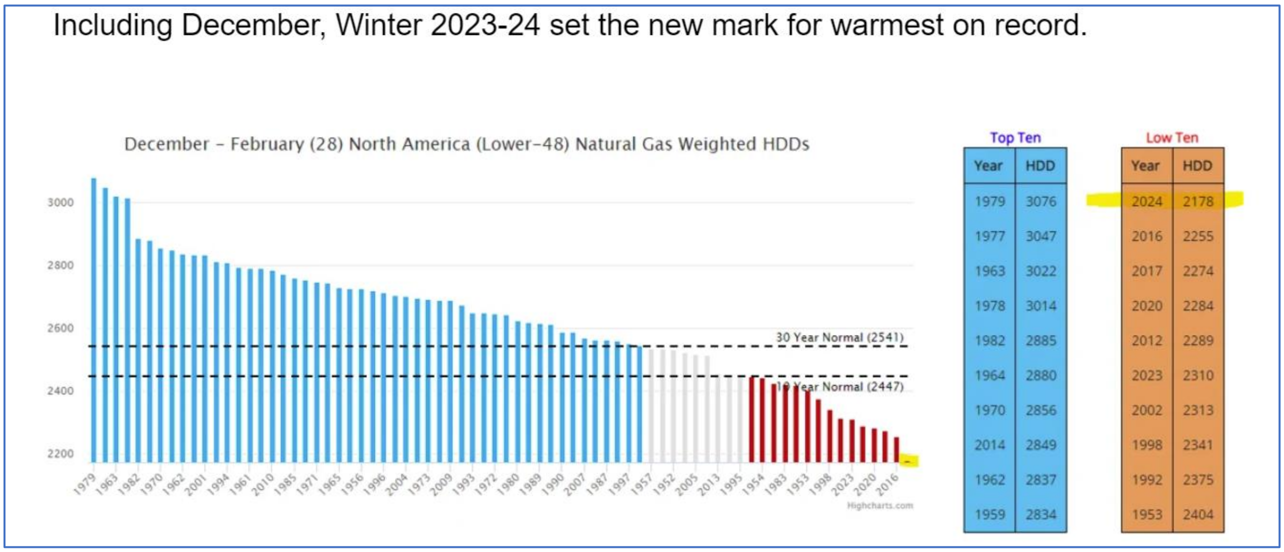
What Happened to Electricity in Q1 '24?

Actual Winter '23/24 Results:

The actual results for Dec'23/Jan'24/Feb'24 were much different. Heating degree days (HDDs) are an energy industry-standard measure for cold temperatures, defined as the difference between actual temperatures and 65°F (with the thesis being that "heating" is needed below this temperature). Typical forecasts tend to focus on overall averages for winter and look at cumulative HDDs for the period.

Winter 23/24 was the warmest on record, with data going back to 1893.



Top Ten

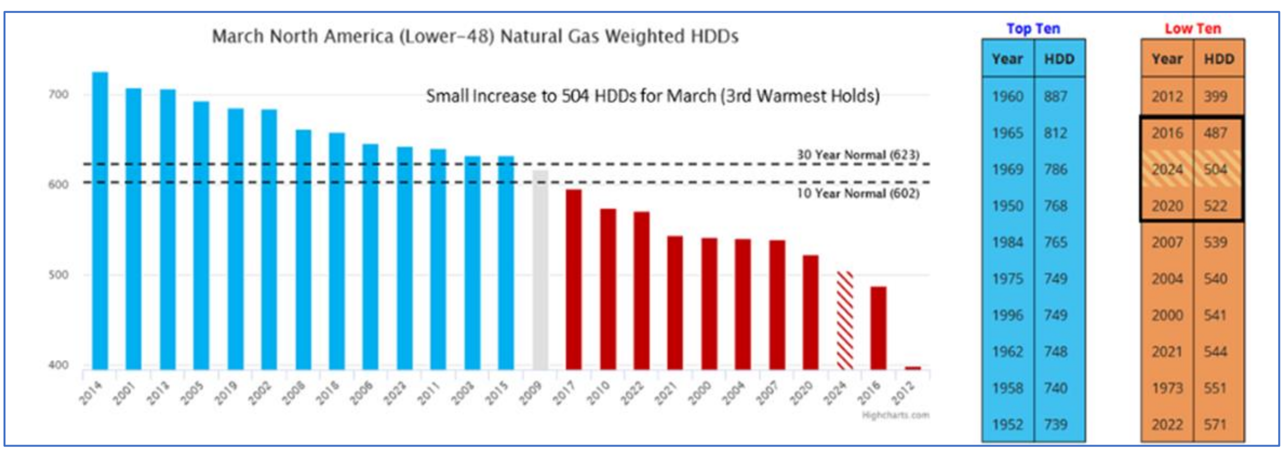
Year	HDD
1979	3076
1977	3047
1963	3022
1978	3014
1982	2885
1964	2880
1970	2856
2014	2849
1962	2837
1959	2834

Low Ten

Year	HDD
2024	2178
2016	2255
2017	2274
2020	2284
2012	2289
2023	2310
2002	2313
1998	2341
1992	2375
1953	2404

March '24 Follow-thru:

March is generally not considered a "winter month" but it still is a period where HDDs are the most prevalent (Spring thaw). March '24 proved to be the 5th mildest March on record, with HDD forecasts much higher than the actual HDDs observed during this period (cold March temps never showed up).



