

Turmoil in Energy Markets Could “It” Happen in the U.S.?

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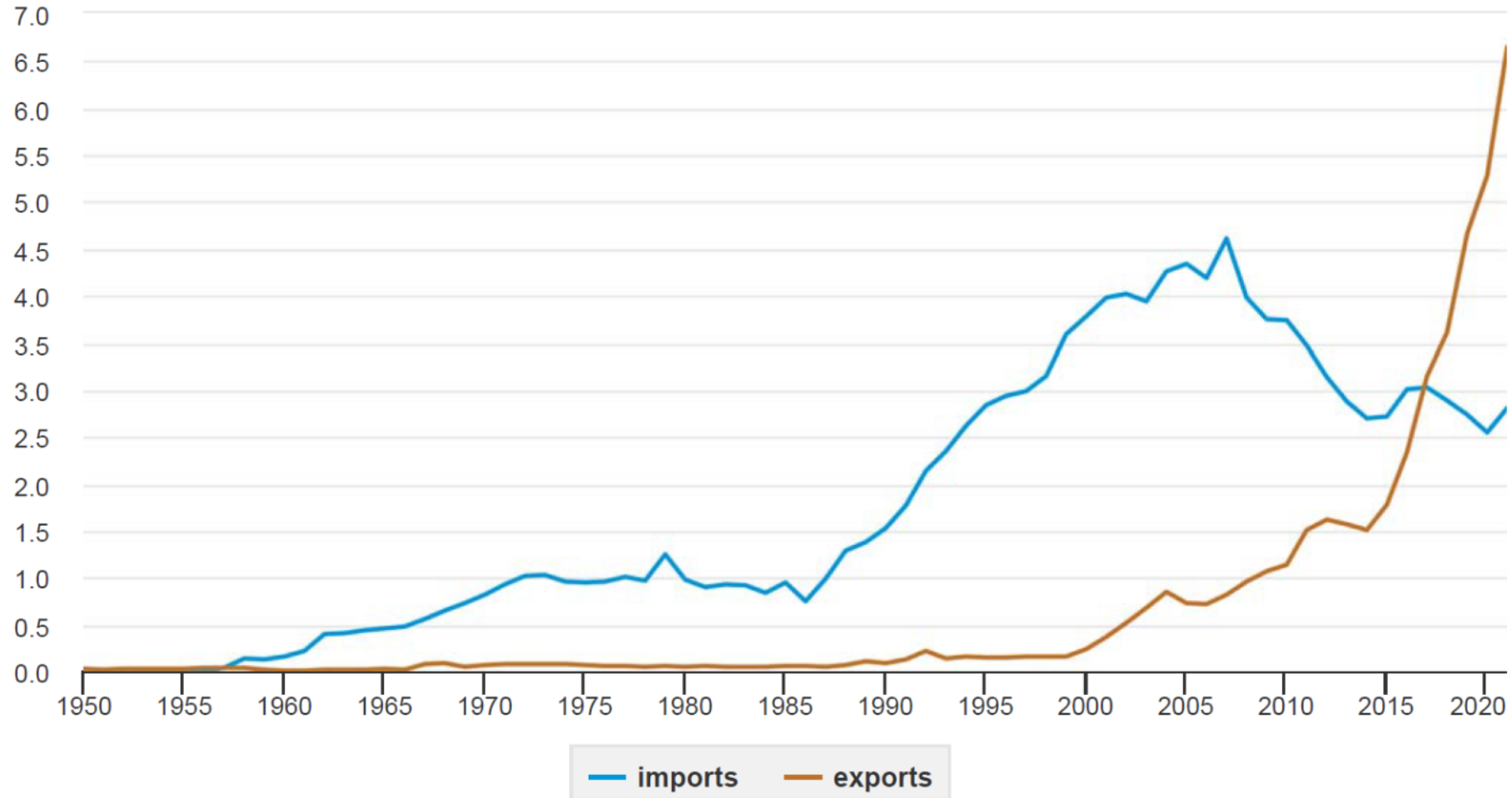
November 17, 2022

What Does “It” Mean?

Natural Gas

U.S. natural gas imports and exports, 1950-2021

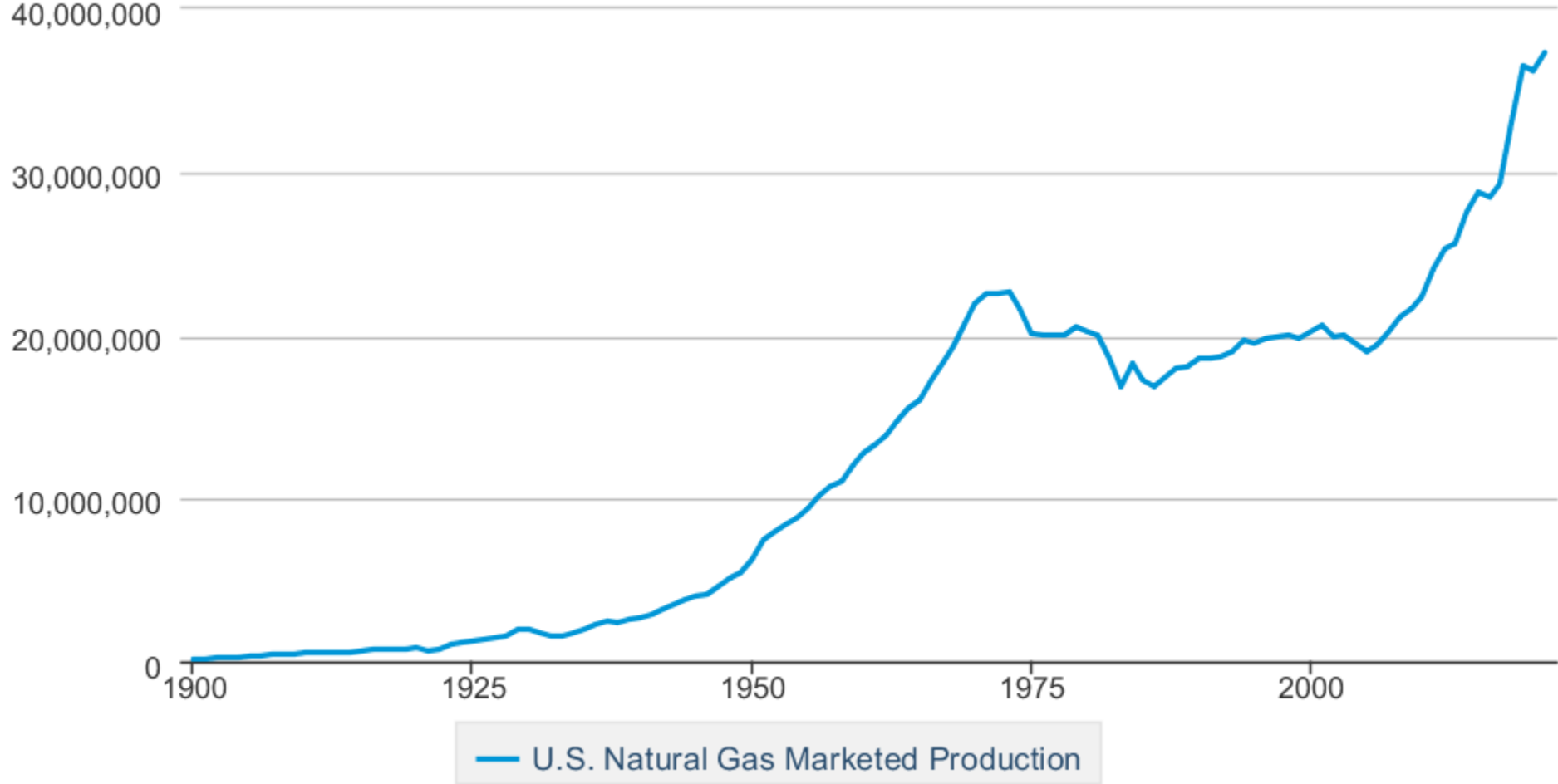
trillion cubic feet



Data source: U.S. Energy Information Administration, *Natural Gas Monthly*, March 2022, preliminary data for 2021

U.S. Natural Gas Marketed Production

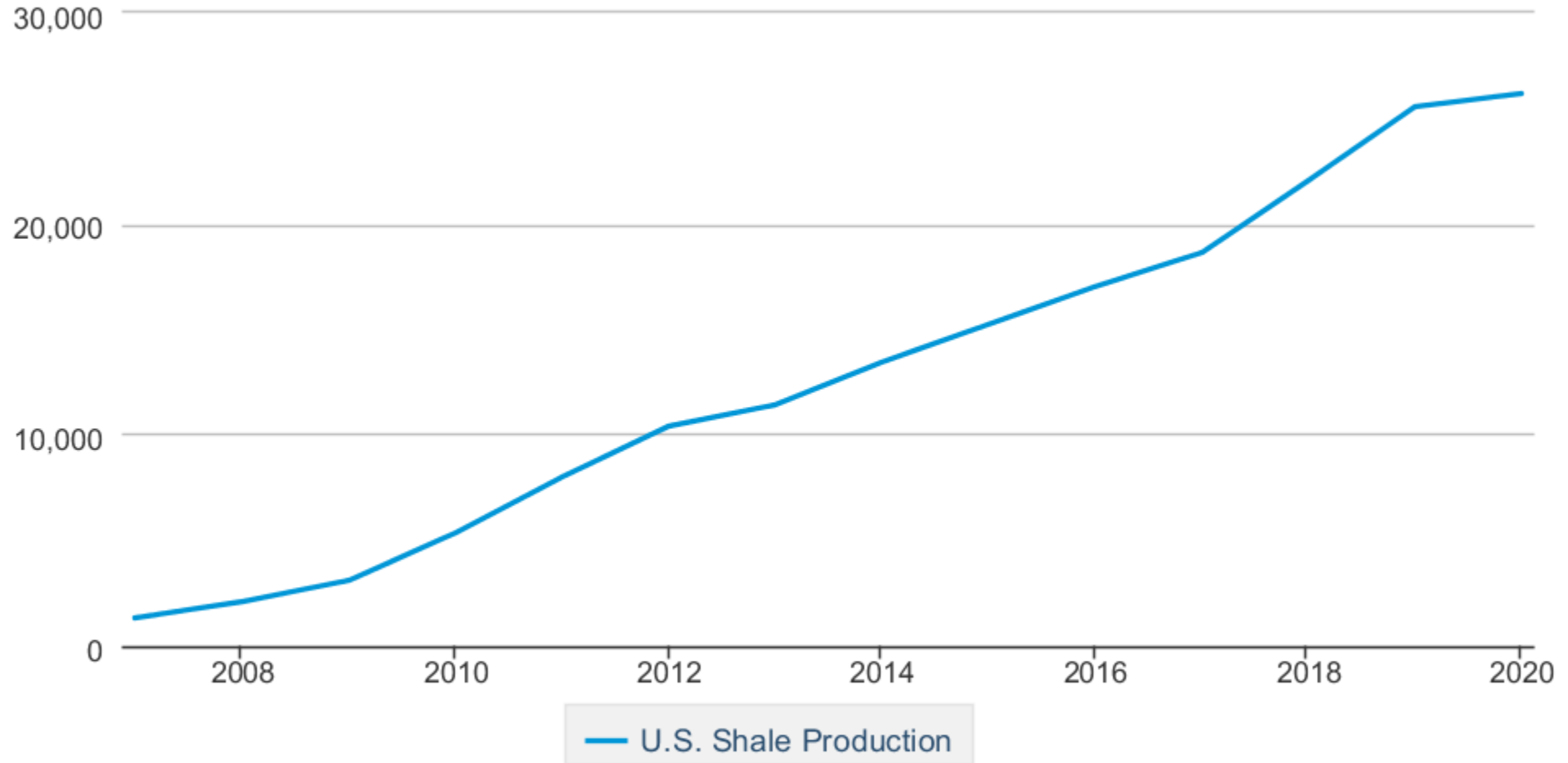
Million Cubic Feet



Source: U.S. Energy Information Administration

U.S. Shale Production

Billion Cubic Feet

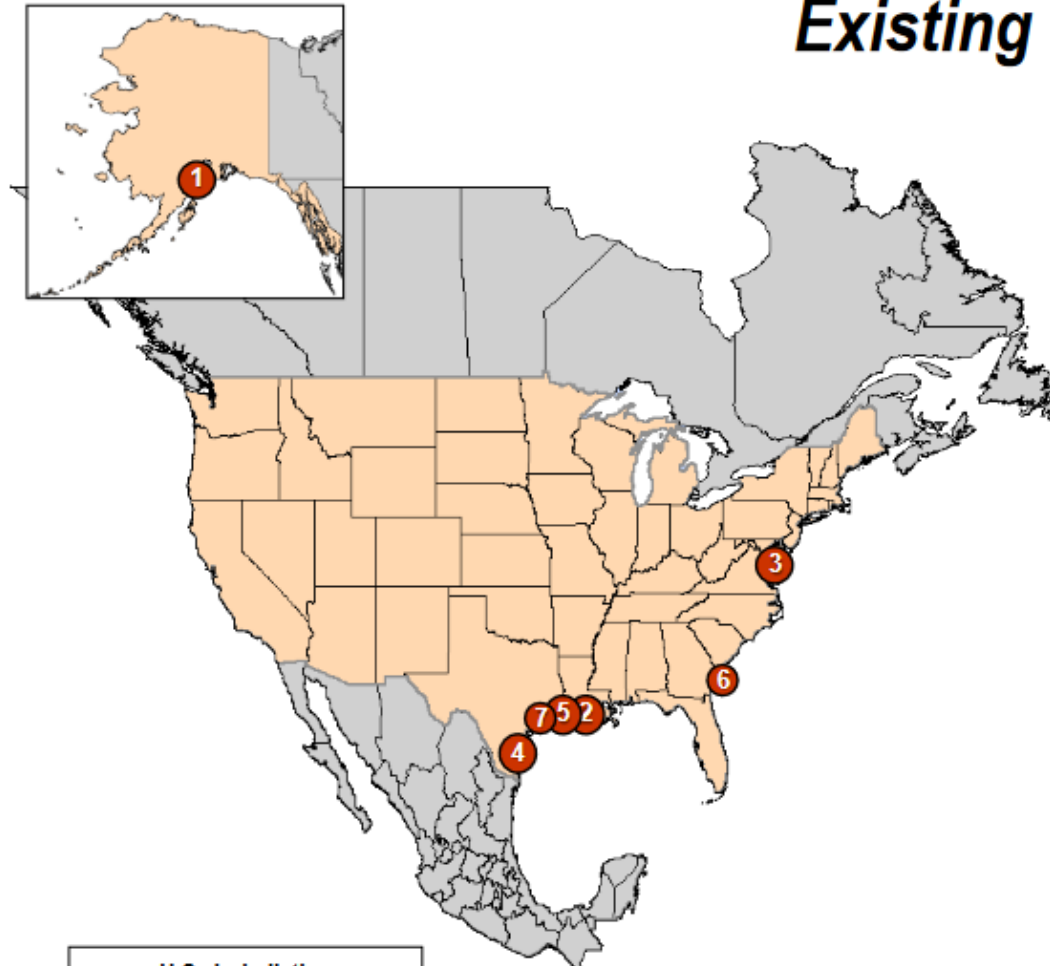


Source: U.S. Energy Information Administration



North American LNG Export Terminals

Existing



U.S. Jurisdiction

- FERC
- MARAD / U.S. Coast Guard

Export Terminals

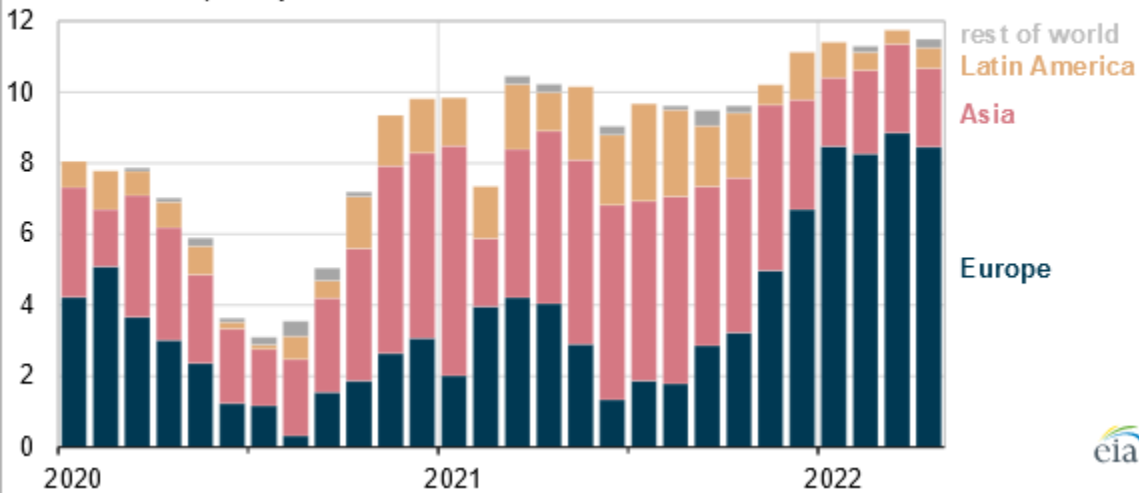
UNITED STATES

1. **Kenai, AK:** 0.2 Bcfd (Trans-Foreland)
2. **Sabine, LA:** 4.55 Bcfd (Cheniere/Sabine Pass LNG – Trains 1-6)
3. **Cove Point, MD:** 0.82 Bcfd (Dominion–Cove Point LNG)
4. **Corpus Christi, TX:** 2.40 Bcfd (Cheniere – Corpus Christi LNG Trains 1-3)
5. **Hackberry, LA:** 2.15 Bcfd (Sempra–Cameron LNG, Trains 1-3)
6. **Elba Island, GA:** 350 MMcfd (Southern LNG Company Units 1-10)
7. **Freeport, TX:** 2.13 Bcfd (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction Trains 1-3)

