

# A Rapidly-Changing Energy Marketplace

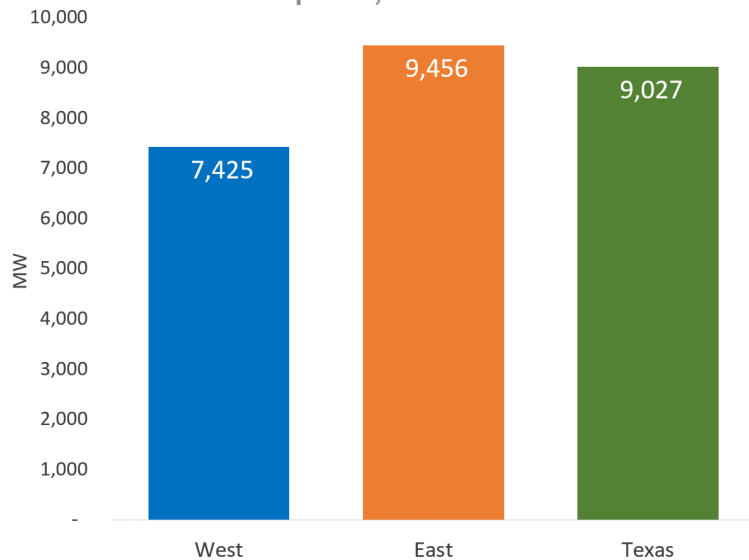
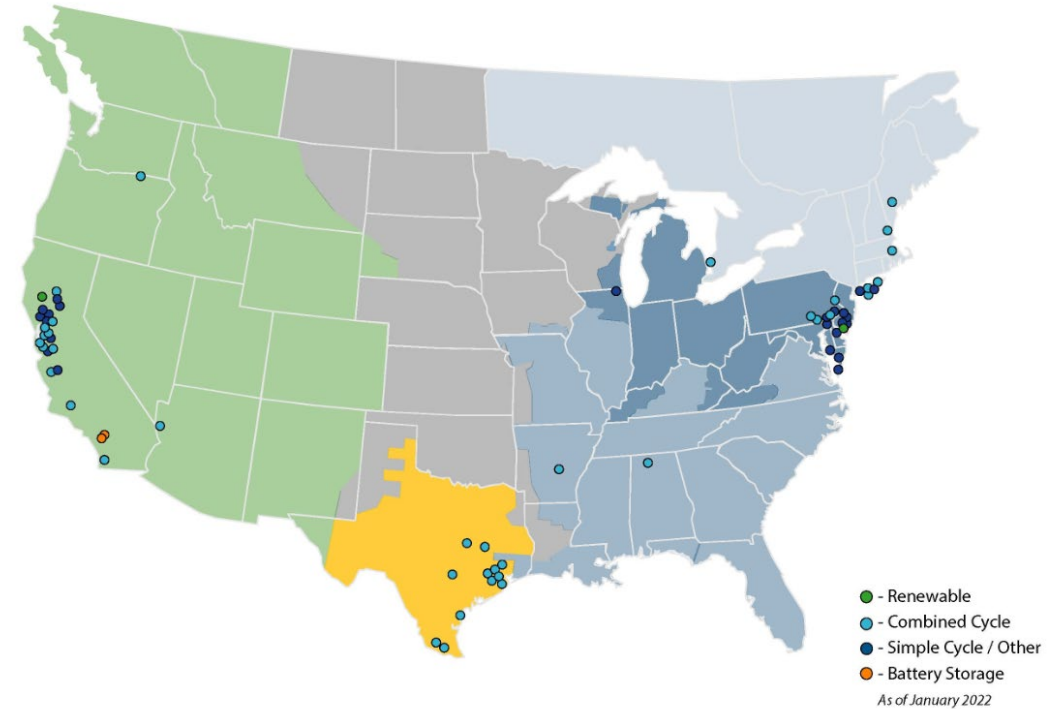
*Global Trends, Natural Gas & Power Markets, Price Risk  
and Renewables*

Feb 28<sup>th</sup>, 2023

# Intro to Calpine

## AMERICA'S PREMIER COMPETITIVE POWER COMPANY

- Founded in 1984, **Calpine Corp.** is America's largest generator of electricity from natural gas and geothermal resources.
- Calpine's fleet is among the cleanest, lowest cost, and most efficient power generators in the US – totaling over 25 GWs across 76 plants.
- Single largest geothermal asset in the world: The Geysers Geothermal Complex, California



**East Region:** 28 operating power plants representing more than 9,300 megawatts of capacity, spanning 12 U.S. states and Canada, with concentrations in the Mid-Atlantic and New England markets.

**Texas Region:** 12 power plants capable of delivering ~9,000 megawatts of electricity to from combined-cycle design, with eight highly efficient cogeneration facilities that provide steam to industrial customers in addition to producing electricity.

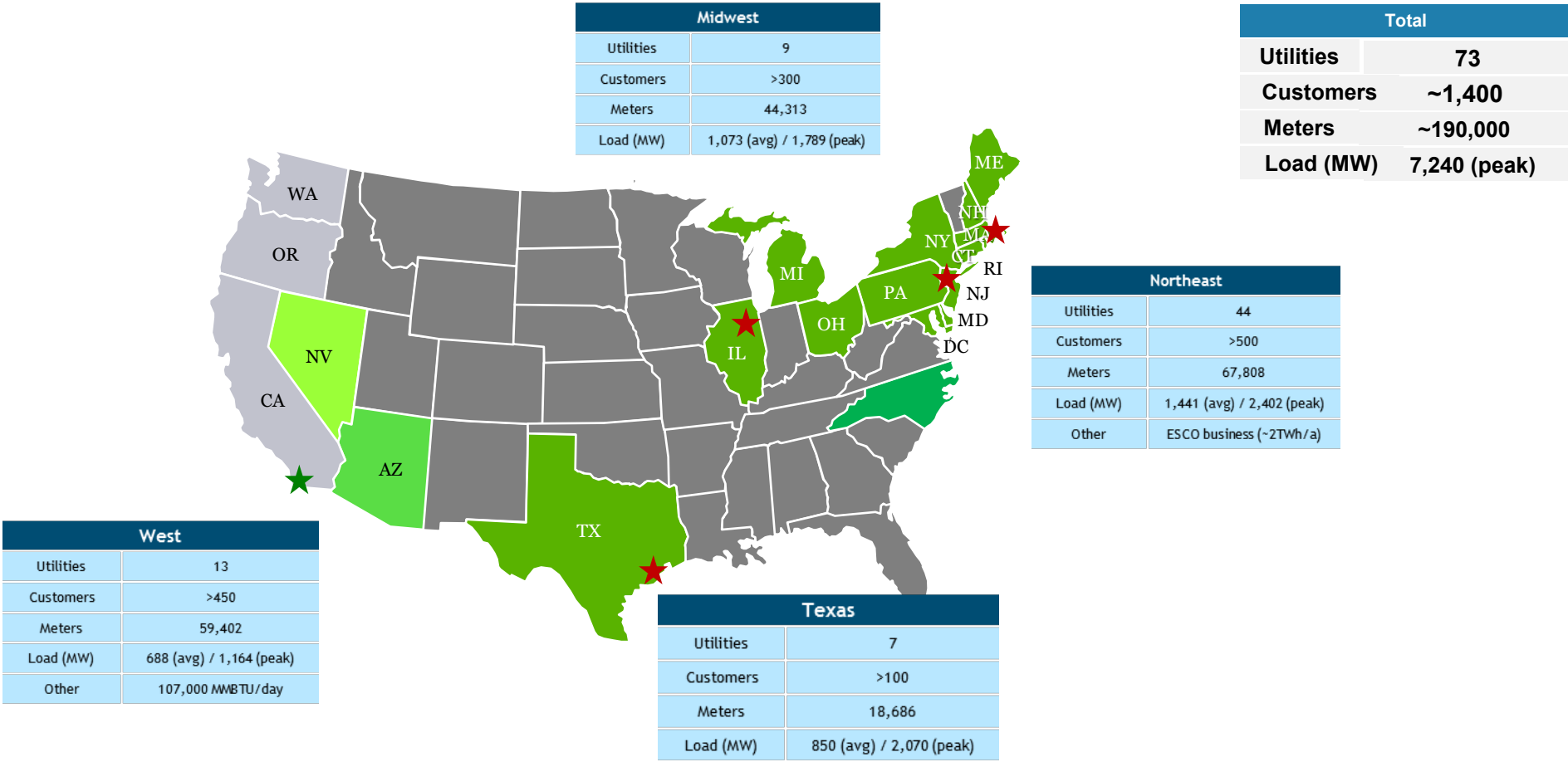
**West Region:** primarily serves more than 6,800 megawatts of natural-gas-fired capacity and 725 megawatts of reliable, renewable geothermal capacity in the state of California.

# Calpine Energy Solutions

## National Presence

Calpine Solutions is a subsidiary of Calpine Corporation and operates in all US deregulated markets. It is licensed to sell power behind 73 utilities where we serve more than 1,400 customers with approximately 190,000 meters, representing a load of ~4 GW (average) to ~7.5 GW (peak)

Calpine Solutions also delivers more than 60,000 MMBTU of natural gas per day in the Western market, and is in the Community Choice Aggregation (“CCA”) data services business



■ Retail electricity  
 ■ Retail electricity and gas  
 ■ Retail gas  
 ■ Wholesale electricity  
★ Satellite office location  
 ★ Corporate Headquarters

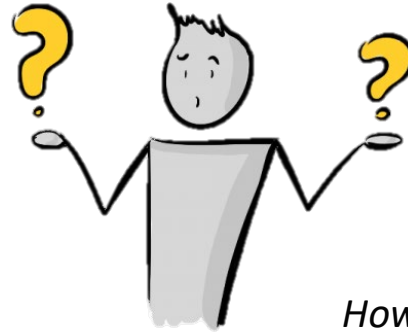
# Sensible Sustainability

*How do I budget for “as-gen”?*

*I signed the wind PPA, now what?*

*What about the state mandated RPS?*

*What if I buy solar and there’s no sun?*



*Should we buy wind or solar?*

*What about the rest of my usage?*

*Can I compare on a risk-adjusted basis?*

*How will we account for the carbon impact?*

**Sensible Sustainability™** *establishes a scalable, repeatable energy portfolio management process that guides ongoing business decisions*



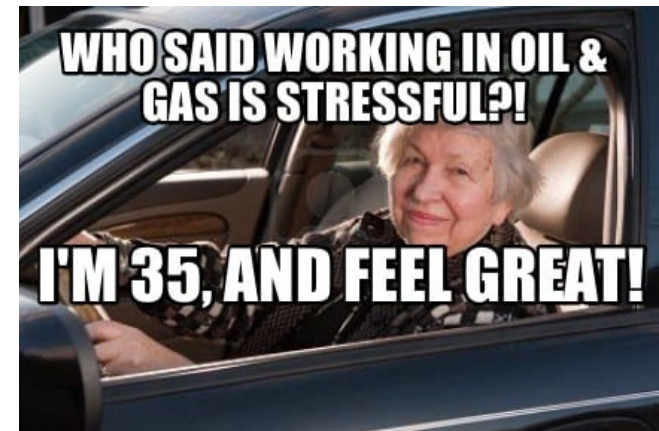
Calpine Energy Solutions work with you to fully capture the benefits of a strategically managed portfolio through implementation of a **data driven process** to manage energy cost, risk, and carbon impacts of renewable energy.

Your organization will have a long term ISO 9001 certified and **CDP Accredited** renewable energy partner who will continue to support your carbon reduction initiatives, long after the initial transaction is complete.

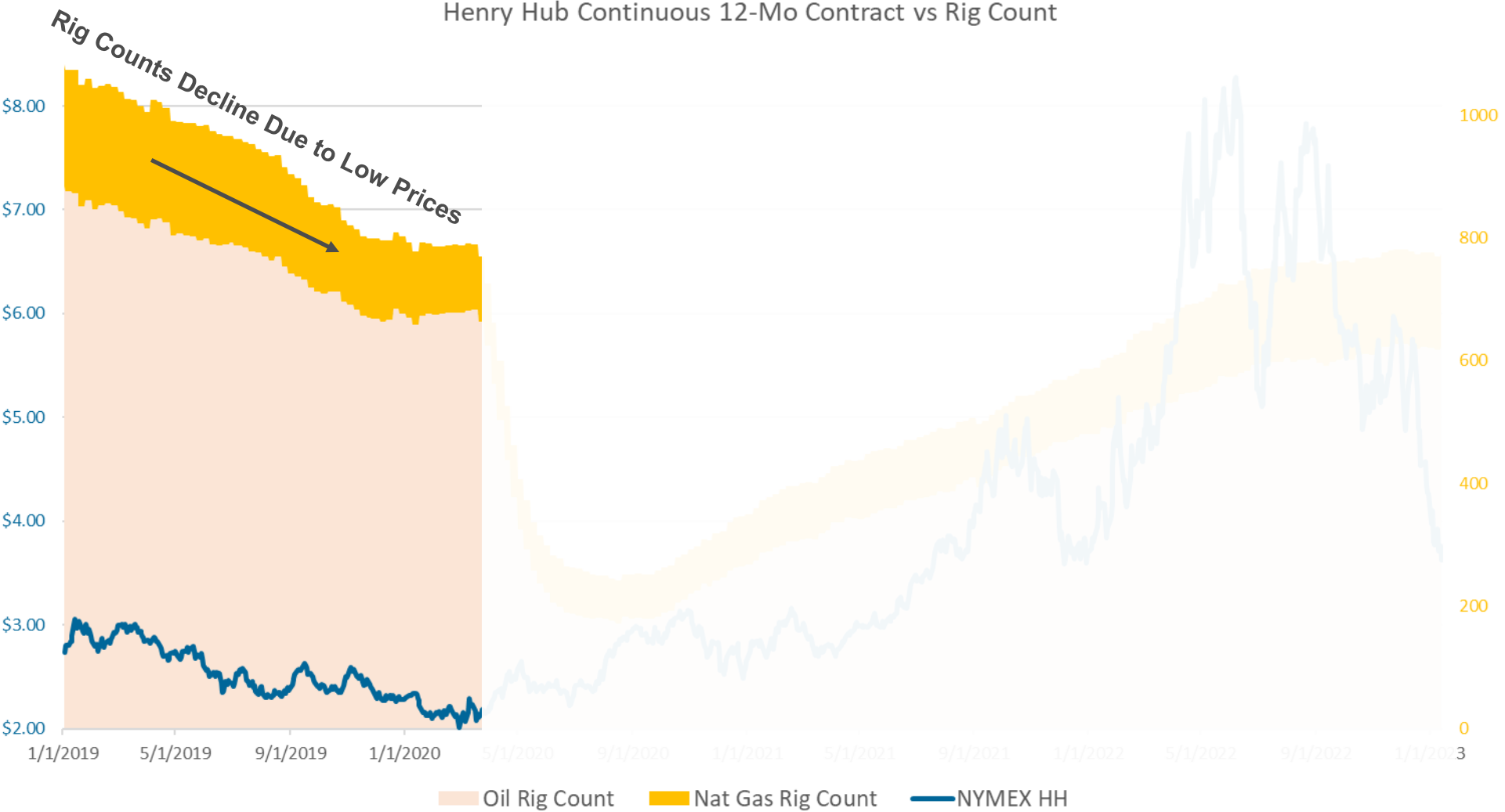
# ORIGINS OF ENERGY CRISIS

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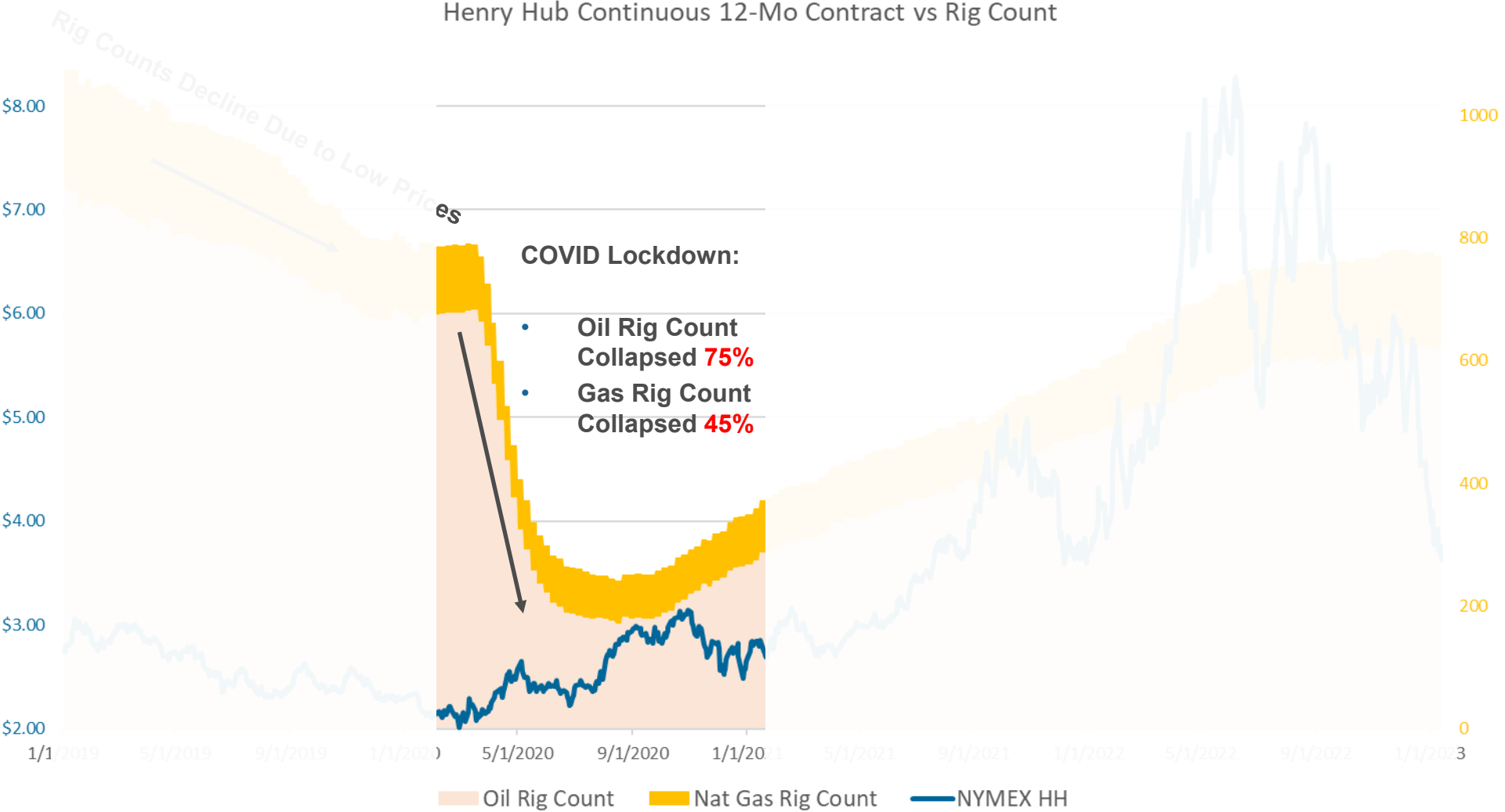
Supply-Driven



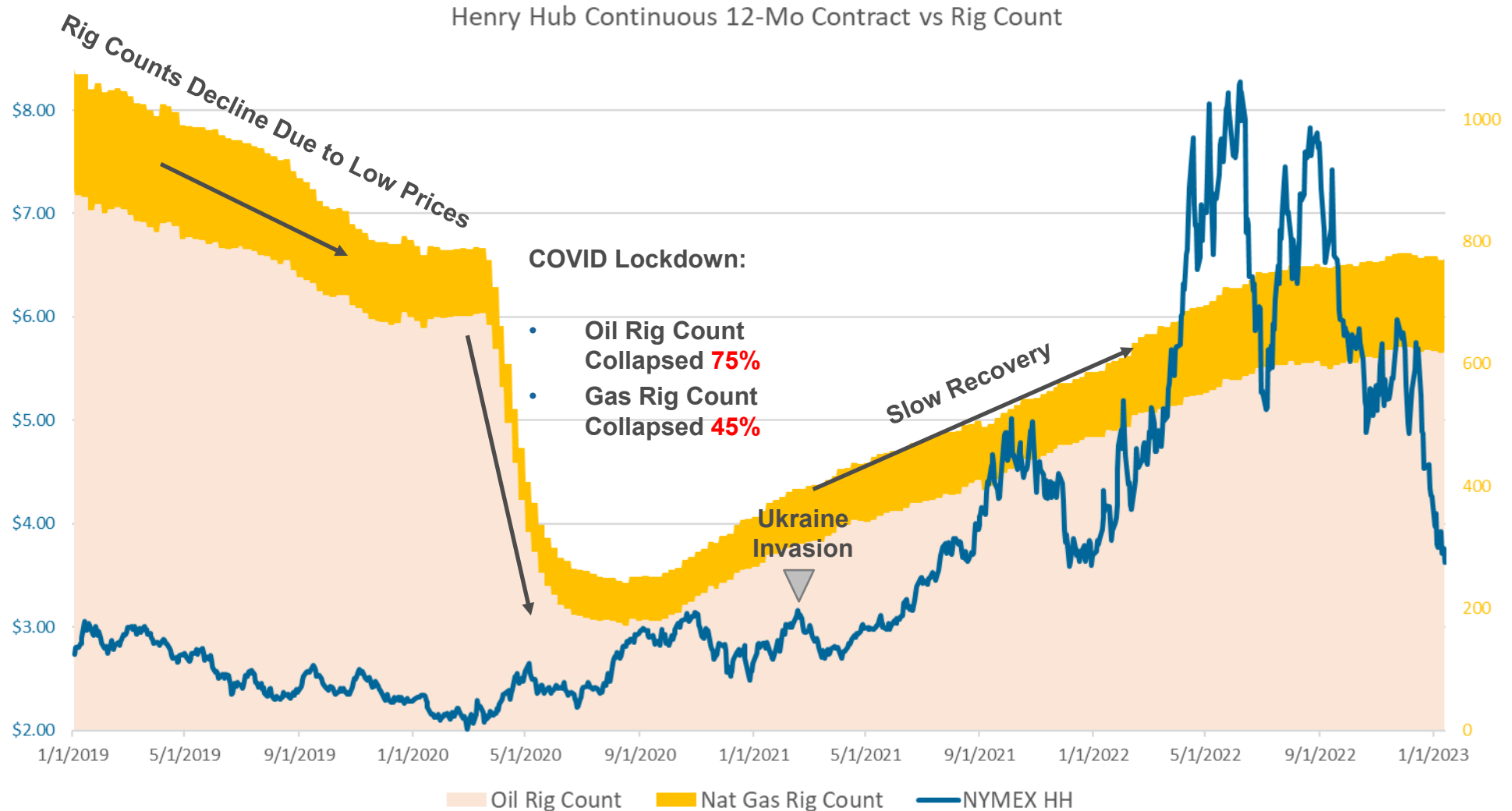
# 2019 Rig Counts



# 2020 Rig Counts



# Last 4 Years Rig Counts





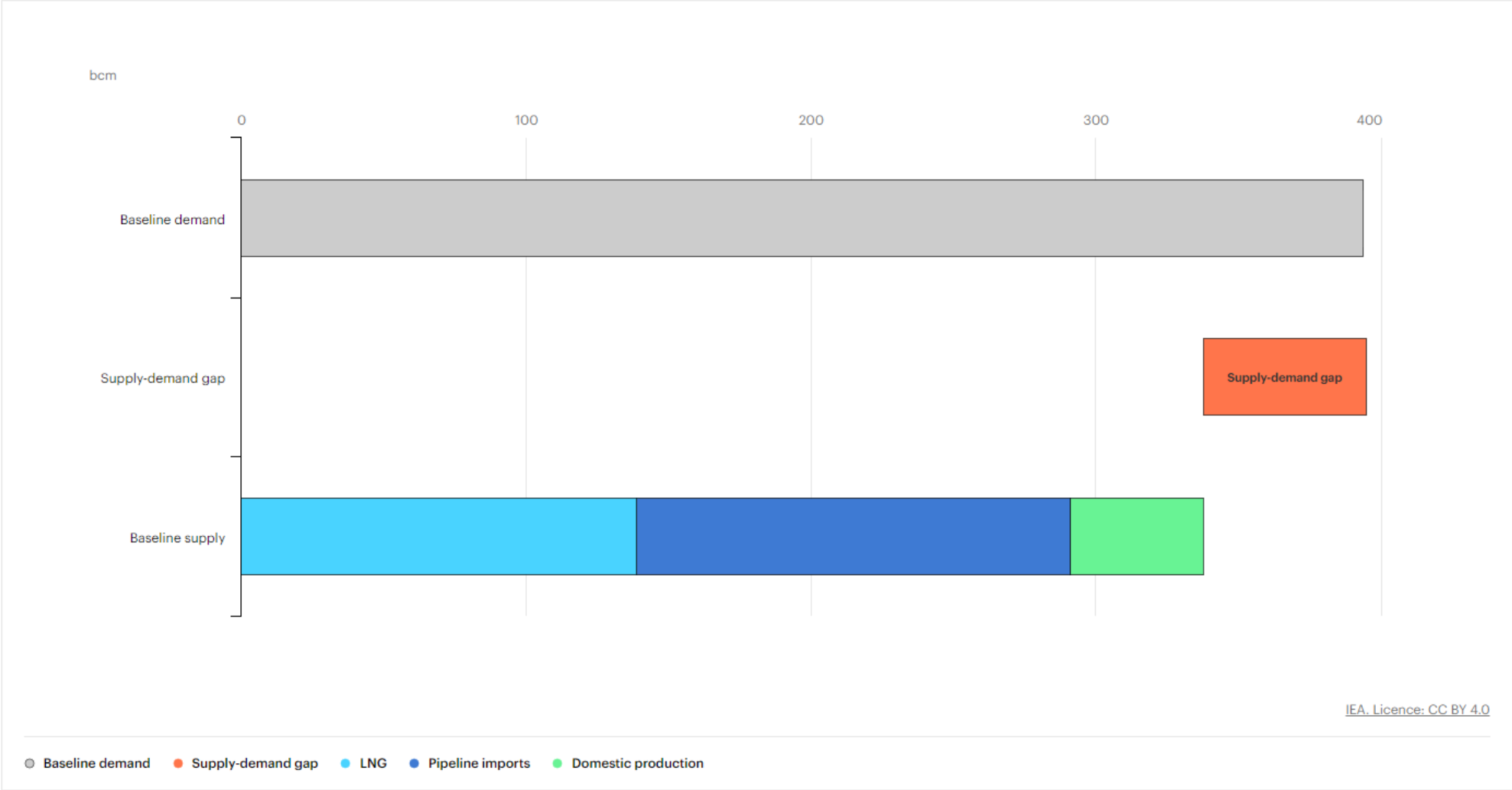
# EU's Supply Problem

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Europe's reliance on imported natural gas from Russia has again been thrown into sharp relief by Russia's invasion of Ukraine on 24 February. In 2021, the European Union imported an average of over 380 million cubic metres (mcm) per day of gas by pipeline from Russia, or around 140 billion cubic metres (bcm) for the year as a whole. As well as that, around 15 bcm was delivered in the form of liquefied natural gas (LNG). The total 155 bcm imported from Russia accounted for around 45% of the EU's gas imports in 2021 and almost 40% of its total gas consumption.

Progress towards net zero ambitions in Europe will bring down gas use and imports over time, but today's crisis raises specific questions about imports from Russia and what policy makers and consumers can do to lower them. This IEA analysis proposes a series of immediate actions that could be taken to reduce reliance on Russian gas, while enhancing the near-term resilience of the EU gas network and minimising the hardships for vulnerable consumers.

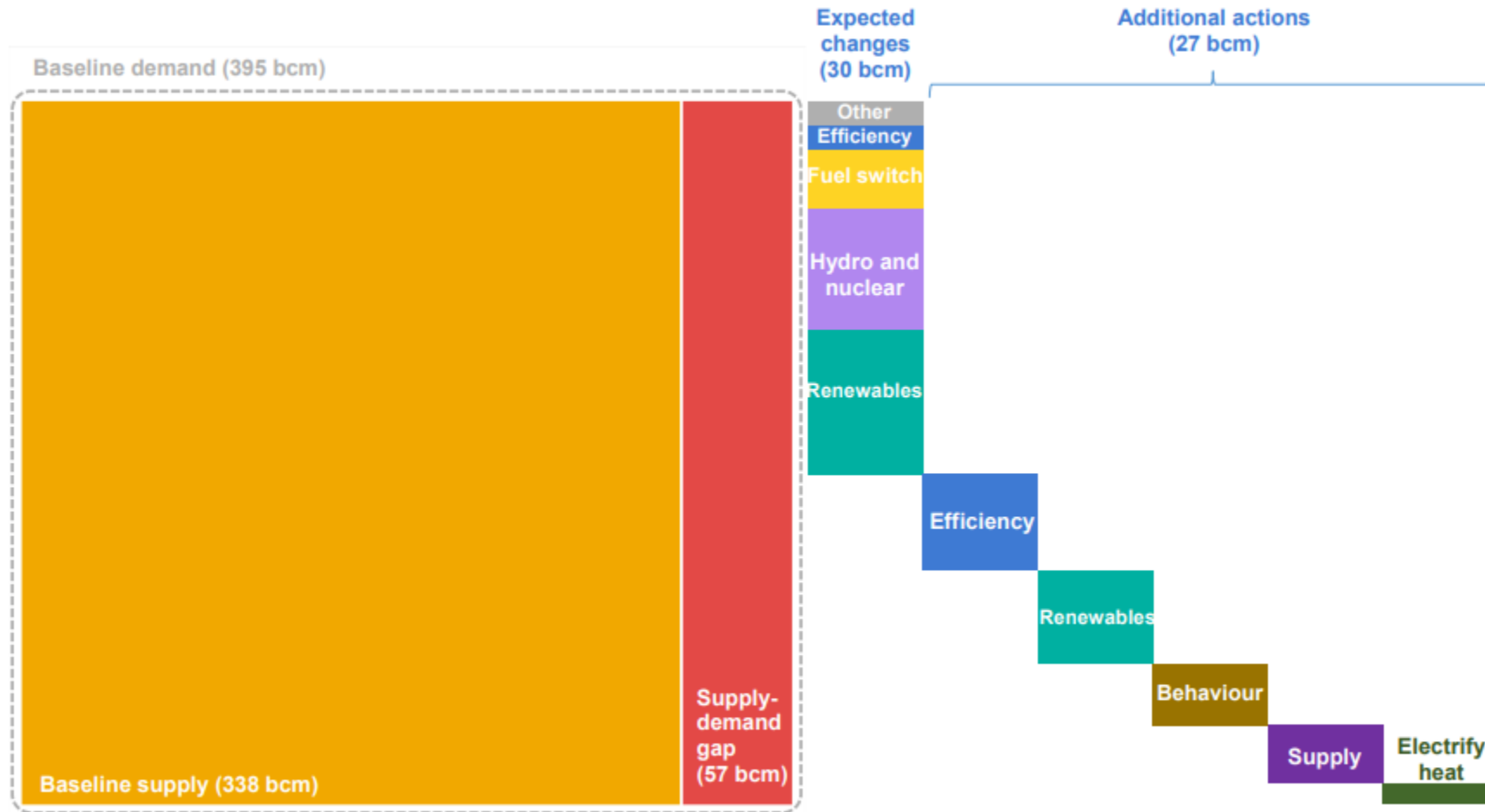
# EU's Supply-Demand Gap



Source: IEA

# EU's Supply-Demand Gap

Expected changes and additional actions to close the supply-demand gap in the European Union in 2023

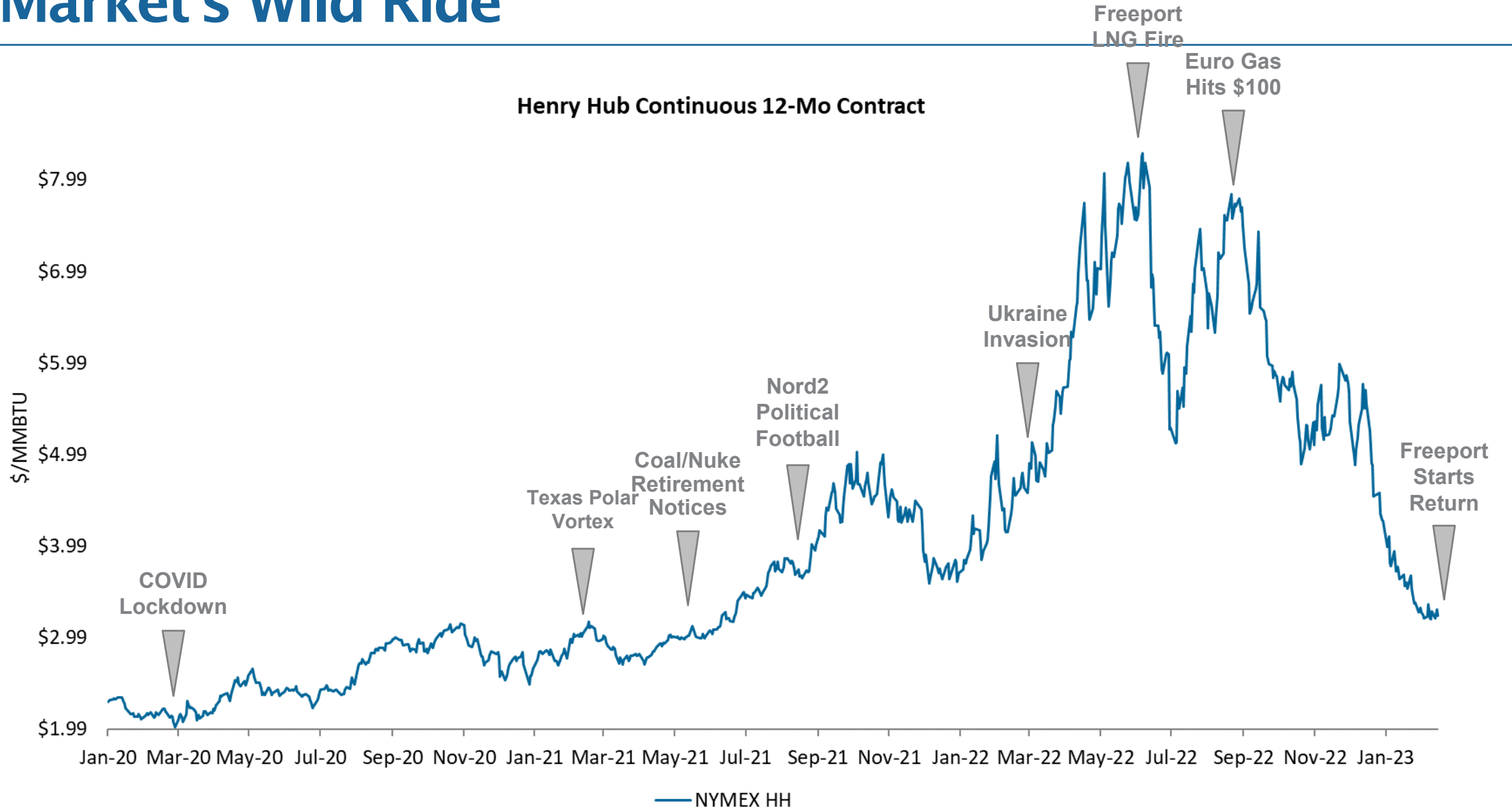


IEA. CC BY 4.0.

