

# A Natural Gas Update

Presented to:  
Colorado Legislature

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Part 1: The Inexorable Link Between Natural Gas and Food

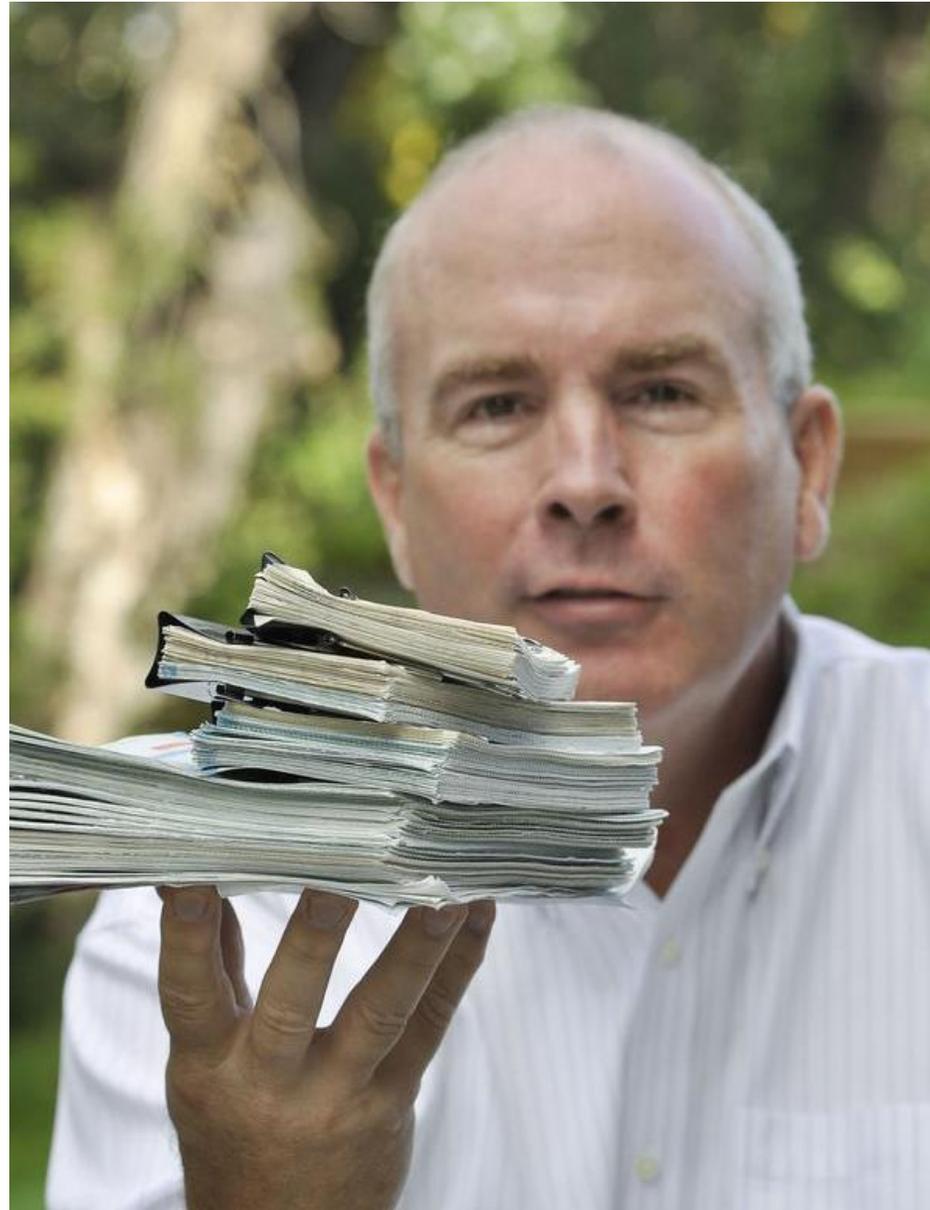
Part 2: What Happened In Europe/Germany

Part 3: What's Happening in California and Its Impact on Colorado











“The test of our progress is not whether we add to the abundance of those who have much. It is whether we provide enough to those who have little.”