As of February 16, 2022



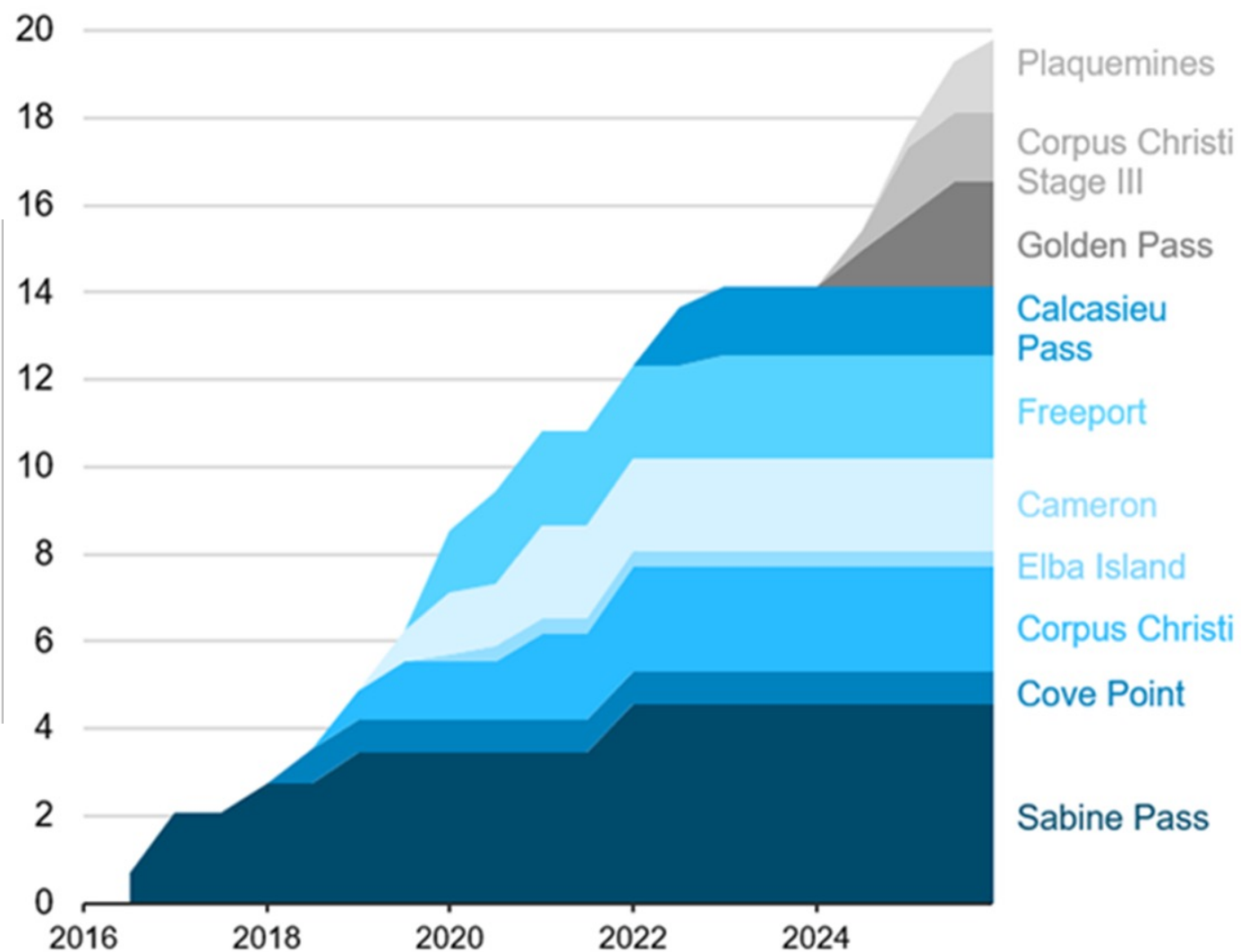
Monthly U.S. liquefied natural gas exports by destination region (Jan 2020–Apr 2022)
billion cubic feet per day



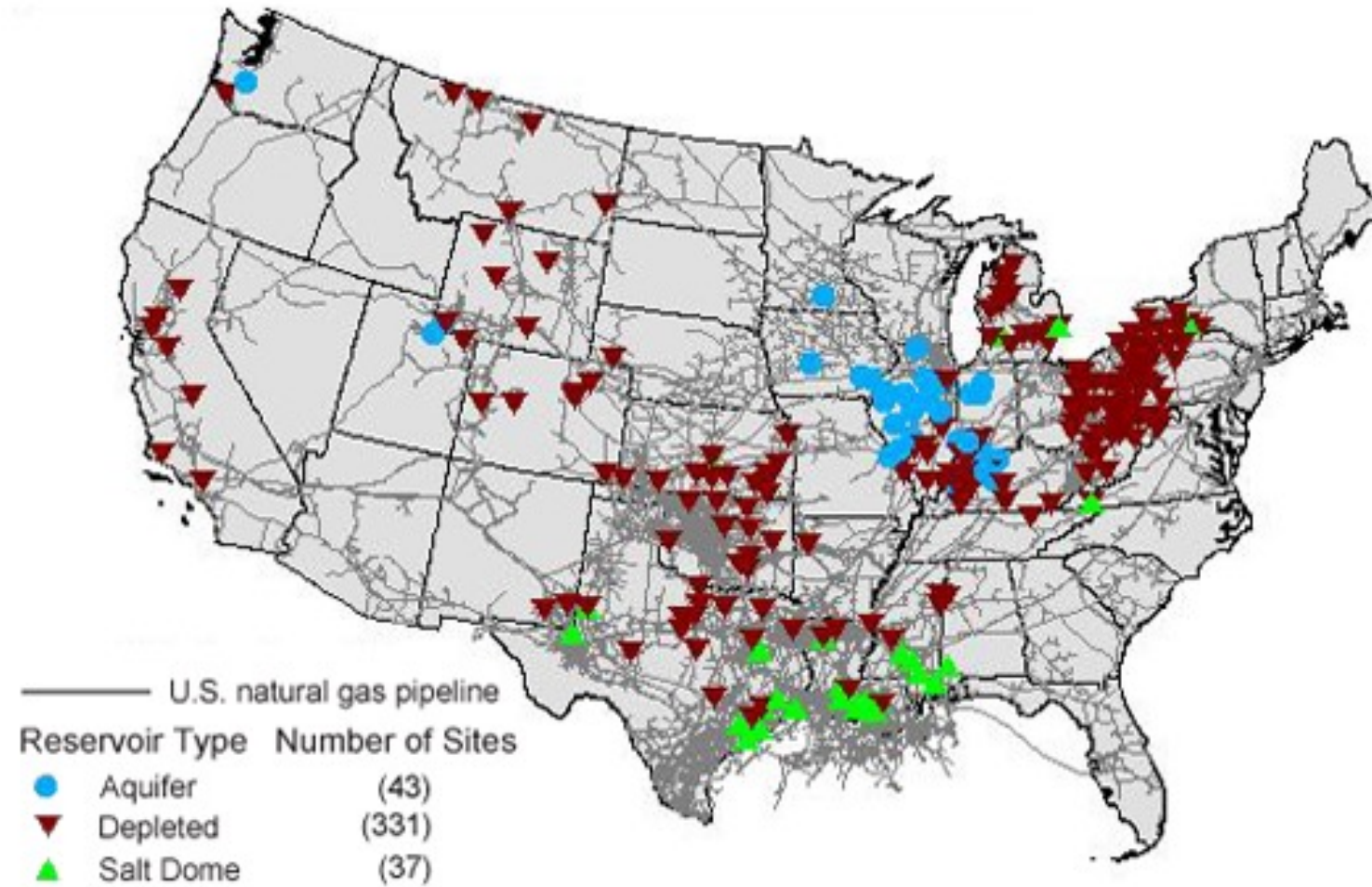
U.S. liquefied natural gas export capacity by project—existing and under construction (2016–2025)