Note: Other = heat pumps and biomethane.

Source: IEA

# Mr. Market's Wild Ride



# INCREASING VOLATILITY

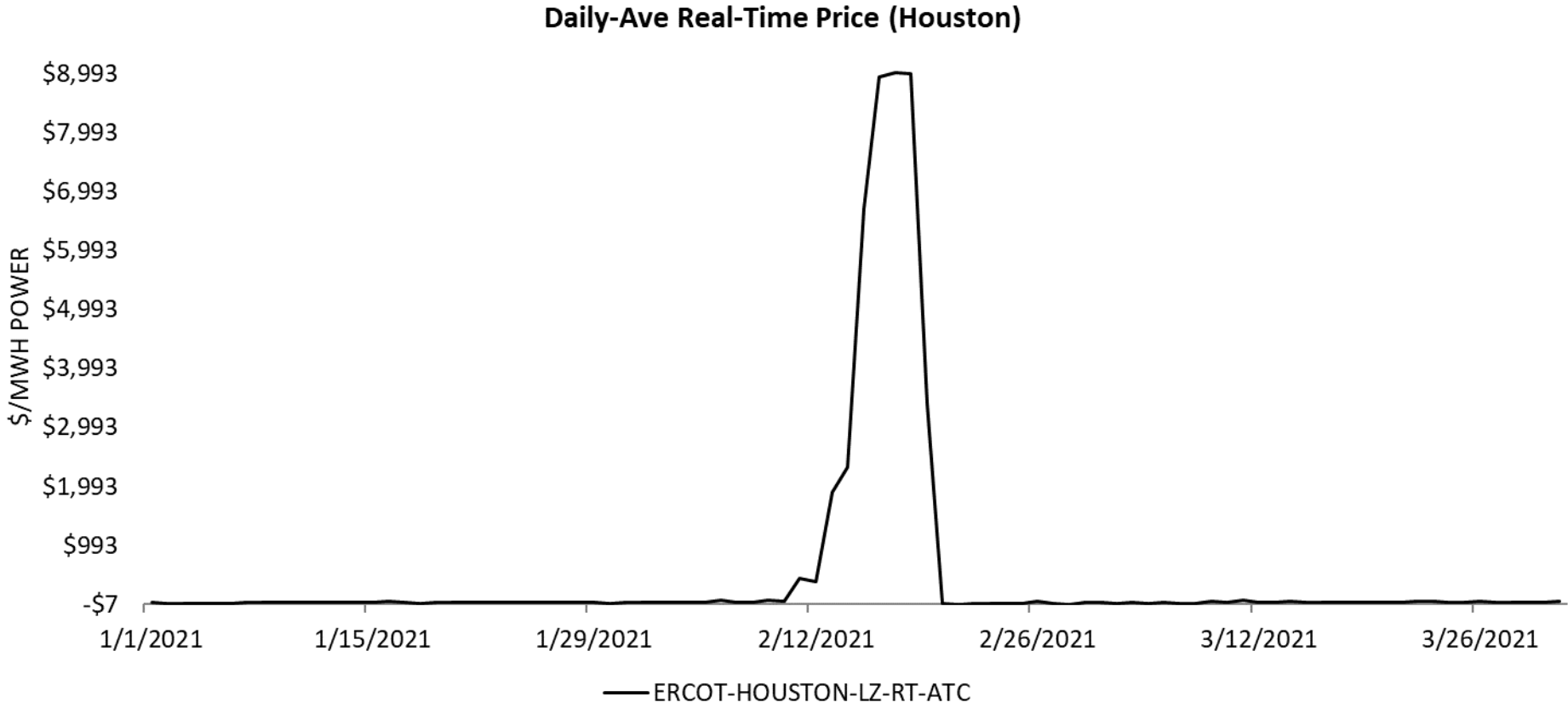
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6-Sigma Event Every Year?

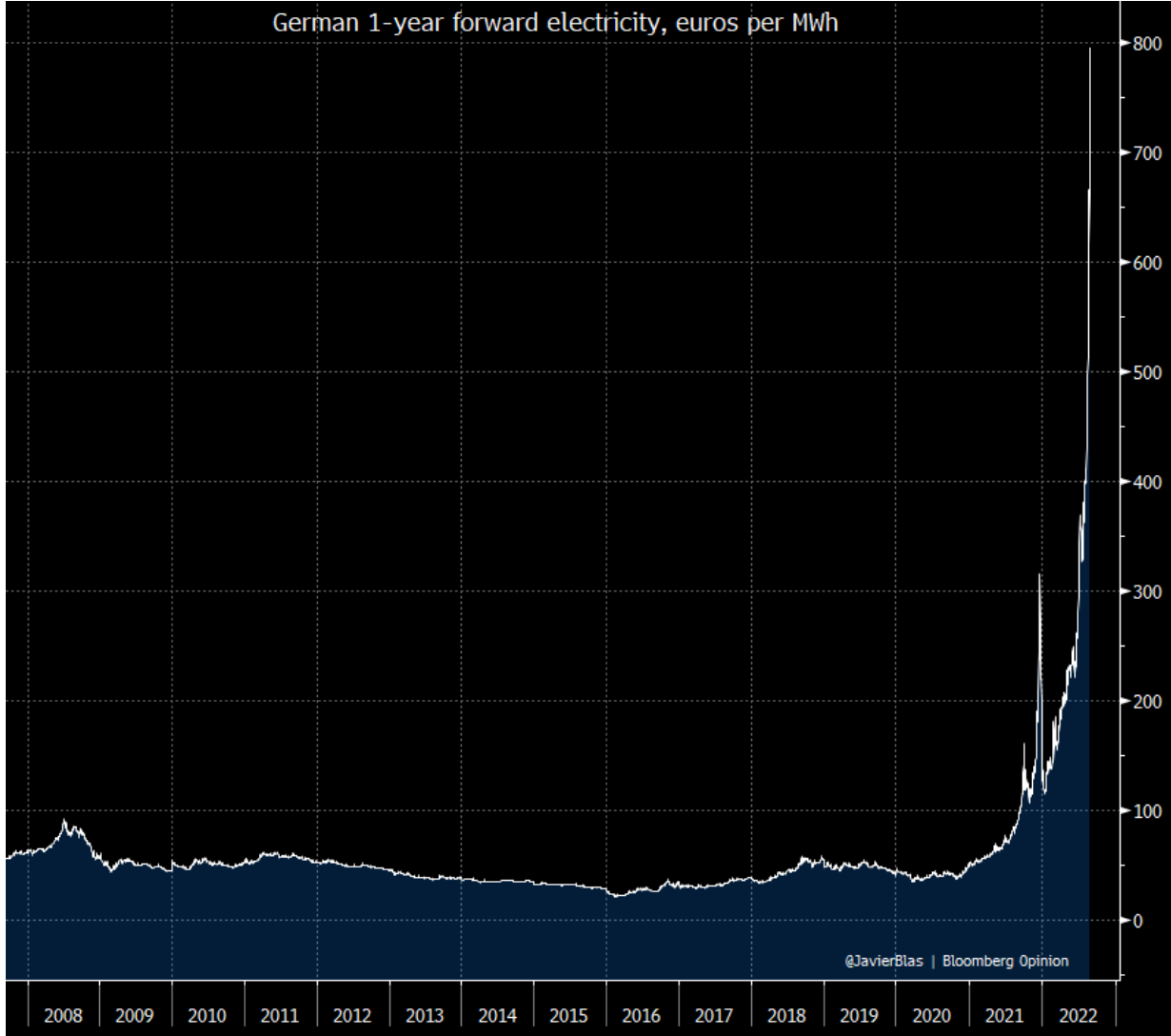
Take me somewhere  
expensive



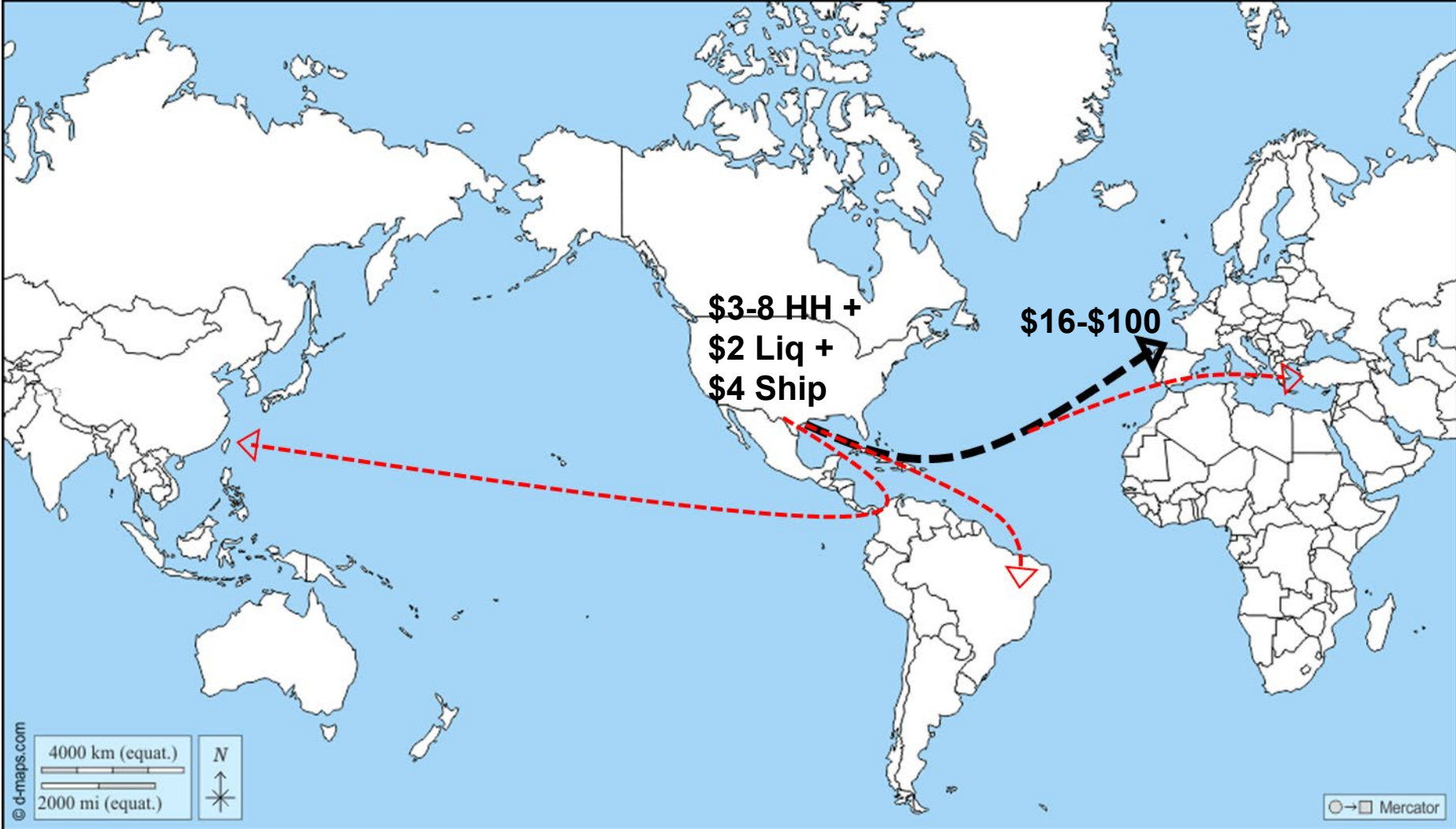
# 2021: Uri



# 2022: Euro Crisis

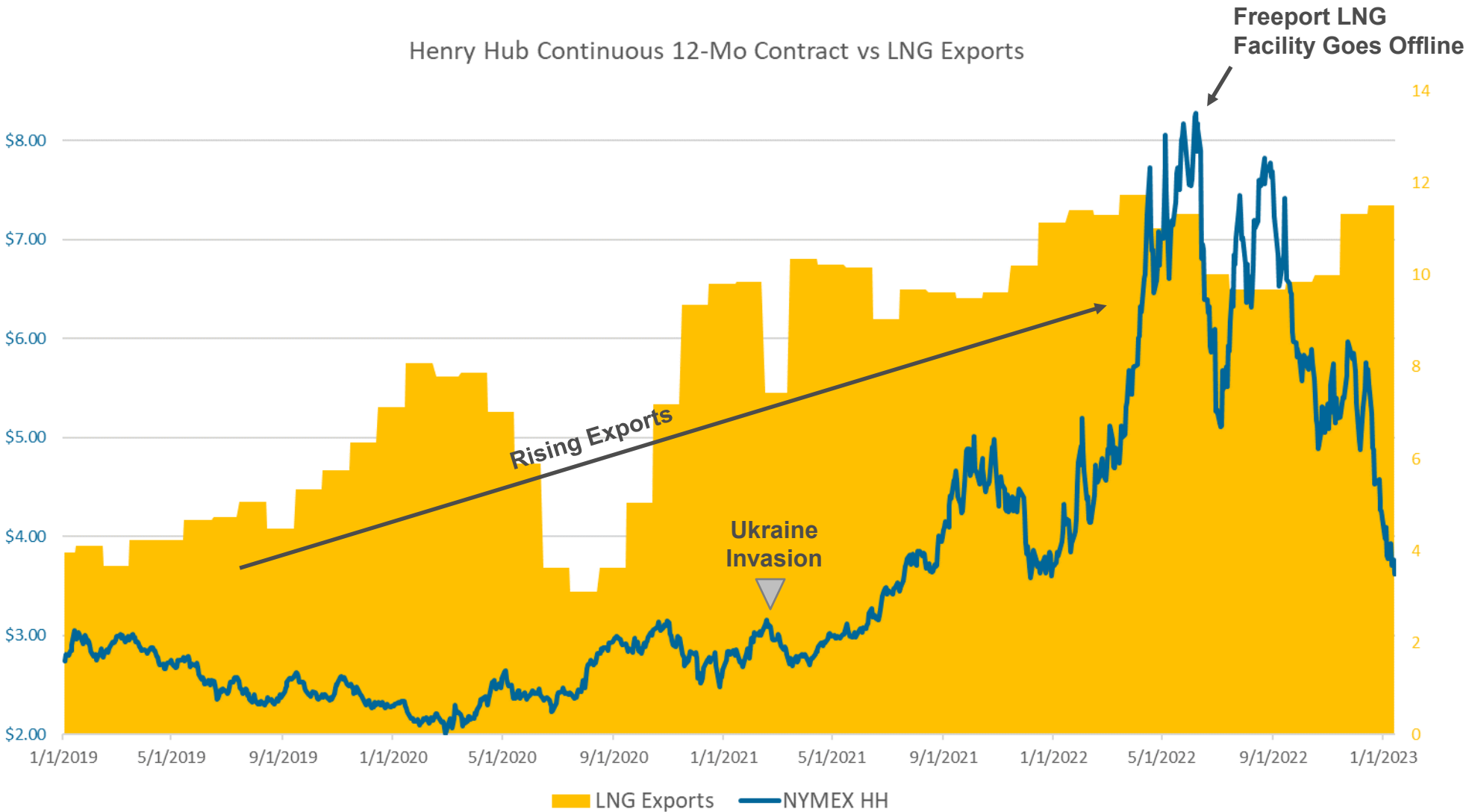


# TTF-HH Arb



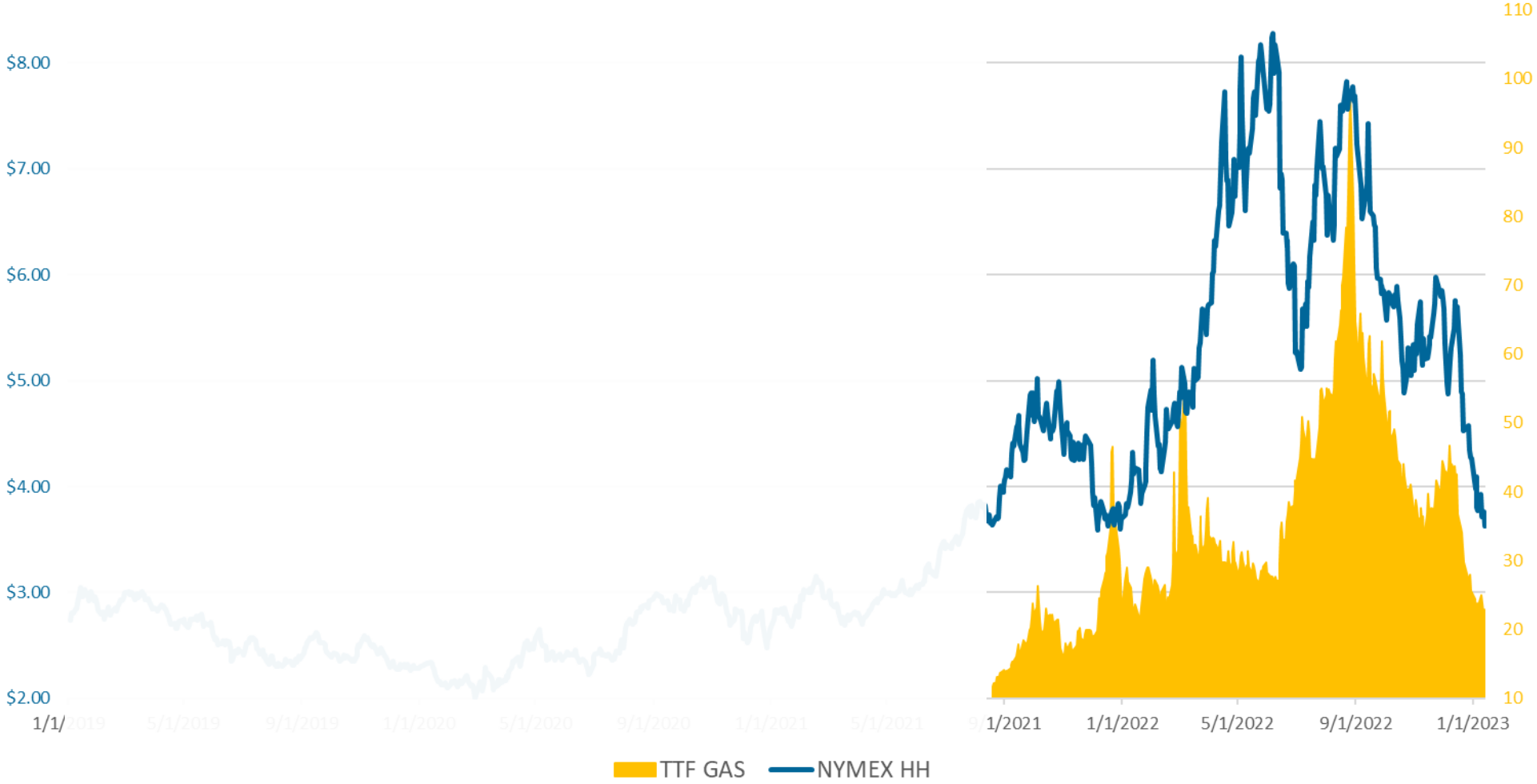


# U.S. LNG Exports

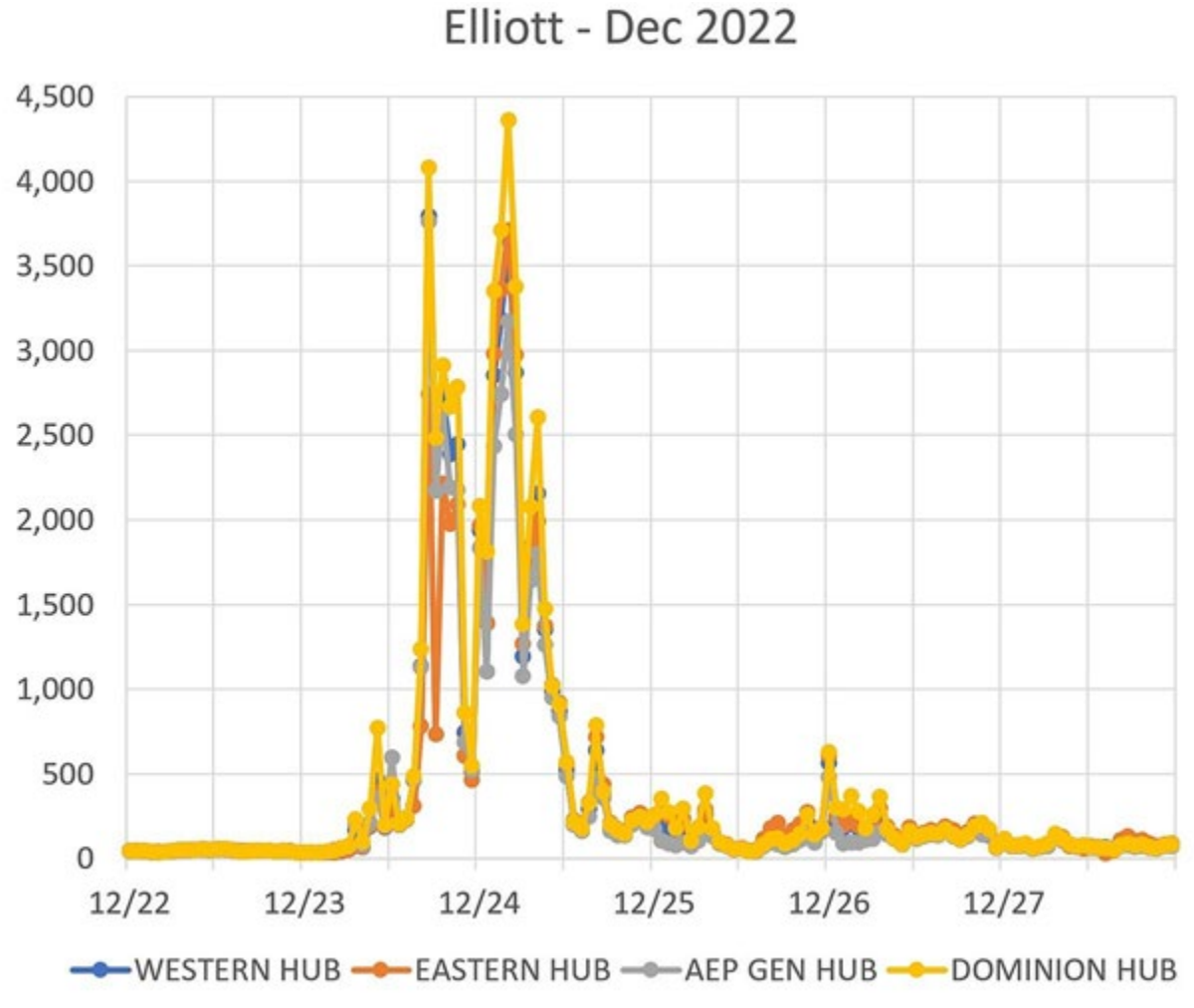


# TTF vs HH

Henry Hub Continuous 12-Mo Contract vs TTF Continuous 12-Mo



# 2022: Elliott



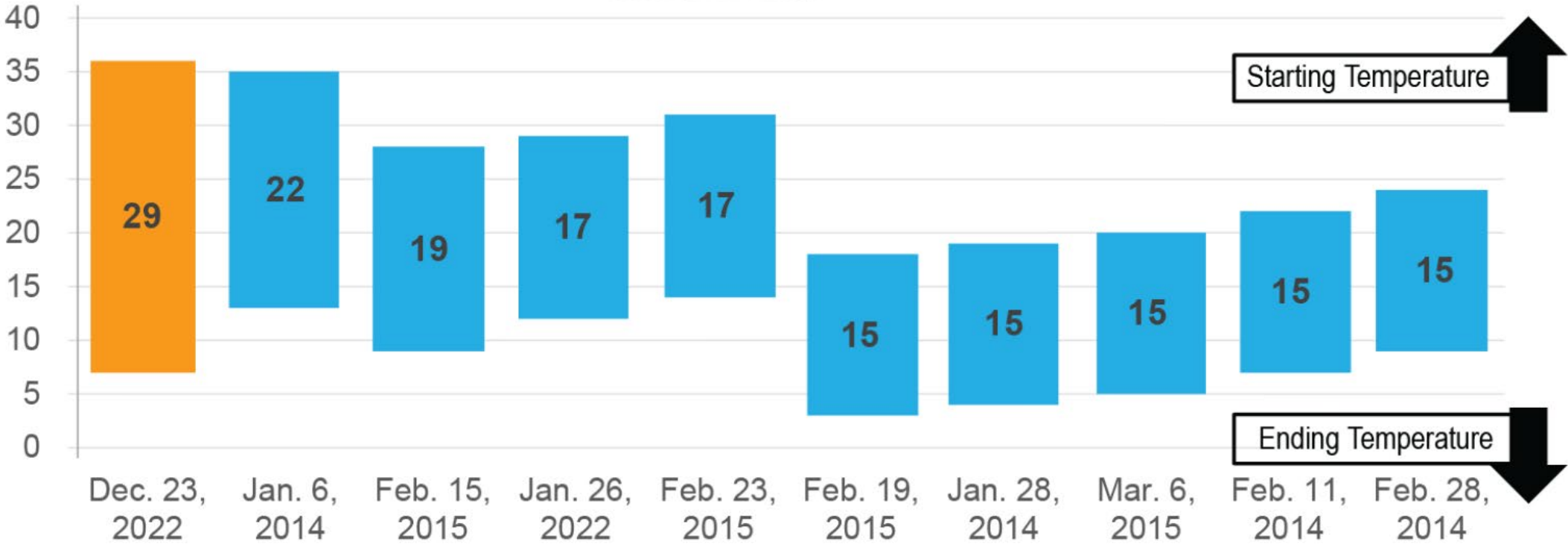
Source: YesEnergy

# Winter Storm Elliott – Temp Drop



Most Drastic Temperature Drop in a Decade

Top Ten 12-Hour Temperature Drops Ending Under 15°

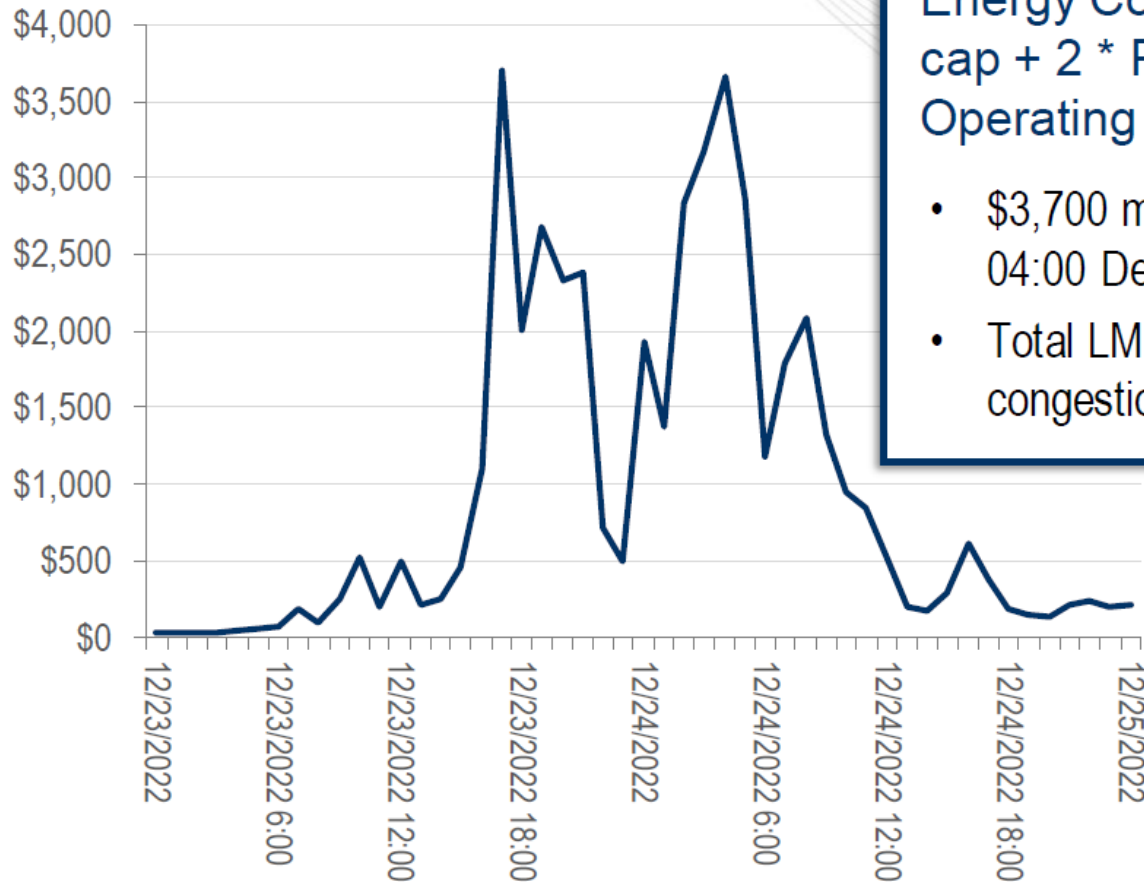


# Winter Storm Elliott – Bullish LMP Volatility



## System Energy Price Overview

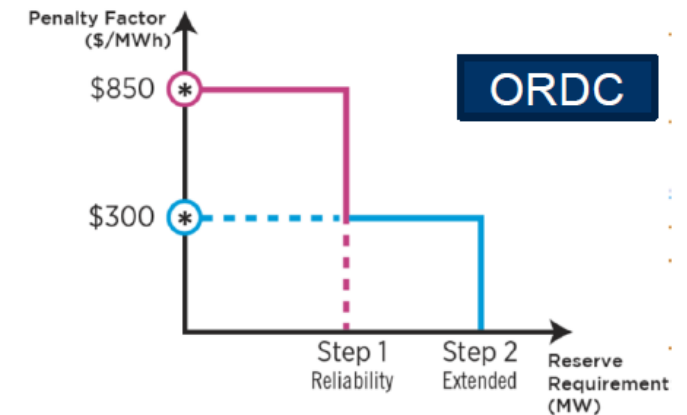
System Energy Price



Energy Component of LMP is capped at the energy offer cap + 2 \* Penalty Factor from first step of reserve Operating Reserve Demand Curve (ORDC).