- Franklin D. Roosevelt

# The Effect of Fracking on Residential Gas Cost



**PUBLIC SERVICE COMPANY OF COLORADO** \*  
 P O BOX 840  
 DENVER, CO. 80201  
 (800) 895-4999 Español: (800) 687-8778

Page 1 of 1

Customer Name	Service Address	Account No.	Date Due	Amount Due
[REDACTED]	[REDACTED]	[REDACTED]	Dec 26, 2012	<b>\$37.75</b>

### Account Activity

Date of Bill	Dec 5, 2012	Previous Balance	\$29.26
Number of Payments Received	1	Total Payments	<u>(\$29.26)</u>
Number of Days in Billing Period	34	Balance Forward	\$0.00
Statement Number	349691134	+ Current Bill	<u>\$37.75</u>
Premise Number	300801460	<b>Current Balance</b>	<b>\$37.75</b>

### Gas Service - Account Summary

Invoice Number	0227514926	Residential	
Meter No.	00000R471013	Usage Charge	45 therms x 0.090444 \$4.07
Rate	RG Residential	Interstate Pipeline	45 therms x 0.000020 \$0.97
Days in Bill Period	34	Natural Gas 4 Qtr	45 therms x 0.355870 <b>\$16.01</b>
Current Reading	7720 Actual 12/05/2012	Pipe Sys Int Adj	45 therms x 0.010000 \$0.70
Previous Reading	7668 Actual 11/01/2012	Service & Facility	\$11.94
Measured Usage	52	<b>Subtotal</b>	<b>\$36.65</b>
Therm Multiplier	0.8606	Franchise Fee	3.00% \$1.10
Therms Used	45.0	Sales Tax	\$0.00
		<b>Total Amount</b>	<b>\$37.75</b>

## Wall Street Journal Editorial September 6, 2013

- “Thanks to the lower price for natural gas, families saved roughly \$32.5 billion in 2012.”
- “The windfall to all U.S. natural gas consumers –industrial and residential—was closer to \$110 billion. This is greater than the annual income of all the residents in 14 states in 2011.”













# Part 1: Natural Gas and Food

65-70% of the world caloric food intake is related to 4 grains:

- Wheat
- Rice
- Corn
- Soybeans



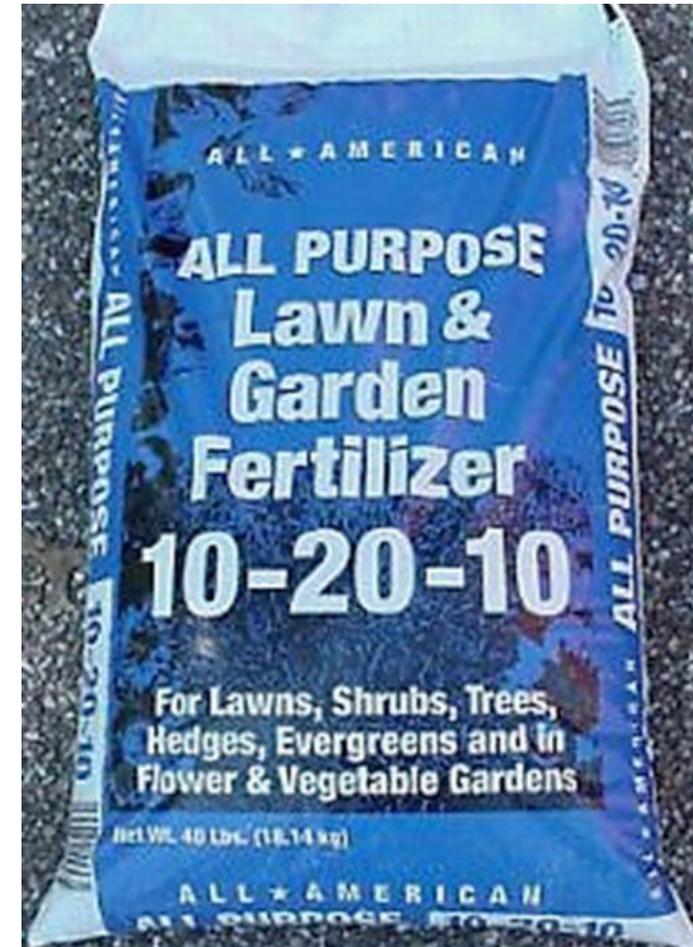
All require intense use of nitrogen fertilizers