billion cubic feet per day



U.S. Natural Gas Storage

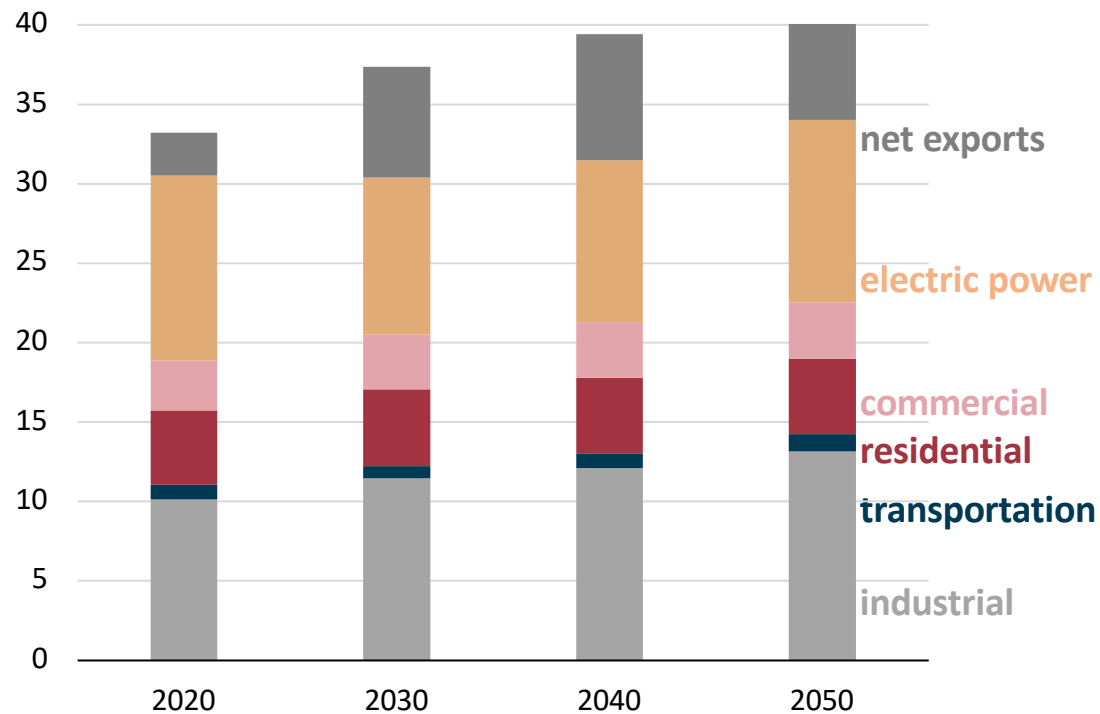


Natural gas consumption rises mostly because of industrial use and exports

Natural gas disposition and net exports

AEO2022 Reference case

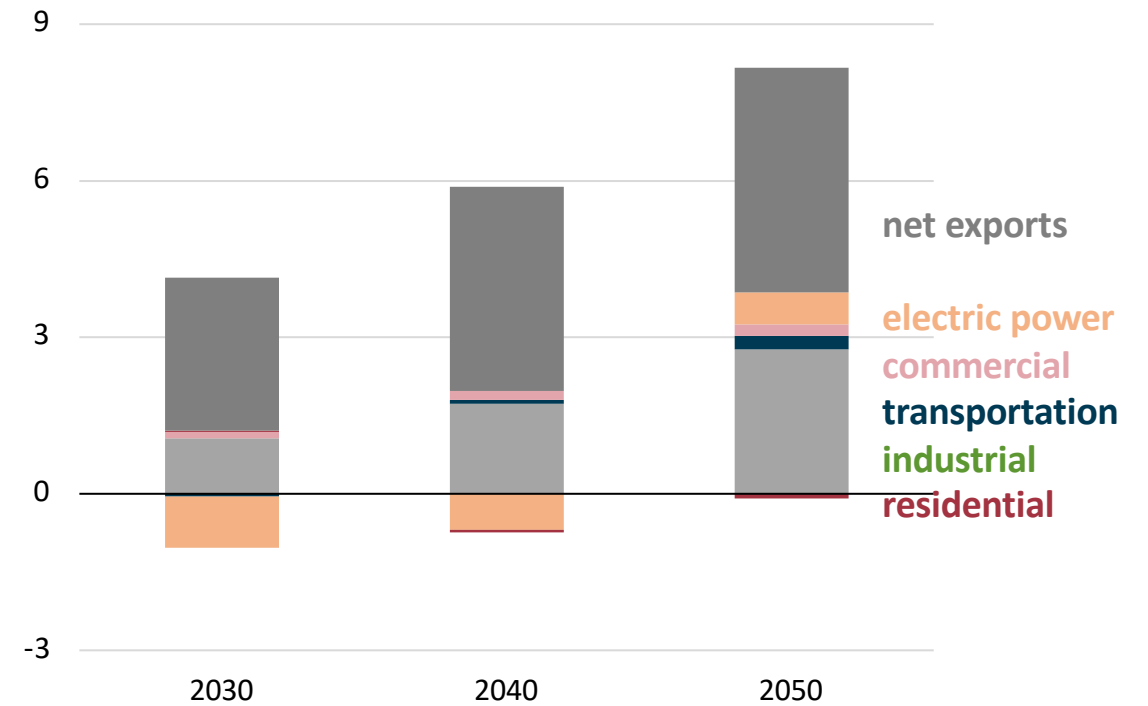
trillion cubic feet



Change in natural gas disposition and net exports

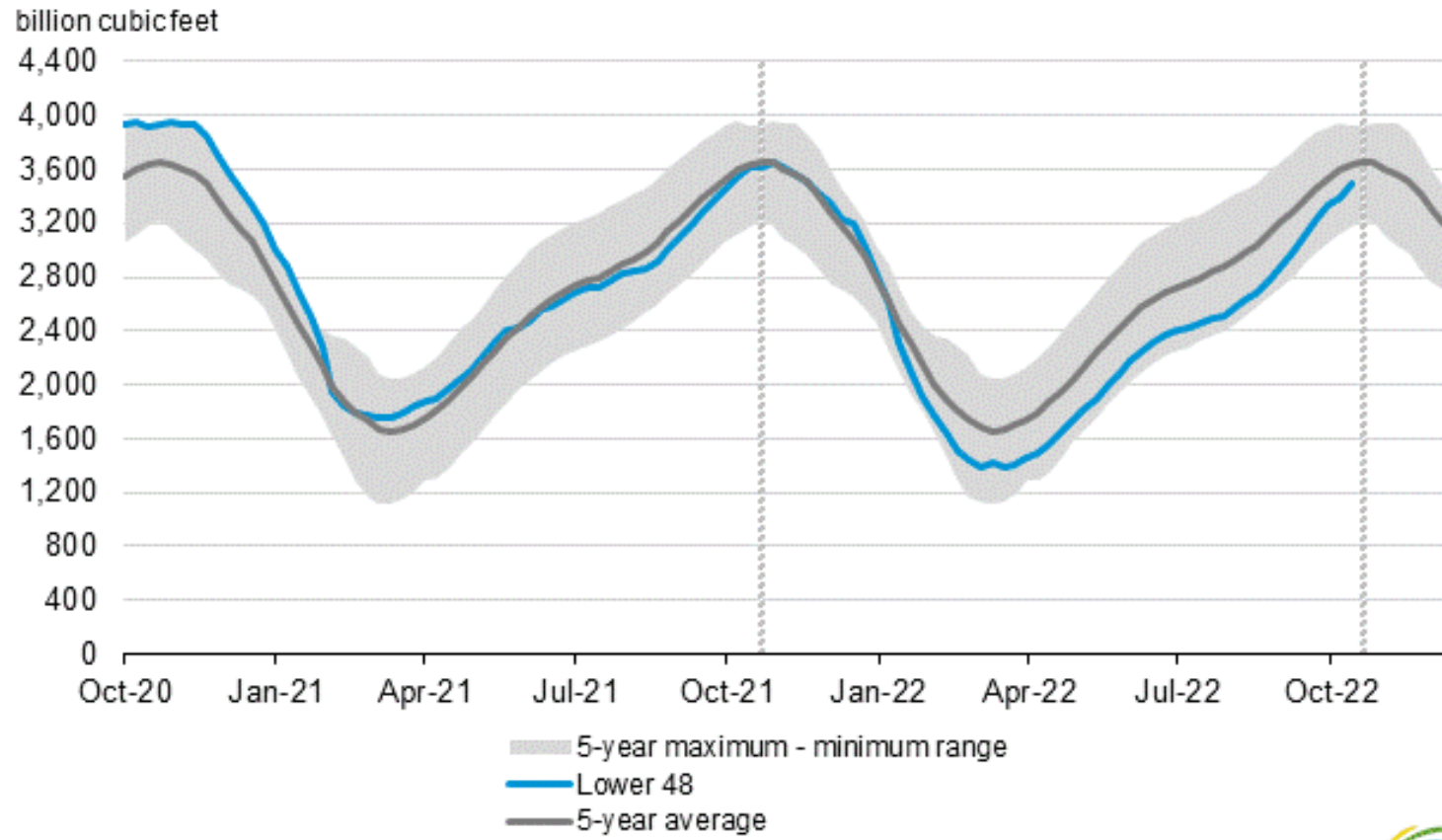
AEO2022 Reference case

relative to 2021 in trillion cubic feet





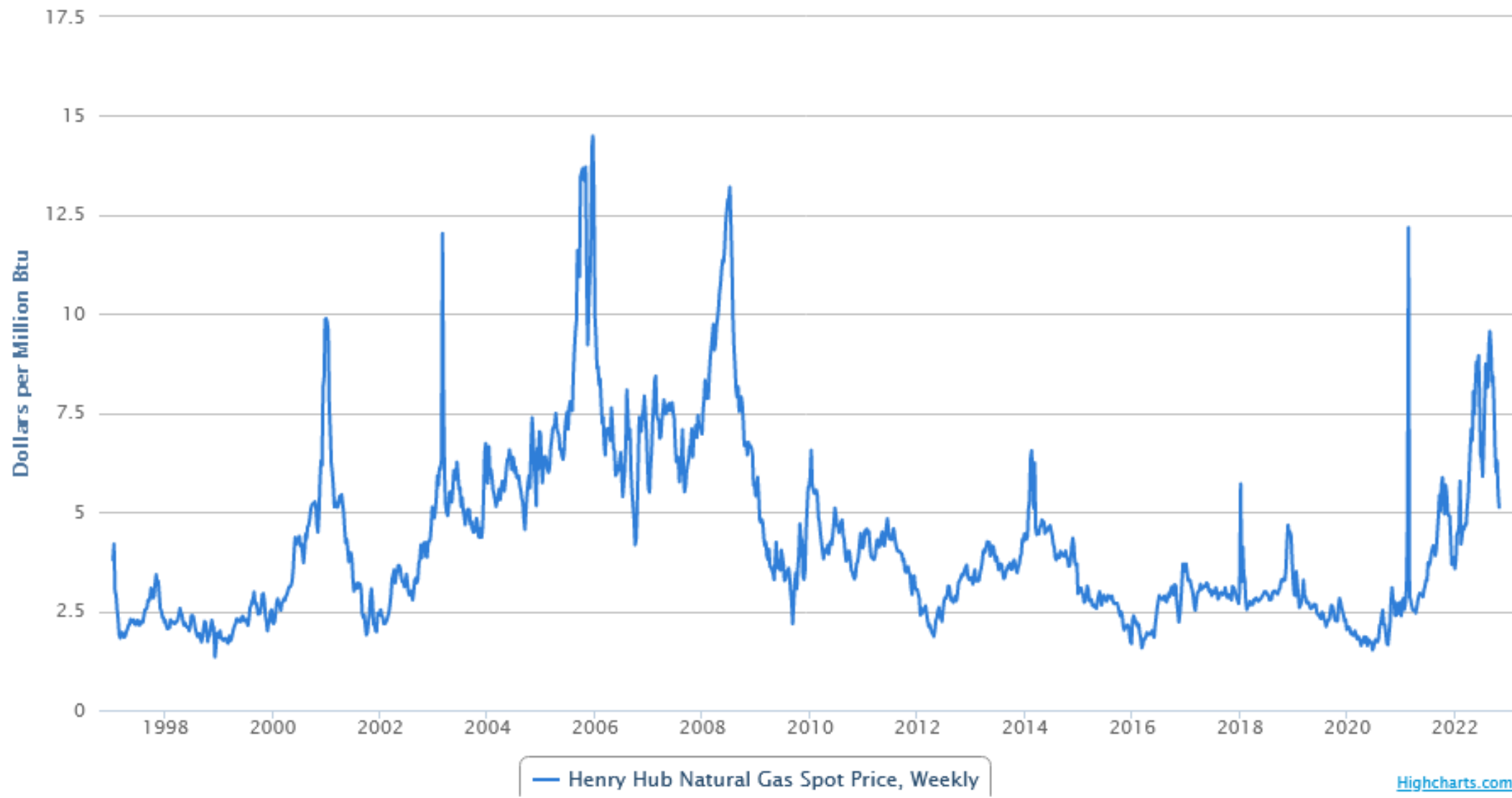
Working gas in underground storage compared with the 5-year maximum and minimum



Source: U.S. Energy Information Administration

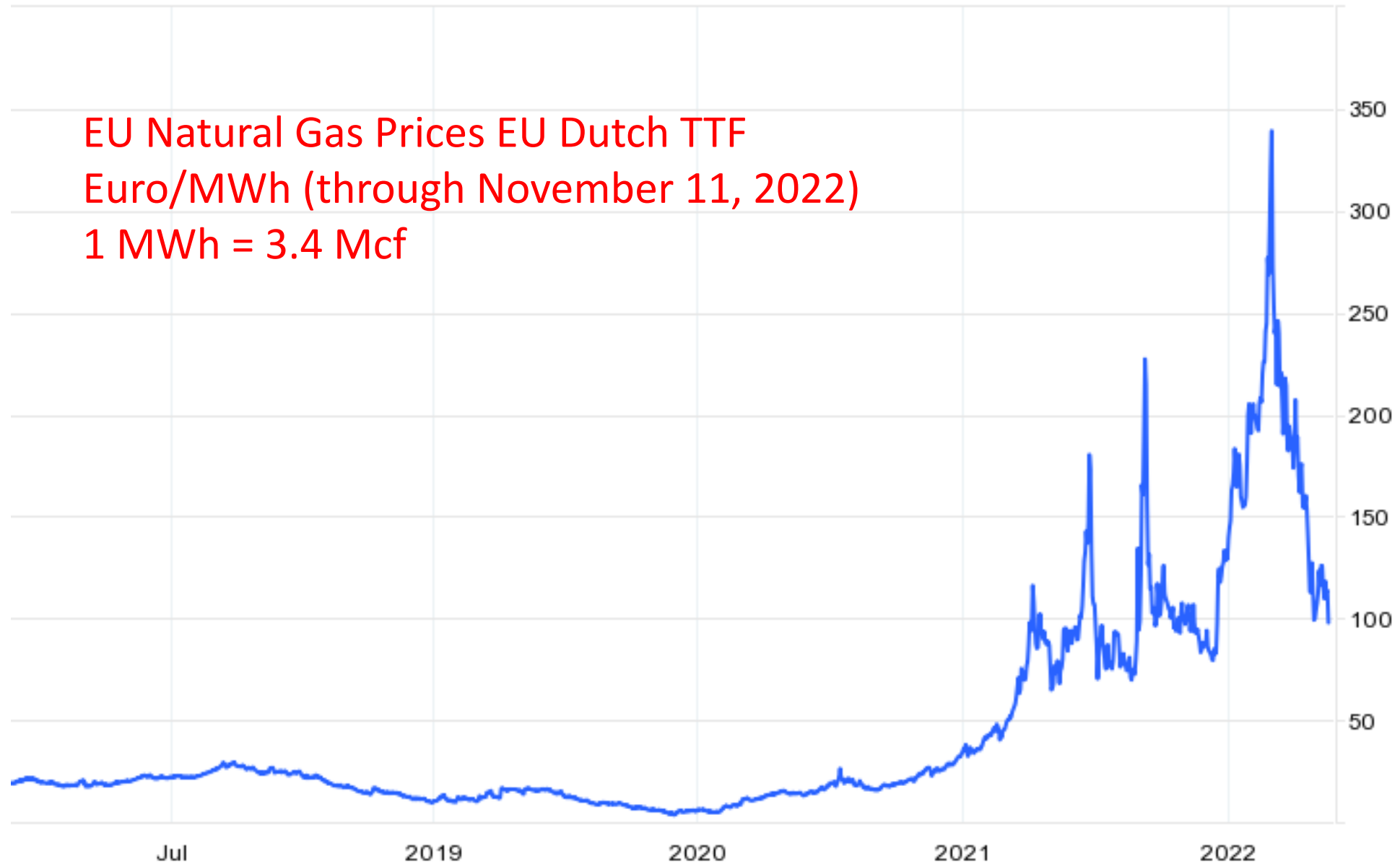


Henry Hub Natural Gas Spot Price, Weekly

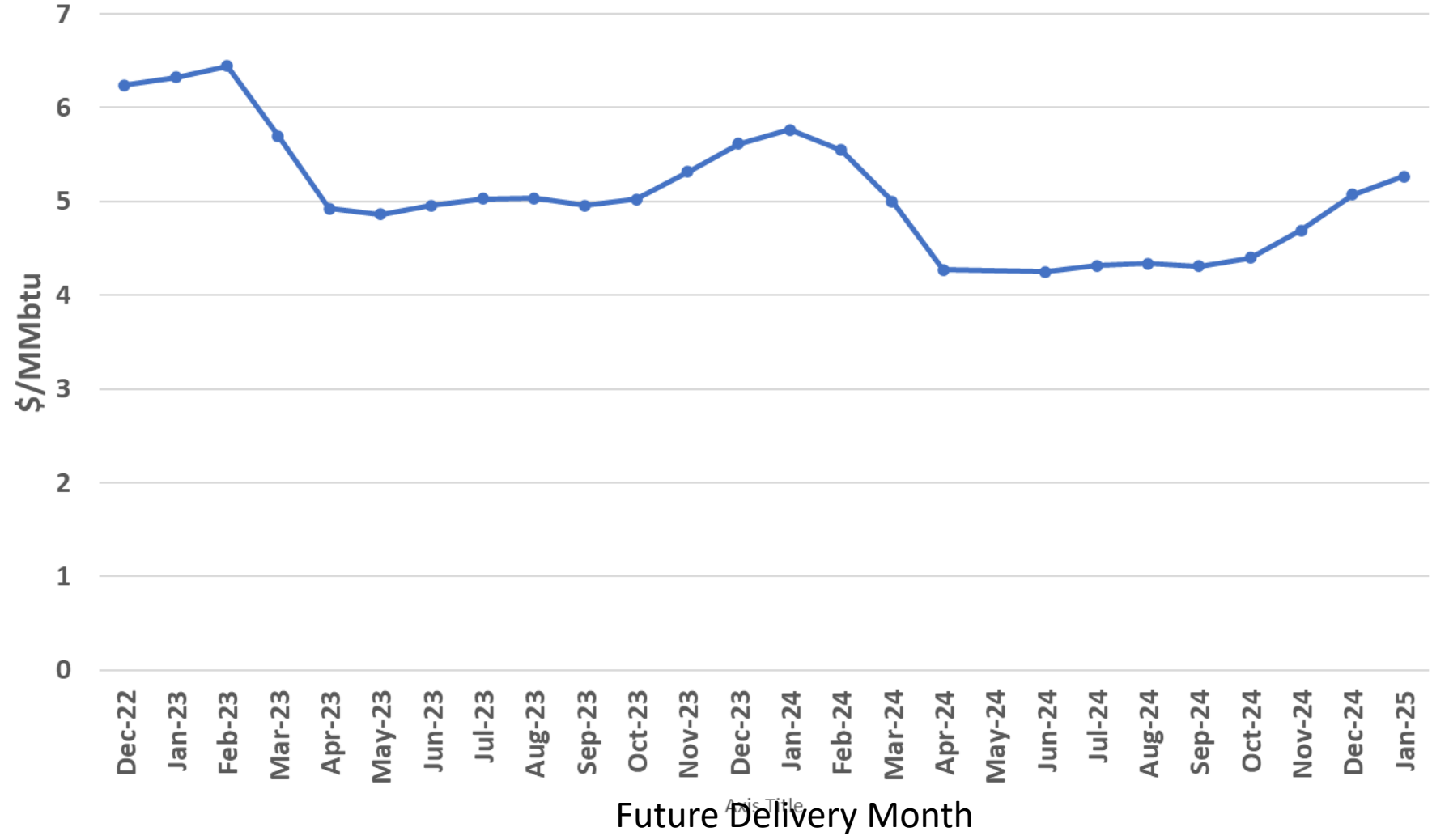


Thru November 1, 2022

EU Natural Gas Prices EU Dutch TTF
Euro/MWh (through November 11, 2022)
1 MWh = 3.4 Mcf

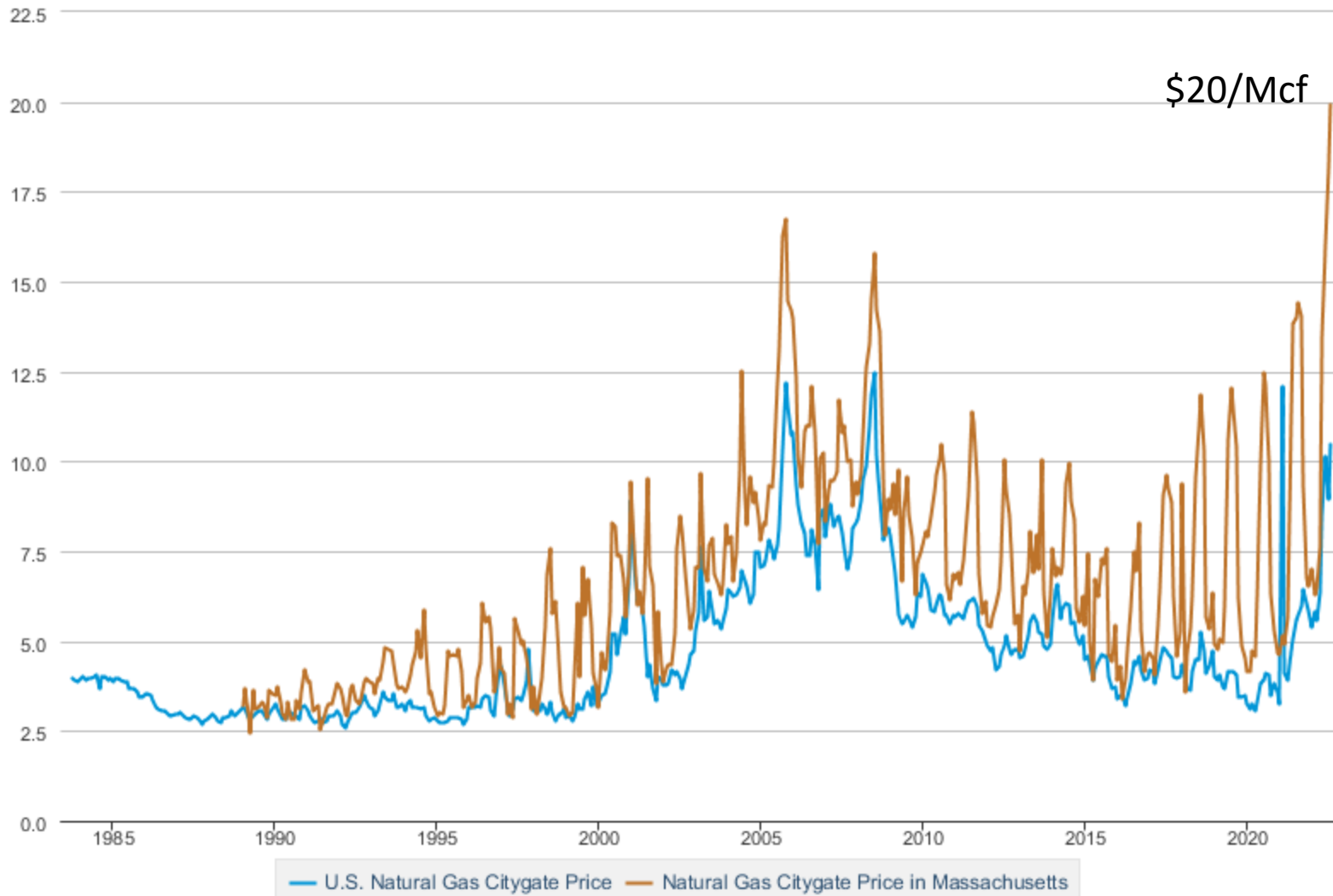


Natural Gas Futures Prices (NYMEX/Globex) November 10, 2022 \$/MMbtu



Natural Gas Summary

\$/Mcf



MA Futures:
December 22: ~ \$35
January 23: ~ \$40

Source: U.S. Energy Information Administration

There but for the grace ...