- \$3,700 multiple intervals, including all of 17:00 Dec. 23 and most of 04:00 Dec. 24
- Total LMPs were above this level when factoring in locational congestion and loss prices for multiple intervals.

**Penalty Factor** sets a price for being unable to meet the reserve requirement.



# Winter Storm Elliott – Bullish Capacity



## Estimated Non-Performance Charges

PJM's *rough estimate* of non-performance charges for Dec. 23 and Dec. 24 is in the \$1 billion to \$2 billion range.

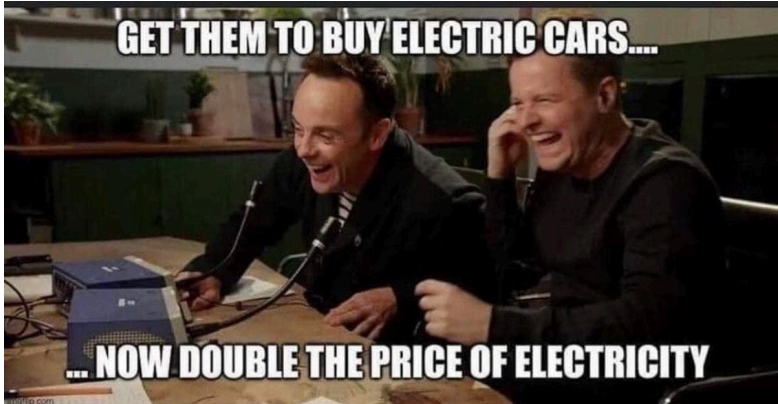
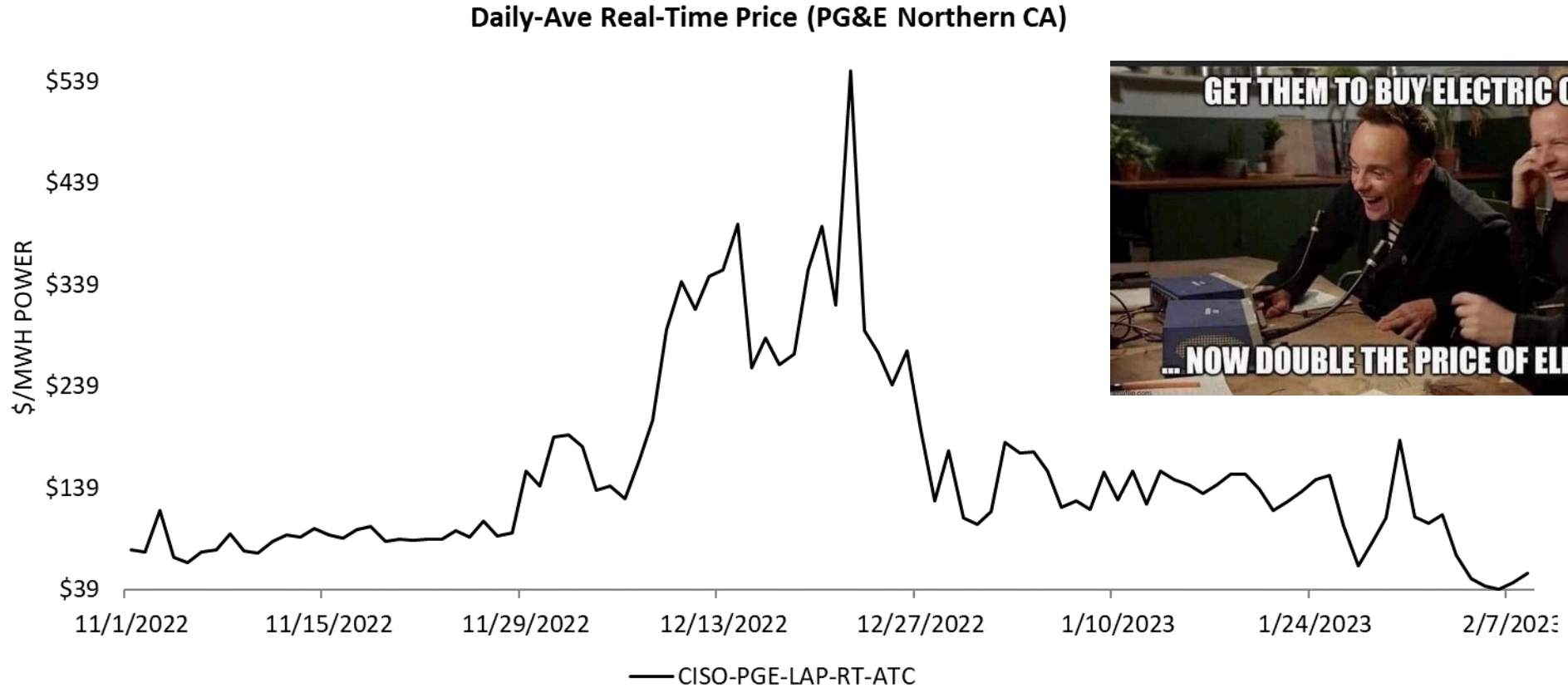
*This estimate is provided as an initial reference point only and can change materially.*

It includes preliminary excusals for MW scheduled down due to economic dispatch. It is subject to further change (*increase or decrease*) based on:

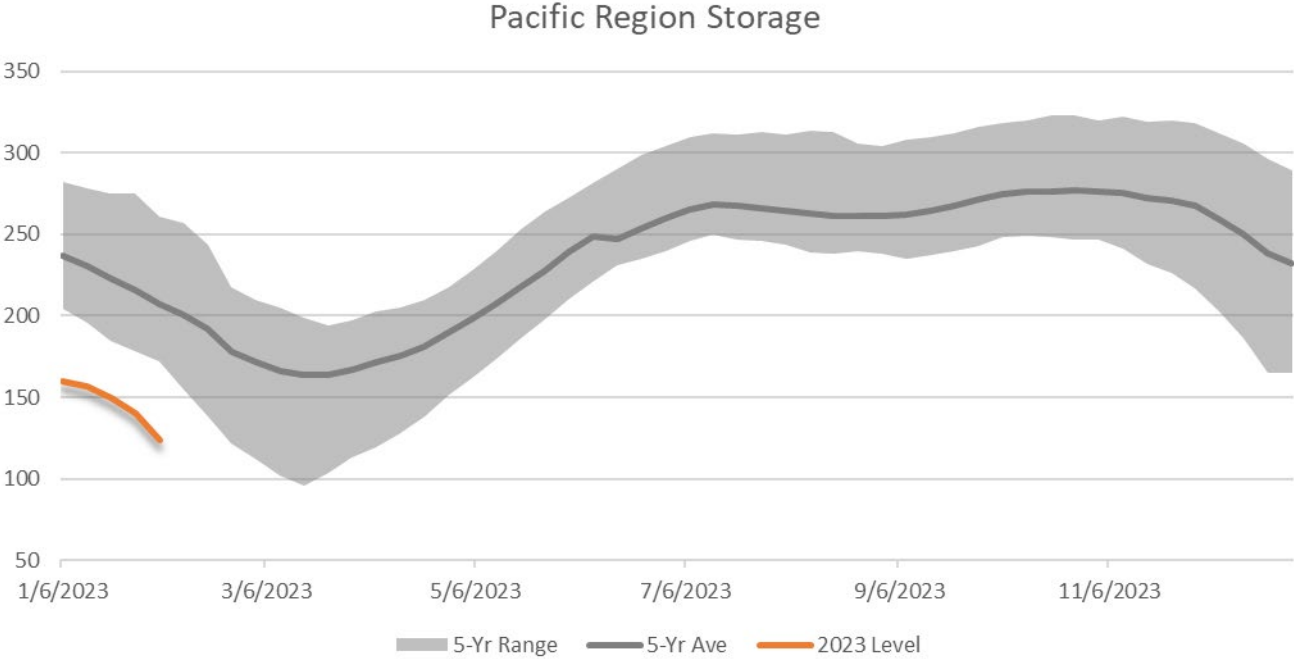
- Changes to the final balancing ratio
- Approval of retroactive replacement transactions
- Further review of actual resource performance data
- Further review of excusals due to economic dispatch
- Inclusion of excusals for:
  - Approved planned or maintenance outages
  - MW scheduled down due to manual dispatch

**Note:** FRR entities could have elected physical penalty in lieu of financial prior to DY.

# 2022-3: CA Nat Gas Blowout



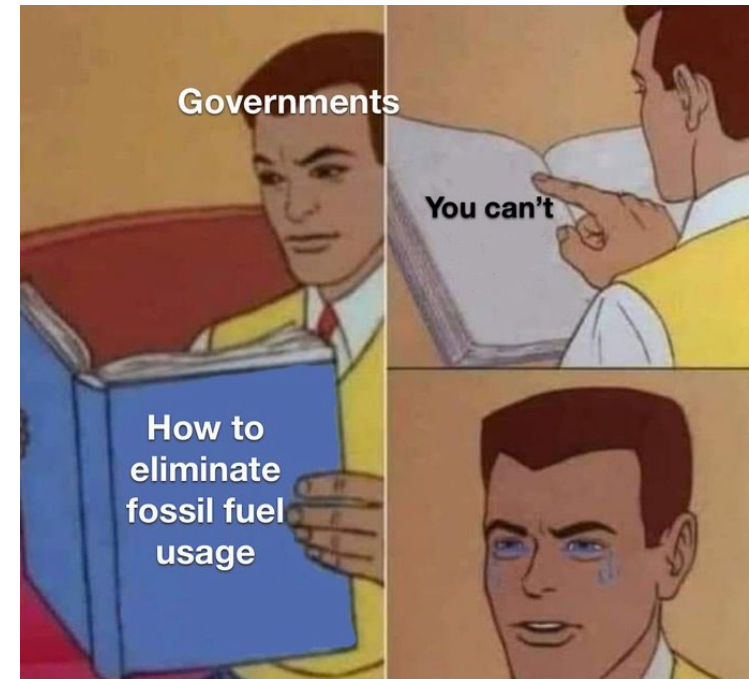
# Pacific Nat Gas Storage Balance





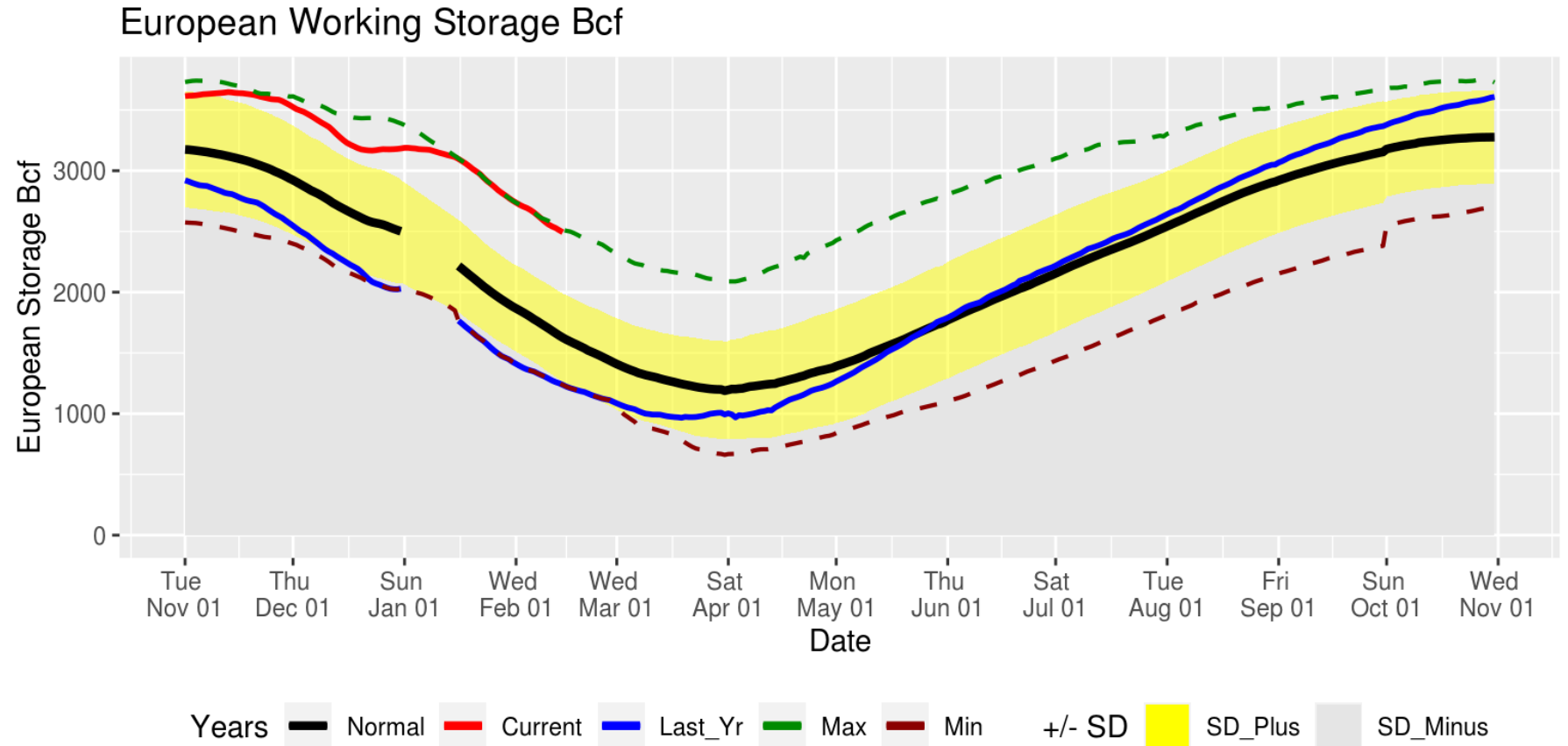
# ROLE OF LUCK

Apparently Hope IS a Strategy

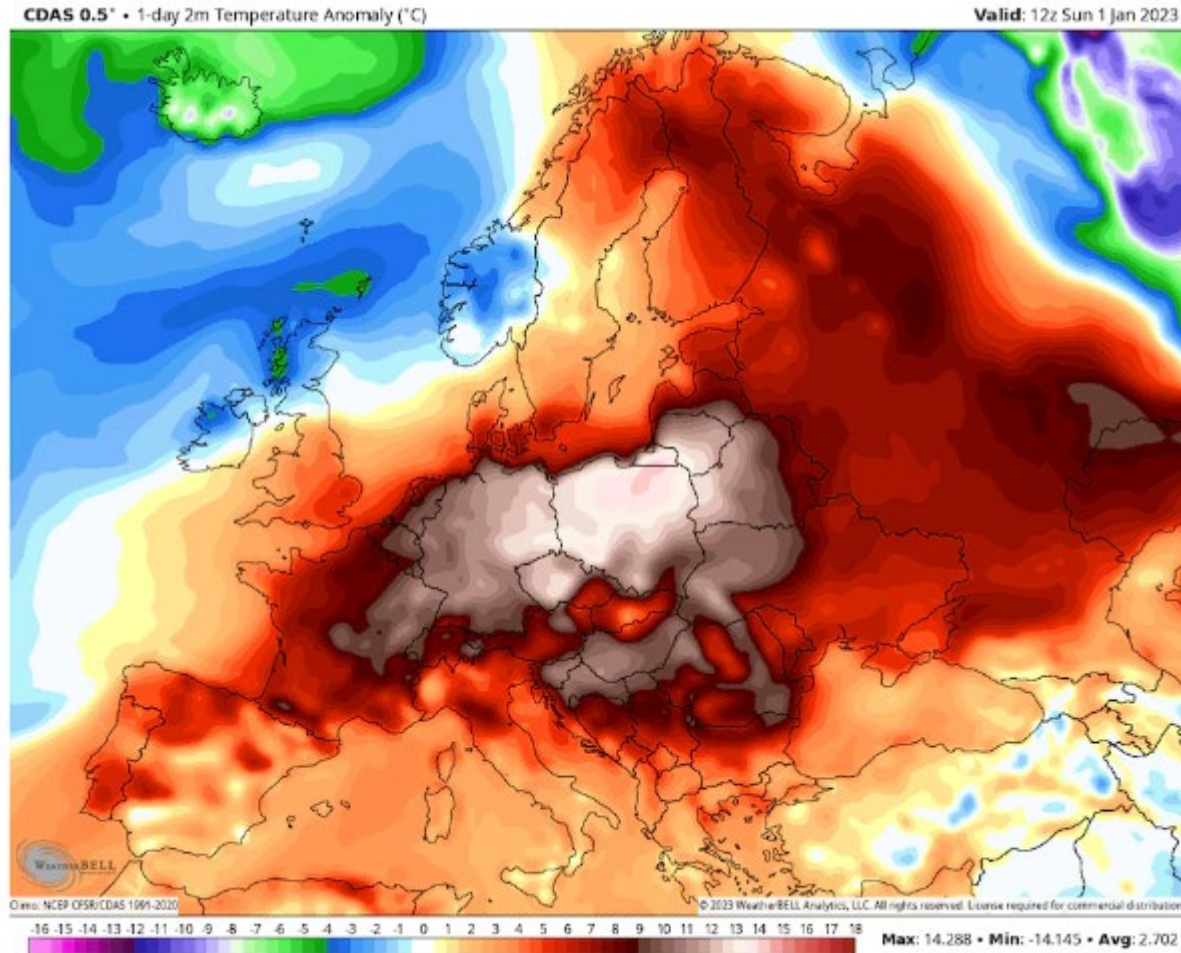


# Euro Storage Rebuild

2022 Storage build was possible, in large part, because China was locked down for and not competing for as many LNG cargoes



# Euro Mild Winter

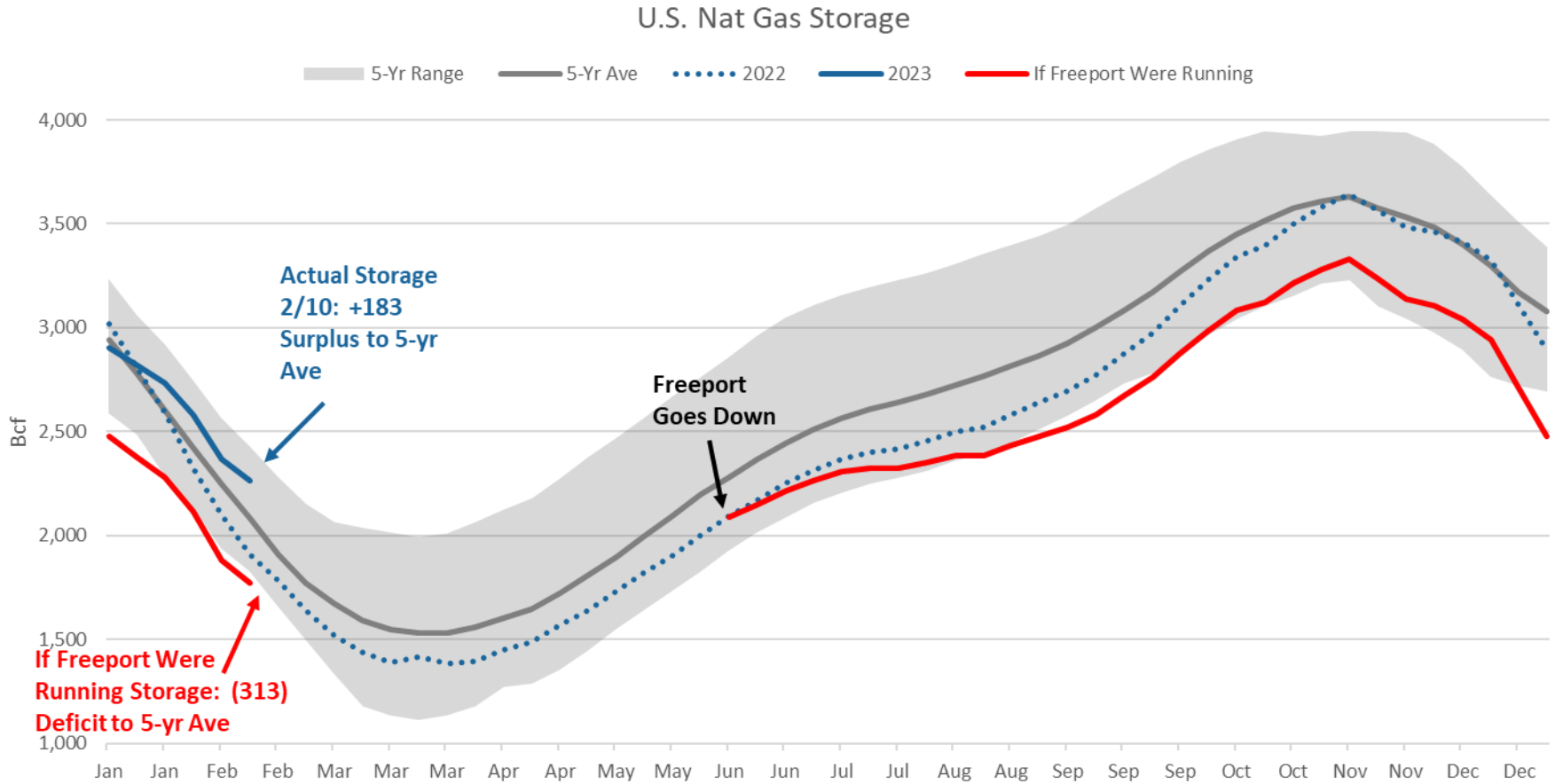


Here are some of the most impressive records that were set in Europe on New Year's Day:

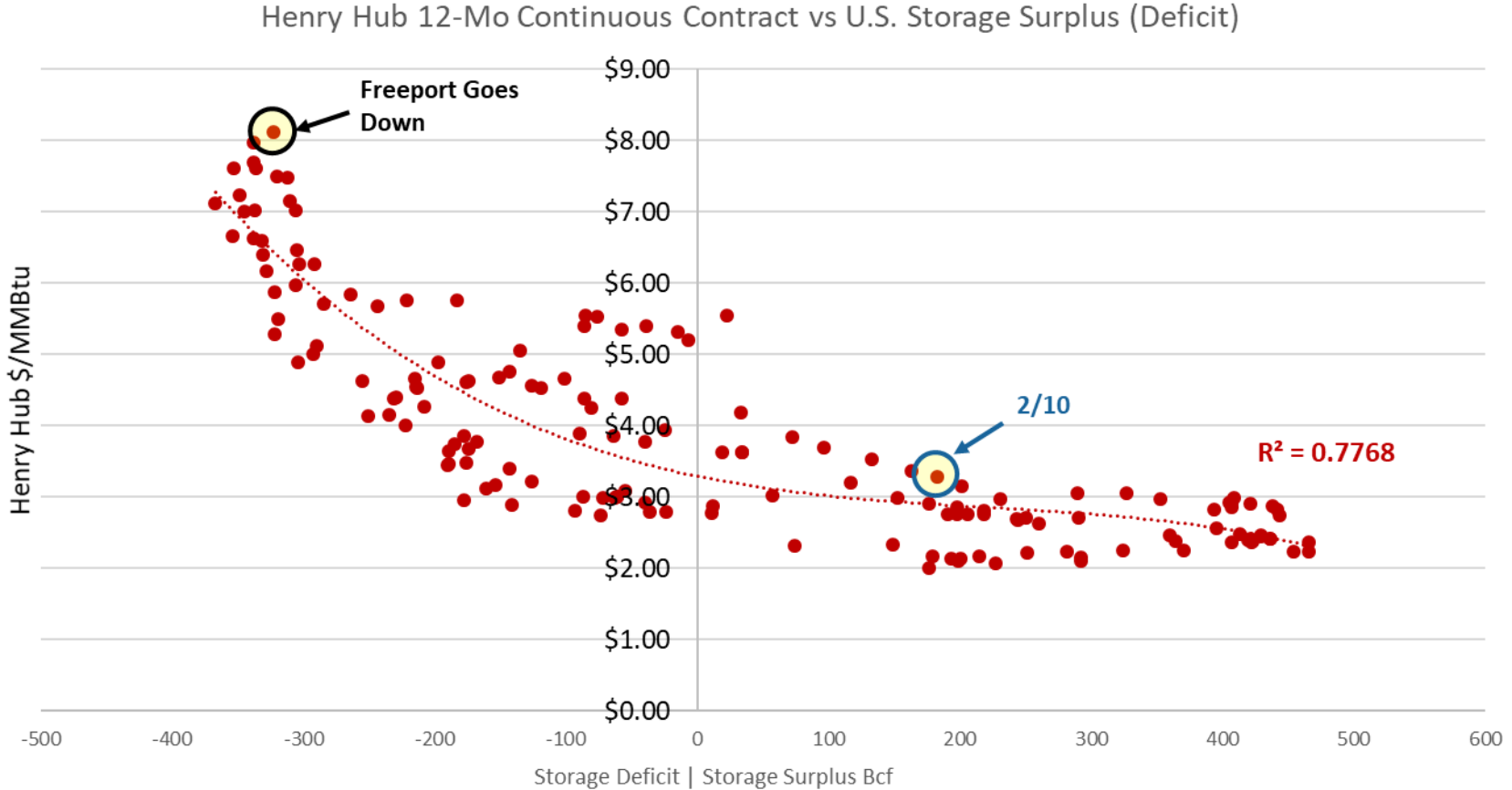
- In Poland, it was so warm that the January national high-temperature record was broken before sunrise. The town of [Glucholazy](#) was 65.7 degrees at 4 a.m., which is warmer than its average low temperature in midsummer. Temperatures rose further as the day progressed.
- Bilbao, Spain, reached 77.2 degrees (25.1 Celsius), its [hottest January day](#).
- Trois-ville, France, reached 76.8 degrees (24.9 Celsius), a [record for the month](#). It was among more than 100 records set across the country Sunday, including 75.2 degrees (24.0 Celsius) in Dax, and 65.5 degrees (18.6 Celsius) at stations with data dating to the 1800s in Besançon and Châteauroux.
- Ohlsbach, Germany, reached 66.9 degrees (19.4 Celsius) for a monthly record and the [highest temperature of the day in Germany](#). Other locations, including Berlin at 60.8 degrees (16 Celsius), also set [January records](#). Berlin was among the places that set [records both New Year's Eve and New Year's Day](#).
- Warsaw's high of 66.2 degrees (19 Celsius) demolished the [its previous January record](#) by 9.2 degrees (5.1 Celsius).

Source: WaPo

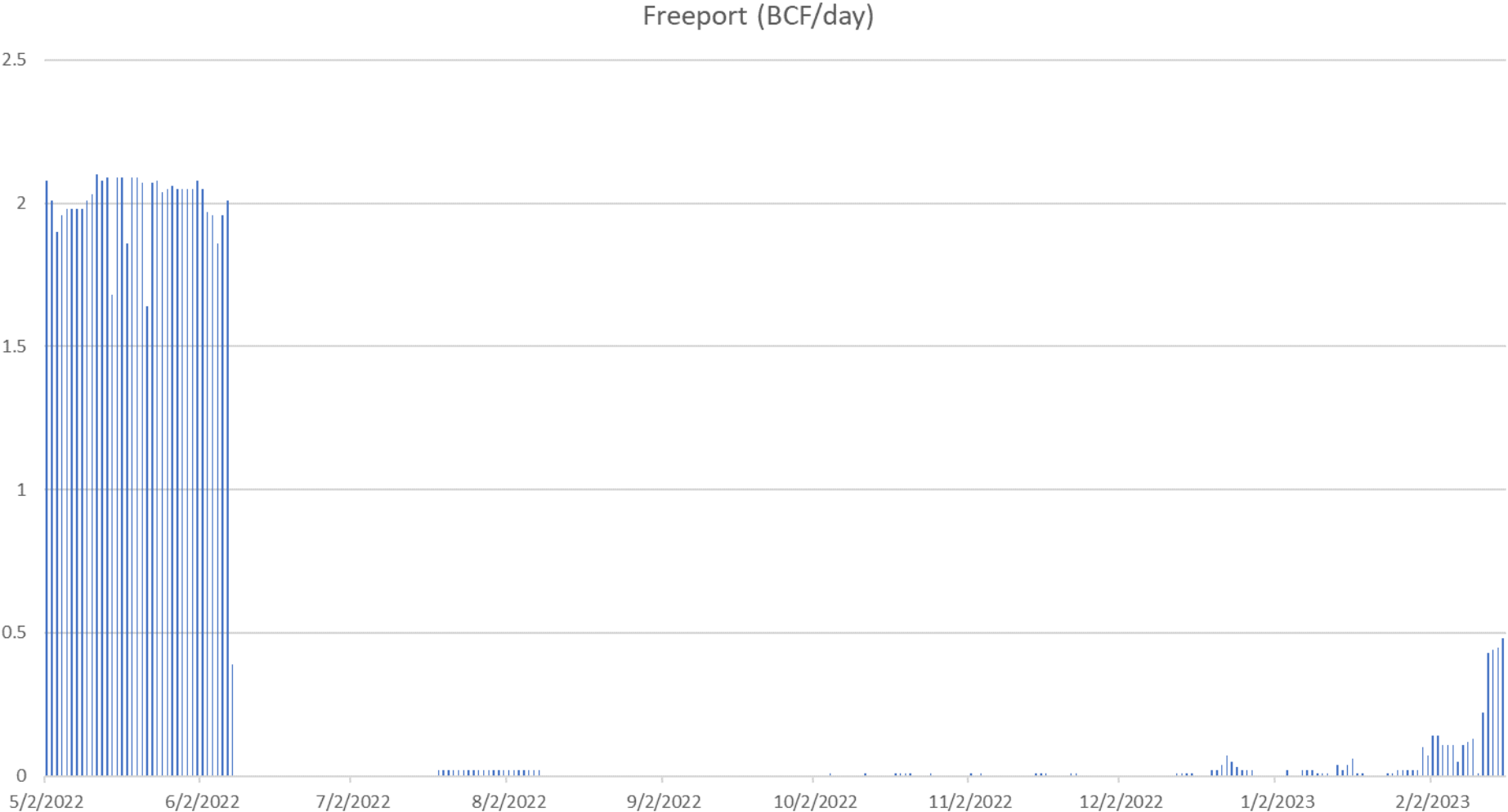
# U.S. Storage Saved by Freeport



# U.S. Prices Saved by Freeport



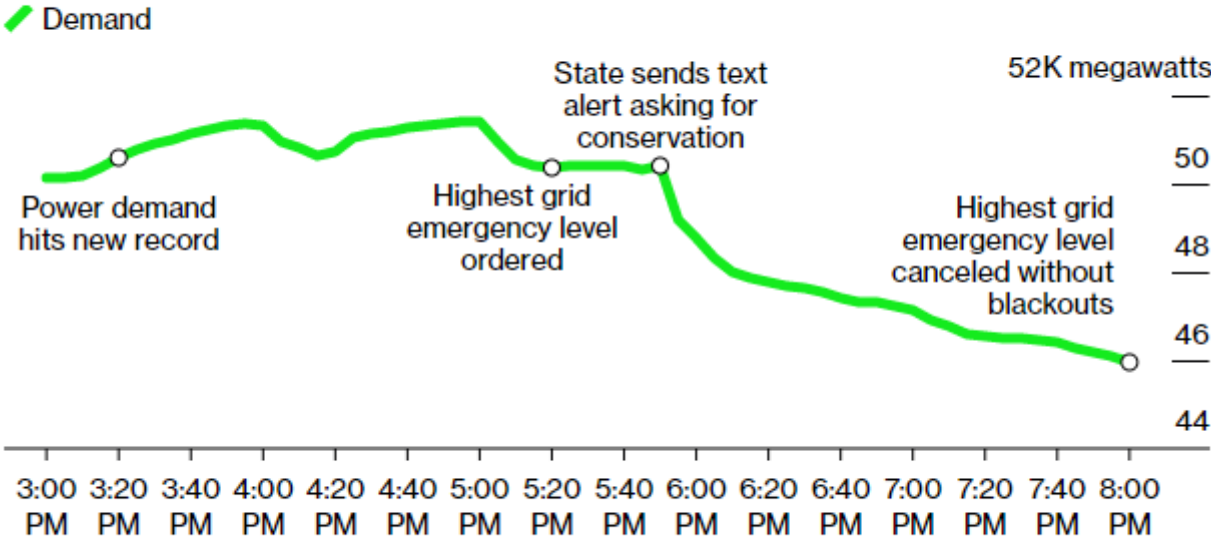
# Return of Freeport



# CA Saved by Voluntary Curtailment (Sep-2022)

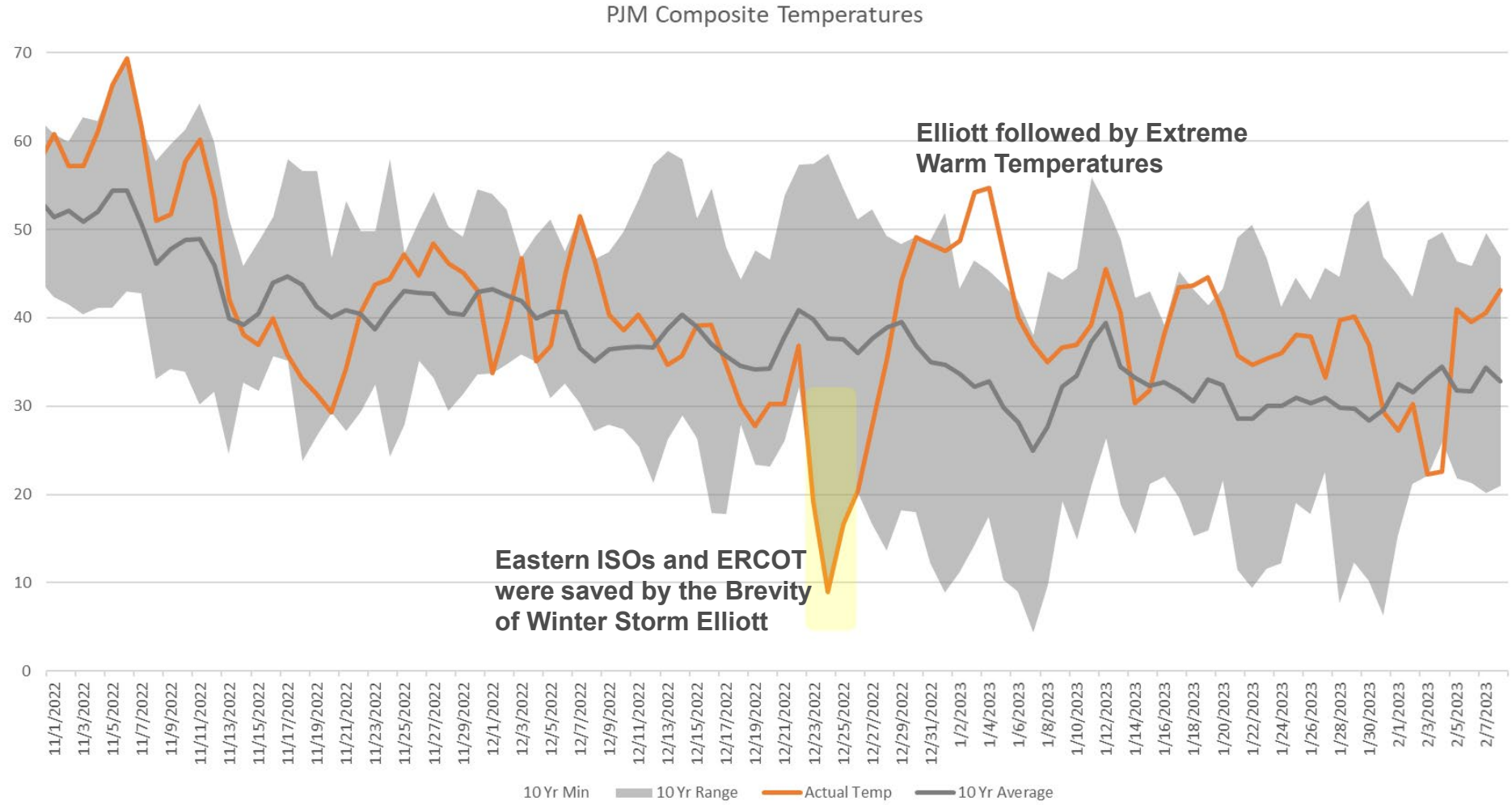
## How California Averted Power Blackouts