Top Ten

Year	HDD
1960	887
1965	812
1969	786
1950	768
1984	765
1975	749
1996	749
1962	748
1958	740
1952	739

Low Ten

Year	HDD
2012	399
2016	487
2024	504
2020	522
2007	539
2004	540
2000	541
2021	544
1973	551
2022	571

With a 2.5% chance of 3 El Nino events in a row, a return to normal weather is expected

What Happened to Electricity in Q1 '24?

Challenging Technicals

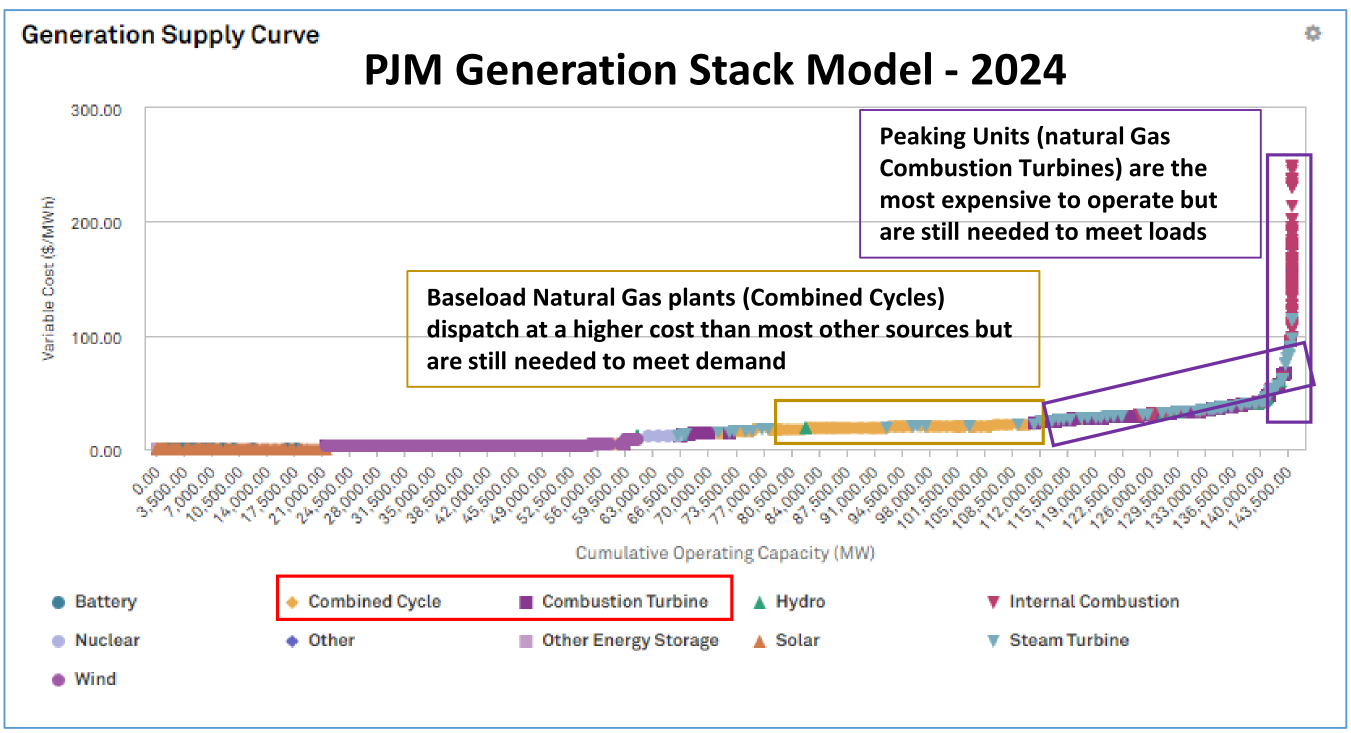
<u>Natural Gas Matters to Power</u>:

During normal conditions of temperature, demand forecasting and actual demand results, there is usually sufficient generation available in the US to meet electricity needs. However, factors such as unit outages (planned maintenance or unexpected repairs), extreme hot/cold temperatures, transmission constraints, and variations in wind/solar output can cause stresses to the system.

Natural gas generation usually consists of baseload (combined cycle), or plants that tend to run 24/7, and have a very efficient heat rate (measure of converting natural gas to electricity), and typically produce power for as low as $20.00 per MWh – with natural gas prices being the fuel input and the major cost driver. In 2023, on average approximately 40% of all US electricity generation was from natural gas.

Natural gas generation can also consist of peaking units (combustion turbine), which have a higher/less efficient heat rate for converting natural gas to electricity. But the peaking units can start much faster, and cycle more quickly between maximum and minimum generation, and are therefore extremely necessary to help meet changing power demands. Peaking units are used for short periods of time to meet load and are usually more expensive to operate and maintain.

Natural gas is still used in the US for baseload generation and for meeting peak loads. Meeting peak loads constitutes providing the "top of the stack" or the marginal electron to serve demand. Since natural gas is the major fuel source for peaking power generation, natural gas prices have a significant impact on actual power prices.



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What Happened to Electricity in Q1 '24?

Even though the US wants to be 80% renewable generation by 2030 and 100% renewable by 2035, there will still not be enough dispatchable (variable) generation to meet electricity demands. Batteries are a partial solution, but most large-scale batteries are 4 hours in duration and will not be able to cover prolonged periods of zero renewable generation output. Combined with the fact that not enough battery generation is planned for future construction and inclusion on the grid, this means that the solution will still continue to be natural gas as the marginal source of fuel for electricity generation and in turn natural gas prices will continue to have significant influence on US power prices.