Table 1. Total energy supply and disposition in the *AEO2004* reference case: summary, 2001-2025

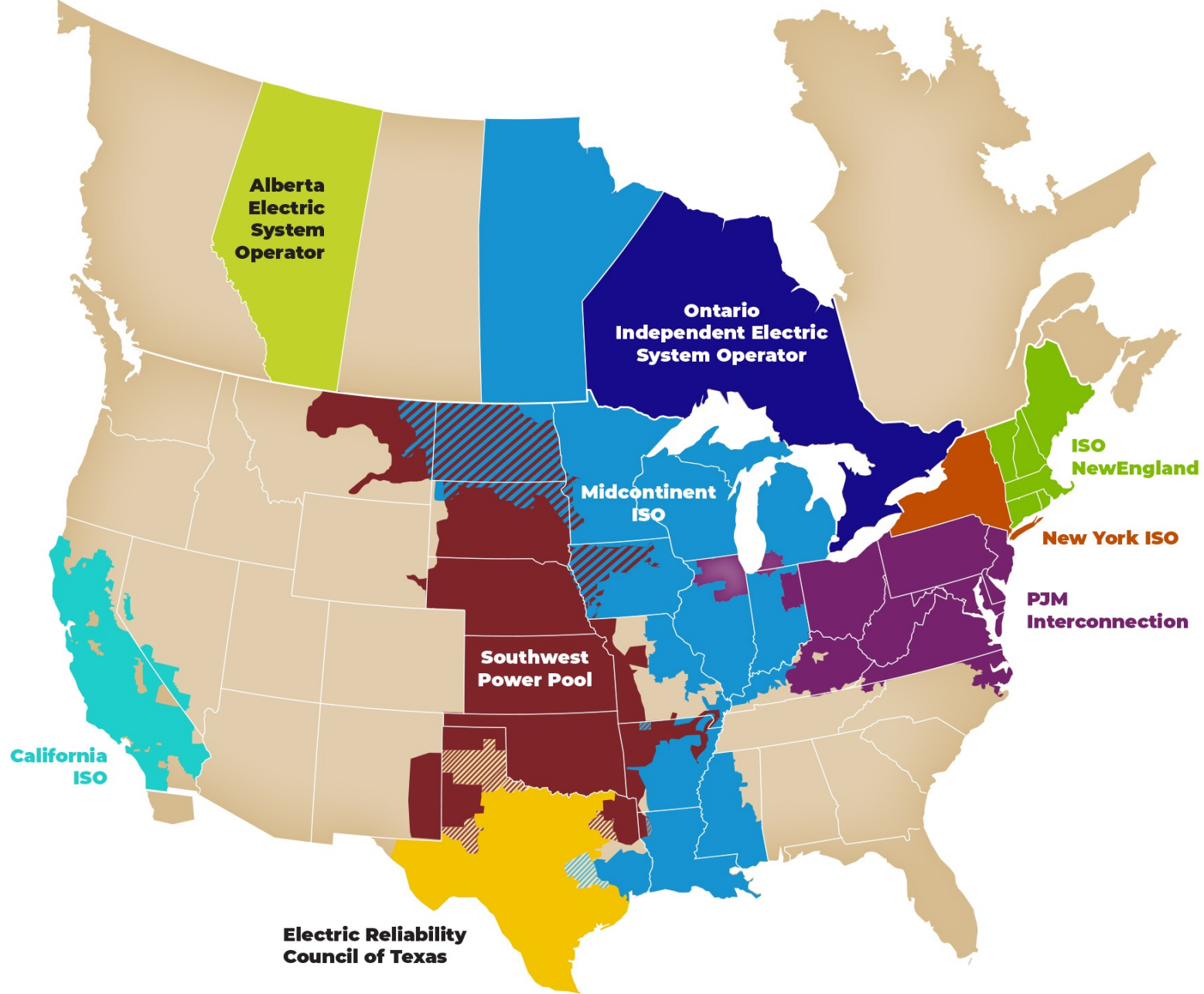
Energy and economic factors	2001	2002	2010	2015	2020	2025	Average annual change, 2002-2025
Primary energy production (quadrillion Btu)							
Petroleum	14.70	14.47	15.66	14.91	13.95	13.24	-0.4%
Dry natural gas	20.23	19.56	21.05	22.20	24.43	24.64	1.0%
Coal	23.97	22.70	25.25	26.14	27.92	31.10	1.4%
Nuclear power	8.03	8.15	8.29	8.48	8.53	8.53	0.2%
Renewable energy	5.25	5.84	7.18	7.84	8.45	9.00	1.9%
Other	0.53	1.13	0.88	0.79	0.81	0.84	-1.3%
Total	72.72	71.85	78.30	80.36	84.09	87.33	0.9%
Net imports (quadrillion Btu)							
Petroleum	23.29	22.56	28.13	33.20	37.25	41.69	2.7%
Natural gas	3.69	3.58	5.63	6.39	6.63	7.41	3.2%
Coal/other (- indicates export)	-0.67	-0.51	0.06	0.26	0.43	0.61	NA
Total	26.31	25.63	33.82	39.84	44.31	49.71	2.9%

A Natural Gas Import Terminal in Every Port

Table 12. North American LNG regasification proposals as of December 1, 2003 (million cubic feet per day)

Project	Owners	Location	Start year	Capacity added
West Coast				
Terminal GNL Mar Adentro de B.C.	ChevronTexaco	Baja California, Mexico (offshore)	2007	750
Tijuana Regional Energy Center	Marathon/Golar LNG/Grupo GGS	Baja California, Mexico	2006	750
Sound Energy Solutions	Mitsubishi	Long Beach, California	2007	700
Terminal LNG de Baja California	Shell	Baja California, Mexico	2007	1,000
Energia Costa Azul LNG	Sempra Energy	Baja California, Mexico	2007	1,000
Crystal	Crystal Energy	Oxnard, California (offshore)	2006	600
Tractebel Mexico	Tractebel	Lazaro Cardenas, Mexico	2007	500
Cabrillo Port LNG	BHP Billiton	Oxnard, California (offshore)	2008	1,500
Florida/Bahamas				
Ocean Express LNG	AES	Ocean Cay, Bahamas	2006	850
Freeport	El Paso	Freeport Grand Island, Bahamas	2007	500
Calypso	Tractebel Bahamas LNG	Freeport Grand Cayman, Bahamas	2007	832
Gulf Coast				
ExxonMobil LNG	ExxonMobil	Quintana Island, Texas	2007	1,000
Sabine Pass/Cheniere	Cheniere	Sabine Pass, Texas	2008	2,000
Port Pelican	ChevronTexaco	Louisiana (offshore)	2007	1,600
Cameron LNG	Sempra Energy	Hackberry, Louisiana	2007	1,500
Altamira	Shell	Altamira, Mexico	2004	500
Corpus Christi LNG	Cheniere Energy	Corpus Christi, Texas	2008	2,000
ExxonMobil/Sabine Pass LNG	ExxonMobil	Sabine Pass, Texas	2008	1,000
Liberty	HNG Storage/Conversion Gas	Cameron, Louisiana	2007	3,000
Main Pass Energy Hub	Freeport-McMoRan Sulphur	Gulf of Mexico (offshore)	2006	1,500
Gulf Landing	Shell	West Cameron, Louisiana (offshore)	2008-2009	1,000
Vermilion 179	Conversion Gas Imports	Louisiana	2008	1,000
Mobile Bay LNG	ExxonMobil	Mobile Bay, Alabama	2008	1,000
Freeport LNG	Freeport, Cheniere, Contango	Freeport, Texas	2006	1,500
Energy Bridge	El Paso	Floating Dock (offshore)	2005	500
East Coast				
Canaport	Irving Oil/Chevron Texaco	Canaport, New Brunswick, Canada	2006	500
Weaver's Cove	Poten	Fall River, Massachusetts	2007	400
Access Northeast Energy	Access Northeast Energy	Bearhead, Nova Scotia, Canada	2008	500
Fairwinds LNG	TransCanada, ConocoPhillips	Harpswell, Maine	2009	500
Providence LNG	Keyspan, BG LNG Services	Providence, Rhode Island	2005	500
Crown Landing	BP	Logan Township, New Jersey	2008	1,200
Somerset LNG	Somerset LNG	Somerset, Massachusetts	2007	430

Transmission of Natural Gas Prices to Wholesale and Retail Electricity Prices



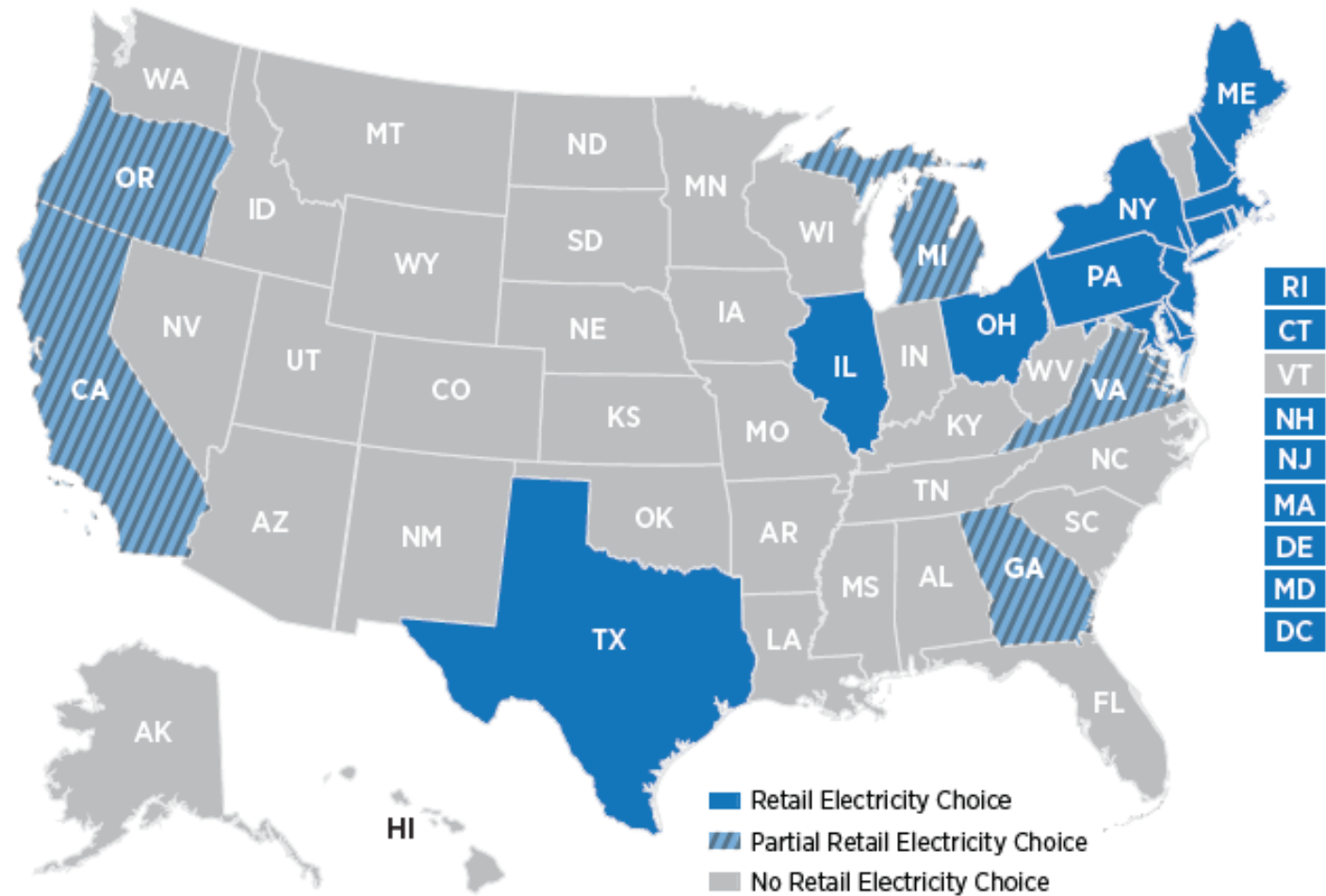
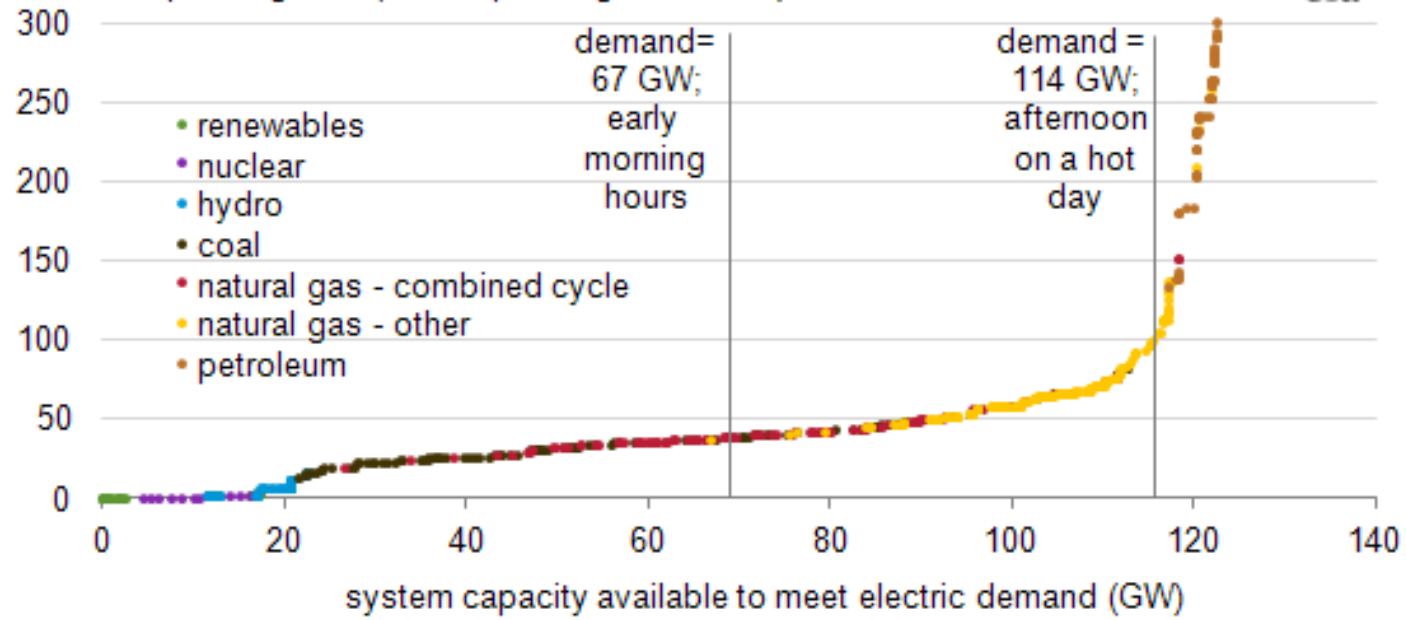


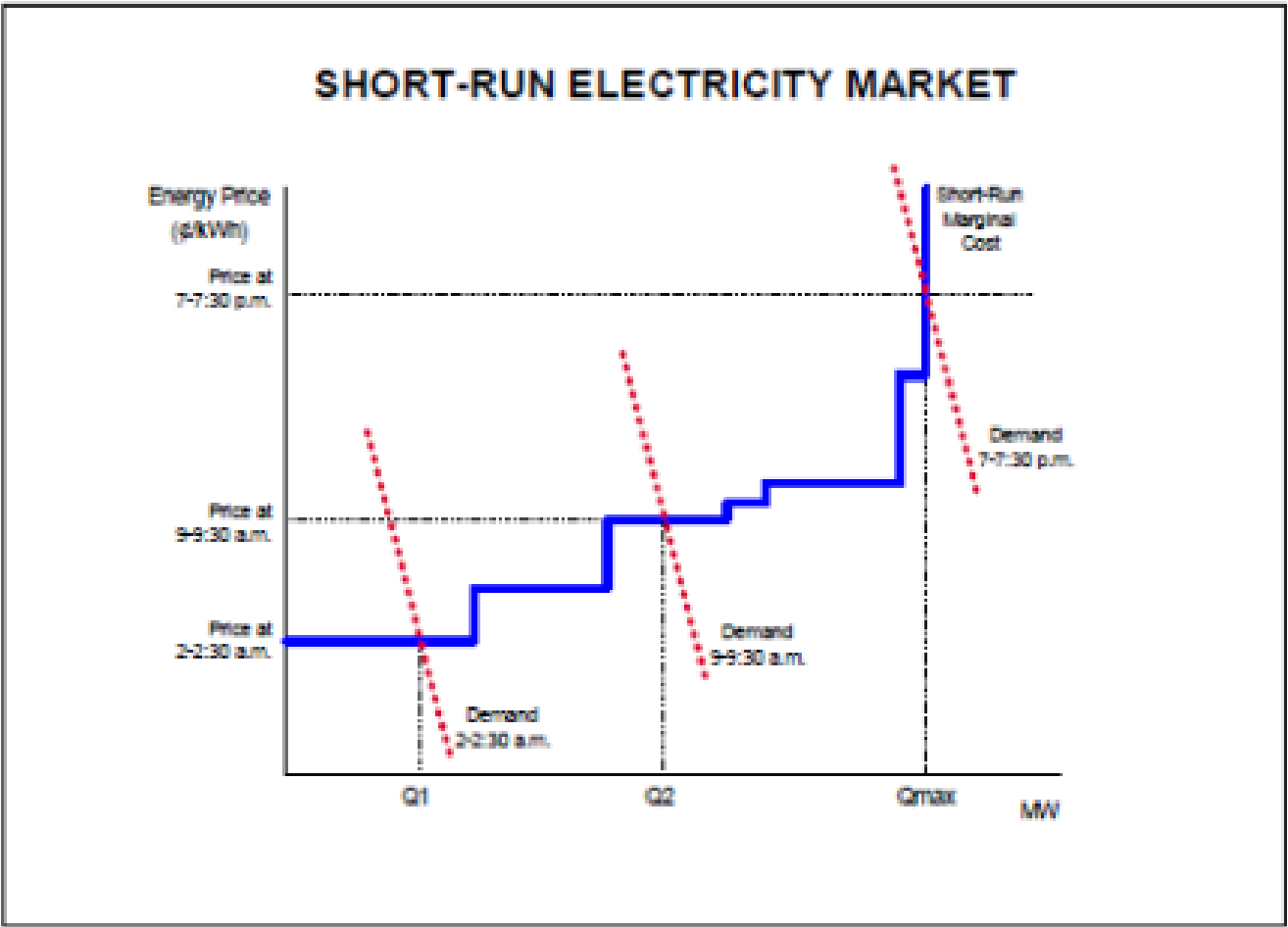
Figure 1. States with retail electricity choice

Source: State public utility commissions (2017)*

Hypothetical dispatch curve for summer 2011
variable operating cost (dollars per megawatthours)