Power use plunged after people received a text alert to conserve



Source: California Independent System Operator

# Elliott Impact Mitigated by Brevity



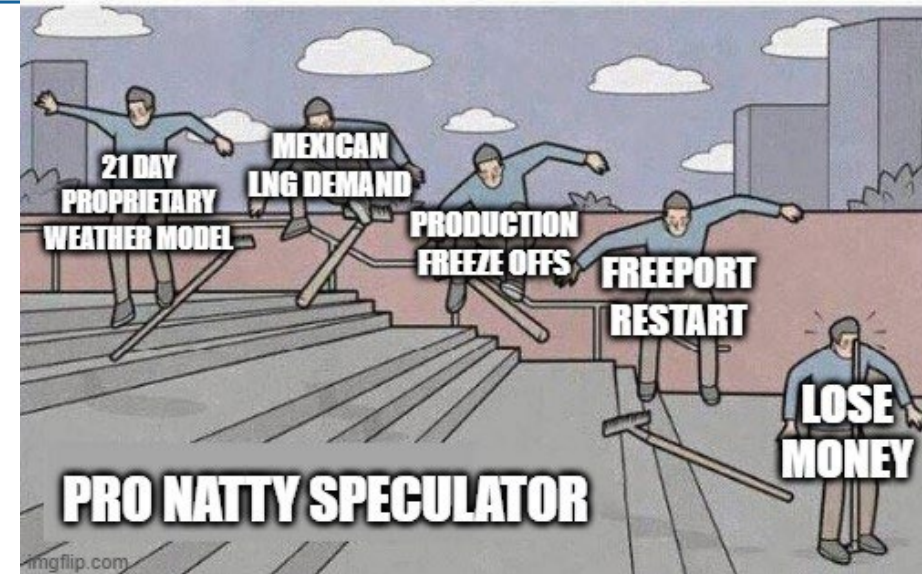


# NAT GAS FUNDAMENTALS

From Bullish to Bearish, But it's Regional



**AMATEUR NATTY SPECULATOR**



**PRO NATTY SPECULATOR**

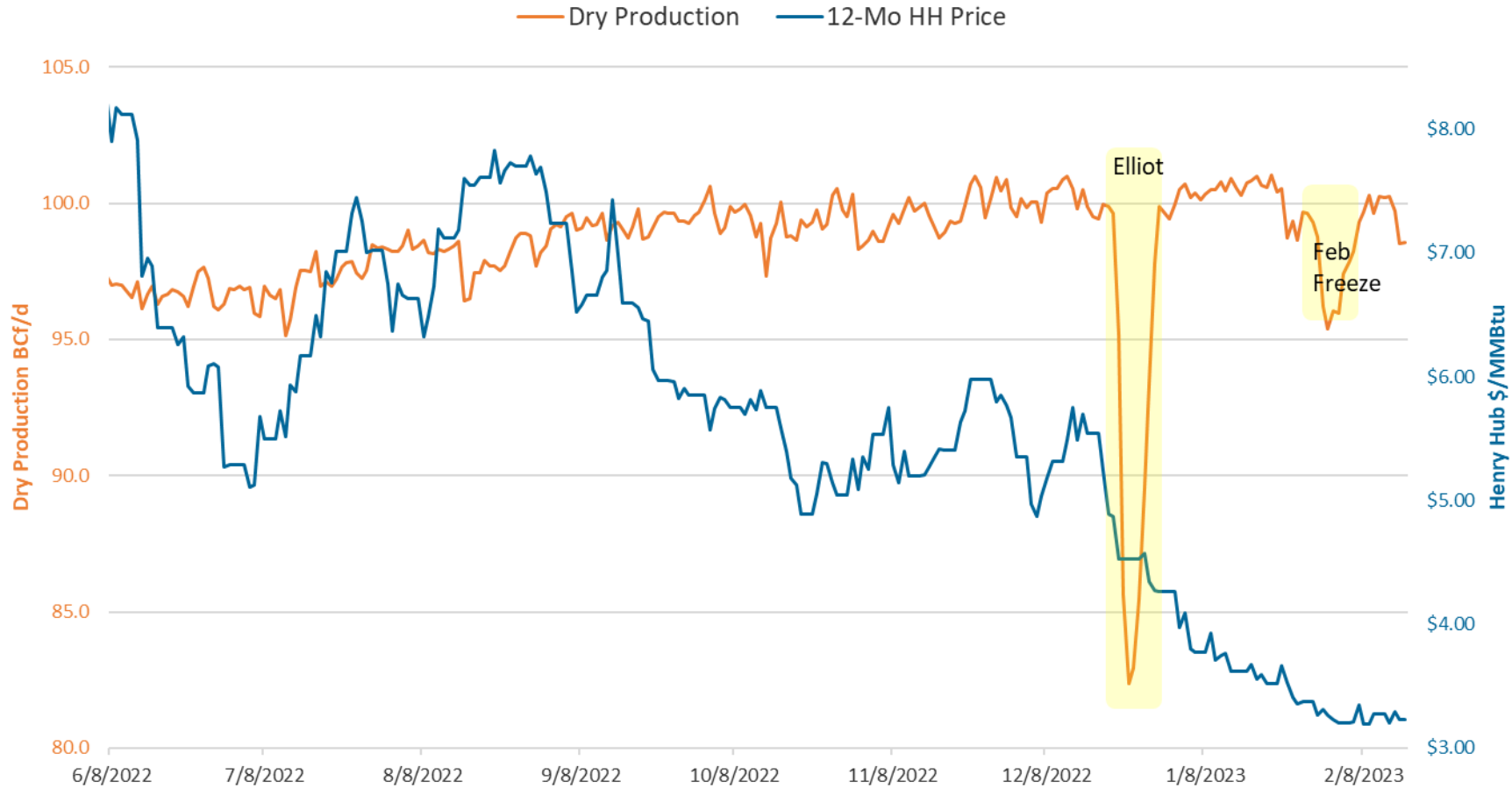
# Why Do Power People Care about Nat Gas?

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Forward Power Hub	Correl Coeff to HH Gas
ERCOT Houston	0.97
PJM West Hub	0.97
MISO Indy Hub	0.97
NEP Mass Hub	0.94
NY ZoneG	0.97
CA NP15	0.76

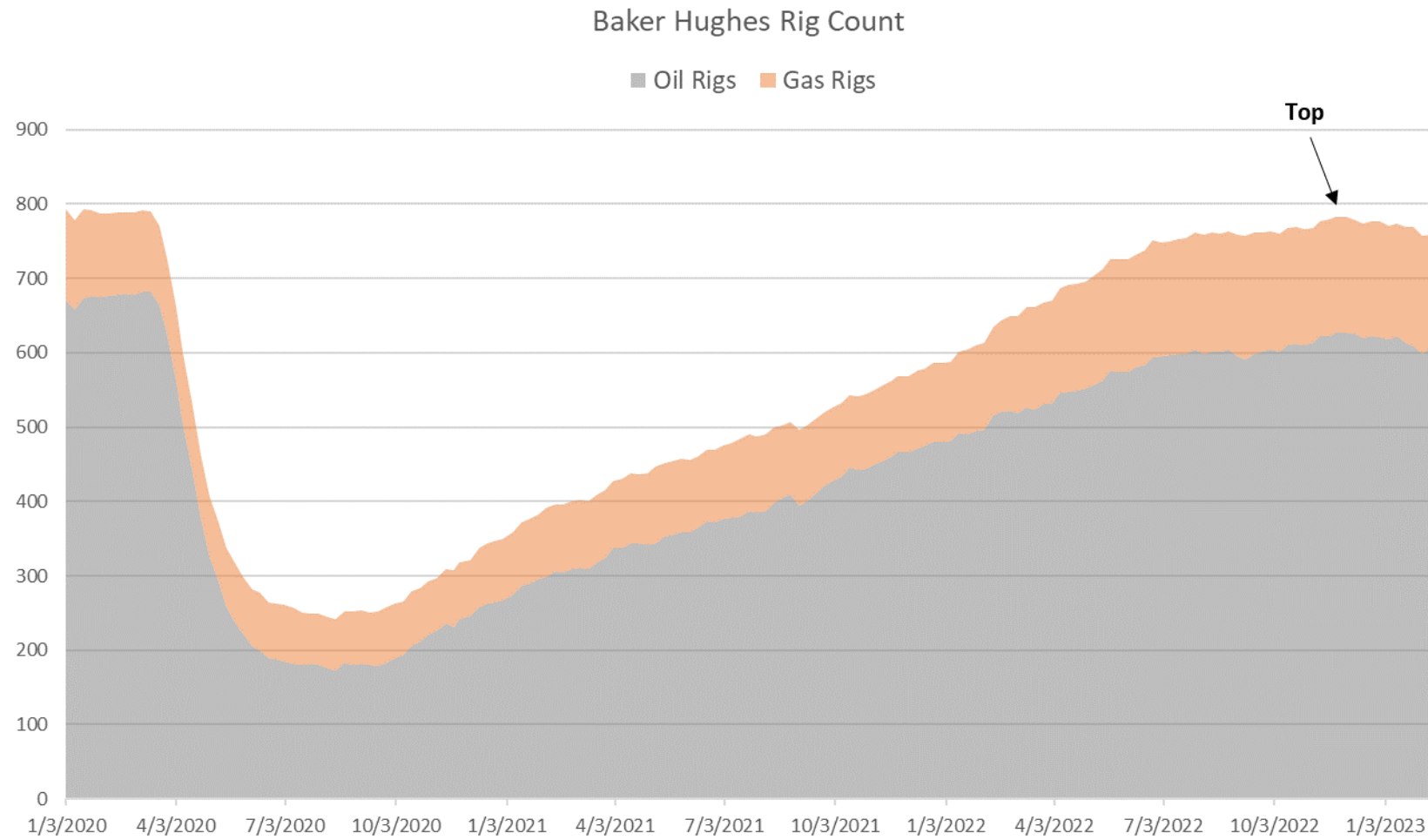
# Daily Production

12-Mo Henry Hub Gas Price vs Dry Gas Production

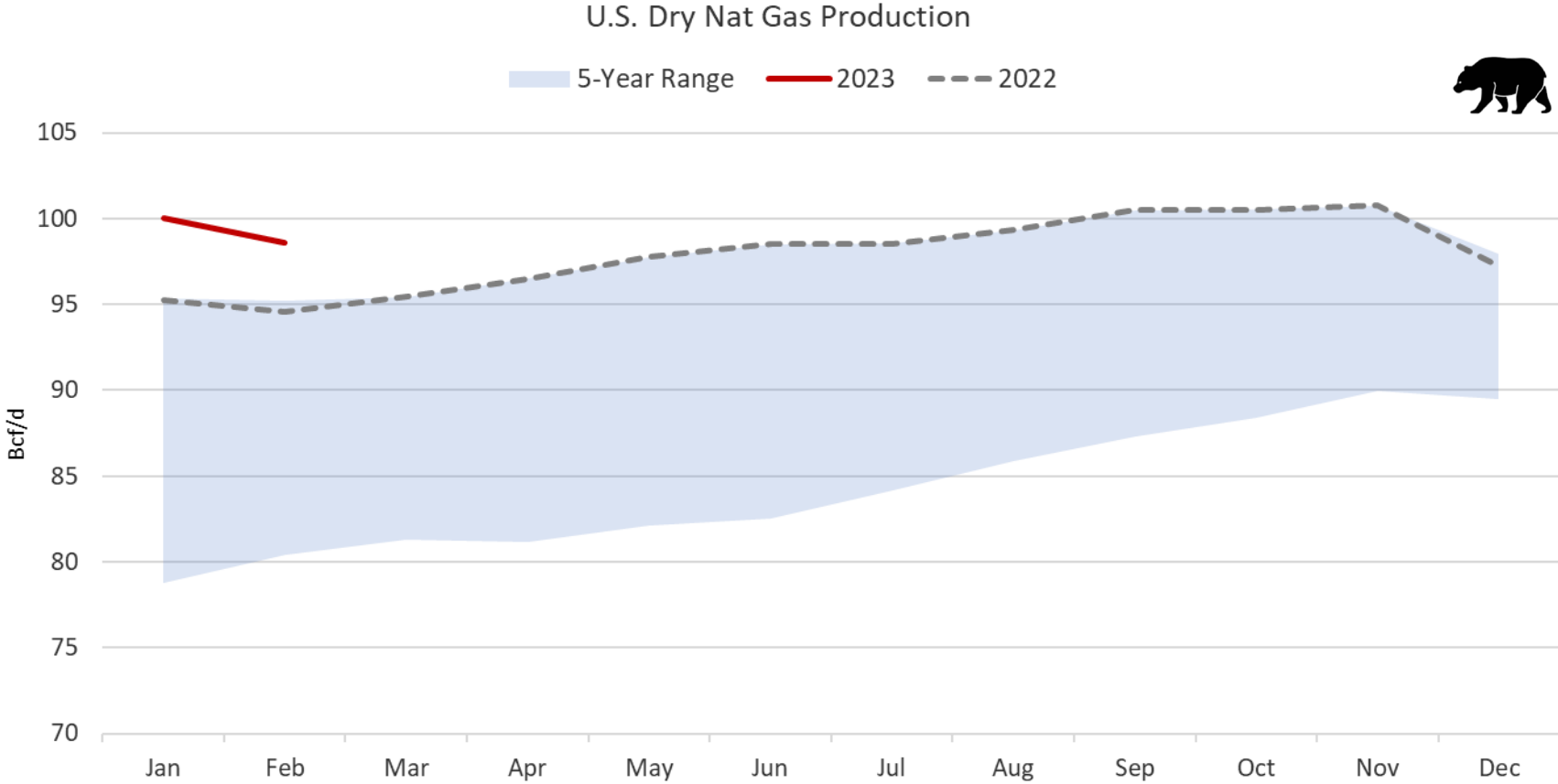


Source: Springrock

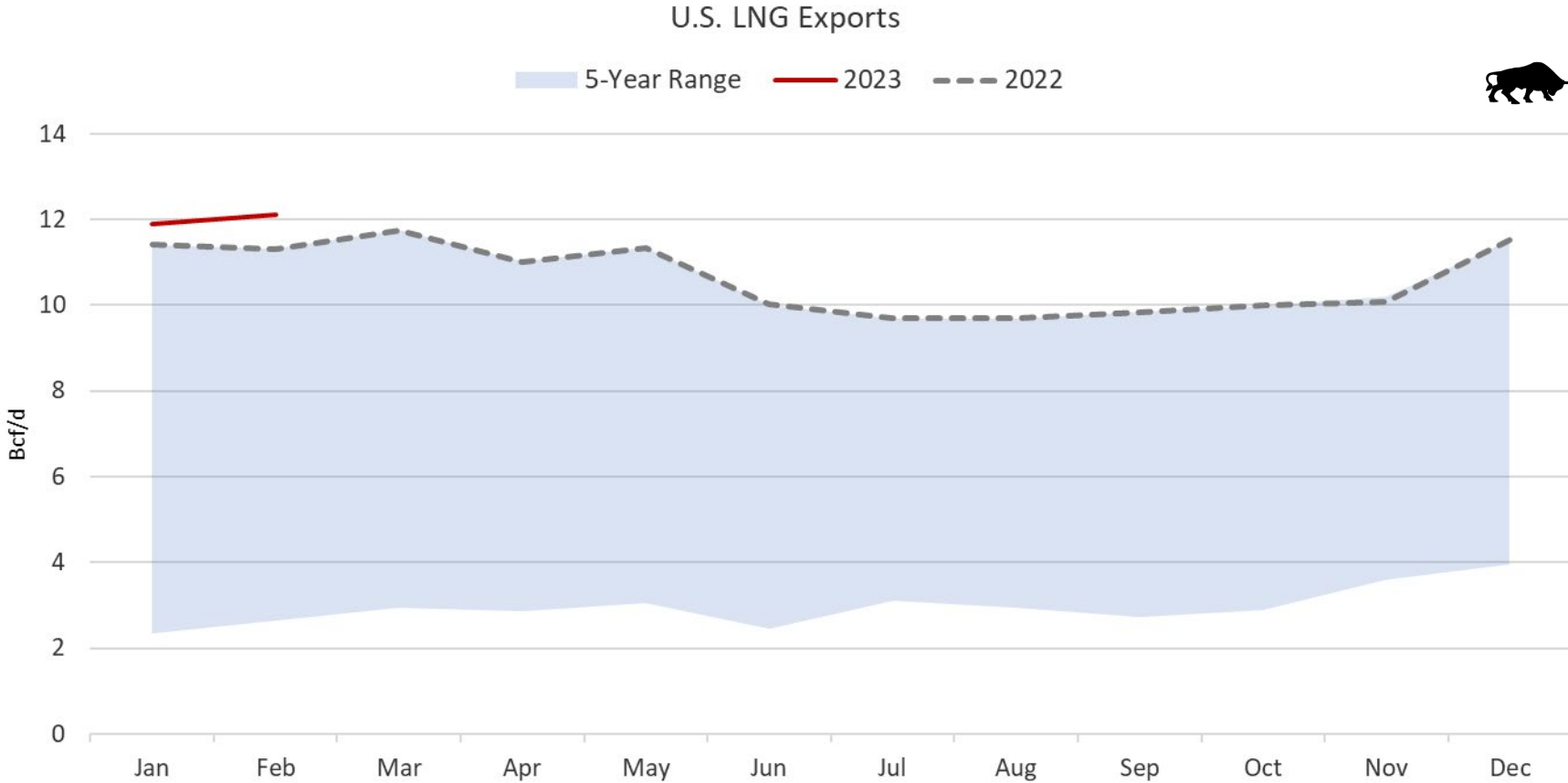
# Rig Counts



# Monthly Production



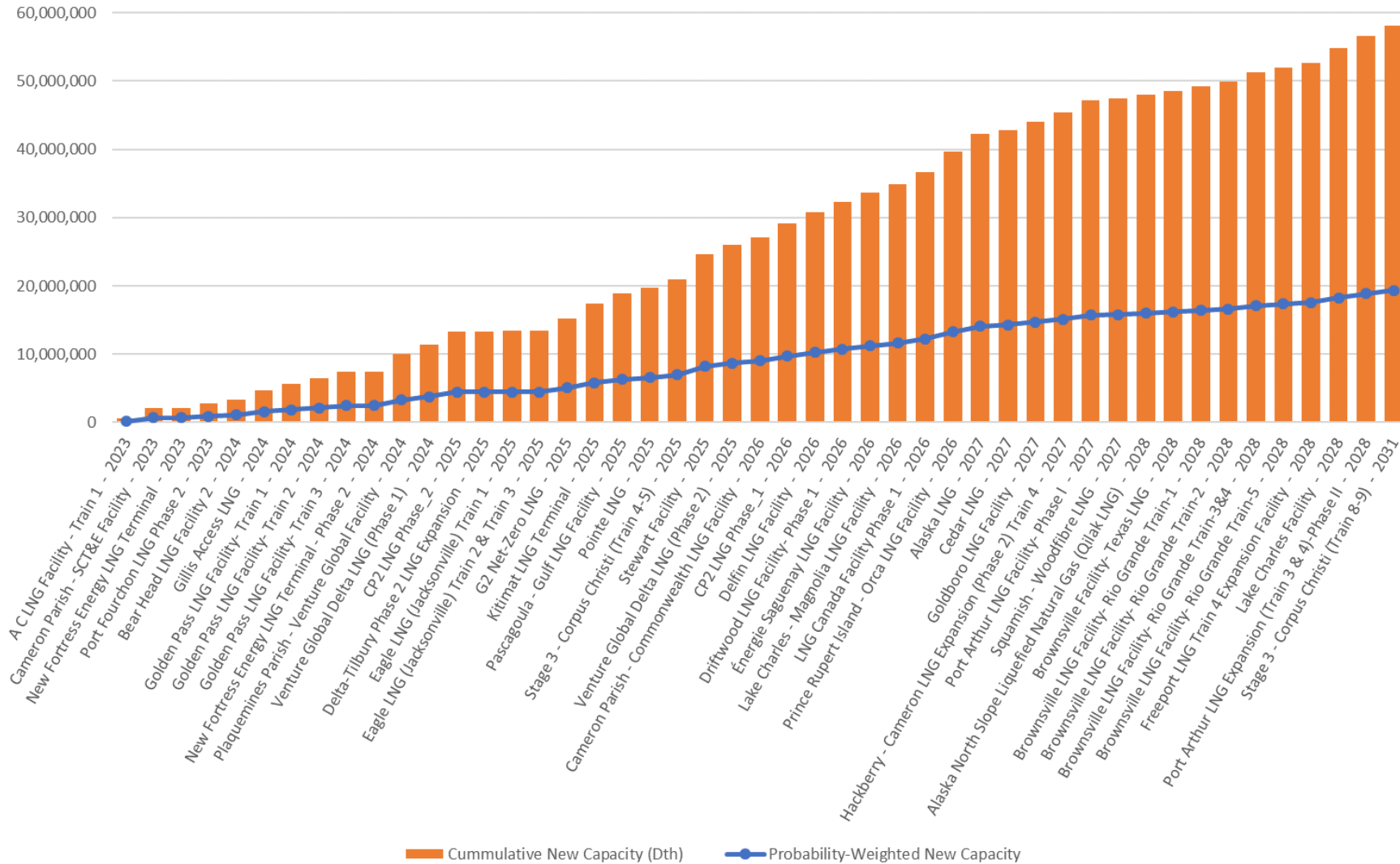
# LNG Exports



Source: EIA, EnergyGPS

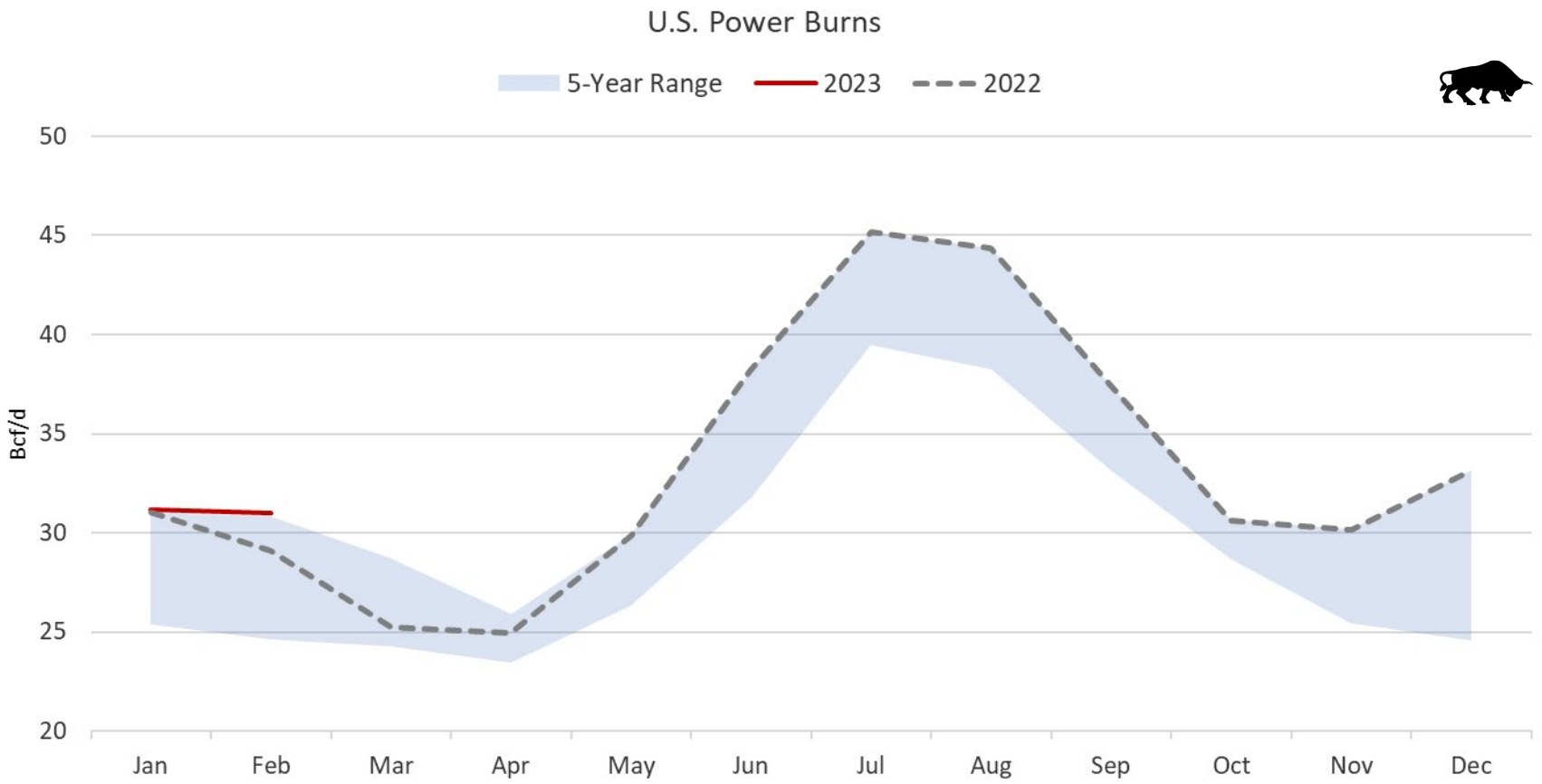
# New LNG Exports

Additional LNG Capacity - North America (Dth)