- Natural Gas will still be the "marginal molecule" for electricity generation
  - Peakers are flexible and responsive
- Batteries will not be able to "firm" renewable generation
  - Not enough being built

ISO NATURAL GAS CAPACITY vs RENEWABLES + BATTERY CAPACITY

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
CAISO	Natural Gas	34%	32%	26%	24%	21%	21%	20%	20%	20%	20%	20%
	Wind	12%	11%	10%	9%	8%	7%	8%	8%	9%	9%	9%
	Solar	22%	24%	25%	25%	28%	28%	27%	27%	27%	27%	27%
	Batteries	7%	10%	21%	28%	31%	31%	30%	30%	30%	30%	30%
ERCOT	Natural Gas	36%	34%	28%	22%	19%	19%	19%	19%	19%	19%	19%
	Wind	28%	28%	24%	19%	18%	17%	17%	17%	17%	17%	17%
	Solar	9%	13%	21%	31%	35%	35%	36%	36%	36%	36%	36%
	Batteries	2%	3%	8%	14%	17%	17%	17%	17%	17%	17%	17%
MISO	Natural Gas	33%	32%	30%	29%	29%	30%	30%	30%	31%	31%	31%
	Wind	16%	17%	18%	18%	18%	18%	18%	18%	18%	18%	18%
	Solar	3%	4%	8%	12%	14%	15%	15%	15%	15%	15%	16%
	Batteries	0%	0%	0%	1%	2%	2%	2%	2%	2%	2%	2%
NEPOOl	Natural Gas	50%	49%	43%	40%	40%	39%	38%	37%	37%	37%	37%
	Wind	5%	5%	7%	12%	13%	14%	17%	19%	19%	19%	19%
	Solar	7%	8%	10%	10%	10%	10%	10%	9%	9%	9%	9%
	Batteries	1%	1%	3%	4%	4%	4%	4%	4%	4%	4%	4%
NYISO	Natural Gas	38%	36%	33%	29%	27%	25%	25%	25%	25%	25%	25%
	Wind	5%	6%	6%	17%	19%	19%	18%	21%	21%	21%	21%
	Solar	4%	4%	9%	11%	13%	16%	17%	17%	17%	17%	17%
	Batteries	0%	0%	2%	2%	5%	5%	6%	6%	6%	6%	6%
PJM	Natural Gas	42%	44%	42%	40%	39%	38%	39%	38%	38%	38%	38%
	Wind	5%	5%	5%	6%	8%	9%	9%	9%	10%	11%	12%
	Solar	4%	5%	10%	12%	14%	14%	15%	15%	14%	14%	14%
	Batteries	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%

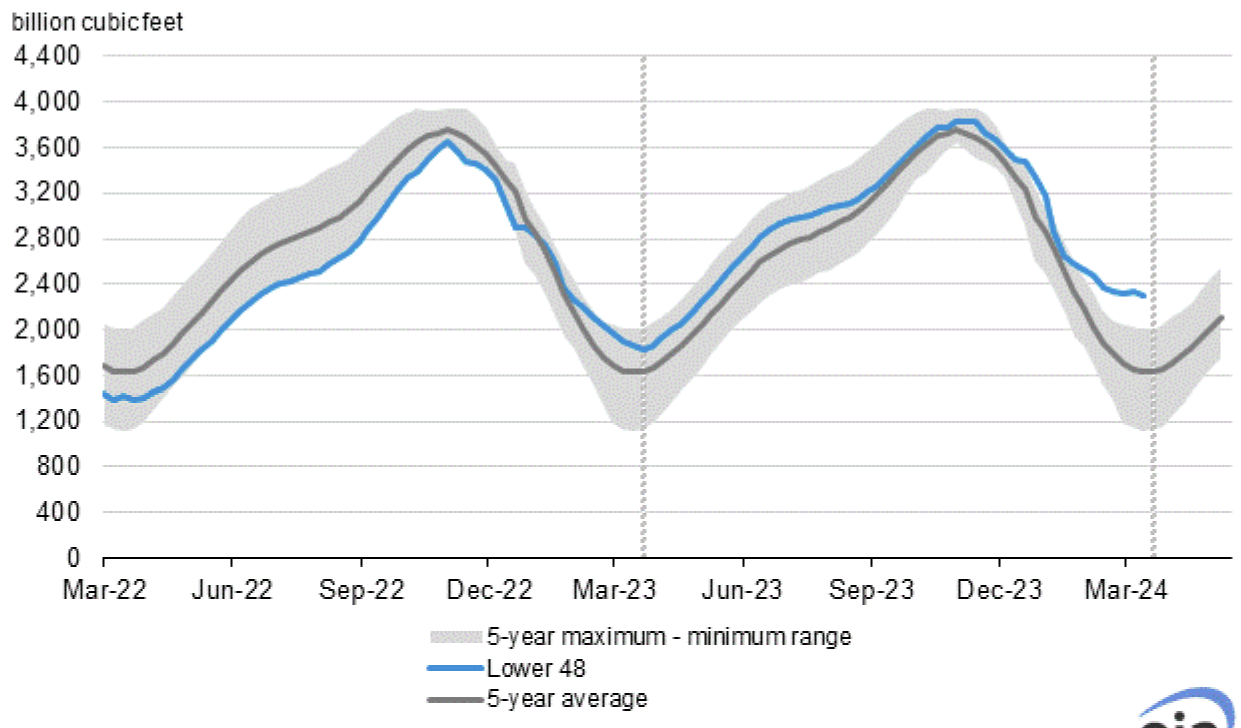
What Happened to Electricity in Q1 '24?