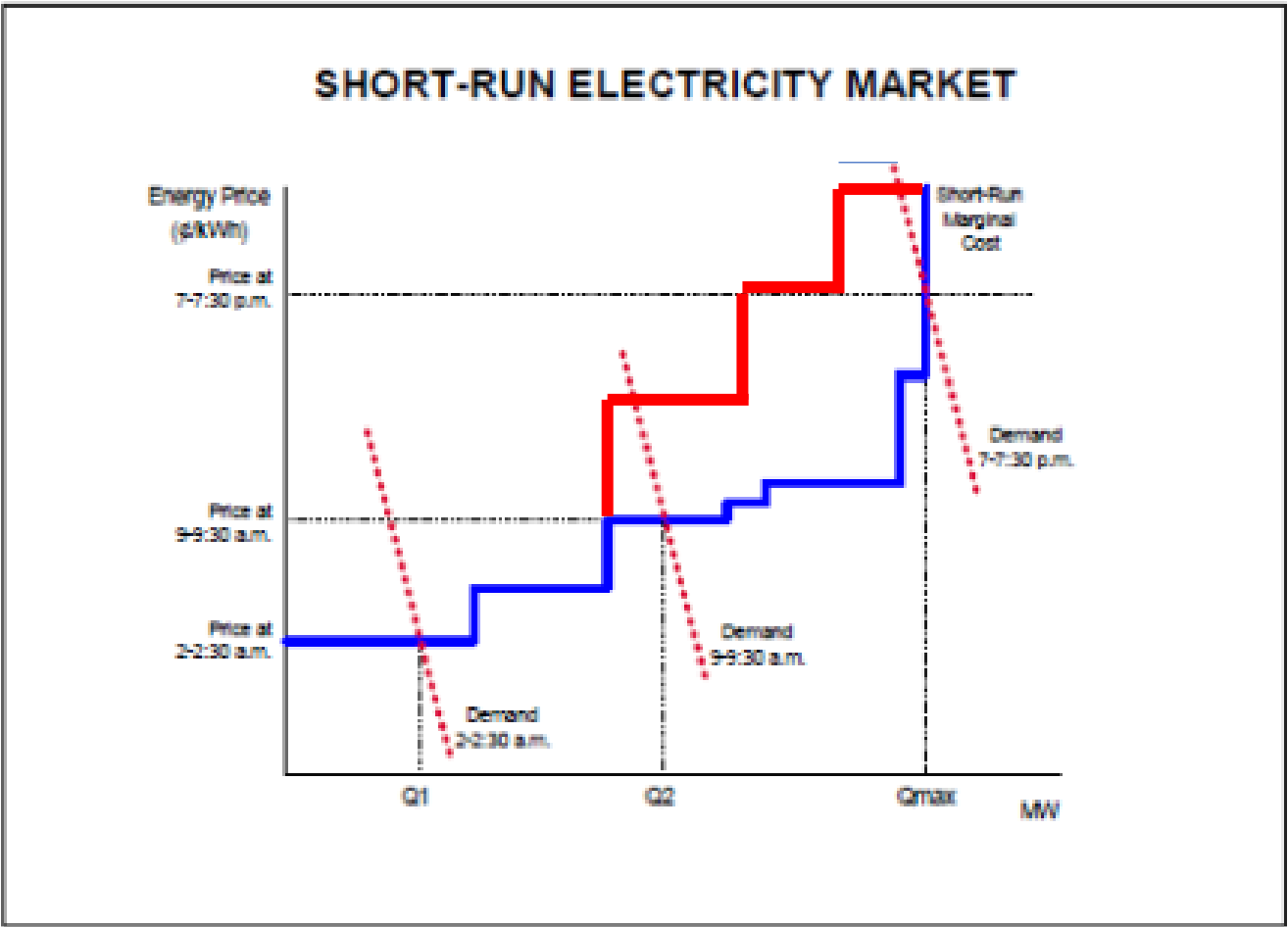


Competitive Auction-based Dispatch Curve



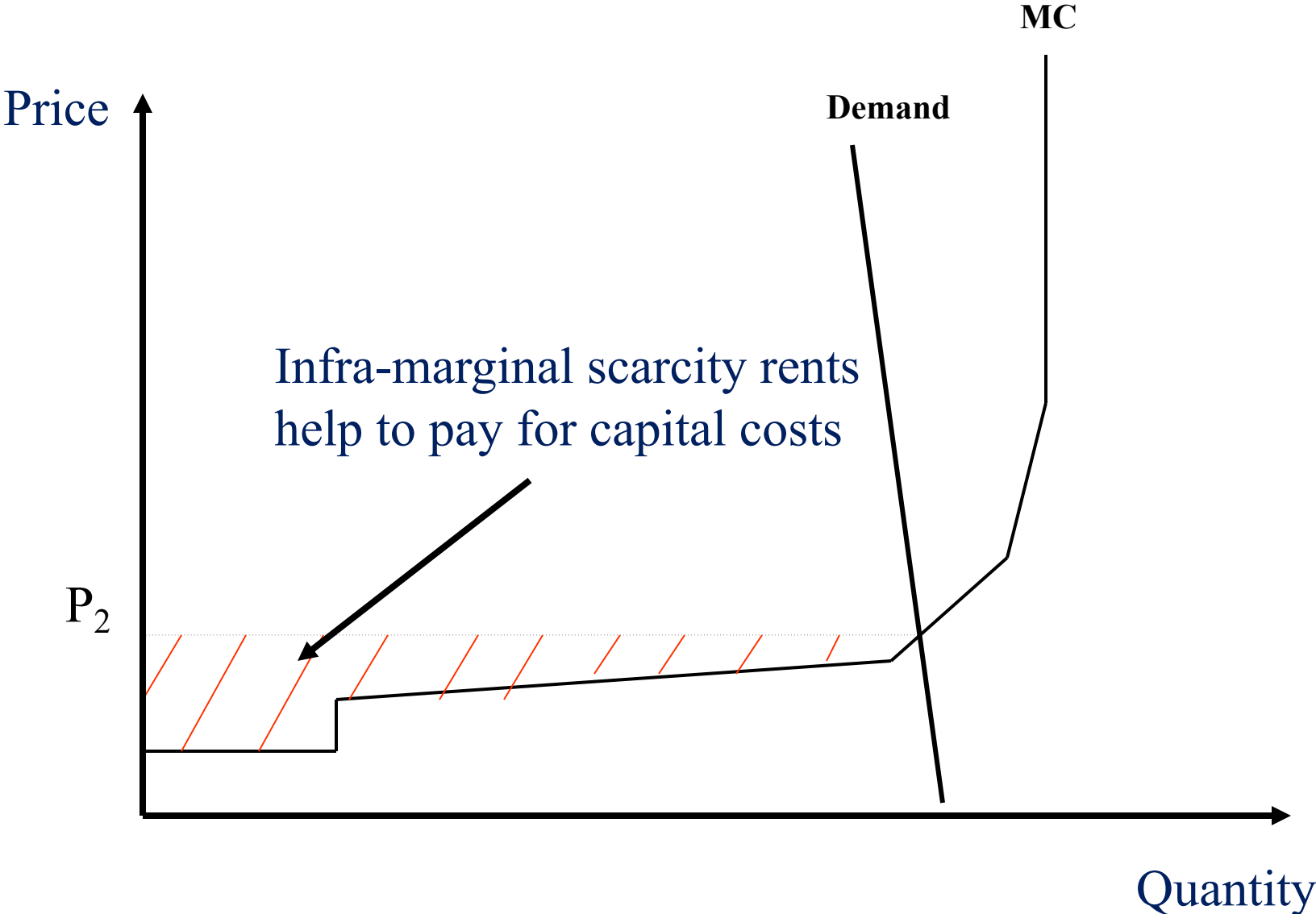
Courtesy of Prof. William Hogan

Competitive Auction-based Dispatch Curve



Courtesy of Prof. William Hogan

PERFECTLY COMPETITIVE WHOLESALE SPOT ELECTRICITY MARKET



PERFECTLY COMPETITIVE WHOLESALE SPOT ELECTRICITY MARKET

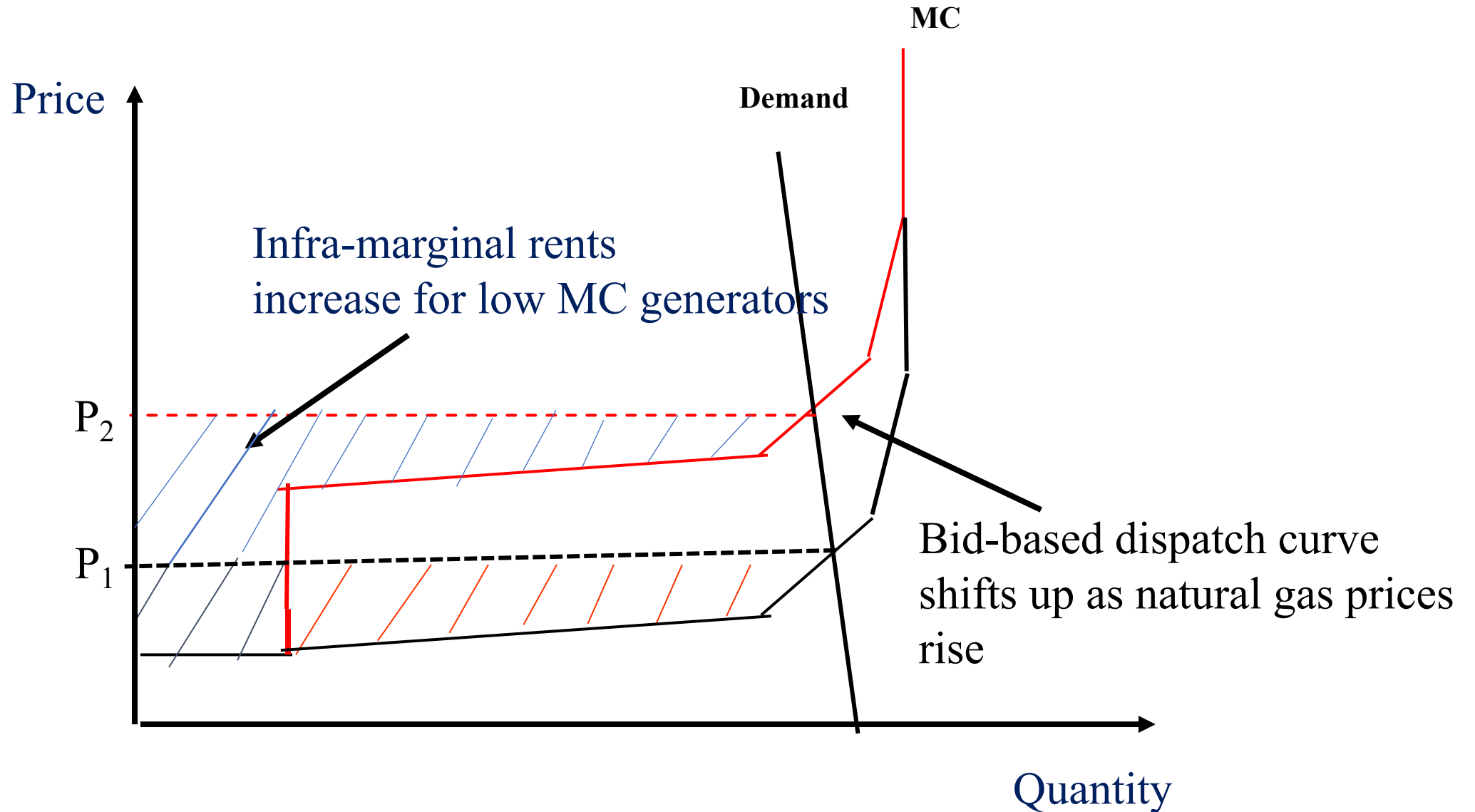


Figure 3-5: Real-Time Marginal Units by Fuel Type

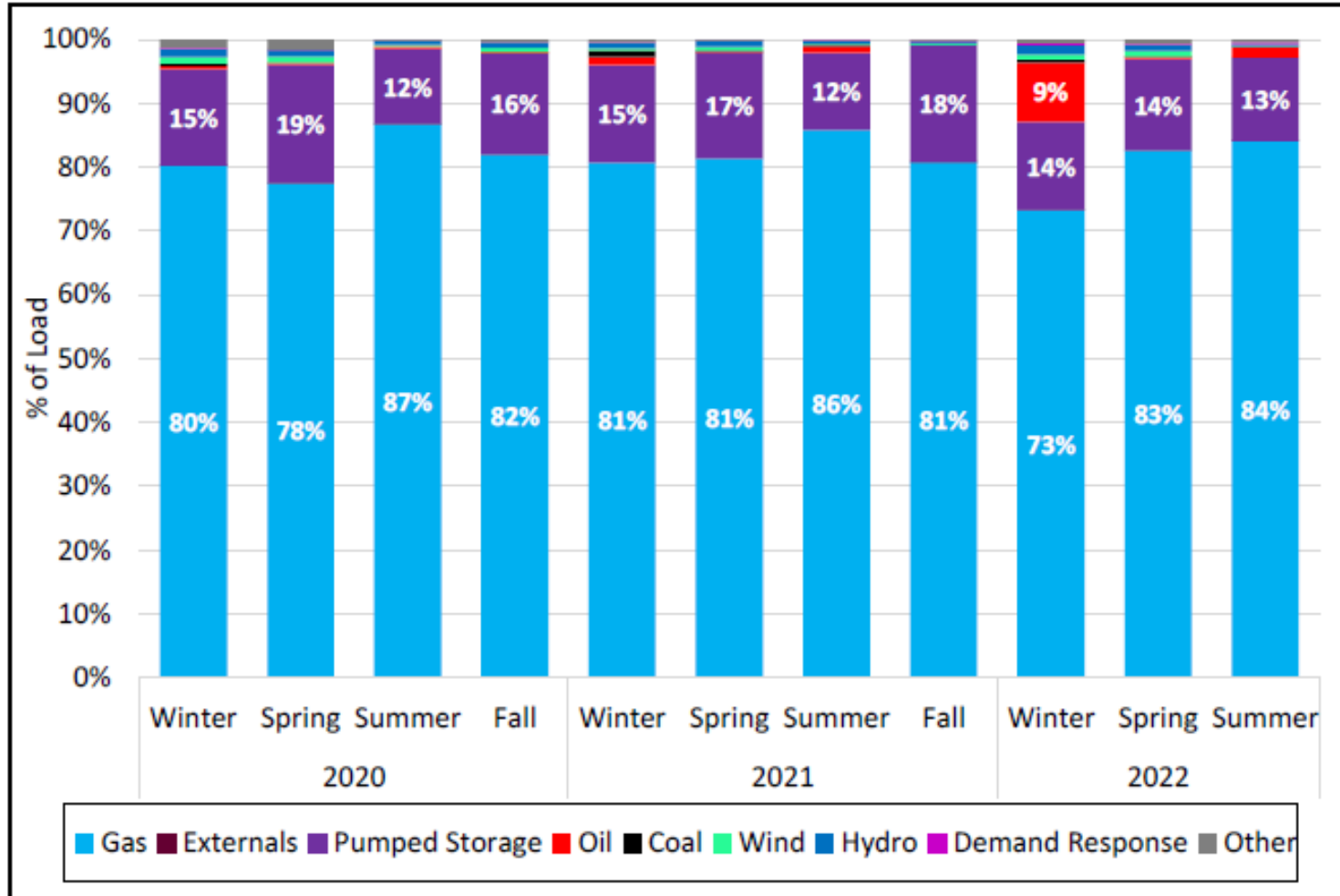
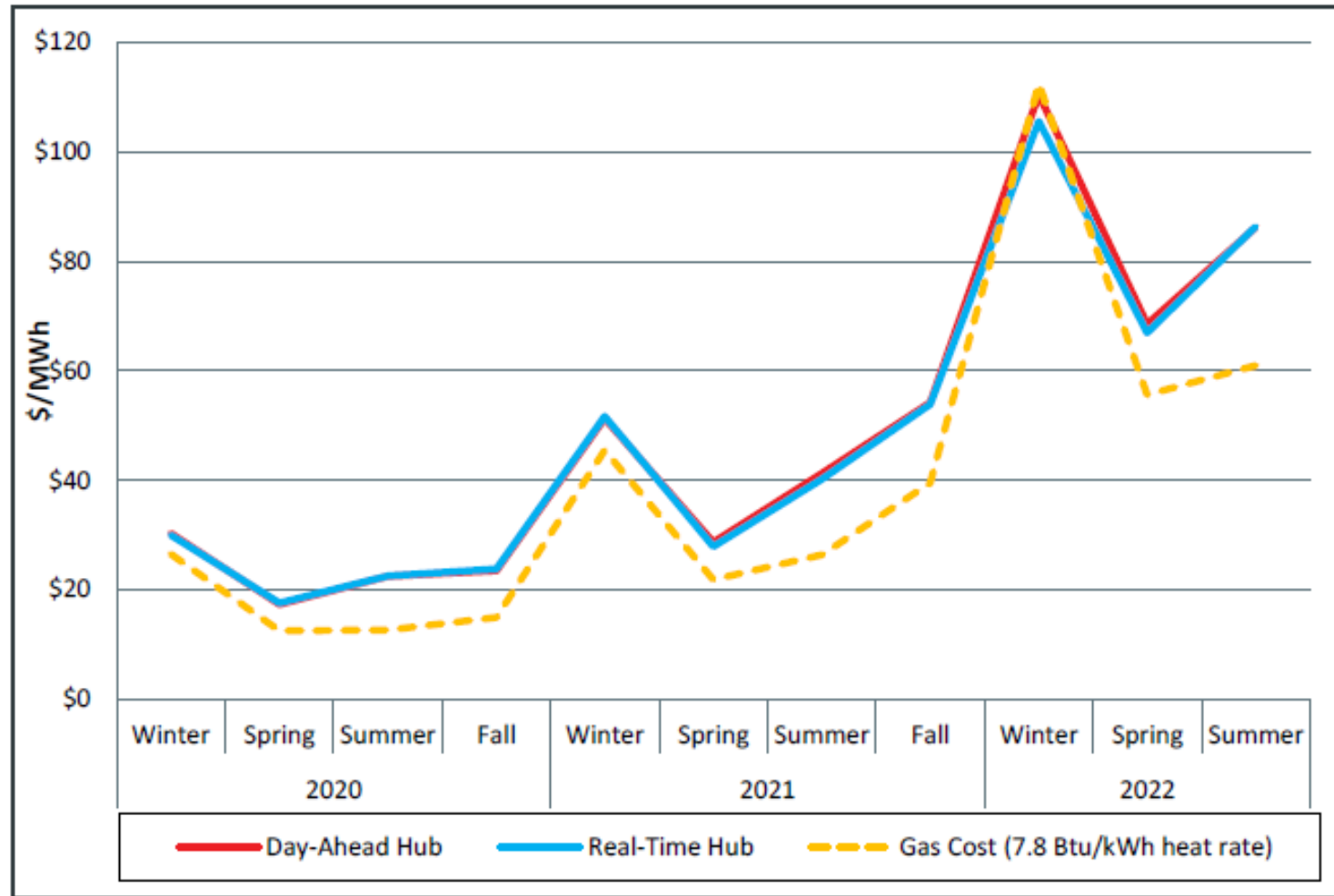
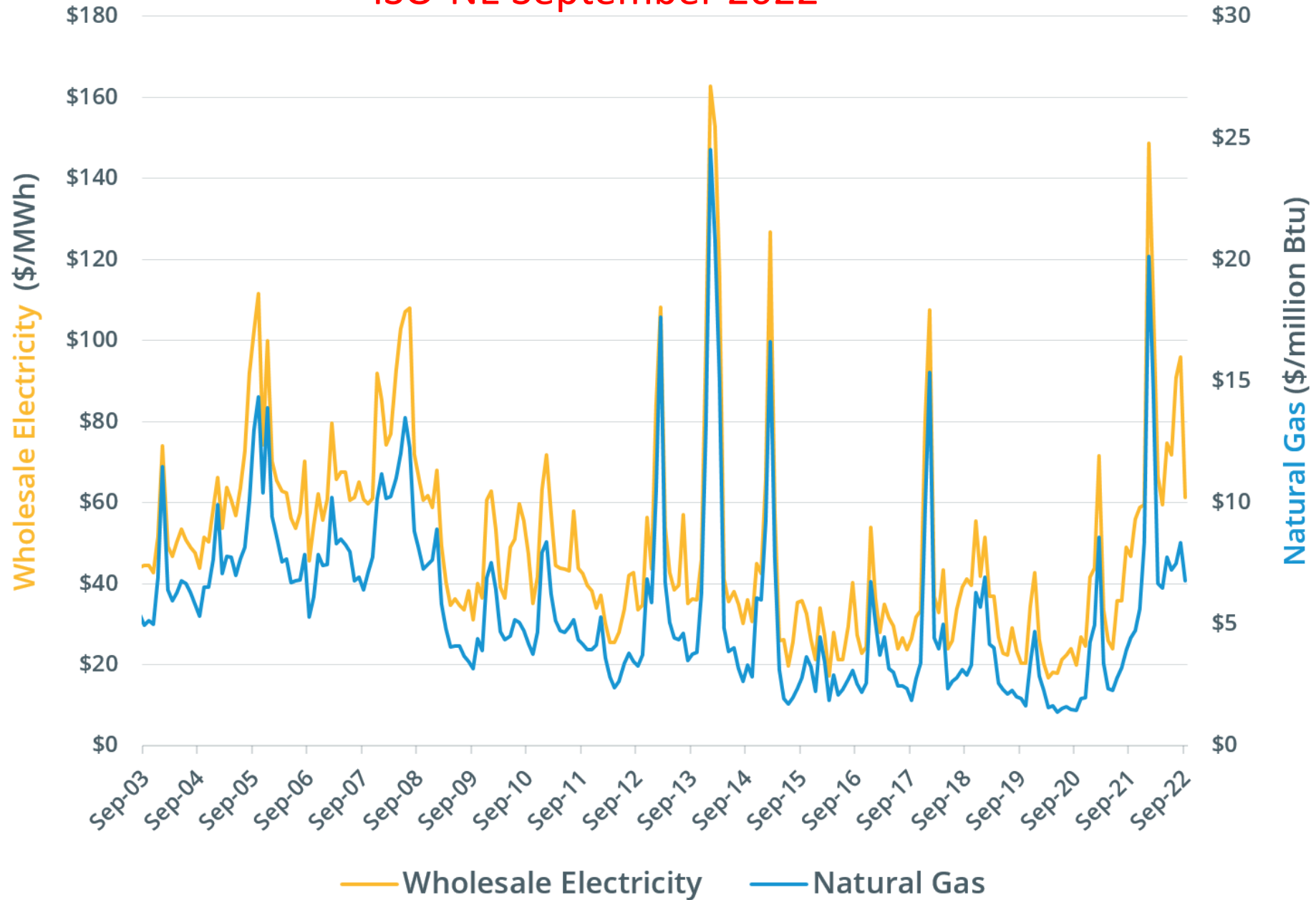
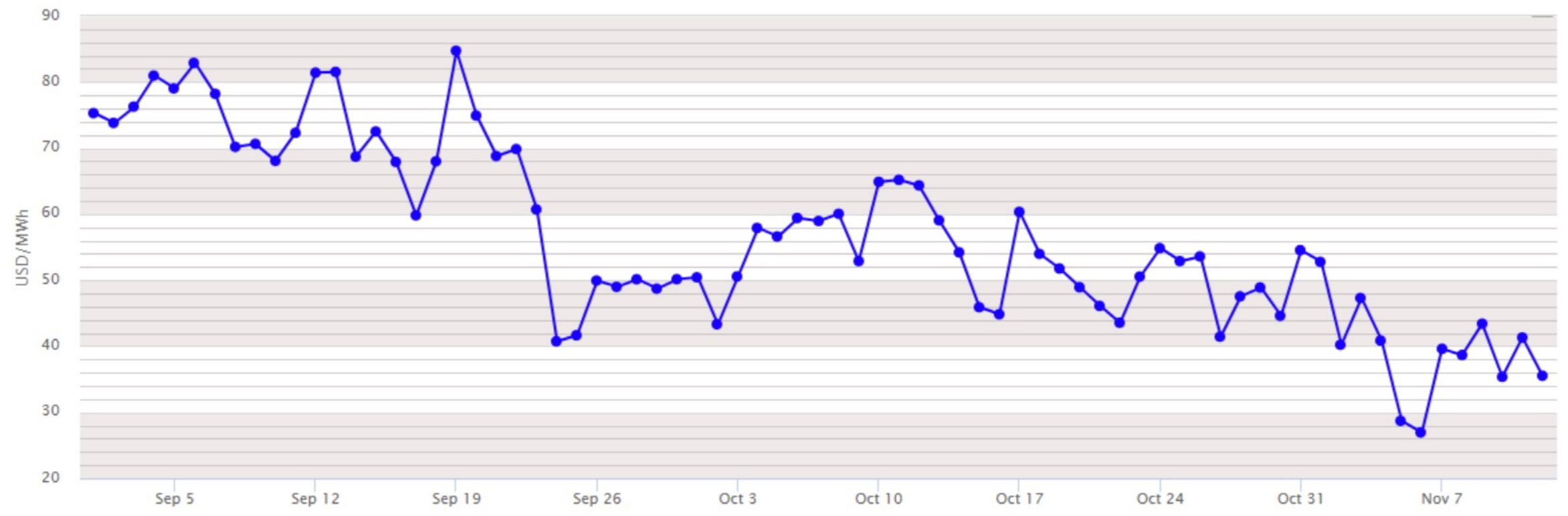