Source: S&P, Bloomberg

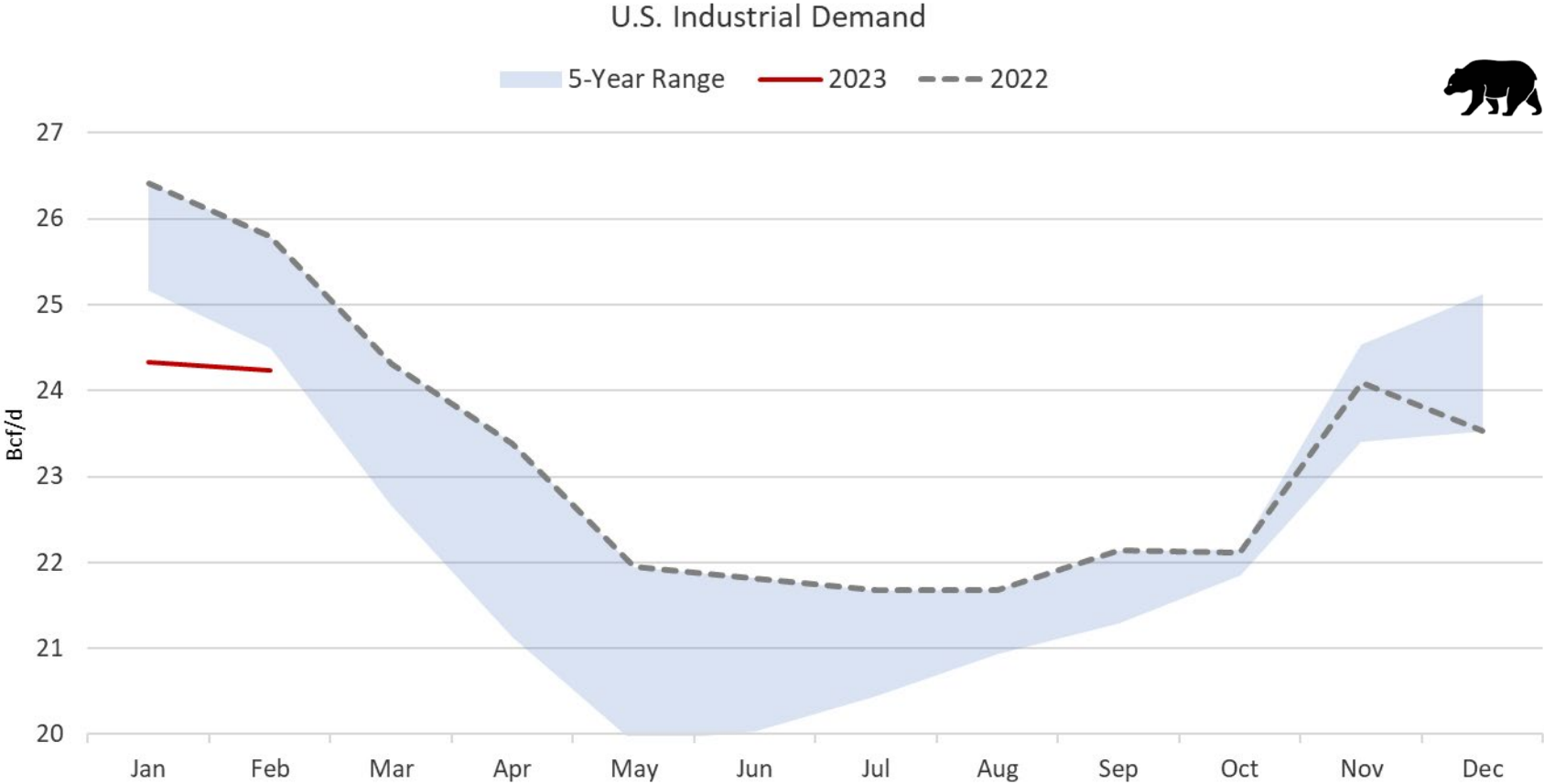
# Power Burns



Source: EIA, EnergyGPS

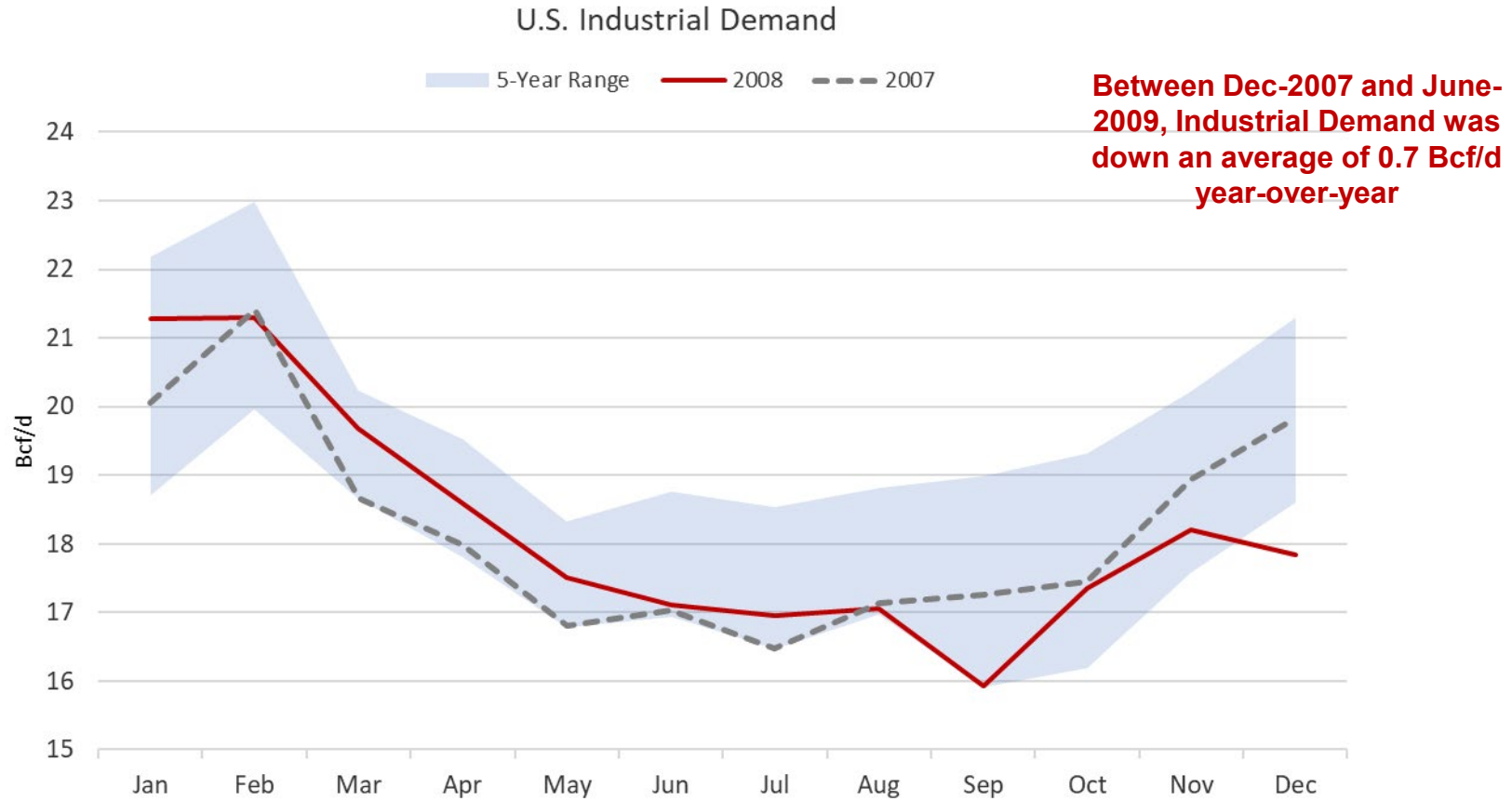


# Industrial Demand

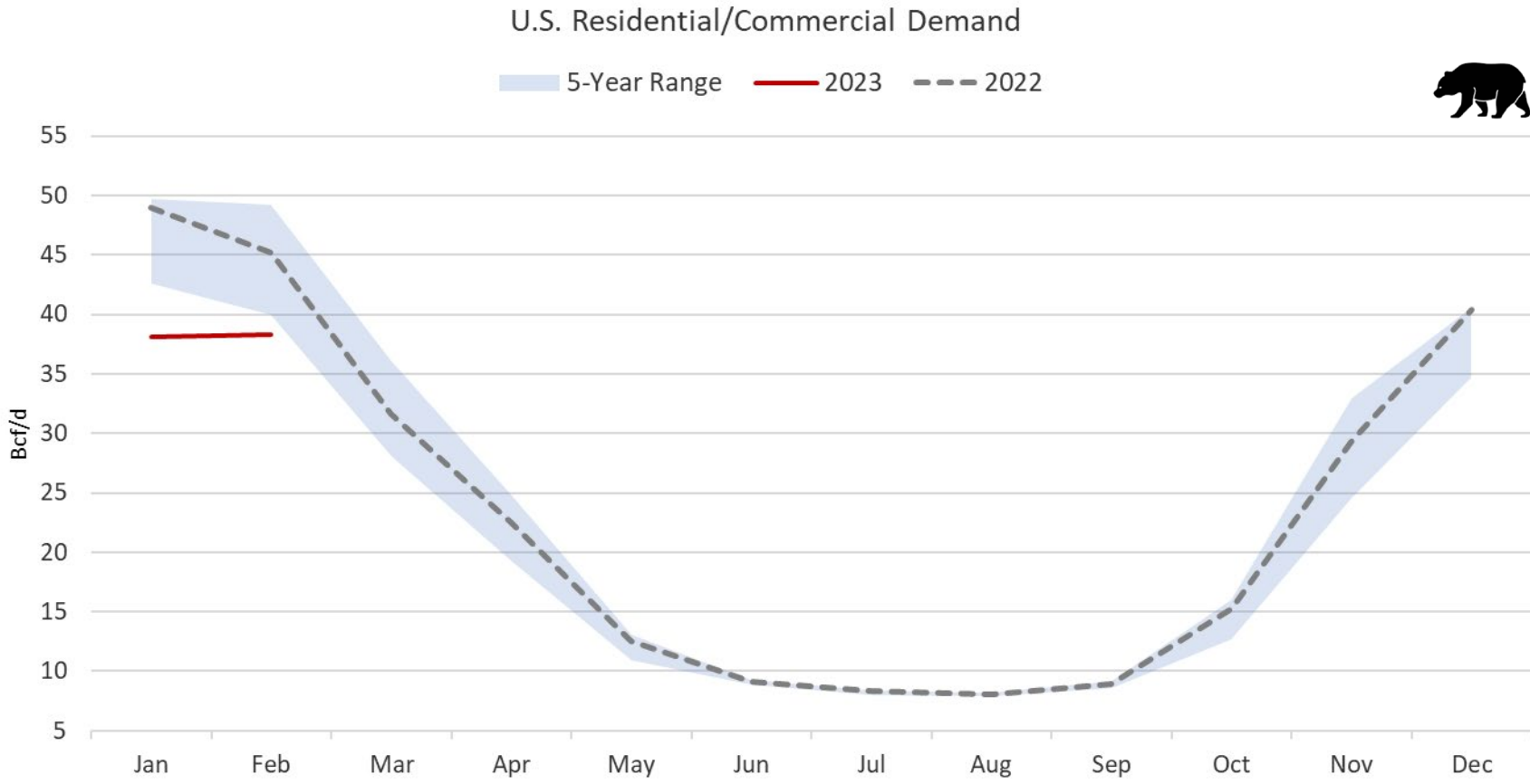


Source: EIA, EnergyGPS

# Industrial Demand in 2008 Recession

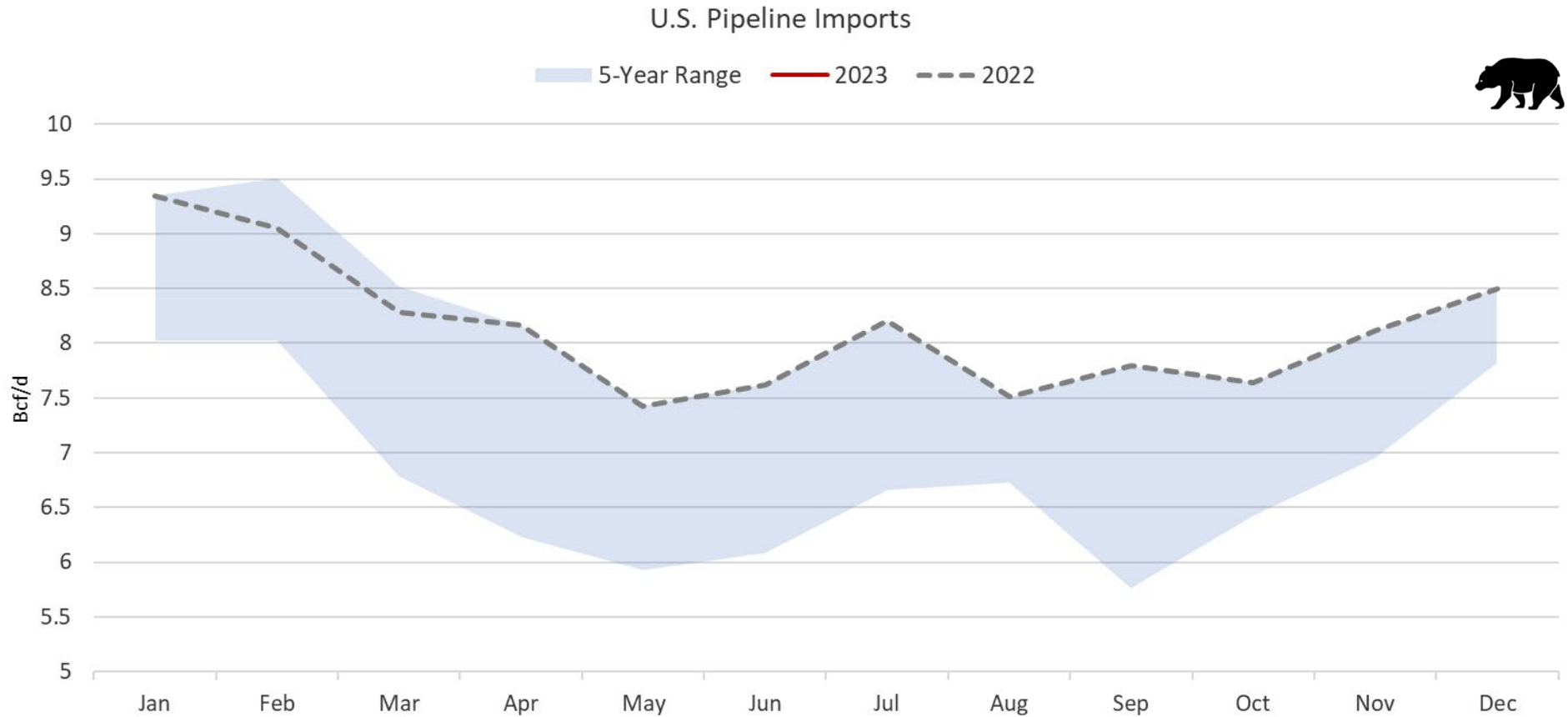


# Res/Comm Demand



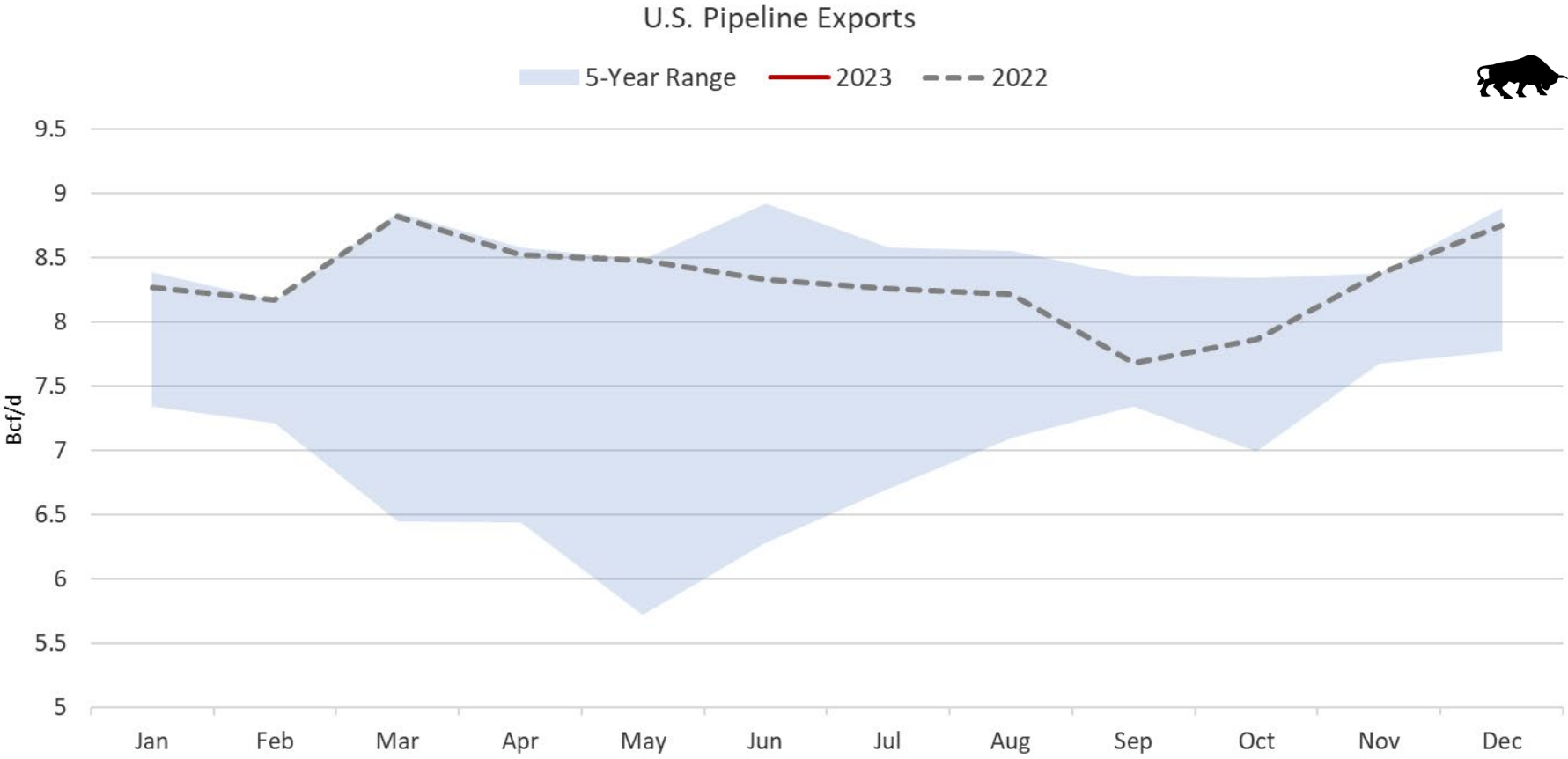
Source: EIA, EnergyGPS

# Imports



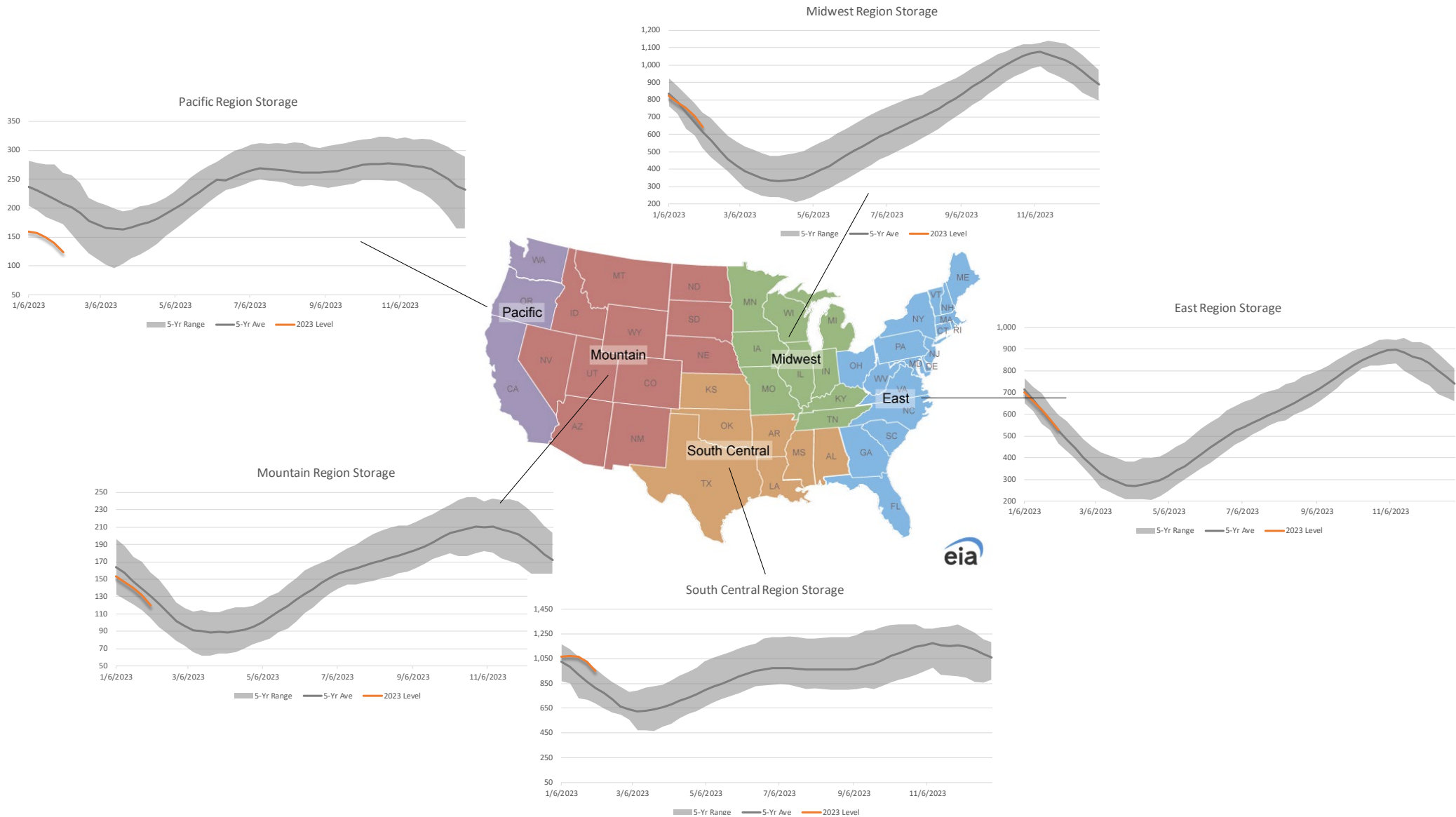
Source: EIA, EnergyGPS

# Pipeline Exports

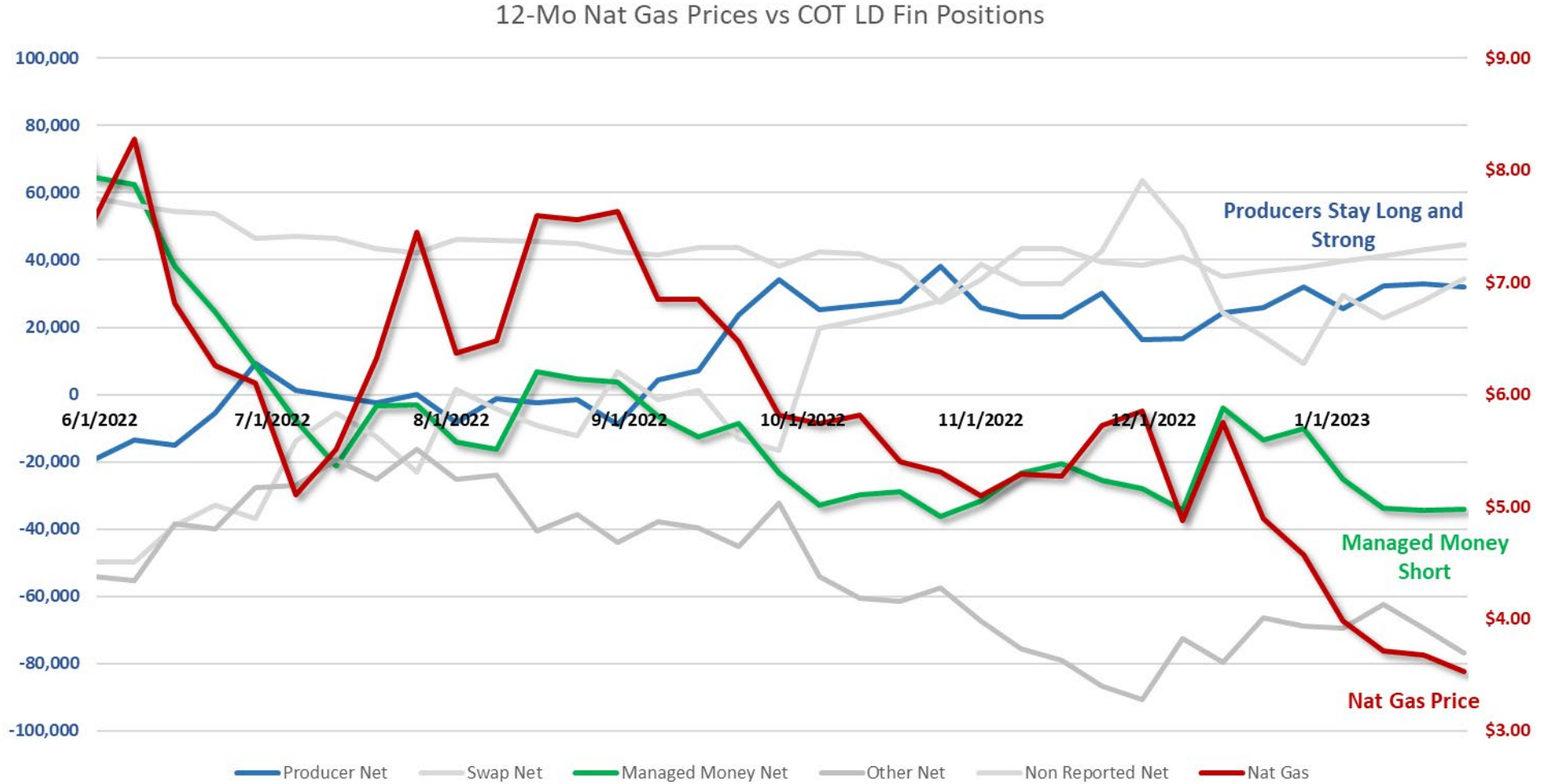


Source: EIA, EnergyGPS

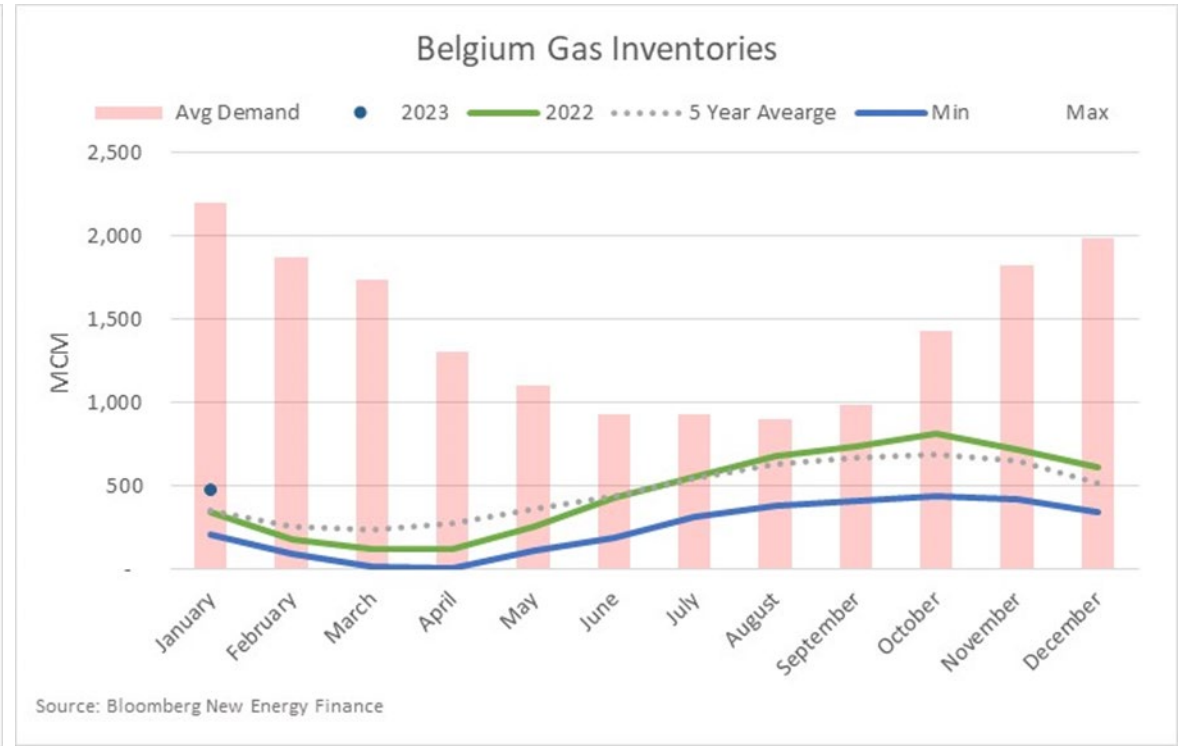
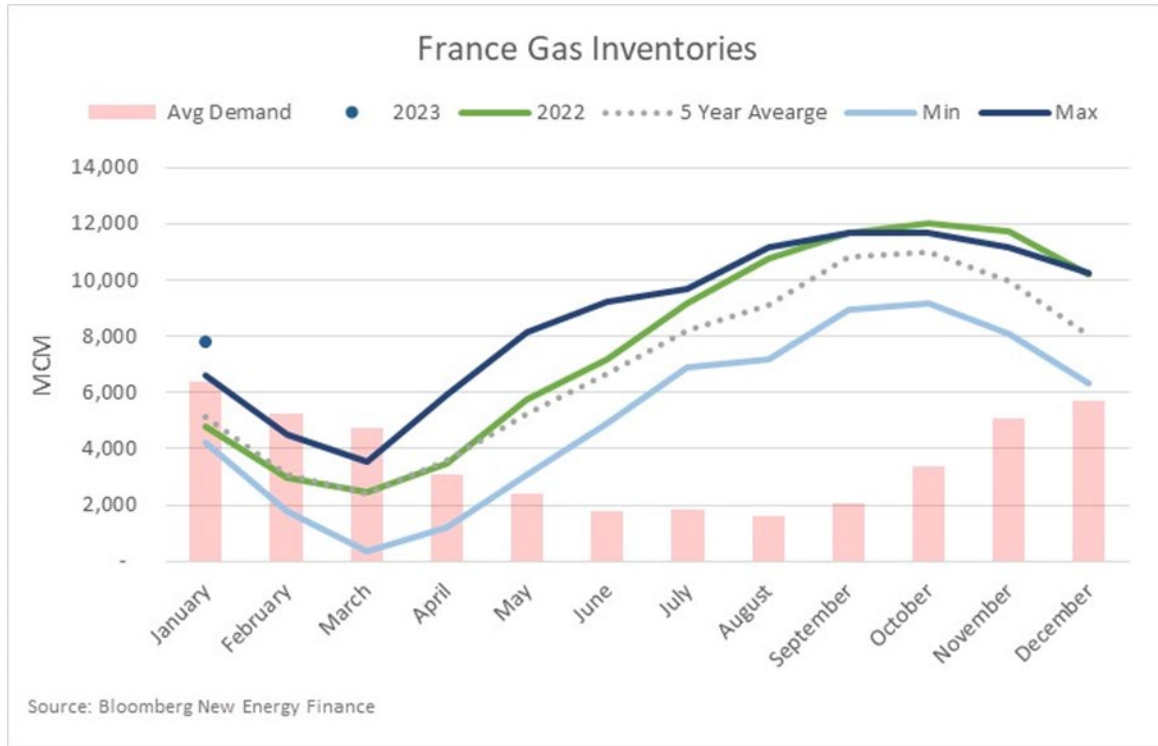
# Regional Storage