Natural Gas Storage Levels:

Natural gas has two "seasons" – "Injection" which is April thru October, and "Withdrawal" which is from November through March. Injection season is when producers can store natural gas underground because demand is typically lower (no heating demand and lower power demand in summer), so gas is stored during periods of low demand during the injection cycle for use during periods of higher demand in the winter/withdrawal cycle. During the withdrawal period, natural gas is taken out of storage and used to meet increased demand.

Most industry participants (hedgers, speculators, producers, end-users, banks) monitor the amount of natural gas in storage, using the weekly EIA storage numbers as a predictor for short-term prices. During Q1 '24, natural gas storage was above the 5-year average, meaning that there was more than enough natural gas to meet the demand during this time period. This lack of demand and high storage number pushed shorter-dated natural gas prices towards a multi-decade low. This low price meant that natural gas generation could operate more cheaply, helping to depress power prices

Working gas in underground storage compared with the 5-year maximum and minimum



Data source: U.S. Energy Information Administration

Note: The shaded area indicates the range between the historical minimum and maximum values for the weekly series from 2019 through 2023. The dashed vertical lines indicate current and year-ago weekly periods.

What Happened to Electricity in Q1 '24?

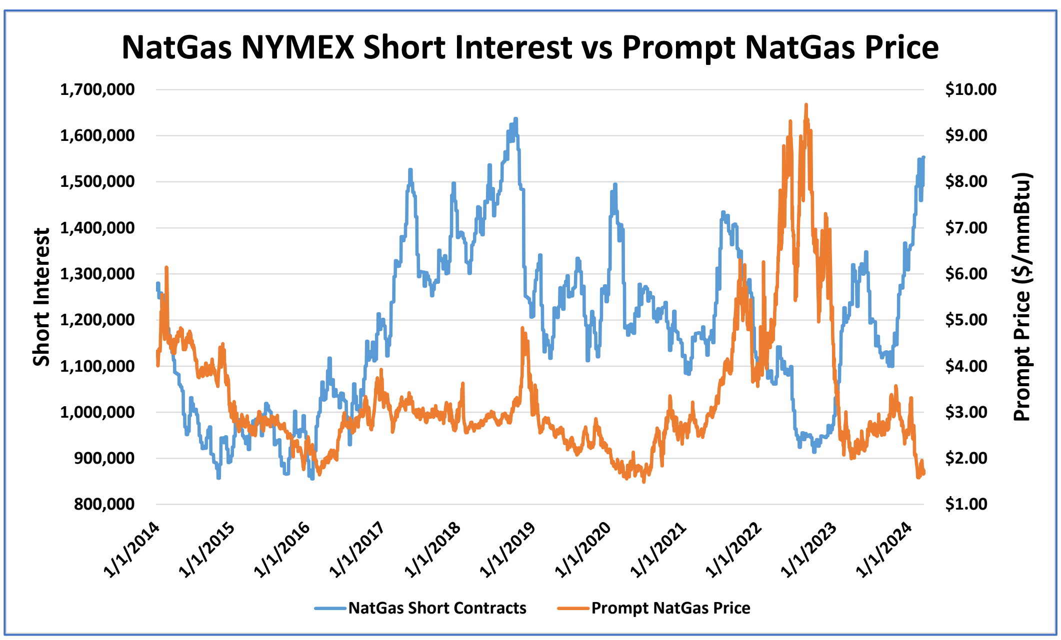
<u>NatGas Short Interest</u>:

Understanding Short Interest in Natural Gas Futures

The natural gas market, like many financial markets, utilizes futures contracts to manage price risk and facilitate future delivery of the commodity. However, futures contracts allow not just for buying (long positions) but also for selling (short positions). Short interest refers to the total number of outstanding futures contracts where a market participant has agreed to sell a specific quantity of natural gas at a predetermined price on a future date, without currently owning the physical commodity. These participants, known as short sellers, are essentially betting that the price of natural gas will decline by the contract expiry date. The level of short interest in natural gas futures contracts can significantly influence the price of the commodity:

- <u>Increased Short Interest, Downward Pressure</u>: When short interest rises, it indicates that a growing number of market participants are anticipating a price decline. This anticipation itself can become a self-fulfilling prophecy. As more participants "short the market", they may be forced to sell additional contracts to meet their margin requirements if prices rise unexpectedly. This selling pressure can drive prices down, validating the bearish sentiment.
- <u>Short Covering and Price Spikes</u>: However, the opposite scenario can also occur. If the price of natural gas unexpectedly rises, short sellers may be forced to buy futures contracts (cover their shorts) to avoid further losses. This surge in buying activity to close out short positions can trigger a short squeeze, pushing prices even higher due to a temporary imbalance between buyers and sellers.

Therefore, short interest acts to magnify market trends. It can amplify price declines if market sentiment leans bearish, while also creating the potential for sharp price increases in case of a price squeeze. By monitoring short interest data alongside other market indicators, natural gas traders can gain valuable insights into potential price movements in the futures market.