Figure 3-1: Simple Average Day-Ahead and Real-Time Hub Prices and Gas Generation Costs



ISO-NE September 2022

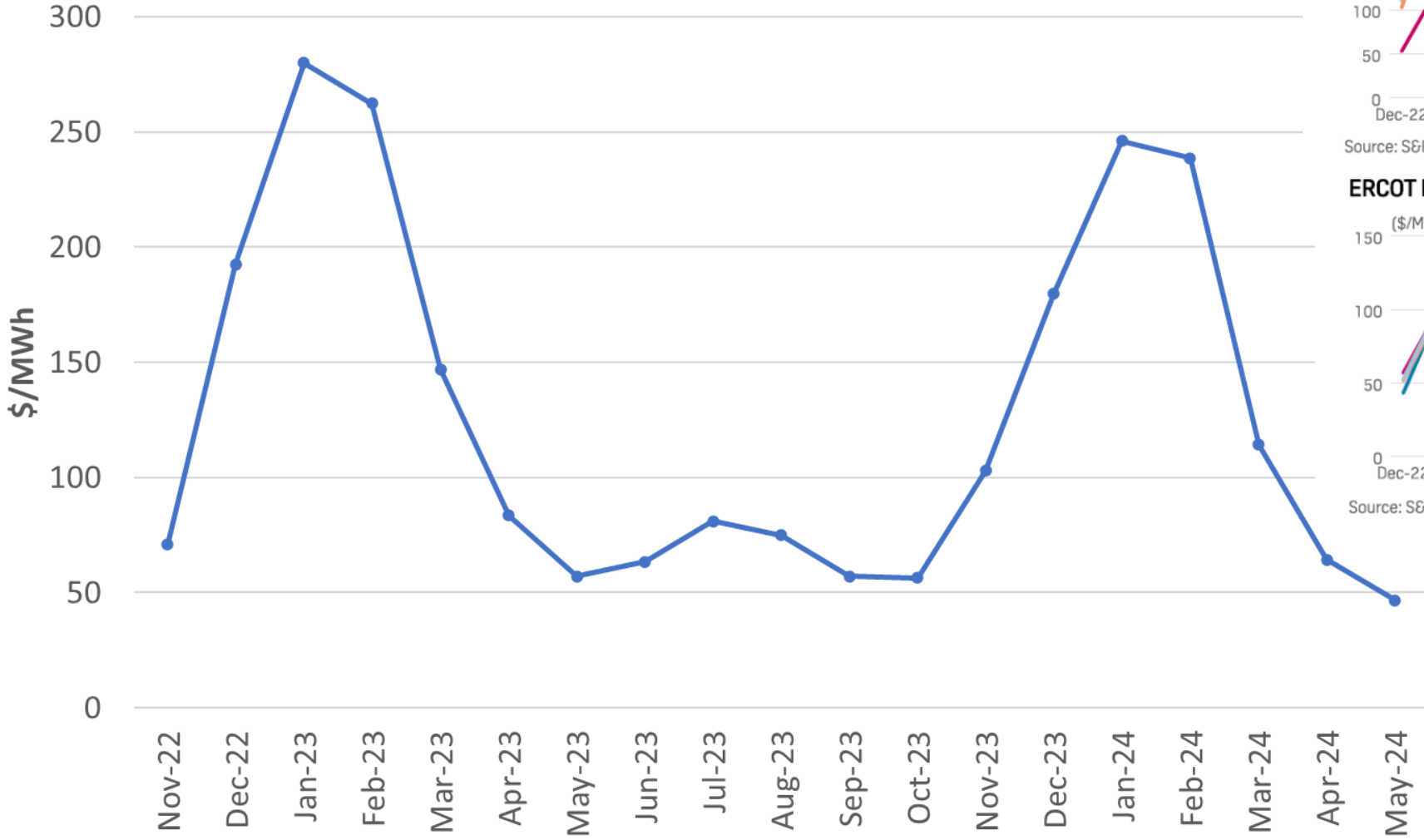




from date	days back	days to	to date
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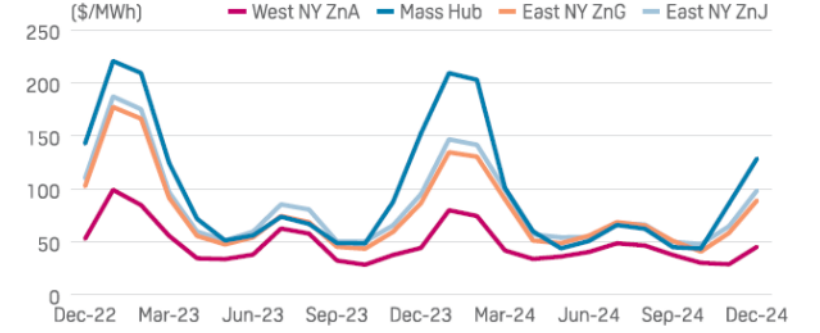
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Select Instant Overlay
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ISO NE Futures Prices (Globex) \$/MWh (Peak -- 16 hours) November 2022-May 2024



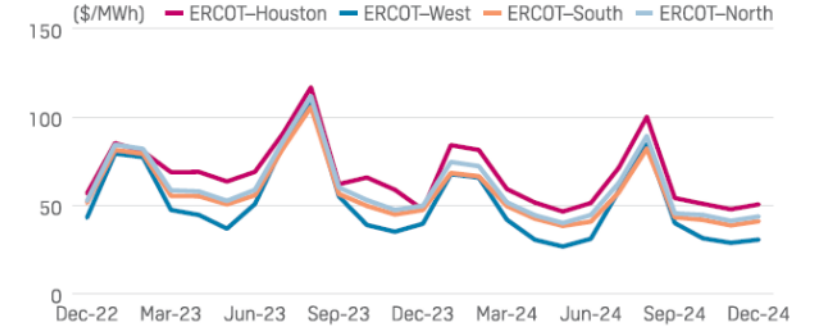
Axis Title

NORTHEAST PLATTS M2MS FORWARD CURVE: ON-PEAK



Source: S&P Global Commodity Insights

ERCOT PLATTS M2MS FORWARD CURVE: ON-PEAK



Source: S&P Global Commodity Insights

Average Residential Rates in Six States cents/Kwh

<u>State</u>	<u>August 2021</u>	<u>August 2022</u>	<u>Change (%)</u>
Massachusetts	22.19	26.66	20.1%
Vermont	19.12	20.20	5.6%
Texas	11.91	13.93	17.0%
California	23.34	27.27	16.8%
West Virginia	12.22	13.86	13.4%
Wyoming	11.65	11.88	2.0%
Oregon	11.52	11.59	0.6%

Unbundled Retail Energy Prices in Massachusetts (cents/Kwh)

November 3, 2022

<u>Retail Supplier</u>	<u>November 2021</u>	<u>November 2022</u>	<u>Notes</u>
Brookline Green	10.715	10.715	Resets in January 2023 to 14.781, 2-year fixed
Eversource (NSTAR)	10.753	17.871	Resets in January 2023 to ? for six months
Lenox Muni Aggregation (Eversource/National Grid)	9.95	9.95	Resets in January 2024, 3-year fixed
National Grid	14.823	33.891	Resets in May 2023 to ? for six months
Pittsfield Community Choice (Eversource—WMeco))	9.603	9.603	Resets in January 2024, 2-year or 3-year fixed
WMeco	9.468	15.348	Resets in January 2023 to ? For six months
Retailer #1		17.49	36 months fixed, cancellation fee, auto renewal
Retailer #2		29.97	12 months, cancellation fee, auto renewal
Retailer #3		19.49	12 months, cancellation fee, auto renewal
Retailer #4		21.79	24 months, no cancellation fee, auto renewal
Retailer #5		18.99	24 months, cancellation fee, auto renewal

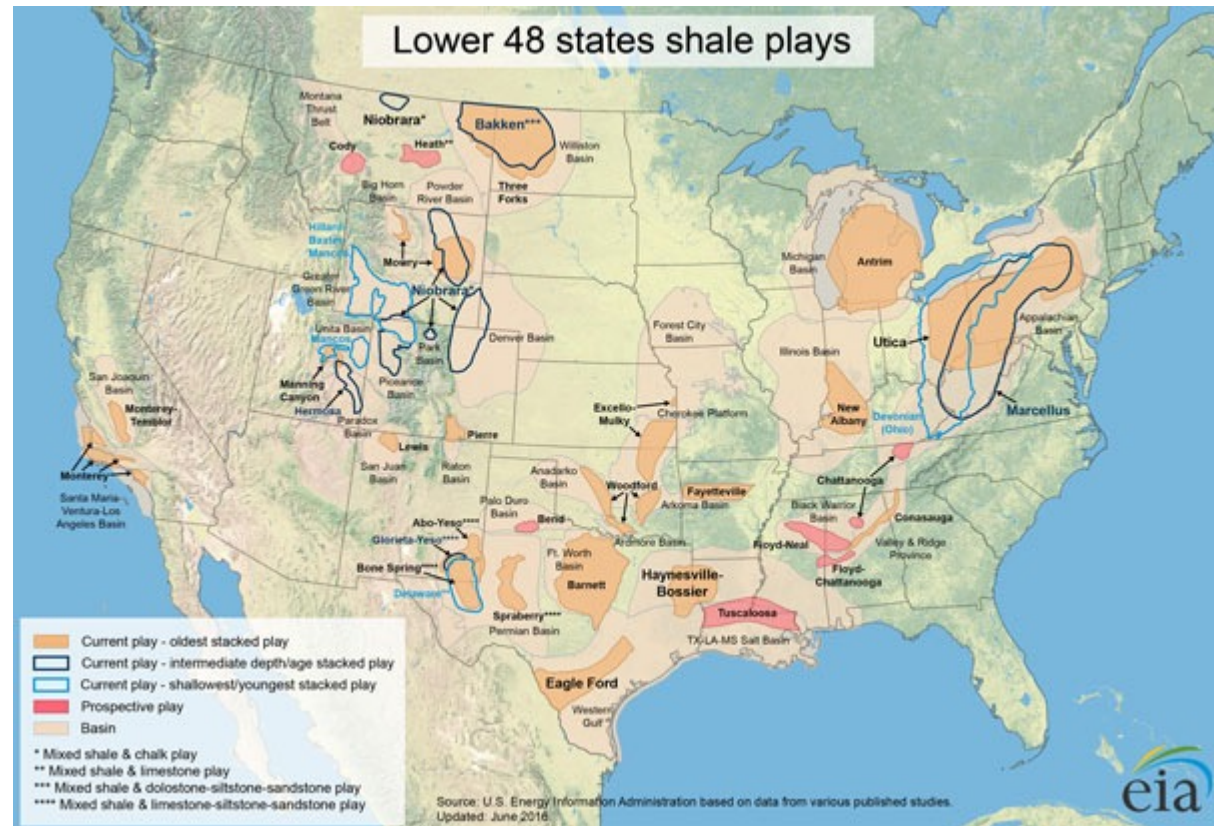
Paul's Bills (cents/Kwh) October/November