# Nat Gas COT

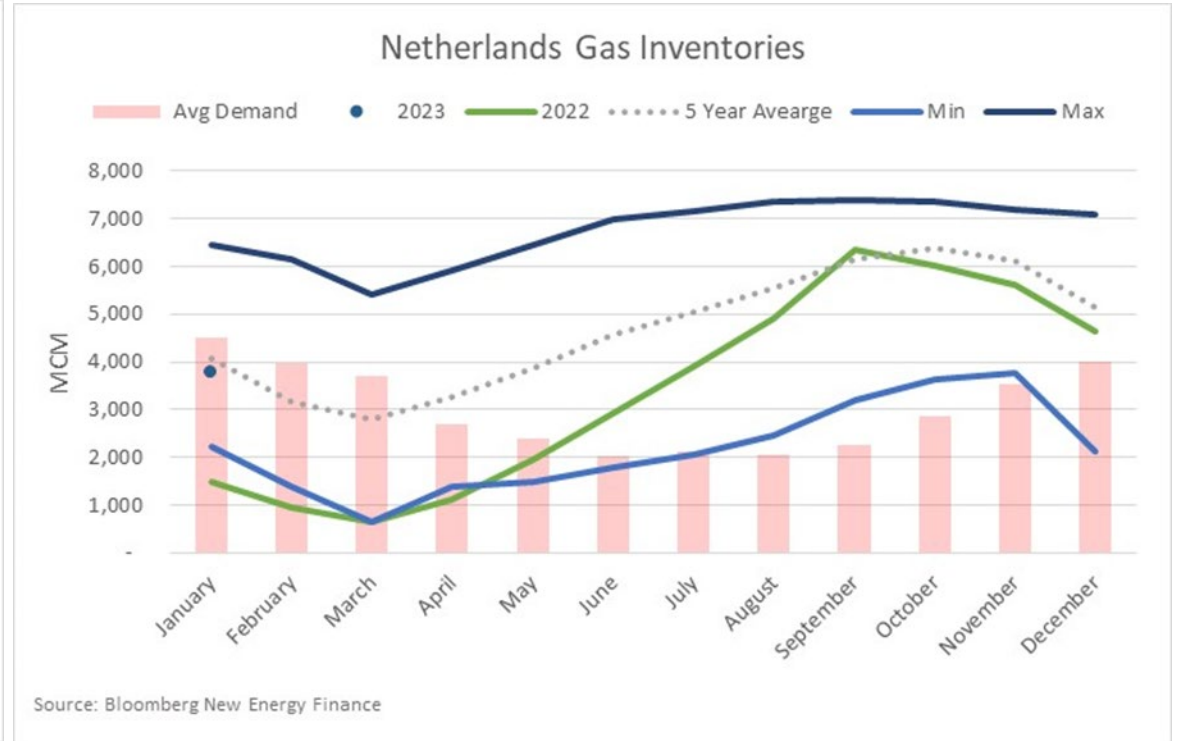
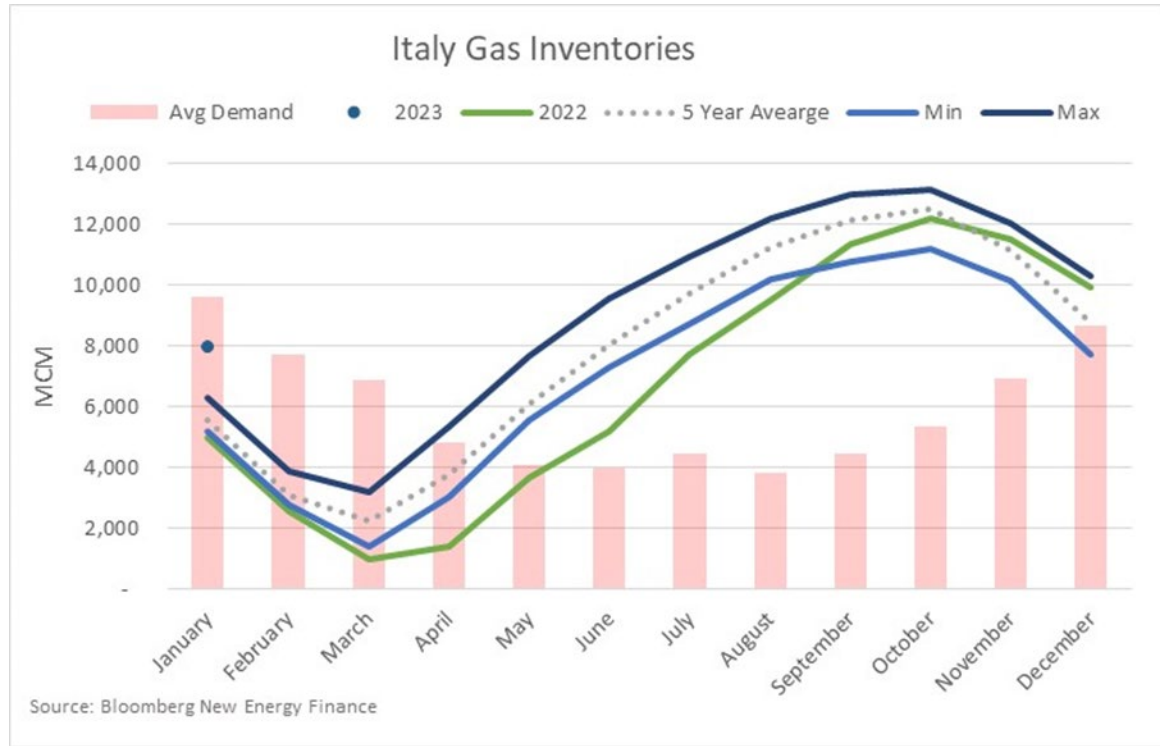


# European Gas Inventories

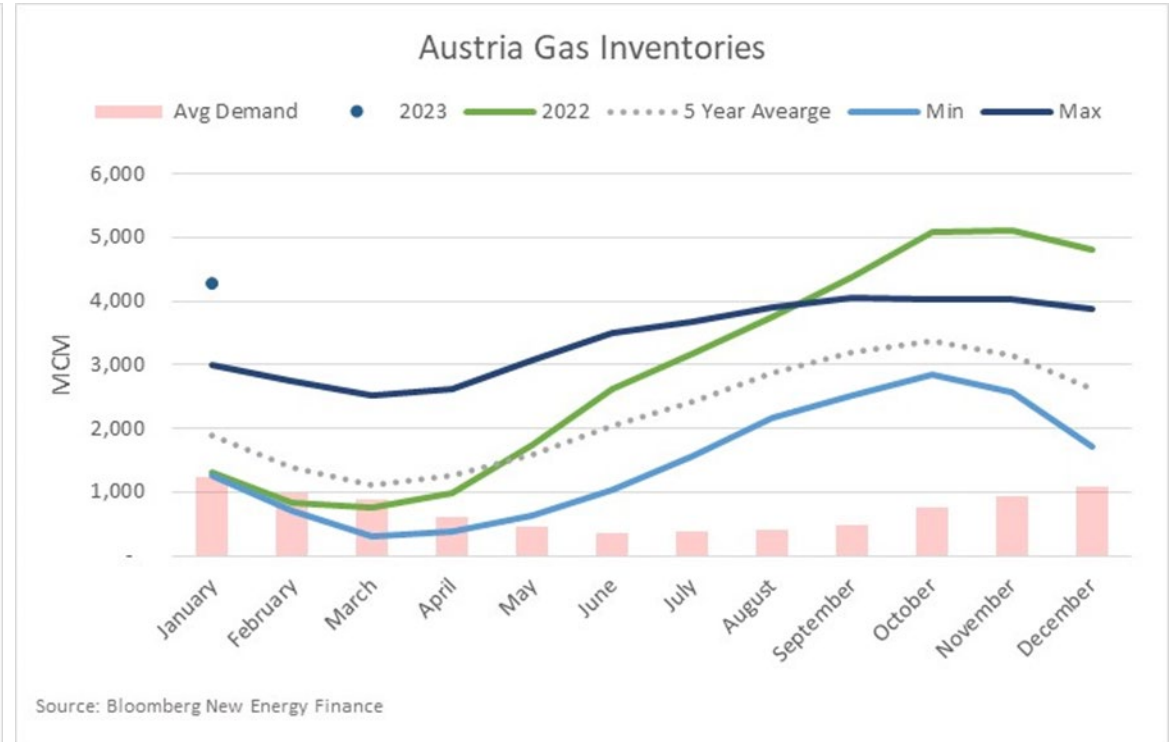
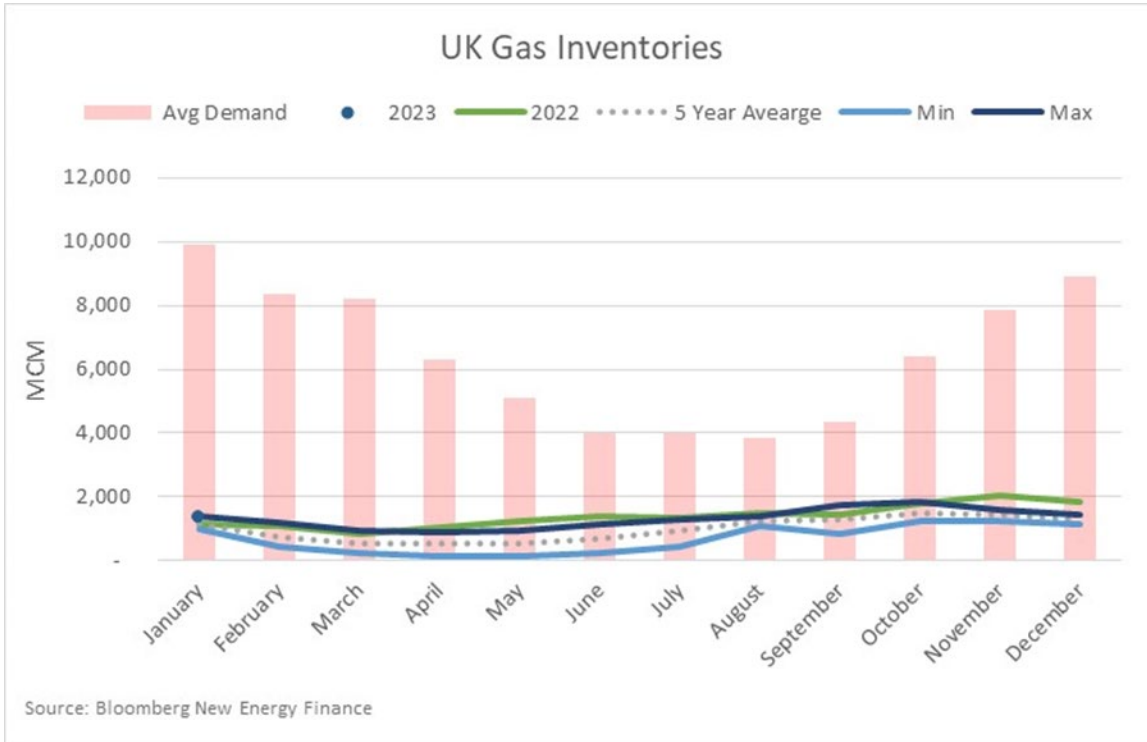




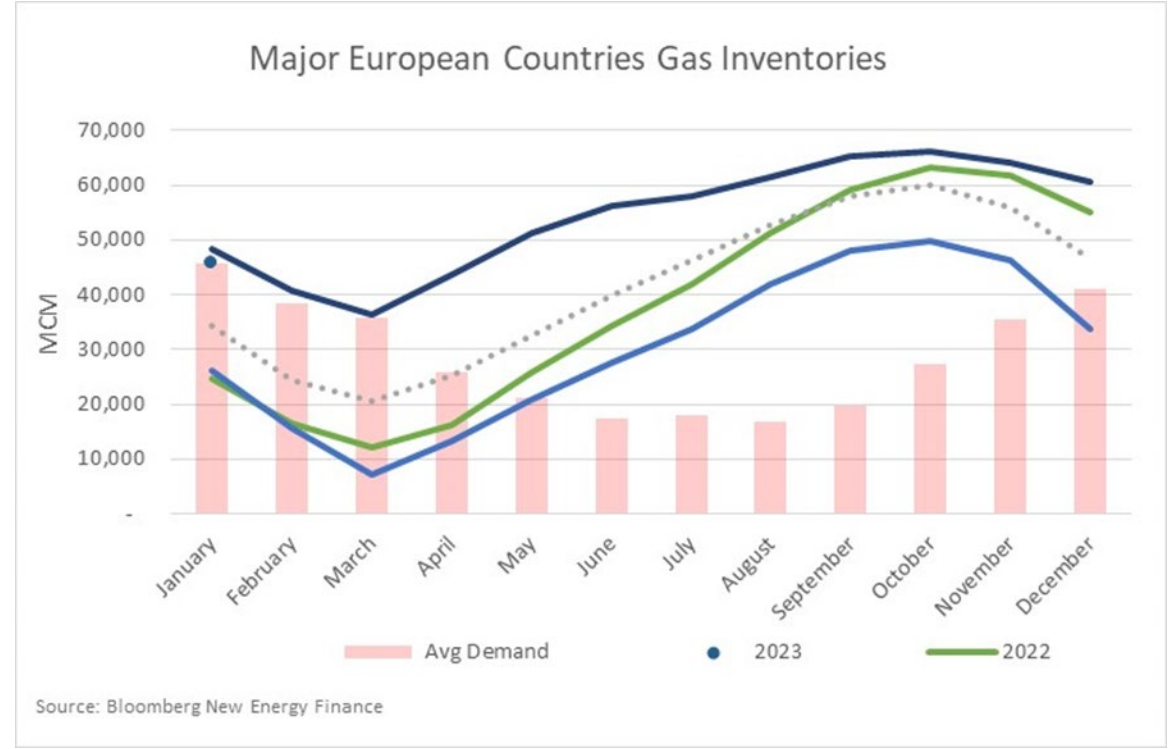
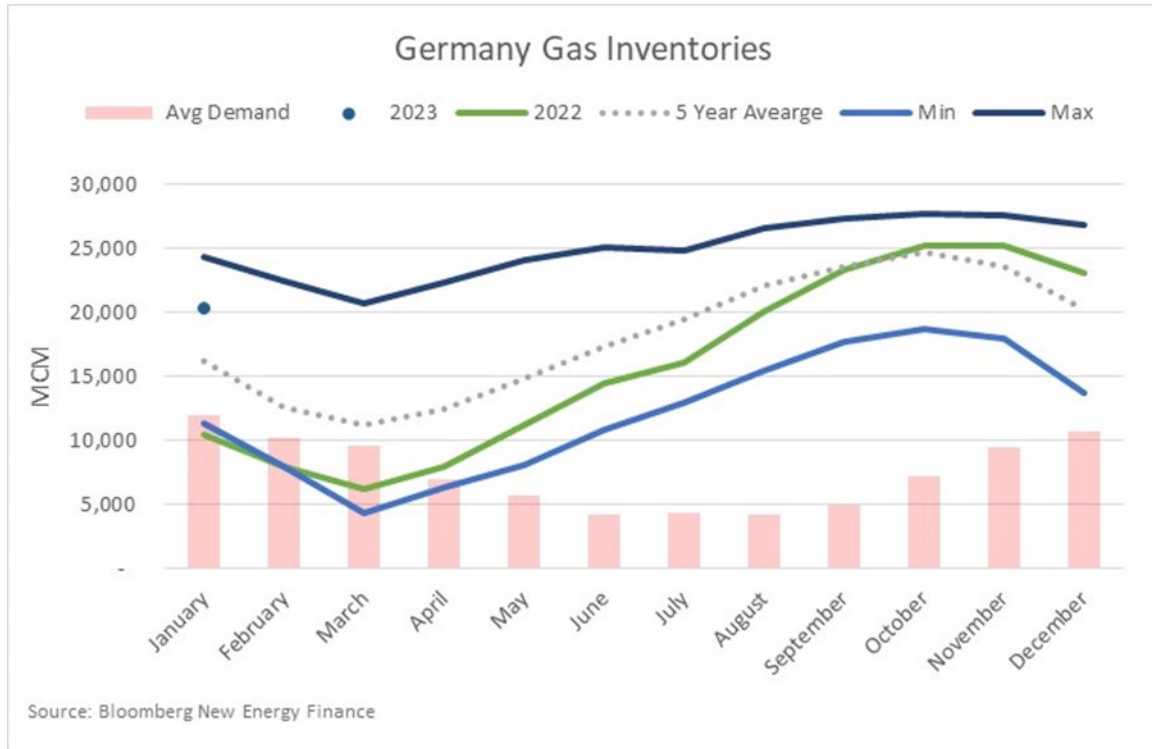
# European Gas Inventories



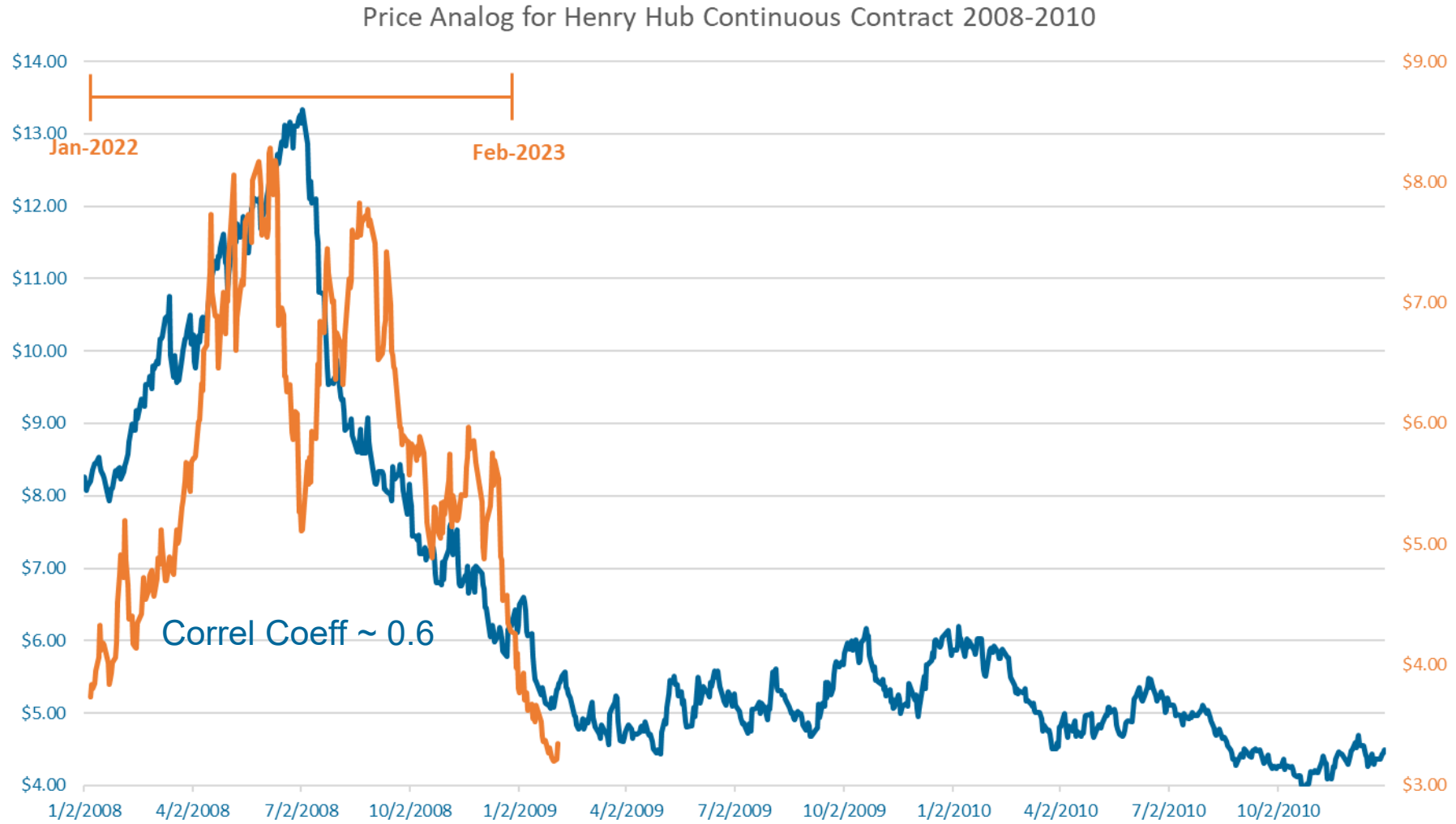
# European Gas Inventories



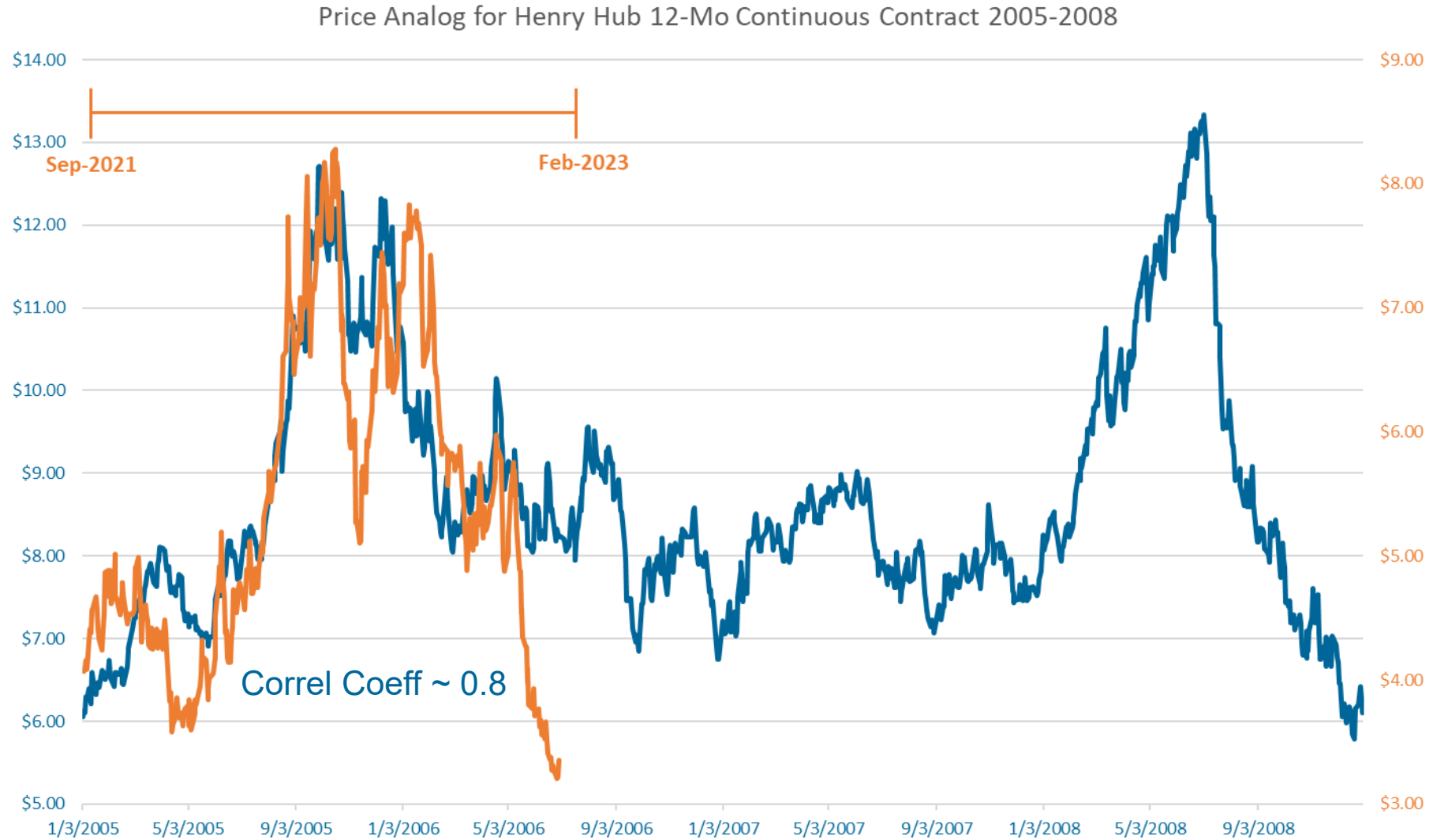
# European Gas Inventories



# Price Analog for Nat Gas 2008-2010



# Price Analog for Nat Gas 2005-2008



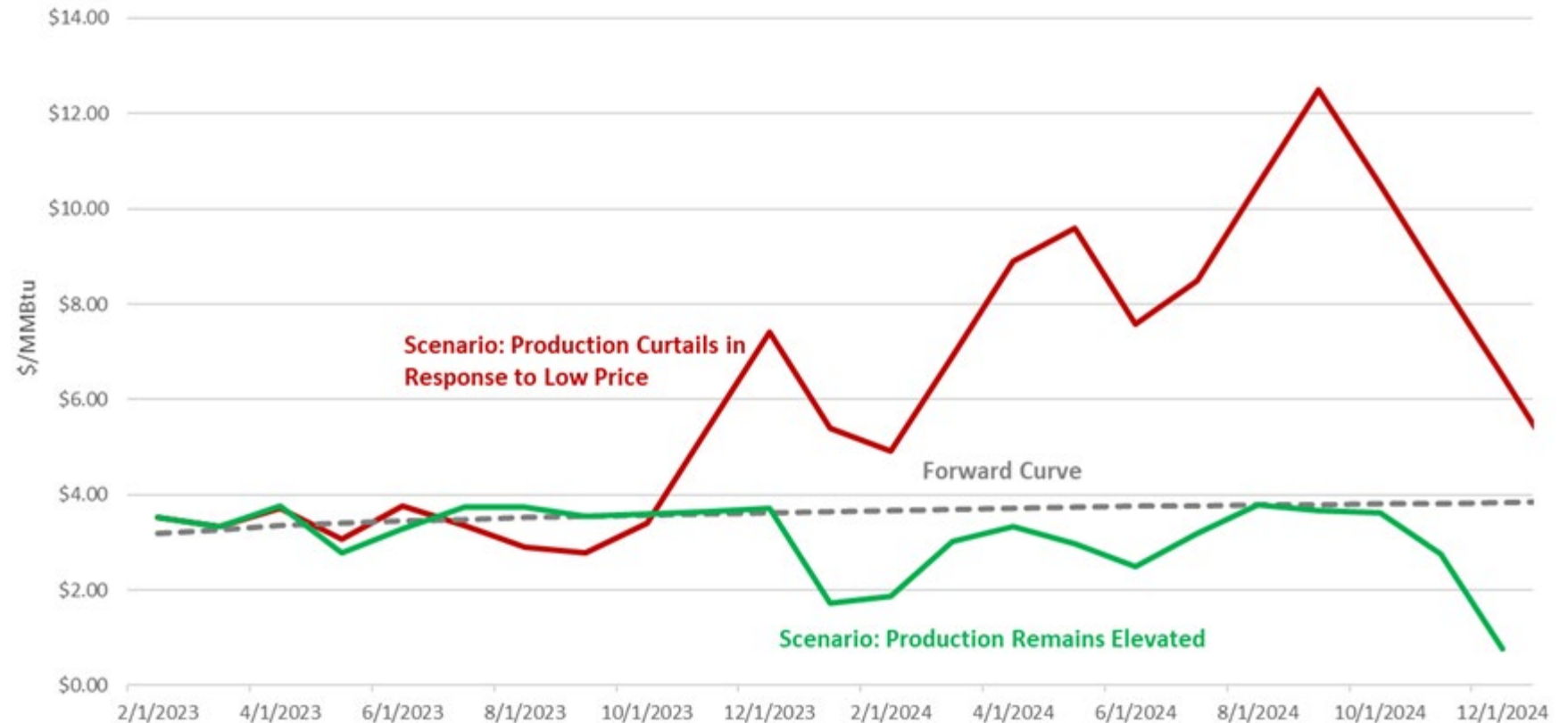
# U.S. Outlook

Core outlook assumptions, next couple of years:

- The US-Rest of World nat gas export arb persists
- Freeport LNG comes fully back online within in the next 2 months (note they sent their first cargo out on the second weekend of Feb and as of 2/16 were pulling 0.5 bcf/d)
- U.S. adds ~1 Bcf/d in new LNG export capability by the end of 2023
- U.S. adds ~2 Bcf/d in new LNG export capability by mid-late 2024
- Summer power burns are elevated due to less coal in stack
- Normal Weather - weather forecasts are notoriously unreliable past 2 weeks.

Assuming the above, the most impactful variable is nat gas production:

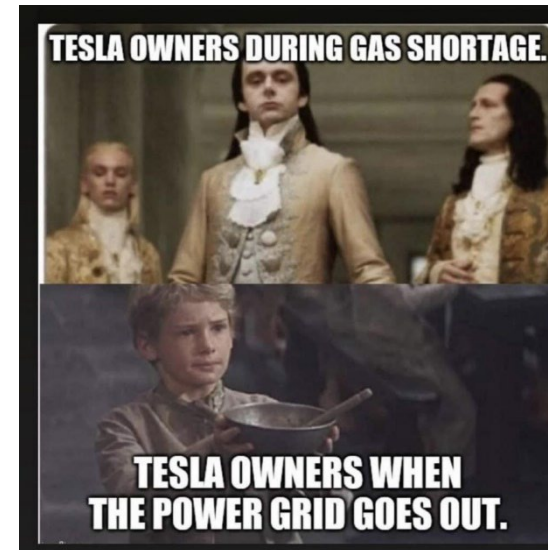
Henry Hub Nat Gas 12-Mo Continuous Contract Outlook



# FUTURE OF POWER

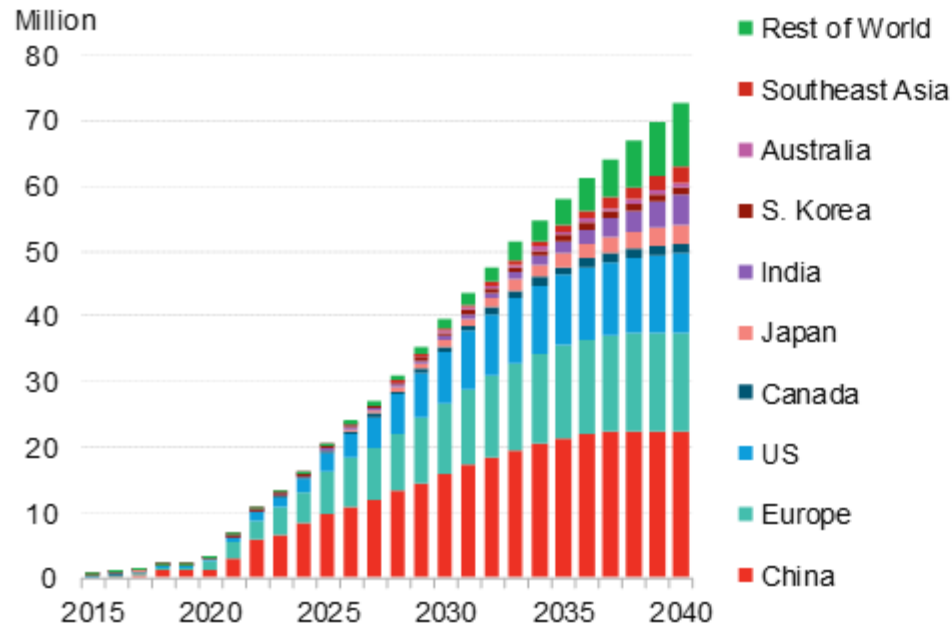
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Which Comes First: the EV or the Panel?

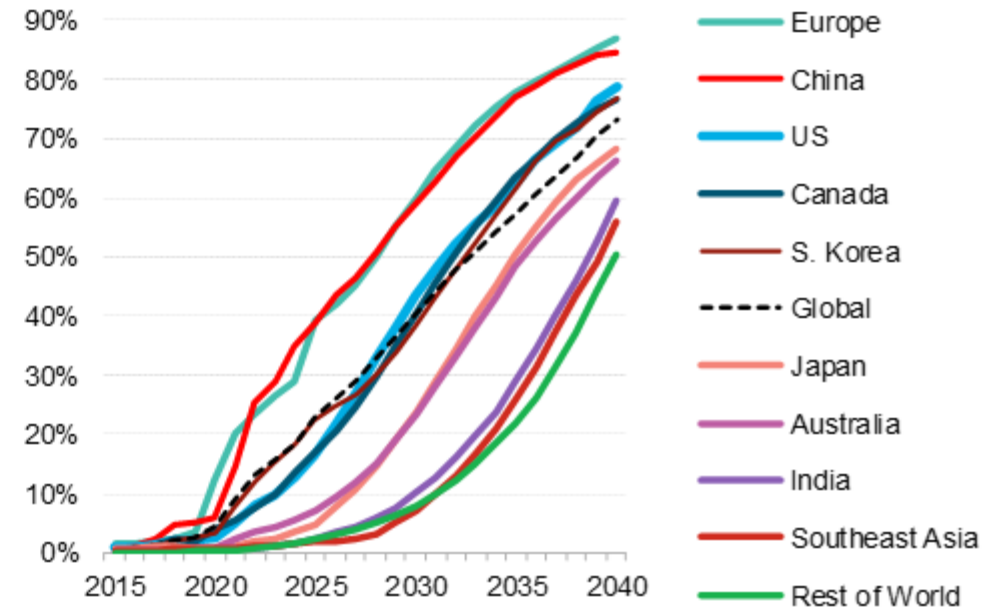


# Power Fundamentals: EV Demand Growth

Global long-term passenger EV sales by market – Economic Transition Scenario



Global long-term EV share of new passenger vehicle sales by market – Economic Transition Scenario

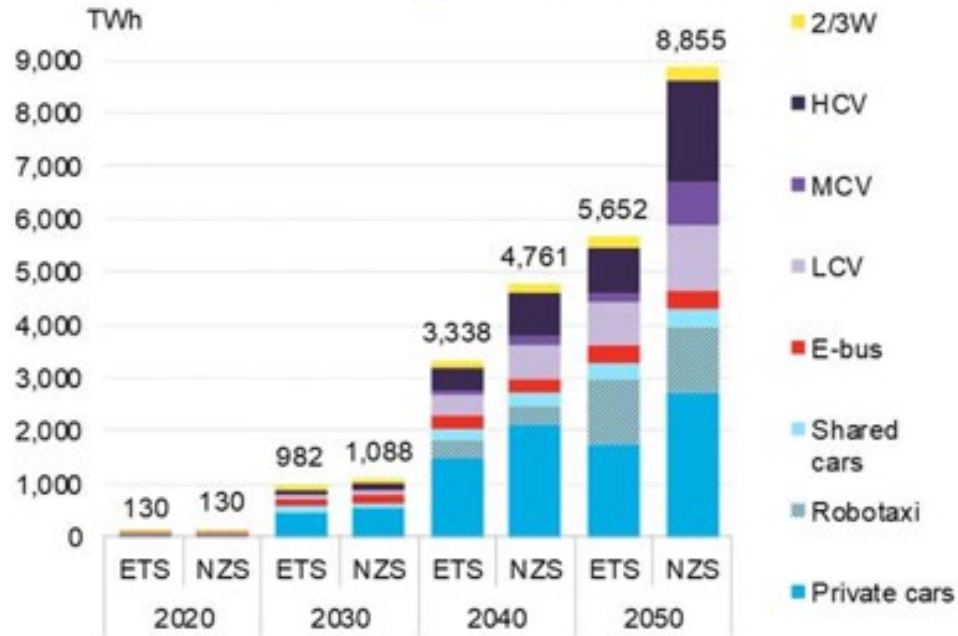


Source: BNEF. Note: Europe includes the EU, the UK and EFTA countries. EV includes BEVs and PHEVs.