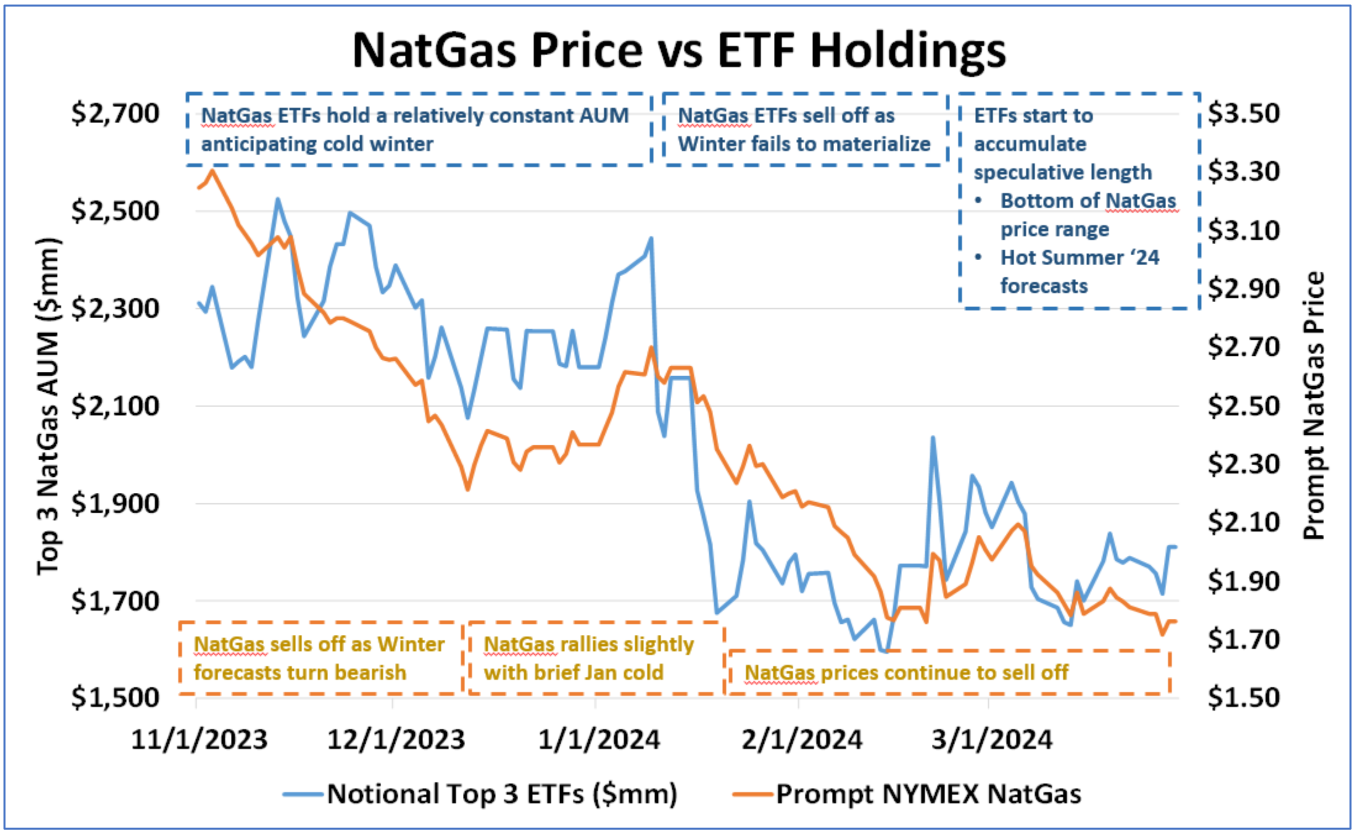
Short Interest = Low Prices

As Winter continued to be mild, speculators, hedgers and market participants continued to sell natural gas futures contracts in anticipation of lower prices. This became a self-fulfilling event, with more selling producing lower prices, and lower prices resulting in more selling

What Happened to Electricity in Q1 ’24?

<u>NatGas ETF Pressures</u>:

Natural gas ETFs (Exchange Traded Funds) which hold underlying natural gas futures contracts, have become a popular investment vehicle with the “Top 3” holding more than $2.5B in AUM at certain times. The percentage of ETF holdings vs natural gas futures open interest varies between 20% to as high as 45%. When natural gas ETFs liquidate holdings (sell due to redemptions or speculator bearish sentiment) there can be significant selling pressure which may accelerate price declines.



What Happened to Electricity in Q1 '24?

Negative Fundamentals

<u>Power Demand Lower</u>:

The lack of winter heating demand resulted in overall lower electricity demand, as expected. Power demand can be expressed two ways 1) Peak demand, or the highest amount of electricity needed at the maximum hour of the day (usually expressed in MWs), and 2) 24-hr demand, or the amount of cumulative electricity needed during a 24-hour period (usually expressed in MWh).