<u>DATE</u>	<u>Energy Rates</u> cents/Kwh	<u>Delivery Rate</u> cents/Kwh	<u>Average ISO DA LMP (September)</u> \$/MWh
Nov. 2018	11.4	11.7	\$34/MWh
Oct. 2020	9.99 (-12.3%)	12.0	\$20/MWh (-41%)
Oct. 2021	10.75 (+7.6%)	13.1	\$48/MWh (+140%)
Oct. 2022	17.87 (+66%)	15.2	\$67/MWh (+40%)

The Larger Challenges

Backup

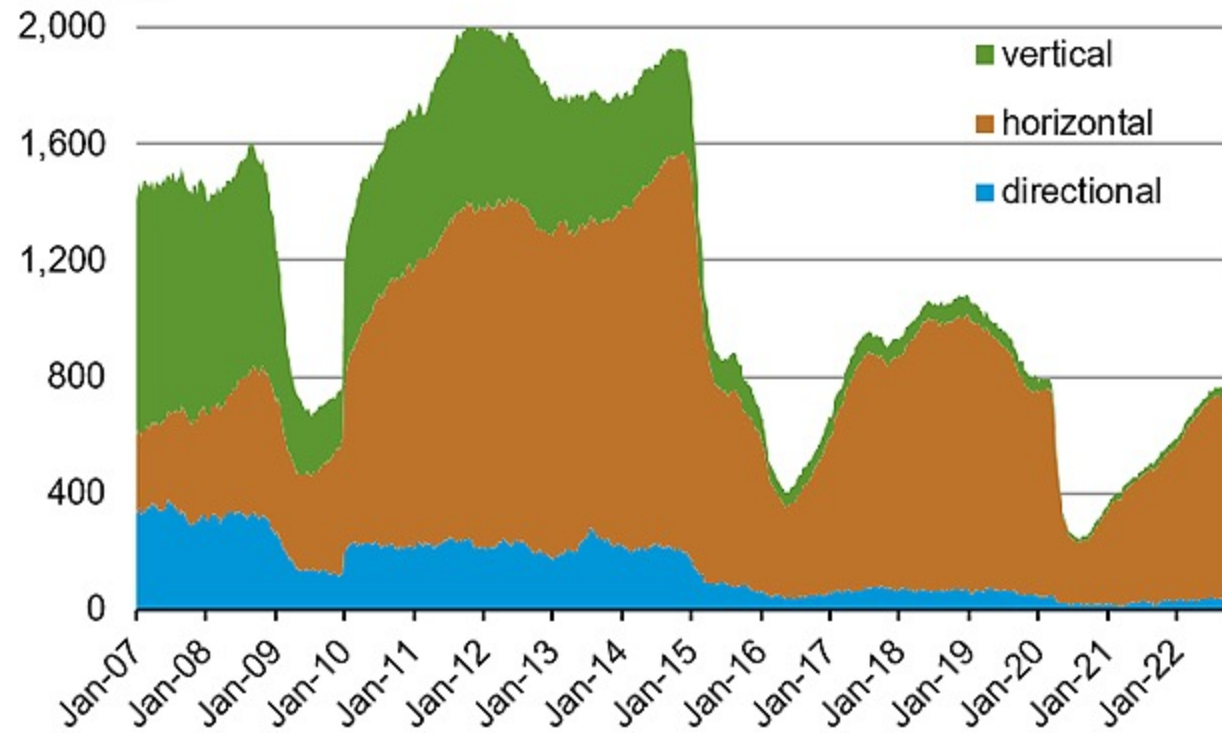
Shale Gas and Shale Oil Plays



Weekly total rig count



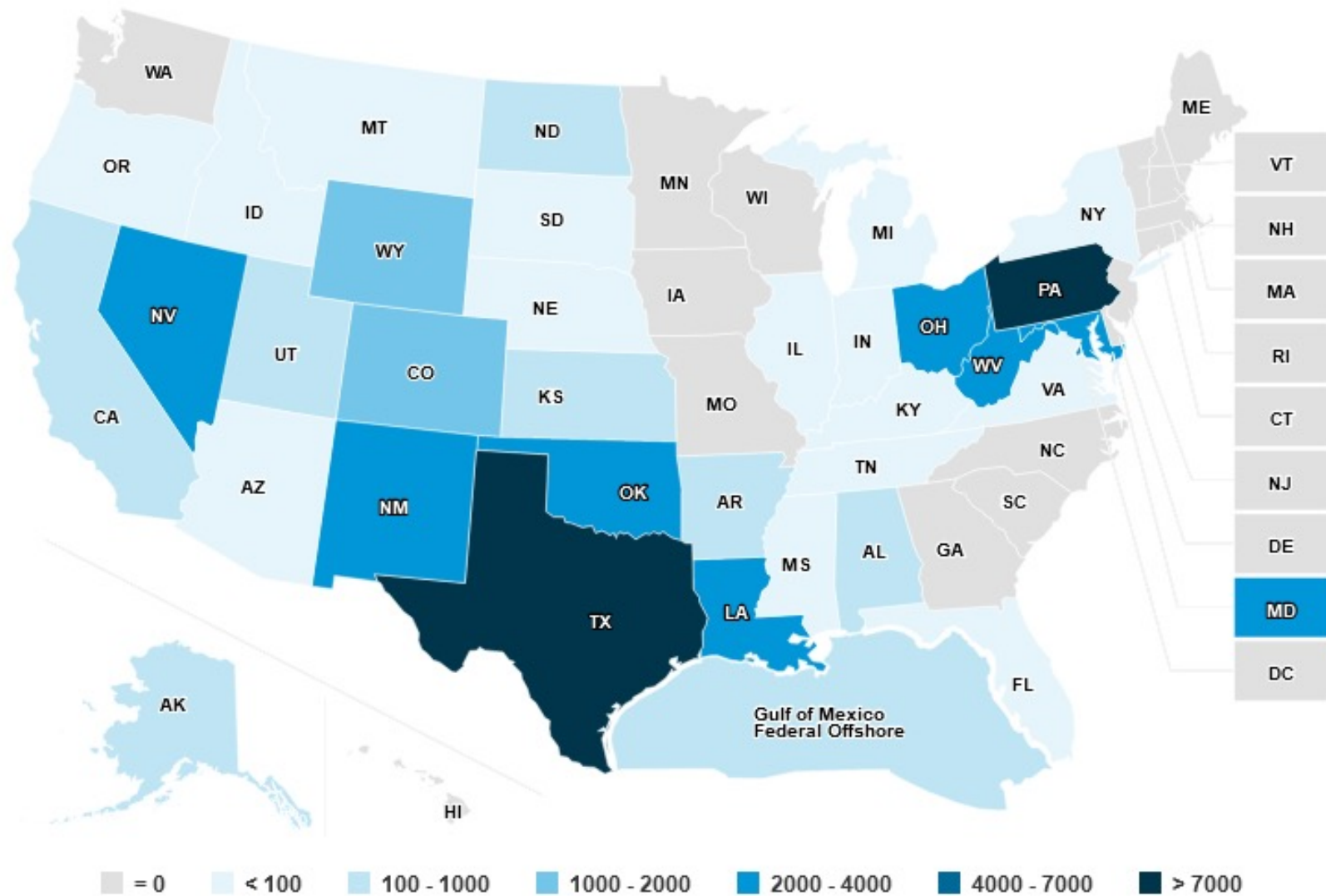
active rigs



Data source: Baker Hughes Company

U.S. dry natural gas production by state in 2021

billion cubic feet

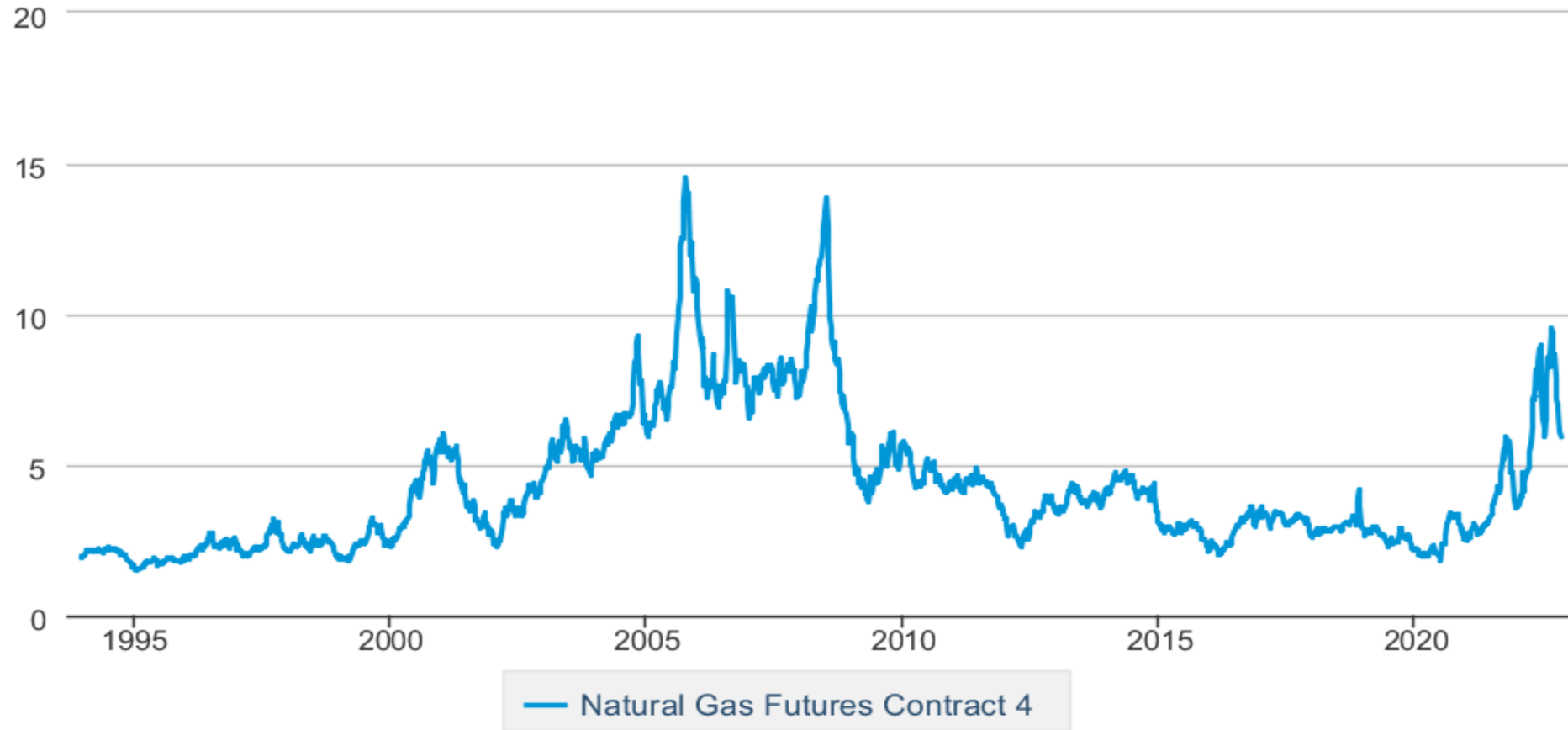


Data source: U.S. Energy Information Administration, *Natural Gas Annual*, September 2022

Thru Nov. 1, 2022

Natural Gas Futures Contract 4

Dollars per Million Btu



Source: U.S. Energy Information Administration

Natural Gas Prices



NYMEX Futures Pricing (\$/MMBtu)	This Week 4-Nov-22	Last Week 28-Oct-22	W-o-W Δ
NYMEX Prompt	\$6.40	\$5.88	\$0.53
NYMEX 12-Month Strip	\$5.53	\$5.14	\$0.39
Balance 2022	\$6.40	\$5.88	\$0.53
Summer 2023 (Apr-Aug)	\$5.08	\$4.75	\$0.32
Winter 2022-'23	\$6.56	\$6.00	\$0.57
Calendar 2023	\$5.47	\$5.11	\$0.36
Calendar 2024	\$4.70	\$4.60	\$0.10

Week Ending November 4, 2022

Week Ending	11/4/2022	RTC Day-Ahead Index Prices			RTC Forward Calendar Strip Prices ¹			
		(\$/MWh)			(\$/MWh)			
Electric Hub	ISO	Min	Max	Avg	2023	2024	2025	2026
Indiana Hub	MISO	\$18.01	\$99.02	\$44.85	\$67.19	\$58.62	\$55.71	\$55.79
Michigan Hub	MISO	\$14.95	\$81.33	\$39.67	\$65.95	\$57.58	\$54.66	\$55.10
PJM West Hub	PJM	\$15.43	\$80.73	\$43.60	\$67.27	\$58.20	\$54.75	\$53.80
AEP-Dayton Hub	PJM	\$15.22	\$77.91	\$42.35	\$64.30	\$55.21	\$51.33	\$50.23
N. Illinois Hub	PJM	\$8.93	\$72.94	\$35.80	\$56.82	\$48.50	\$44.49	\$43.12
Mass Hub	ISO-NE	\$13.95	\$81.39	\$42.13	\$96.75	\$85.83	\$72.78	\$72.49
NYZ J	NYISO	\$18.02	\$77.20	\$42.11	\$80.58	\$72.92	\$69.70	\$70.45
ERCOT N ²	ERCOT	(\$24.58)	\$71.40	\$26.53	\$57.83	\$48.20	\$45.95	\$45.43
SP15	CAISO	\$10.49	\$112.59	\$68.16	\$84.43	\$73.59	\$70.29	\$65.80

¹These prices are an indicative, non-transactable snapshot of the wholesale market as of close of business on Friday of the report week. Actual price on contract is contingent upon customer's load, product and market prices at time of execution. ²ERCOT index prices are from Real-Time market.