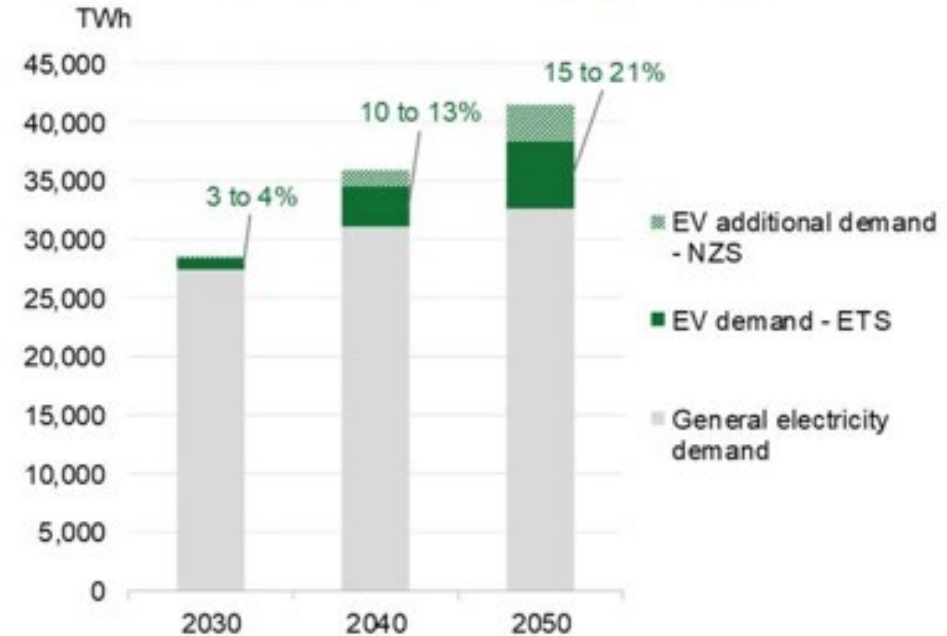
# Power Fundamentals: EV Demand Growth

Global electricity demand outlook by electric-vehicle segment and scenario



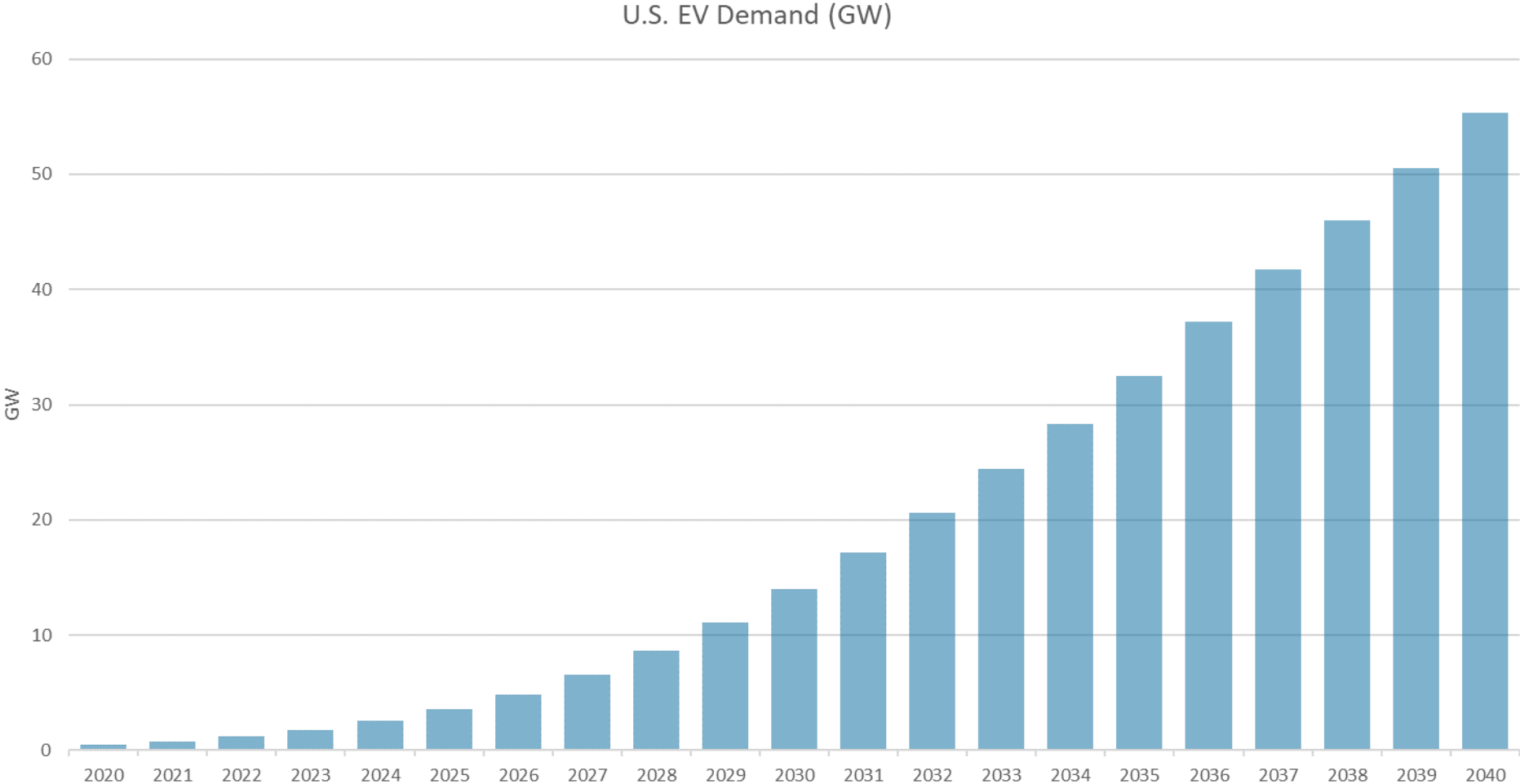
Source: BNEF. Note: ETS is Economic Transition Scenario, NZS is Net Zero Scenario. 'LCVs, MCVs and HCVs' are light-, medium-and heavy-duty commercial vehicles.

Global electricity demand with and without electric vehicles, by scenario



Source: BNEF. Note: The percentages shown indicate the share of electric vehicle electricity demand of total demand between the ETS and NZS scenarios. Includes all vehicle segments.

# Power Fundamentals: EV Demand Growth



Source: Bloomberg

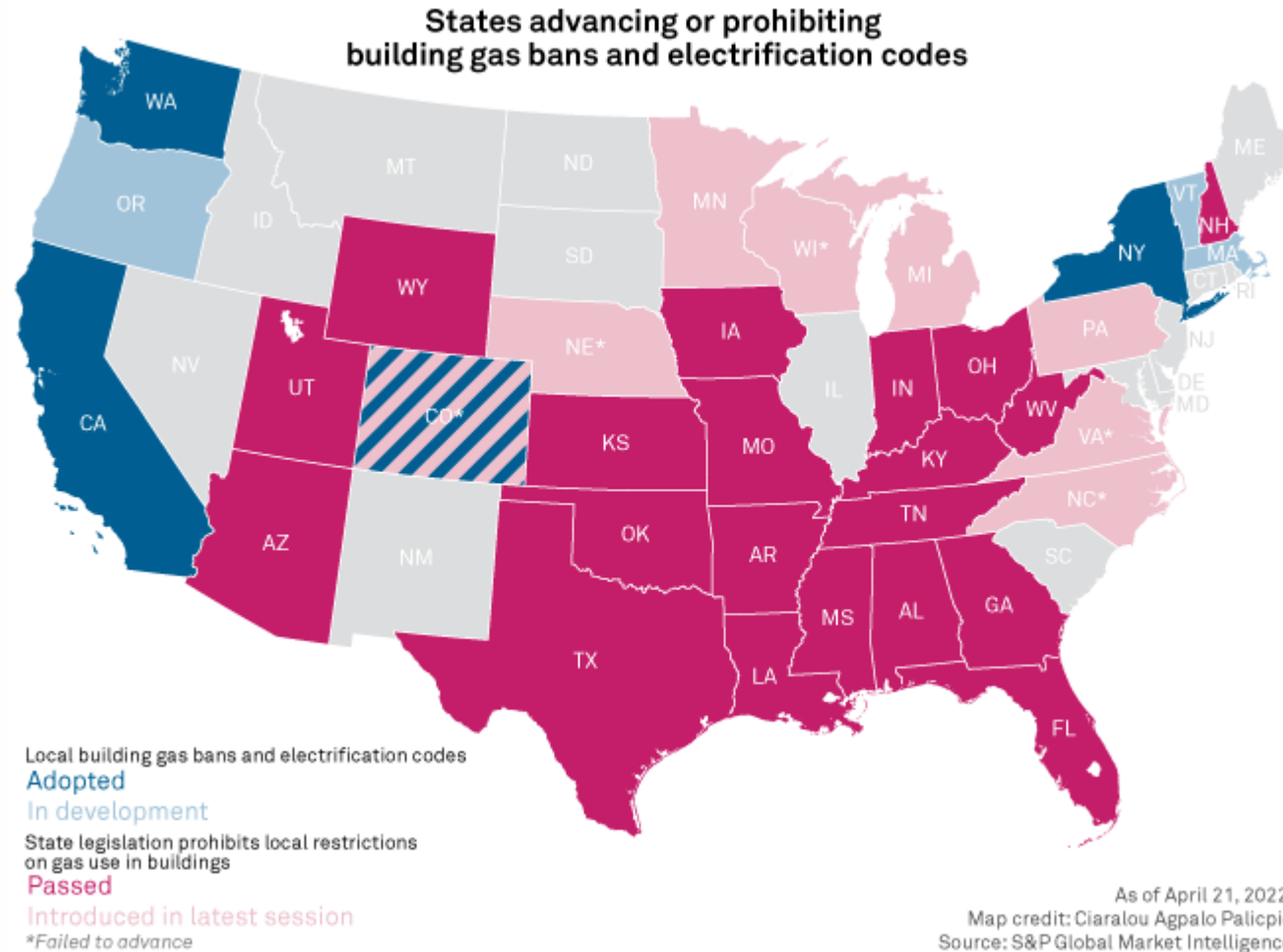
# Electrification of Buildings

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- “Nearly 100 cities and counties in the United States, mostly in blue areas, have already adopted policies restricting the use of gas-powered stoves and heaters or to begin phasing them out in new construction.
- At least 20 states have also introduced or advanced similar efforts.
- **SAN FRANCISCO BAY AREA:** In 2019, the city of Berkeley became the first U.S. city to implement a ban on natural gas appliances, including stoves. That sparked an ultimately unsuccessful court challenge by the California Restaurant Association, which argued in a lawsuit that gas-powered stoves are crucial for chefs to prepare food the way they are classically trained. In the years since, several other cities in the Bay Area, including San Francisco, Oakland, Los Gatos, and Sunnyvale, as well as Marin County have adopted similar bans, either banning or restricting natural gas appliances, including gas-powered stoves.
- **NEW YORK STATE:** Gov. Kathy Hochul (D-NY) announced a proposal Tuesday that would make New York the first state to ban natural gas heaters and appliances in new buildings. Beginning in 2025, the law would begin phasing in a ban on natural gas-powered appliances, such as stoves and heaters, in new buildings. From 2030 on, it calls for a complete ban on the sale of any new natural gas heating systems.
- **NEW YORK CITY:** In 2021, New York City Council passed a citywide ban on natural gas hookups in most new construction, which it will begin phasing in this year.
- **ITHACA, NEW YORK:** The city of Ithaca made history in 2021 when it voted to decarbonize and electrify all 6,000 of its residential and commercial buildings by 2030 — an ambitious goal that will involve retrofitting older buildings with solar pumps, installing more efficient heat pumps, and ensuring all its existing natural gas and propane powered appliances are replaced with electric models.
- **WASHINGTON STATE:** Washington state lawmakers passed a law last year banning all natural gas appliances in new commercial construction projects and some residential buildings beginning this summer. The law applies to all buildings that will have four stories or more, echoing an initiative passed by the city of Seattle in 2021.
- **MASSACHUSETTS:** Massachusetts approved first-of-its-kind climate legislation in 2022 that will allow up to 10 cities to ban fossil fuels in new and major construction projects.”

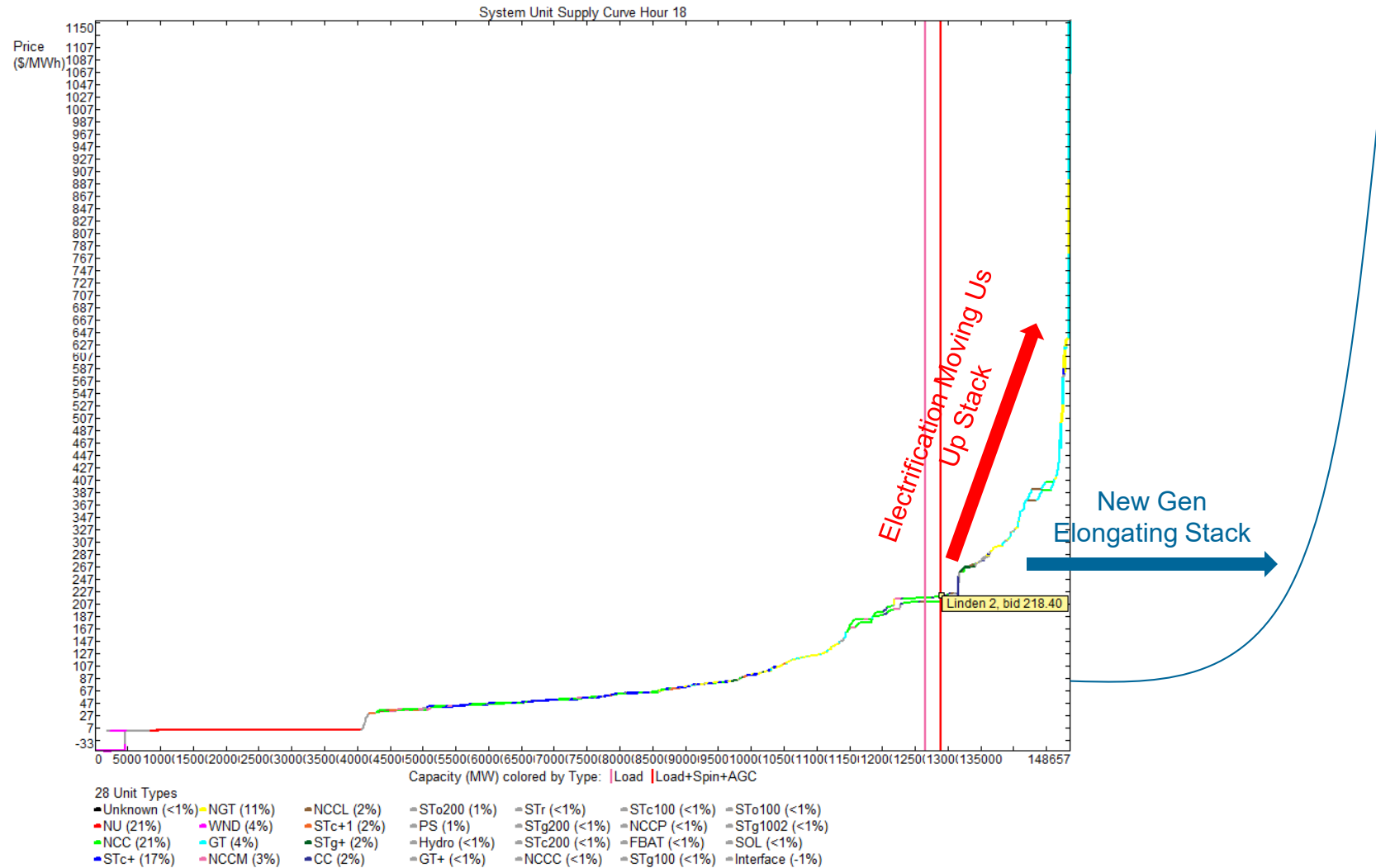
Source: Washington Examiner

# Electrification of Buildings

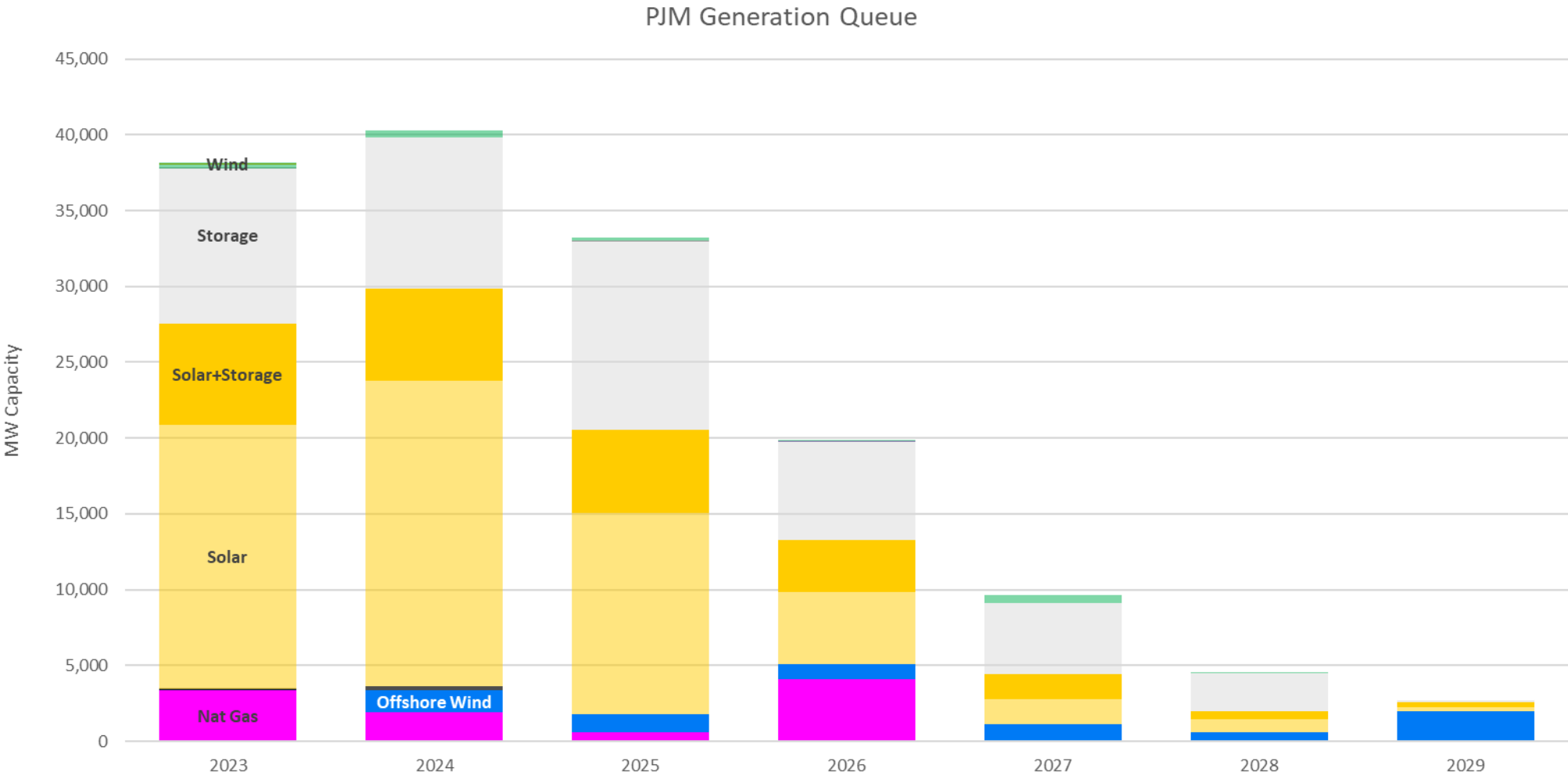


Source: S&P

# Electrification Up Stack vs New Solar Elongating Stack



# Power Fundamentals: New Generation



# Challenges to Panel Supply Persist

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"The trade barriers are bringing increasing difficulties for Chinese solar firms seeking to expand in overseas markets, and the rapid development of local manufacturers in those countries will hit China's solar manufacturing industry," Wang said.

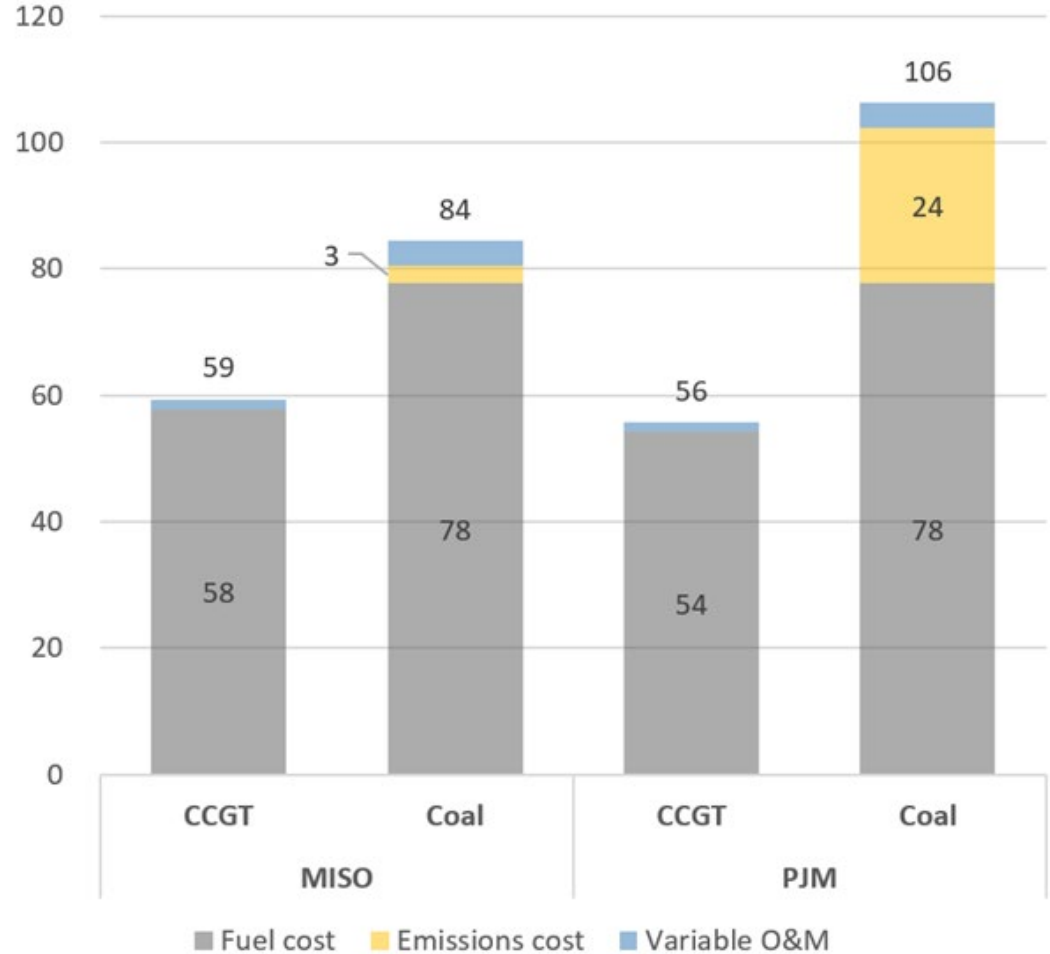
The United States in December banned imports, including solar products, from China's Xinjiang region over concerns about forced labour.

Some 3 GW of solar modules exported from China have been seized by U.S. customs due to suspicion they could have come from slave labour camps.

Source: Reuters

# Fuel Economics of Nat Gas vs Coal

**Figure 3: Comparison of illustrative variable dispatch costs for coal vs CCGT for summer 2022, \$/MWh**  
 (see detailed breakout of dispatch costs below in Table 4)



Source: S&P



# Less Coal, More Solar

## PJM Coal Retirements

Plant	MWs	State	Ret. Date
Will County	510	IL	6/30/2022
Carneys Point Generating Plant	244	NJ	6/7/2022
W H Zimmer	1,305	OH	6/1/2022
Logan Generating Plant	219	NJ	5/31/2022
Morgantown Generating Station	1,205	MD	5/31/2022
Waukegan	702	IL	5/31/2022
Avon Lake	627	OH	3/31/2022
Cheswick Power Plant	565	PA	3/31/2022
<b>MWs Retired Winter over Winter</b>	<b>5,377</b>		
Joliet (converted to gas)	1,381	IL	6/1/2023
W H Sammis	1,200	OH	6/1/2023
Pleasants	1,278	WV	6/1/2023
Chesterfield	1,006	VA	5/31/2023
Herbert A Wagner	212	MD	3/16/2023
<b>MWs Retired Summer over Summer</b>	<b>5,077</b>		

## MISO Coal/Nuke Retirements

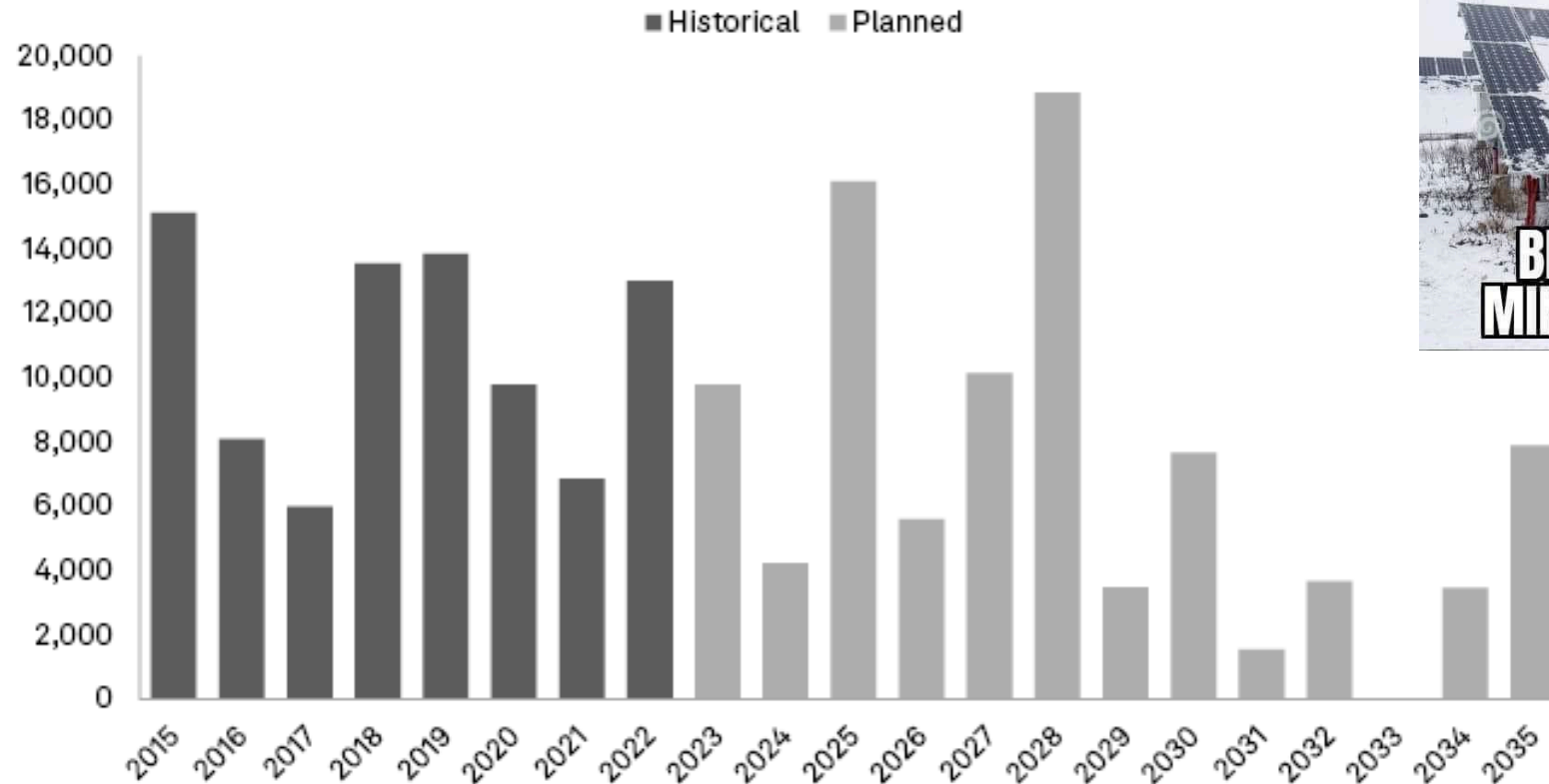
Plant	MWs	State	Ret. Date
Trenton Channel	495	MI	6/21/2022
MEPI	239	MI	6/1/2022
St Clair	1,065	MI	5/31/2022
Palisades - NUKE	700	MI	5/31/2022
E D Edwards	560	IL	12/31/2022
Erickson	162	MI	12/31/2022
Lansing	241	IA	12/31/2022
Meramec	736	MO	12/30/2022
AES Petersburg	300	IN	10/1/2022
Joppa Steam	948	IL	8/31/2022
<b>MWs Retired Winter-over-winter</b>	<b>5,446</b>		
<i>Summer-over-summer retirements overlap with E D Edwards - Joppa from above</i>			
Muscatine	235	IA	6/30/2023
D E Karn	1,150	MI	5/31/2023
Taconite Harbor Energy Center	150	MN	3/31/2023
<b>MWs Retired Summer-over-summer</b>	<b>4,482</b>		

## US power plant capacity additions by source

	2013	2023
		(planned)
Nat gas	51%	14%
Solar	22%	54%
Coal	11%	0%
Wind	8%	11%
Biomass	4%	0%
Hydro	3%	0%
Other	2%	0%
Nuclear	0%	4%
Battery	0%	17%

# Coal Retirements

### Coal capacity retirements by year (MW)



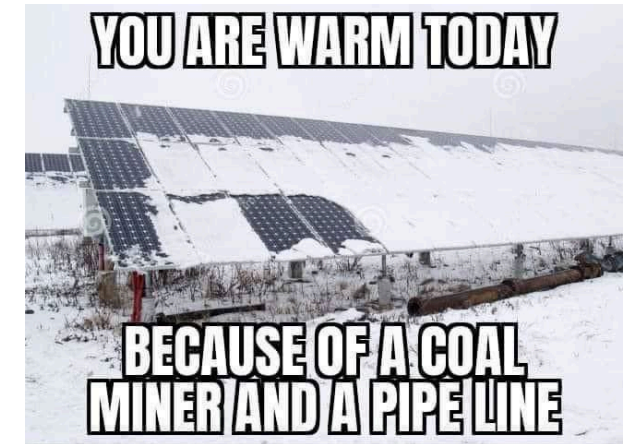
Data compiled Jan. 26, 2023.

Planned retirements include those approved by regulatory bodies, and those announced for closure but still pending regulatory approval. Also includes company announcements of broader coal capacity phaseouts.

Announced retirements are compiled on a best-effort basis.

Source: S&P Global Market Intelligence.

© 2023 S&P Global.