Peak demand for all of the power regions in the US during winter '23/'24 was strong in January (above averages) but low in Feb and March due to the lack of weather. Average demand was a bit more resilient in the face of no weather, with the monthly numbers remaining stronger than anticipated for the associated HDDs. There are several reasons why average demand was overall lower yet stronger than expected for the observed temperatures, including:

- <u>AI</u>: demand from computers and advanced chips tends to be constant rather than peak
- <u>Data Centers</u>: data centers pulled 2.5% of overall US power demand in '22 and 5% in 2023; these sources of demand are "24/7"
- <u>EVs</u>: EV demand was 1% of overall US electricity consumption in '22 and almost 2% in 2023; EVs are being incentivized to charge at night, adding to overall load instead of peak load
- <u>Industrial Growth</u>: Overall US economic growth and additions such as Hydrogen Plants (constant electricity demand) add to these numbers

PEAK LOAD WINTER COMPARISONS (mW Peak Load in Month)

PJM	Jan	Feb	Mar
2024	133,426	111,906	
2023	110,141	121,265	111,024
2022	129,316	123,815	110,130
2021	117,383	116,686	106,503
Max	140,468	143,115	126,630
Avg ('08-'24)	124,565	118,356	108,938

ERCOT	Jan	Feb	Mar
2024	78,138	56,172	
2023	65,557	63,401	53,252
2022	63,526	68,954	56,449
2021	58,598	69,692	45,367
Max	78,138	69,692	60,652
Avg ('08-'24)	56,060	52,829	47,589

NYISO	Jan	Feb	Mar
2024	22,754	20,981	
2023	20,641	23,369	19,881
2022	23,237	22,477	20,450
2021	22,500	21,746	20,795
Max	25,738	24,384	23,528
Avg ('08-'24)	23,781	22,876	21,626

NEPOOL	Jan	Feb	Mar
2024	18,277	16,983	
2023	17,059	19,487	16,007
2022	19,604	18,371	16,764
2021	18,654	18,017	17,650
Max	21,700	20,427	19,706
Avg ('08-'24)	19,862	18,912	17,841

CAISO	Jan	Feb	Mar
2024	28,794	28,406	
2023	29,039	29,045	28,650
2022	29,062	29,010	28,538
2021	29,163	27,171	28,074
Max	33,155	31,926	31,089
Avg ('08-'24)	30,505	29,935	29,359

MISO	Jan	Feb	Mar
2024	106,415	88,413	
2023	92,915	94,453	89,628
2022	99,639	95,353	84,661
2021	91,808	103,299	83,255
Max	109,613	103,299	98,158
Avg ('08-'24)	93,808	89,663	82,905

US Electricity Generation Output (gwHrs/month)

		Dec	Jan	Feb	Mar
	2018	308,452	338,461	306,438	359,952
	2019	305,373	313,597	315,648	366,429
COVID	2020	307,803	378,205	303,203	278,852
COVID	2021	374,720	388,104	322,277	280,039
Rebound	2022	397,400	333,447	321,715	290,551
El Nino 1	2023	383,366	306,815	308,552	368,441
El Nino 2	2024		419,005	304,629	361,877

Loads = lower but stronger

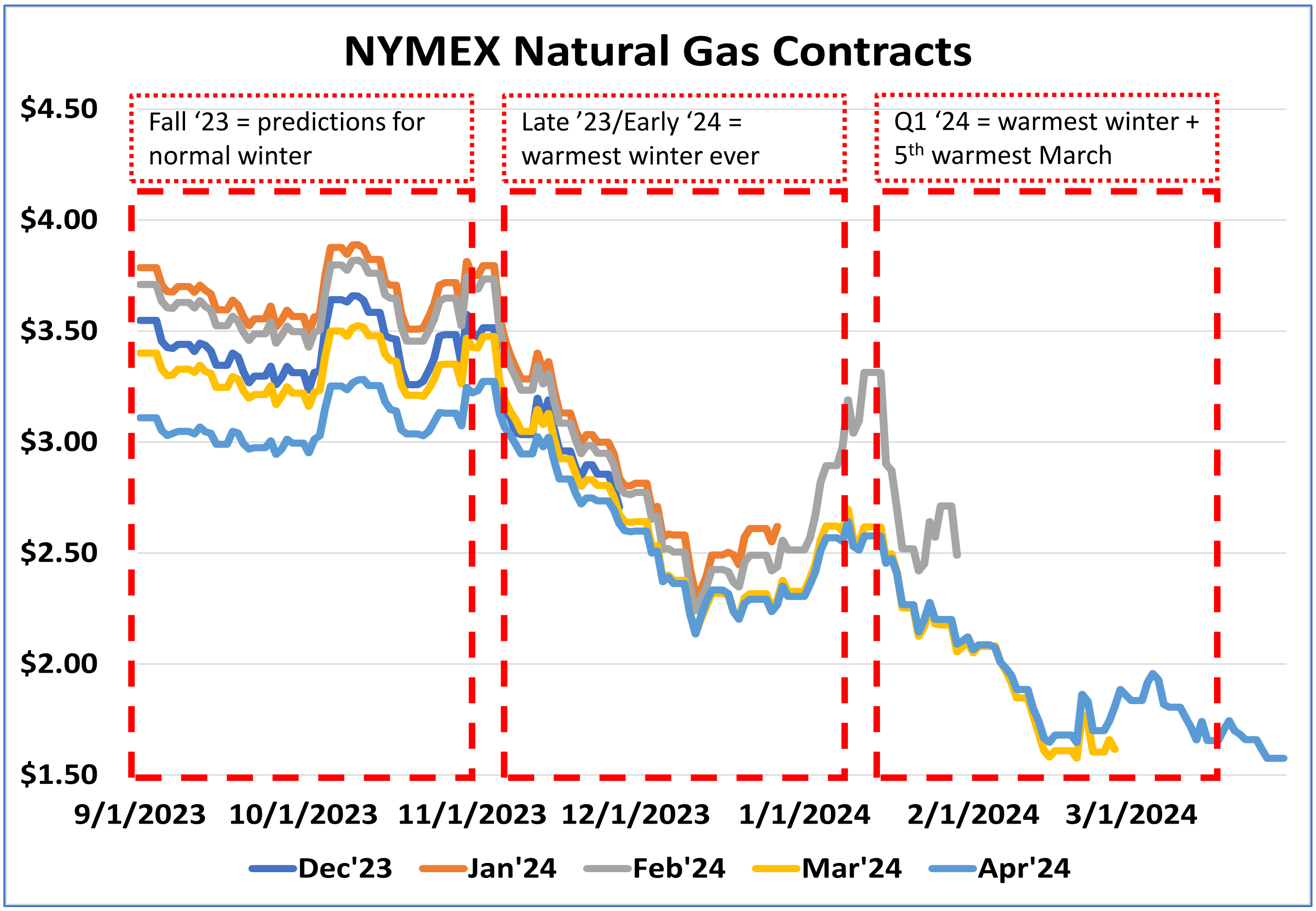
A lack of material coldness resulted in electricity demand lower than most previous years, yet on a "weather-normalized" basis the loads were actually stronger