Figure 2-1: Wholesale Market Costs and Average Natural Gas Prices by Season

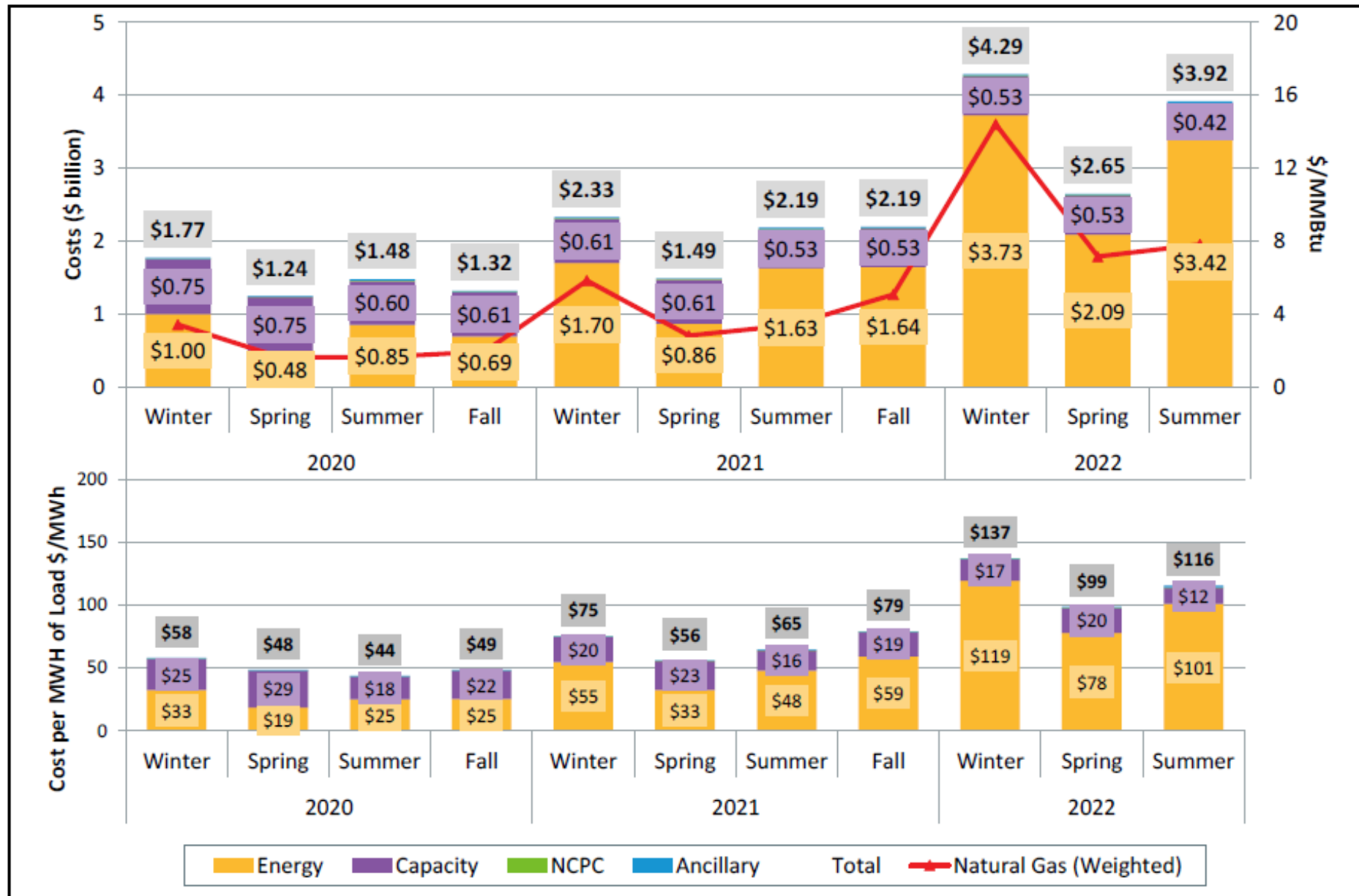
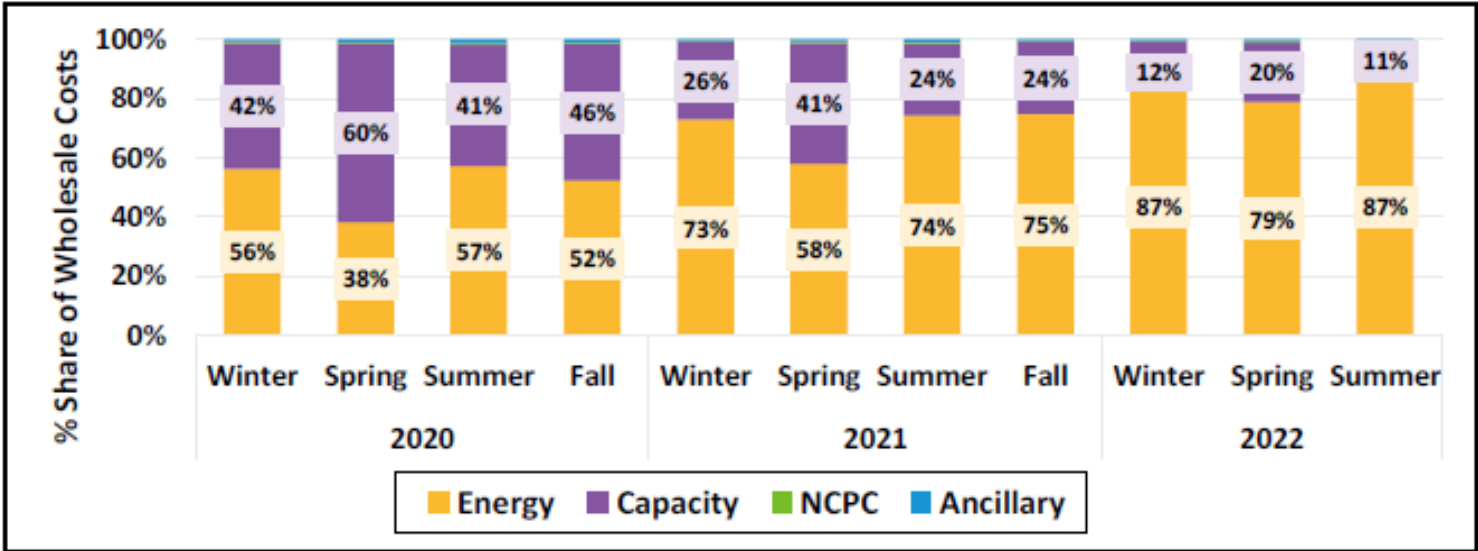
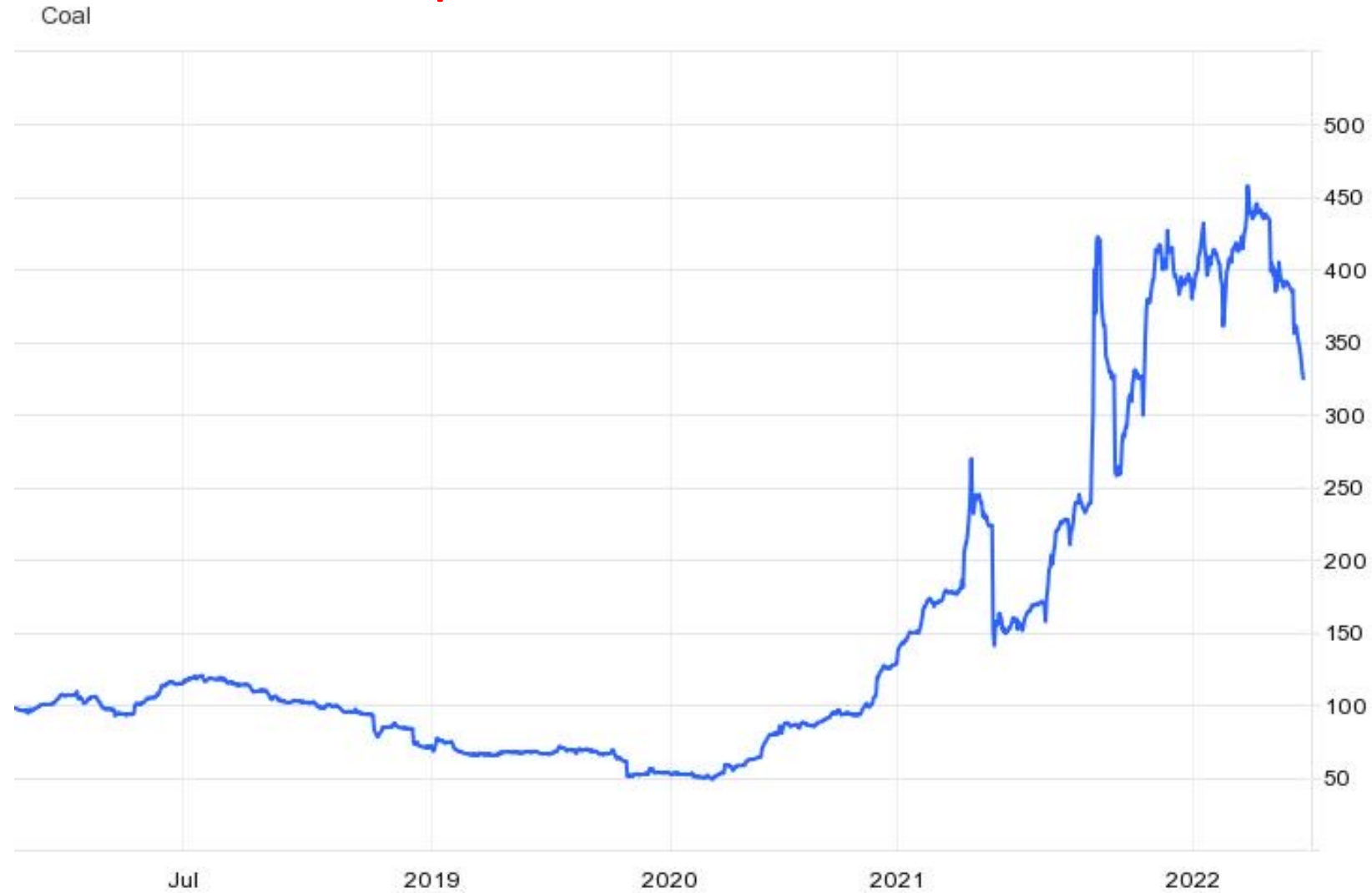
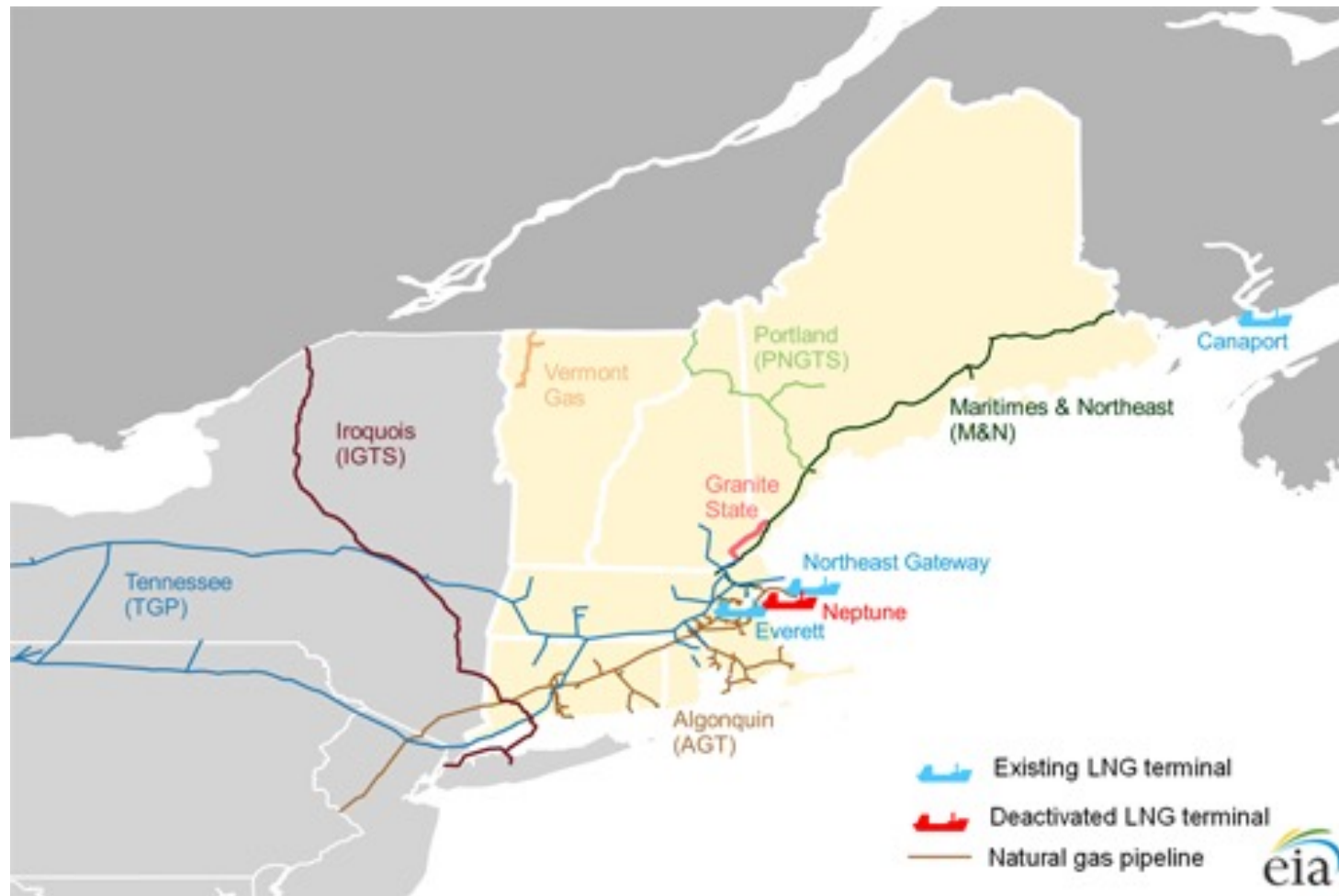


Figure 2-2: Percentage Share of Wholesale Cost



Open Market Coal Prices

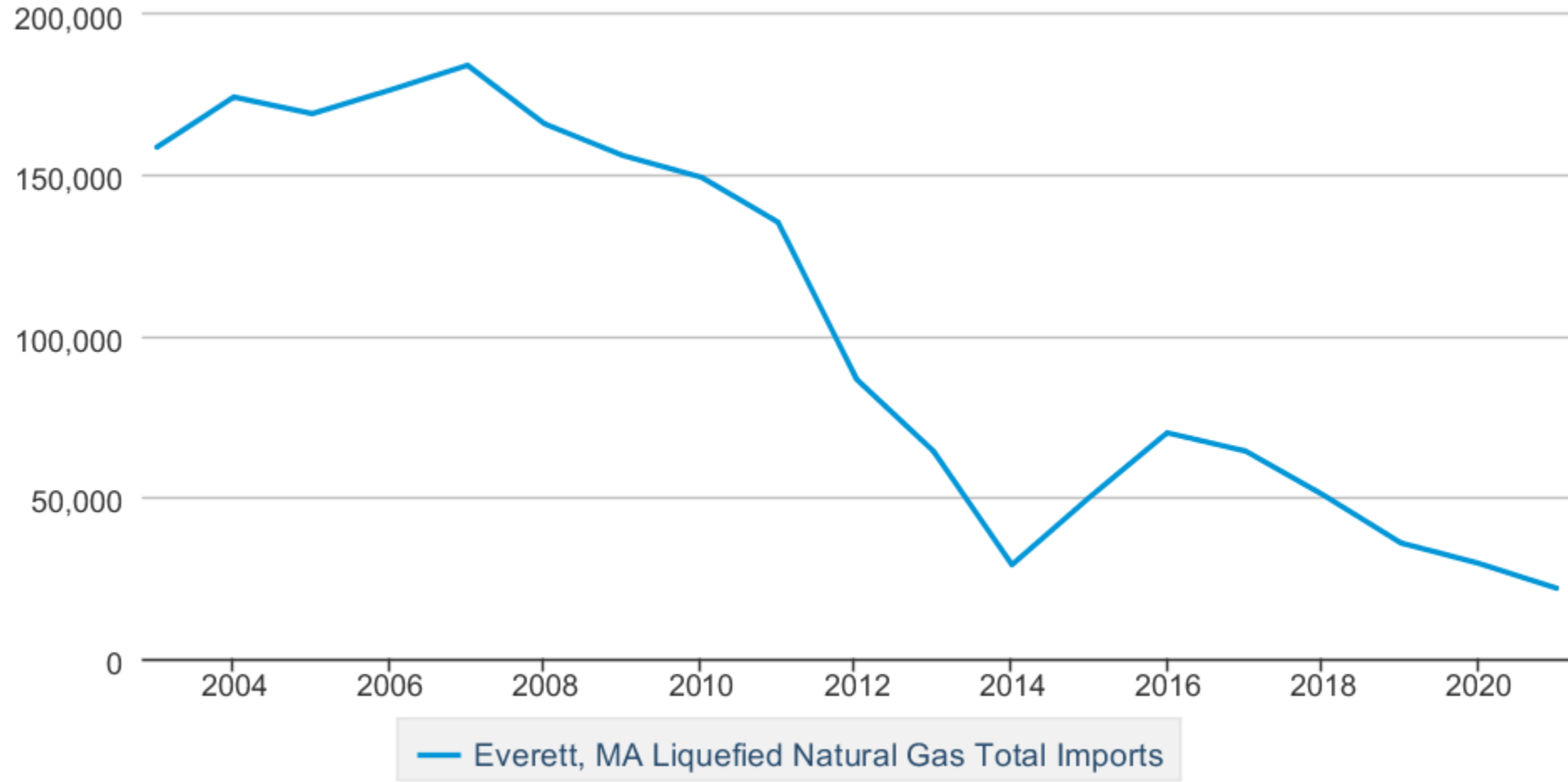






Everett, MA Liquefied Natural Gas Total Imports

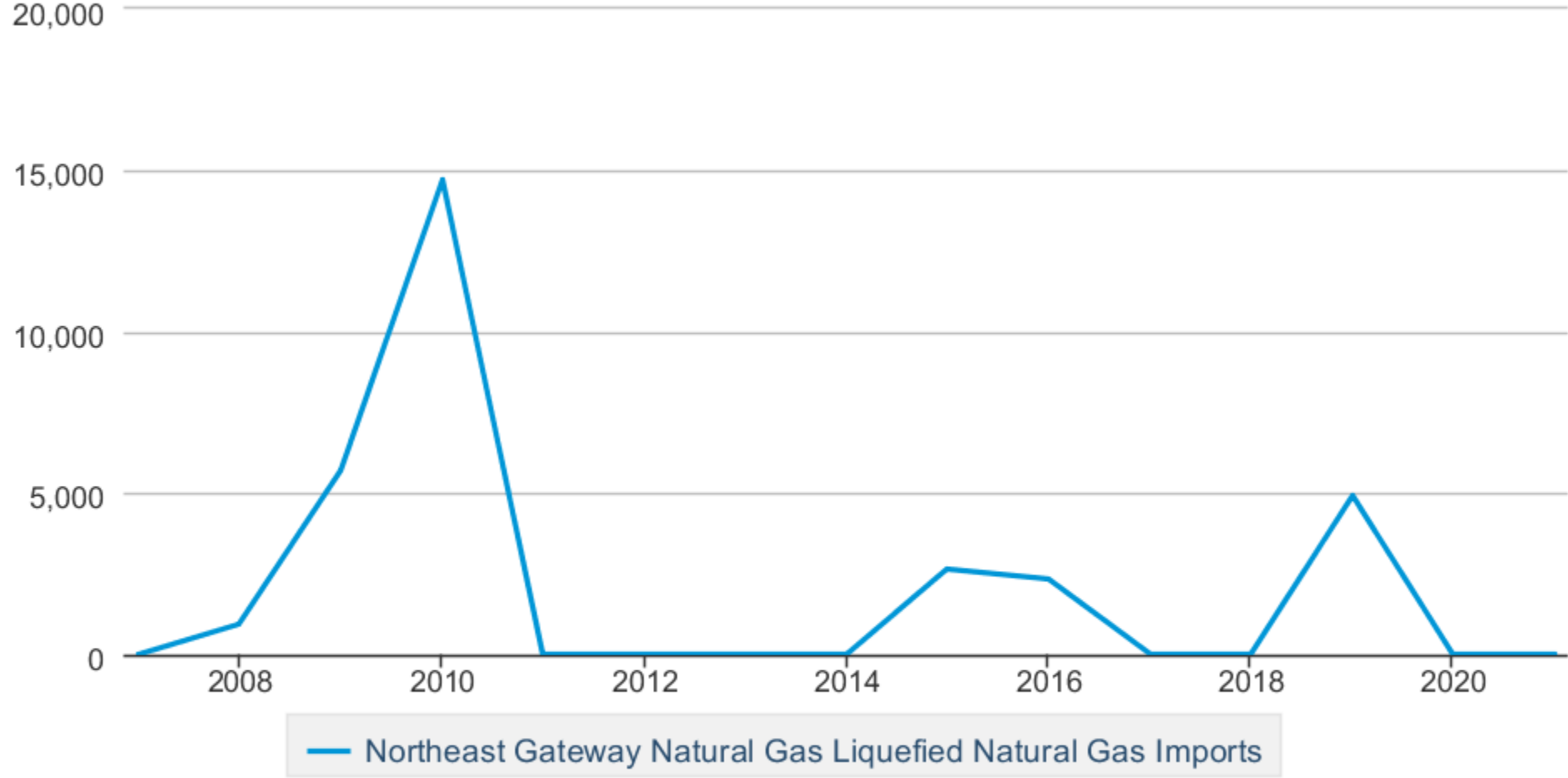
Million Cubic Feet



Source: U.S. Energy Information Administration

Northeast Gateway Natural Gas Liquefied Natural Gas Imports

Million Cubic Feet



Source: U.S. Energy Information Administration