Source: S&P

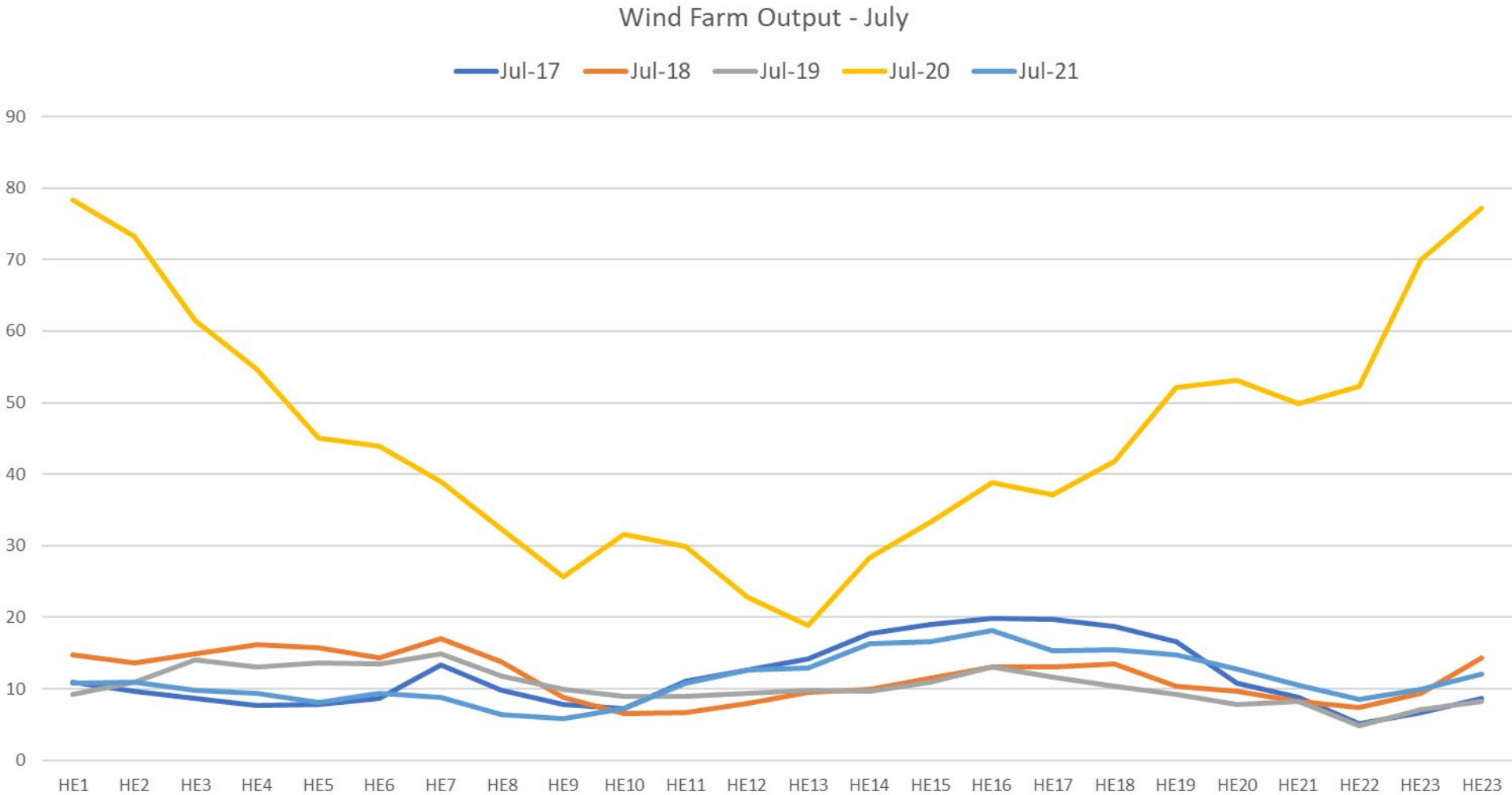
# RENEWABLES EVALUATION

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Get Good Help

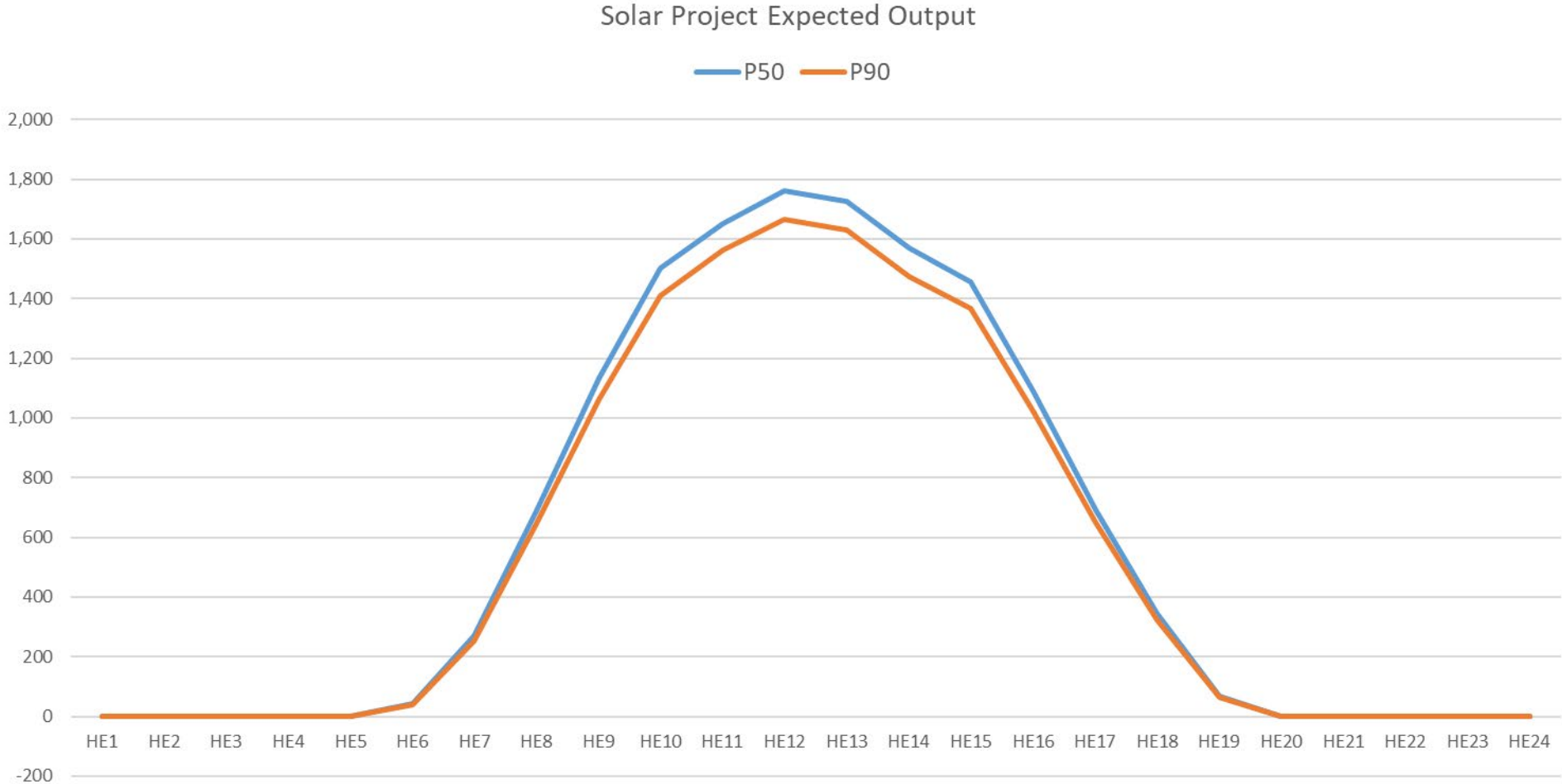
# Wind Volumes: As-Gen vs Firm

As-Gen Volumes for Wind have a wider distribution than As-Gen for Solar. Much Less Predictable



# Solar Volumes: As-Gen vs Firm

Solar is more predictable but still can have a wide distribution of actual output. Which probability-based volume set do you use?



# Hourly Matched vs Annually/Monthly Matched

Do you need 7x24 hourly matching? ISOs will be moving the attribute tracking systems to hourly



NEWS  
RELEASE

FOR IMMEDIATE RELEASE

**PJM EIS To Produce Energy Certificates Hourly**  
*Service Offered To Track 24-Hour Carbon-Free Generation*

(Valley Forge, PA – Feb. 13, 2023) – PJM Environmental Information Services, Inc. will provide hourly, time-stamped certificates for PJM generation starting in March 2023, answering the growing demand for procuring and tracking carbon-free energy around the clock.

PJM Environmental Information Services, Inc. (PJM EIS), a subsidiary of PJM Interconnection, LLC, manages the Generation Attribute Tracking System (GATS). GATS is a trading platform designed to meet the needs of buyers and sellers involved in the carbon-free energy market, from homeowners and aggregators to state and federal agencies and other market participants seeking to reduce their carbon footprint.

For both the electric utilities and generation suppliers, GATS helps meet state and federal environmental requirements associated with electric operations, such as renewable portfolio standard (RPS) compliance and emissions disclosure.

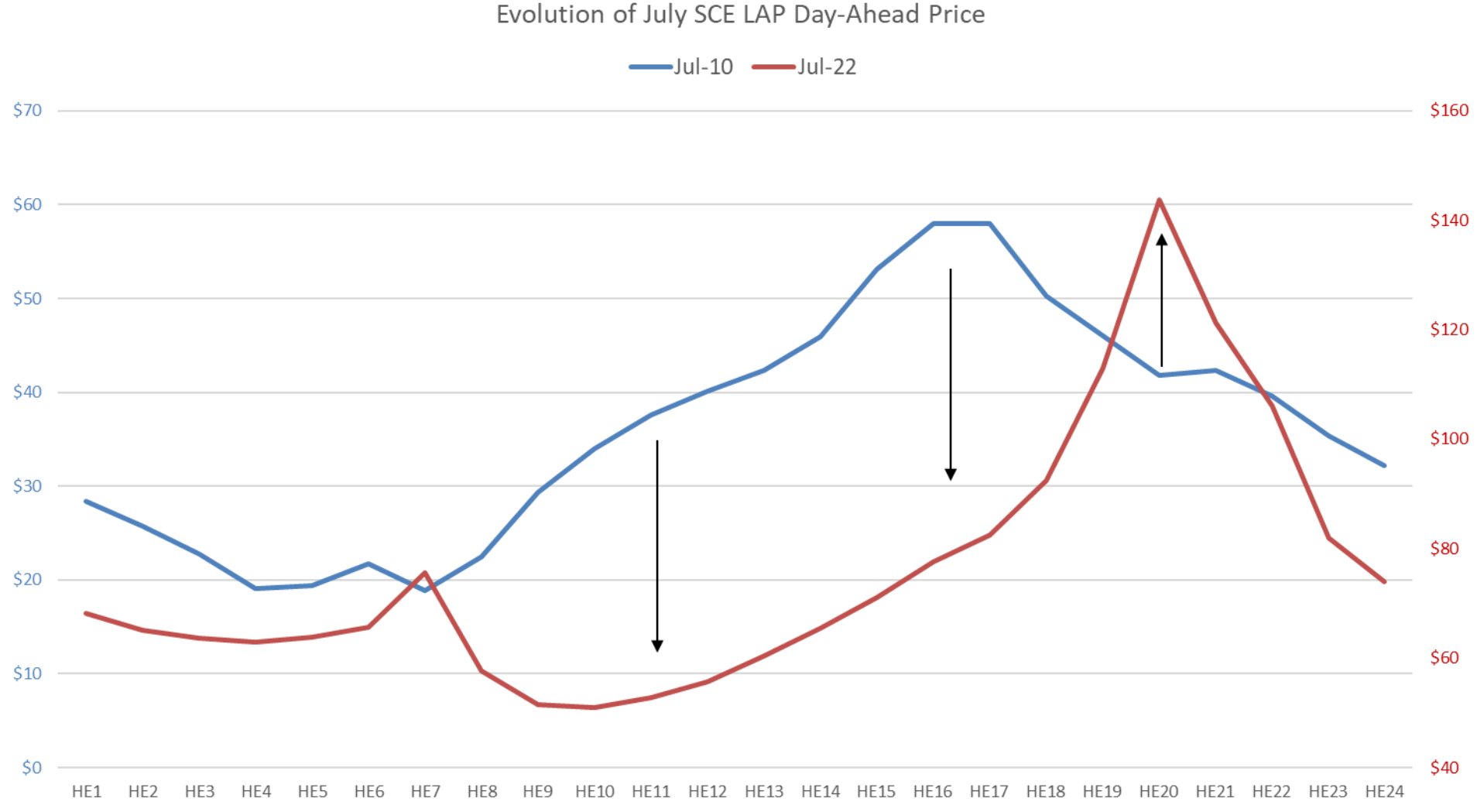
Each certificate represents one megawatt-hour of electricity produced and includes generator location, emissions output, fuel source and date the generator went online. Currently, GATS produces certificates based on how much energy a resource produces in a month. Now GATS becomes the first registry in the U.S. to produce hourly, time-stamped certificates to reflect not only where, but the hour and date when energy is produced.

"We recognize that customers are interested in more granular, real-time data that can be used to innovate new ways to incentivize clean energy," said Ken Schuyler, President – PJM EIS. "Using the unique data offered by GATS, customers can make more informed choices about their energy use."

Advocates of the 24/7 clean-energy approach maintain that that hourly certificates can help electricity consumers, including large government and business customers, tailor their energy consumption to the availability of carbon-free energy at all hours of the day. Such demand expressed through the market could also incentivize new carbon-free generation resources to serve the hours of the day when renewable energy production is currently lacking.

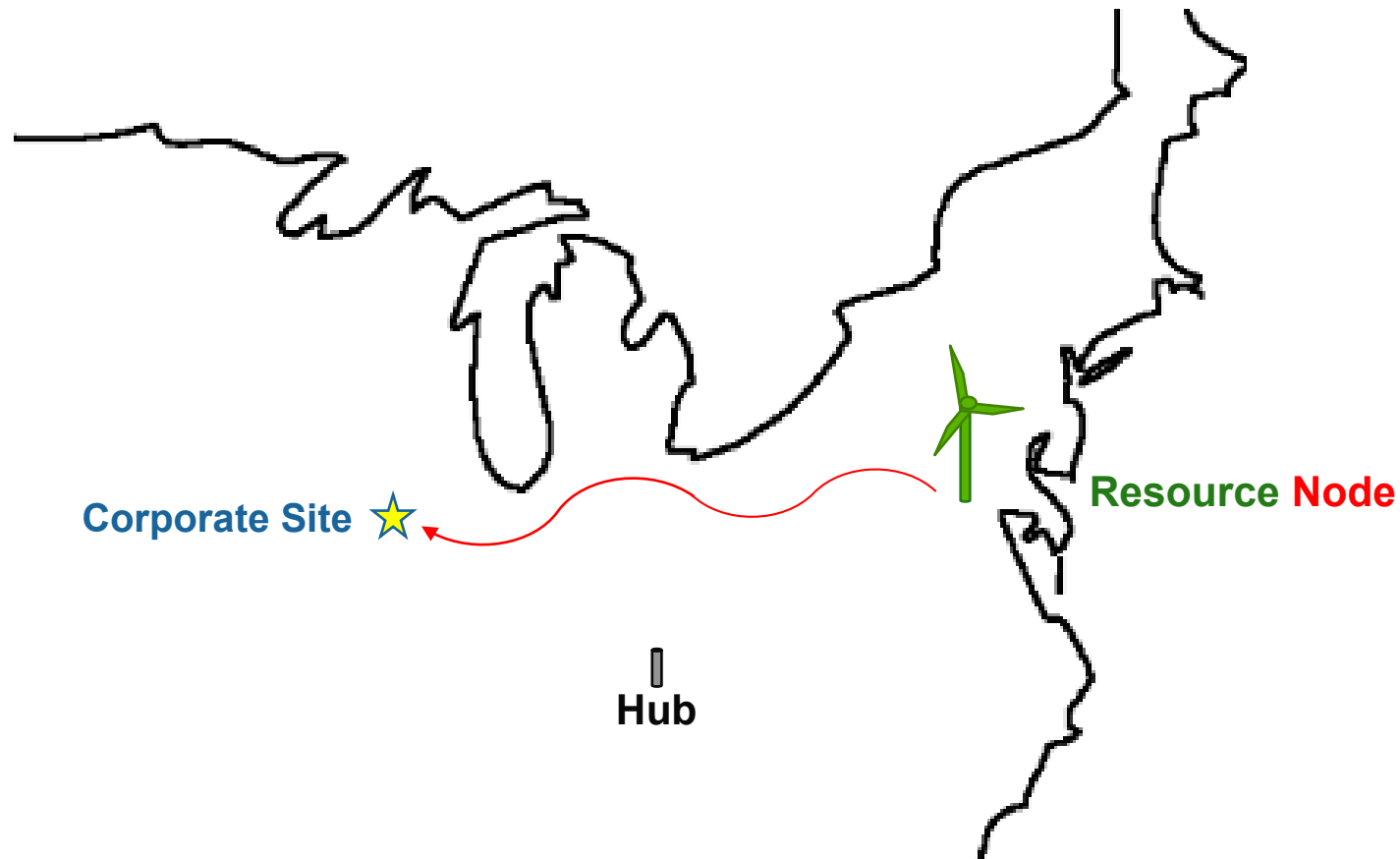
# Value of Hourly Shaping

Pricing hourly shapes, looking at historical LMPs only, will likely result in overvaluation



# Delivery Point: Node Basis Risk

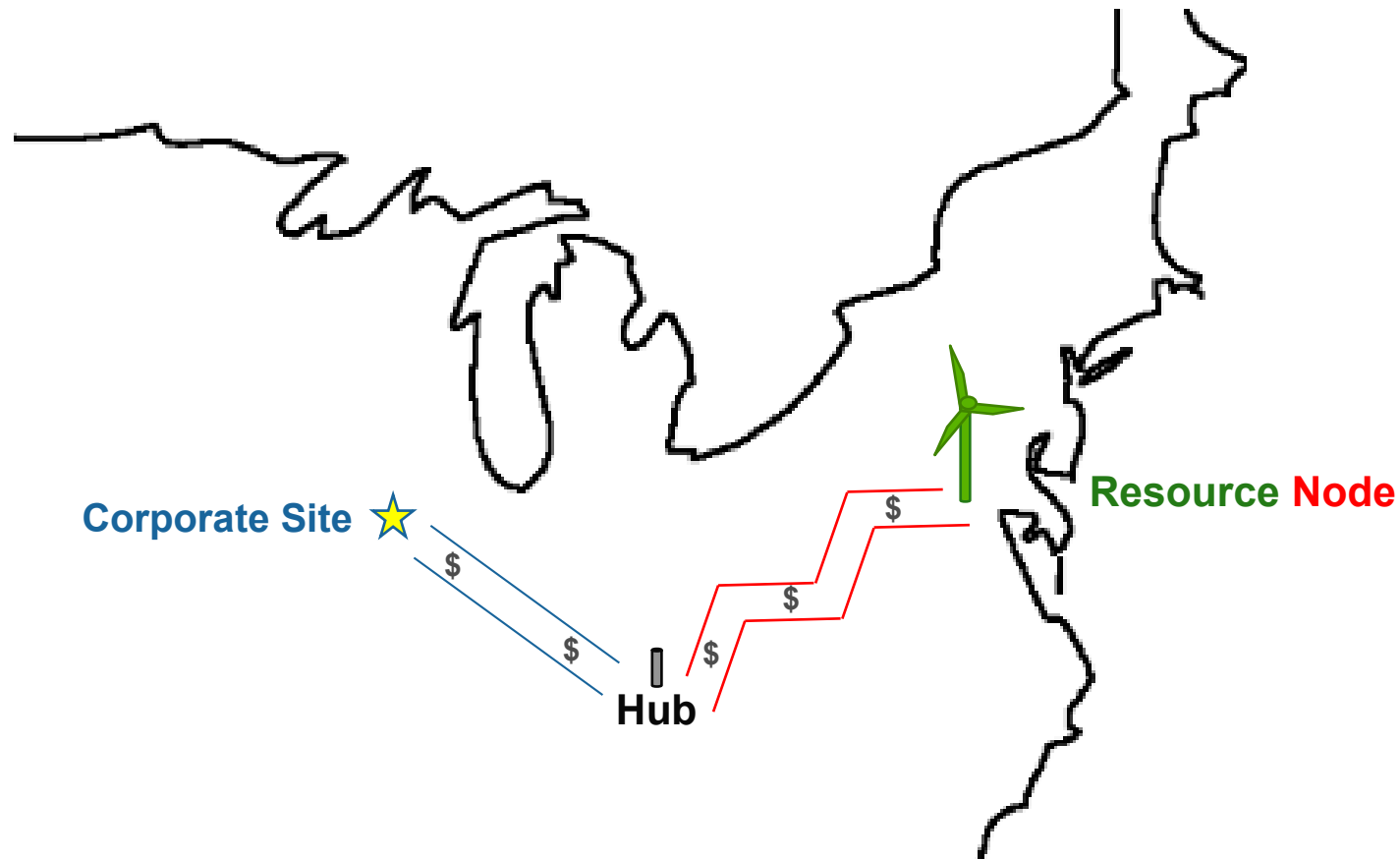
Taking power from a resource node leaves corporate off-takers **on the hook for managing the volatile price spread risk** between the resource node and the corporate facility's load zone





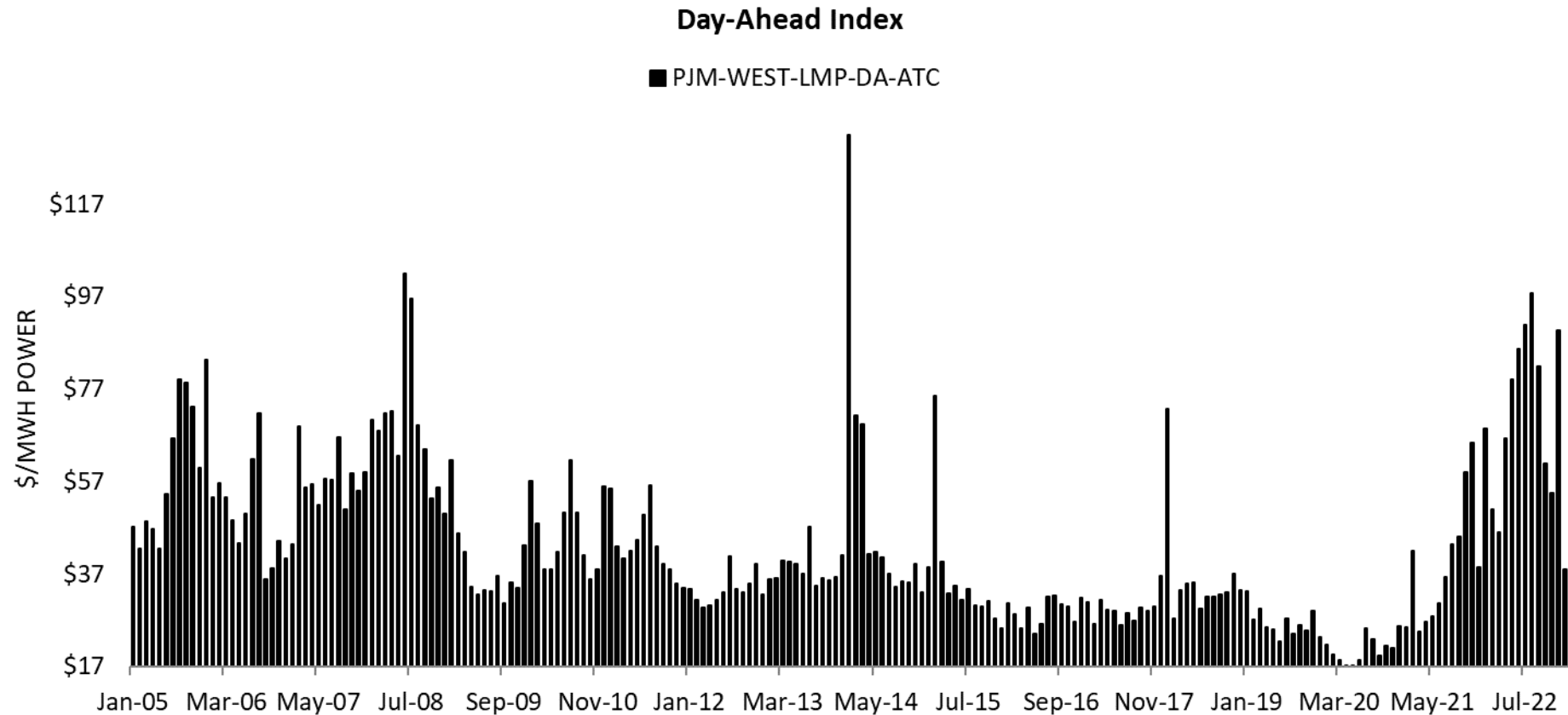
# Delivery Point: Hub Basis Risk

Alternatively, many PPAs offer price exposure at the more liquid Hub. However, this still leaves the off-taker **exposed to the basis spread between Node and Hub**



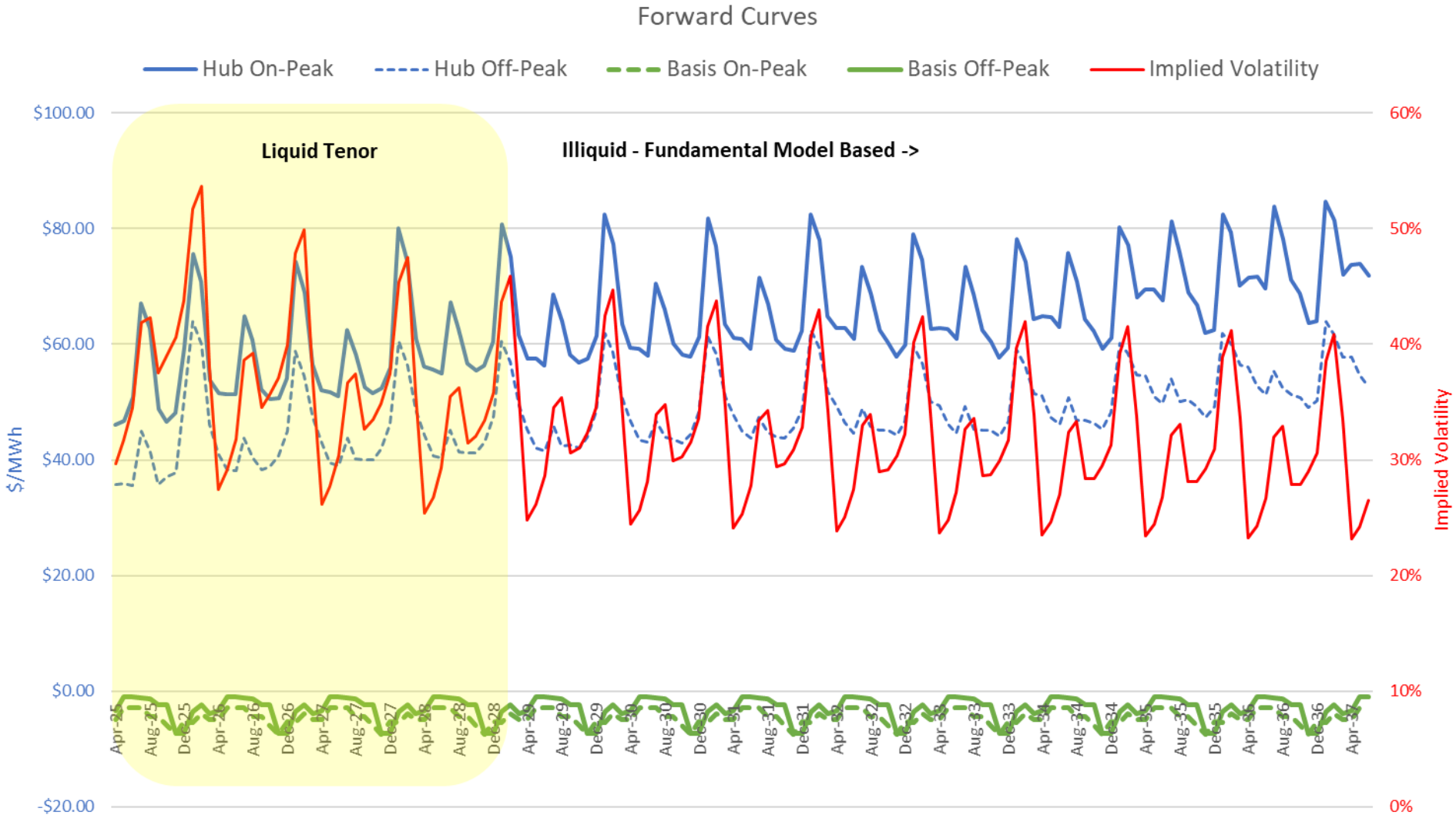
# Using Historic Prices

Evaluating PPAs based on historical LMPs ... which period will you use? Can bias your evaluation too high or too low for a decade



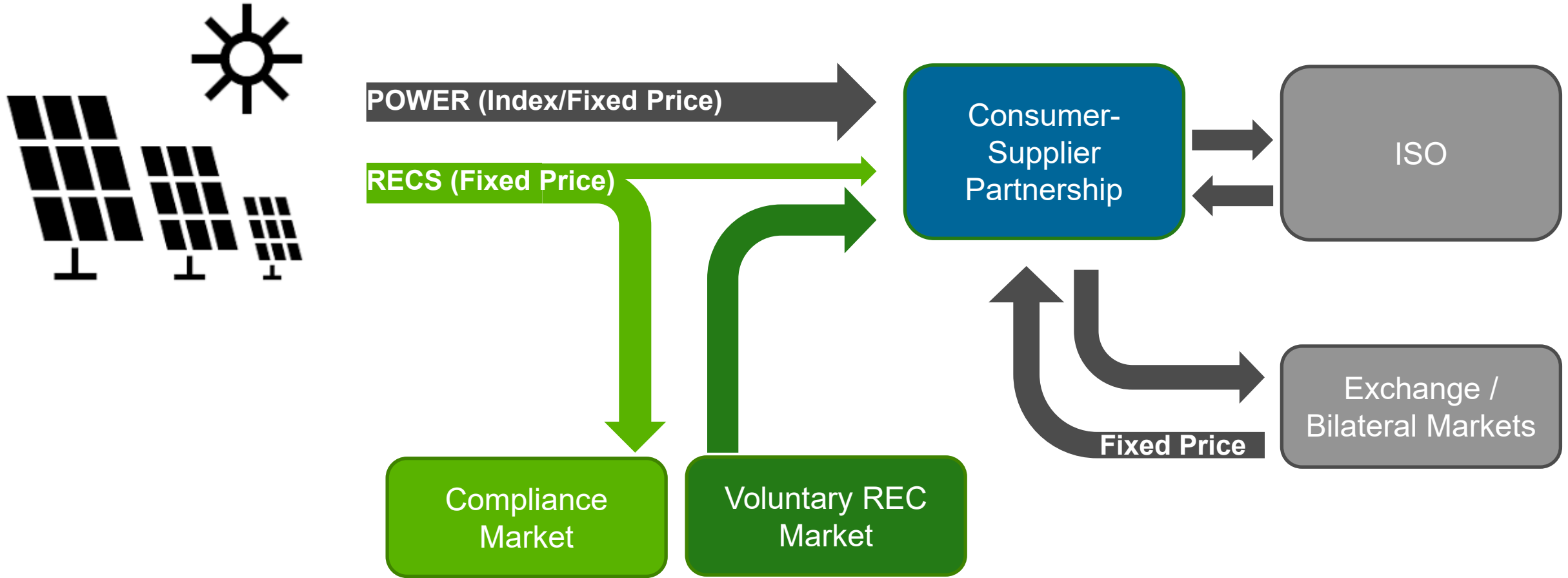
# Using Forwards

Building and maintaining forward curves beyond a 5-year tenor is non-trivial



# Bundled or Decoupled Power/RECs

There are many ways to mix and match the Power and REC attributes associated with a project





 **CALPINE**  
ENERGY SOLUTIONS

## **Biographical Information**

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Seasoned professional with Calpine Energy Solutions. Over 25 years of providing Electric and Gas supply with extensive risk management applications around various renewable energy deliverables. Have worked with large Industrial and Commercial customer in providing unique products solutions that manages risk in deregulated markets. Vast knowledge of understanding customer needs and providing simple solutions around company's new sustainability goals and objectives to manage cost and risk associated with corporate goals.

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Josh has over 20 years of deregulated power and gas experience, with roles spanning quantitative modelling, structured products, M&A, and trading and portfolio management. He currently manages the retail portfolios for Calpine's three retail business units in the NE and MW regions. He earned a Bachelor of Science degree in Electrical Engineering from the University of California, San Diego, a Master of Business Administration degree from the University of California, Los Angeles, and is a CFA Charterholder.