<u>NatGas Prices Collapsed:</u>

What Happened to Electricity in Q1 '24?

The lack of weather also weighed on natural gas prices in the US. The winter is typically the period of strongest pricing, as the US uses the largest amounts of gas during this time period for electricity generation (~35%), residential/commercial heating demand (~40%), and industrial loads (~25%). With reduced electricity demand and reduced natural gas heating demand, prices for the NYMEX Henry Hub contract reached the lowest prices seen in the past 25 years.

Lower natural gas demand and lower natural gas prices usually create lower electricity prices since natural gas is almost always the marginal fuel for generation.



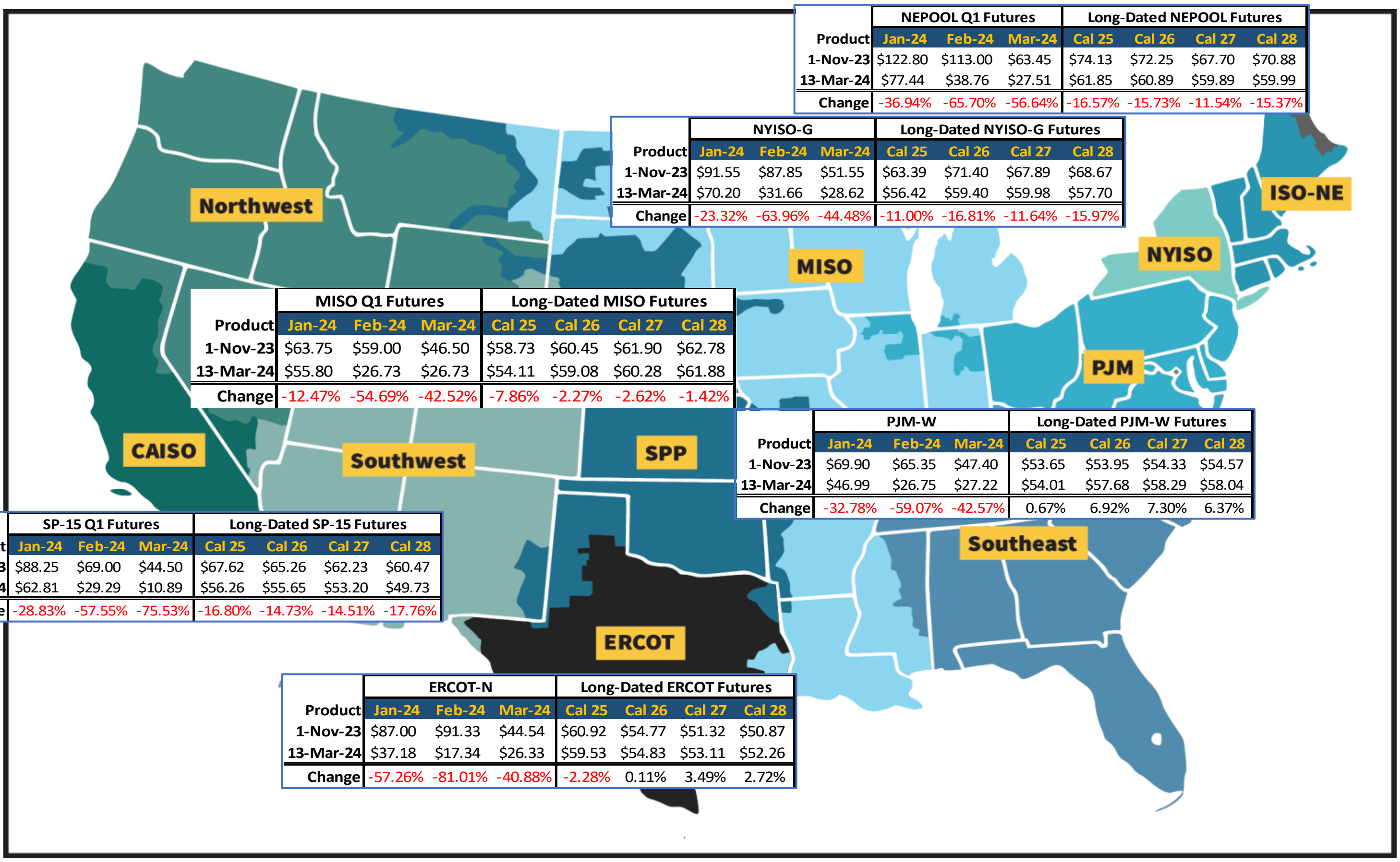
What Happened to Electricity in Q1 '24?

<u>Power Prices Declined</u>:

The lack of winter load, combined with the decline in natural gas prices, caused power prices to decline for Q1 '24. Every region of the US had significant price declines for Jan/Feb/Mar '24. Of note would be that power prices did not decline as much as the associated natural gas prices, and the longer-dated power prices declined minimally (and in some instances were actually marginally higher).

The strength in longer-dated power prices can be attributed to:

- <u>Demand Growth</u>: the market expectations of demand growth (AI, Data Centers, EVs, and Industrial Demand)
- <u>Supply Issues</u>: lower supply (fossil fuel generation being retired at a rate faster than renewables can be built)
- <u>Reliability Issues</u>: non-dispatchable (output cannot be controlled) power generation such as renewable wind and solar is replacing retiring dispatchable fossil generation (natural gas and coal, where output can be controlled); the inability to control output creates greater volatility, uncertainty and higher prices



Product	NEPOOL Q1 Futures Jan-24	Feb-24	Mar-24	Long-Dated NEPOOL Futures Cal 25	Cal 26	Cal 27	Cal 28
1-Nov-23	$122.80	$113.00	$63.45	$74.13	$72.25	$67.70	$70.88
13-Mar-24	$77.44	$38.76	$27.51	$61.85	$60.89	$59.89	$59.99
Change	-36.94%	-65.70%	-56.64%	-16.57%	-15.73%	-11.54%	-15.37%

Product	NYISO-G Jan-24	Feb-24	Mar-24	Long-Dated NYISO-G Futures Cal 25	Cal 26	Cal 27	Cal 28
1-Nov-23	$91.55	$87.85	$51.55	$63.39	$71.40	$67.89	$68.67
13-Mar-24	$70.20	$31.66	$28.62	$56.42	$59.40	$59.98	$57.70
Change	-23.32%	-63.96%	-44.48%	-11.00%	-16.81%	-11.64%	-15.97%

Product	MISO Q1 Futures Jan-24	Feb-24	Mar-24	Long-Dated MISO Futures Cal 25	Cal 26	Cal 27	Cal 28
1-Nov-23	$63.75	$59.00	$46.50	$58.73	$60.45	$61.90	$62.78
13-Mar-24	$55.80	$26.73	$26.73	$54.11	$59.08	$60.28	$61.88
Change	-12.47%	-54.69%	-42.52%	-7.86%	-2.27%	-2.62%	-1.42%

Product	PJM-W Jan-24	Feb-24	Mar-24	Long-Dated PJM-W Futures Cal 25	Cal 26	Cal 27	Cal 28
1-Nov-23	$69.90	$65.35	$47.40	$53.65	$53.95	$54.33	$54.57
13-Mar-24	$46.99	$26.75	$27.22	$54.01	$57.68	$58.29	$58.04
Change	-32.78%	-59.07%	-42.57%	0.67%	6.92%	7.30%	6.37%

Product	SP-15 Q1 Futures Jan-24	Feb-24	Mar-24	Long-Dated SP-15 Futures Cal 25	Cal 26	Cal 27	Cal 28
1-Nov-23	$88.25	$69.00	$44.50	$67.62	$65.26	$62.23	$60.47
13-Mar-24	$62.81	$29.29	$10.89	$56.26	$55.65	$53.20	$49.73
Change	-28.83%	-57.55%	-75.53%	-16.80%	-14.73%	-14.51%	-17.76%

Product	ERCOT-N Jan-24	Feb-24	Mar-24	Long-Dated ERCOT Futures Cal 25	Cal 26	Cal 27	Cal 28
1-Nov-23	$87.00	$91.33	$44.54	$60.92	$54.77	$51.32	$50.87
13-Mar-24	$37.18	$17.34	$26.33	$59.53	$54.83	$53.11	$52.26
Change	-57.26%	-81.01%	-40.88%	-2.28%	0.11%	3.49%	2.72%

What Happened to Electricity in Q1 ’24?

Conclusion

What Happened to Electricity in Q1 ’24?

Wholesale power prices in the US exhibited surprising resilience during the first quarter of 2024. Despite a significant drop in Q1 and a challenging economic climate, the CNIC-ICE US Carbon Neutral Power Index (ICECNPIT) ended the quarter down only 0.5%. This stability can be attributed to several key factors.

First, Winter 2024 proved to be the warmest on record. This resulted in significantly lower Heating Degree Days (HDDs), a metric indicating periods requiring heating. Second, power demand remained low, leading to lower overall power prices. This mild weather also impacted the natural gas market, a crucial fuel source for winter power generation.

The natural gas market itself faced several headwinds. Record natural gas storage levels, coupled with bearish investor sentiment and liquidation within natural gas ETFs, exerted downward pressure on natural gas prices. This ultimately translated into lower wholesale power prices.

Despite these challenges, the power market displayed remarkable resilience. This stability, even in the face of unfavorable weather conditions and a weak natural gas market, suggests potential for a bullish trajectory in the remaining quarters of 2024. However, future performance will depend on a range of factors, including weather patterns, natural gas market dynamics, and overall economic conditions. Continued monitoring of these factors will be crucial for accurate forecasting of future wholesale power prices.