The goal of fertilizing grains is to increase the yield



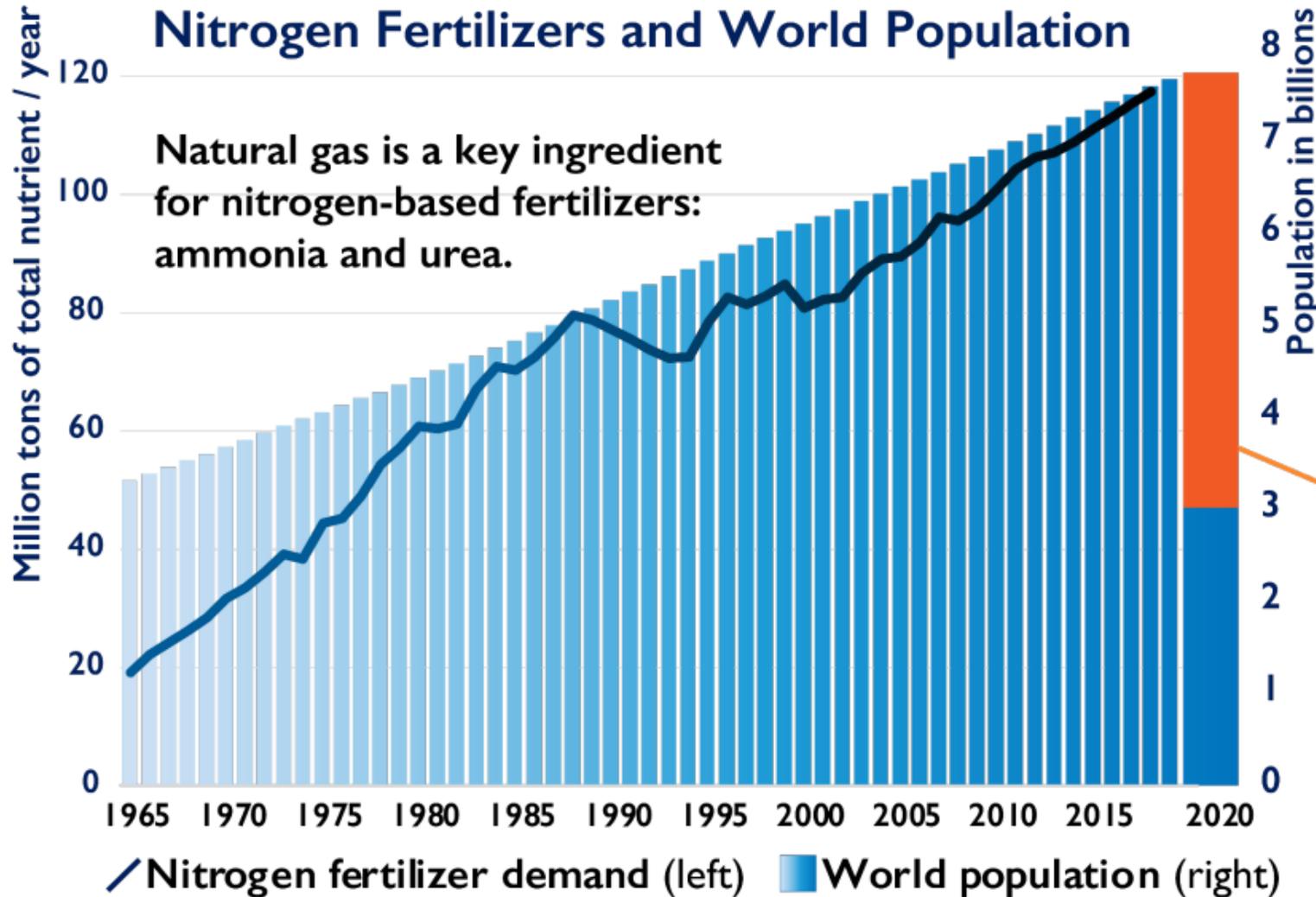
# There are only three types of fertilizers:

- Potash (K) mined
- Phosphate (P) mined
- Nitrogen (N) man-made



If you aggregate the world's daily demand for natural gas (**11 Bcf/day**) that is converted into fertilizer (through the Haber Bosch process) into one country, that country would rank 10<sup>th</sup> in the world for daily natural gas demand

# Natural Gas is Critical for Global Food Production

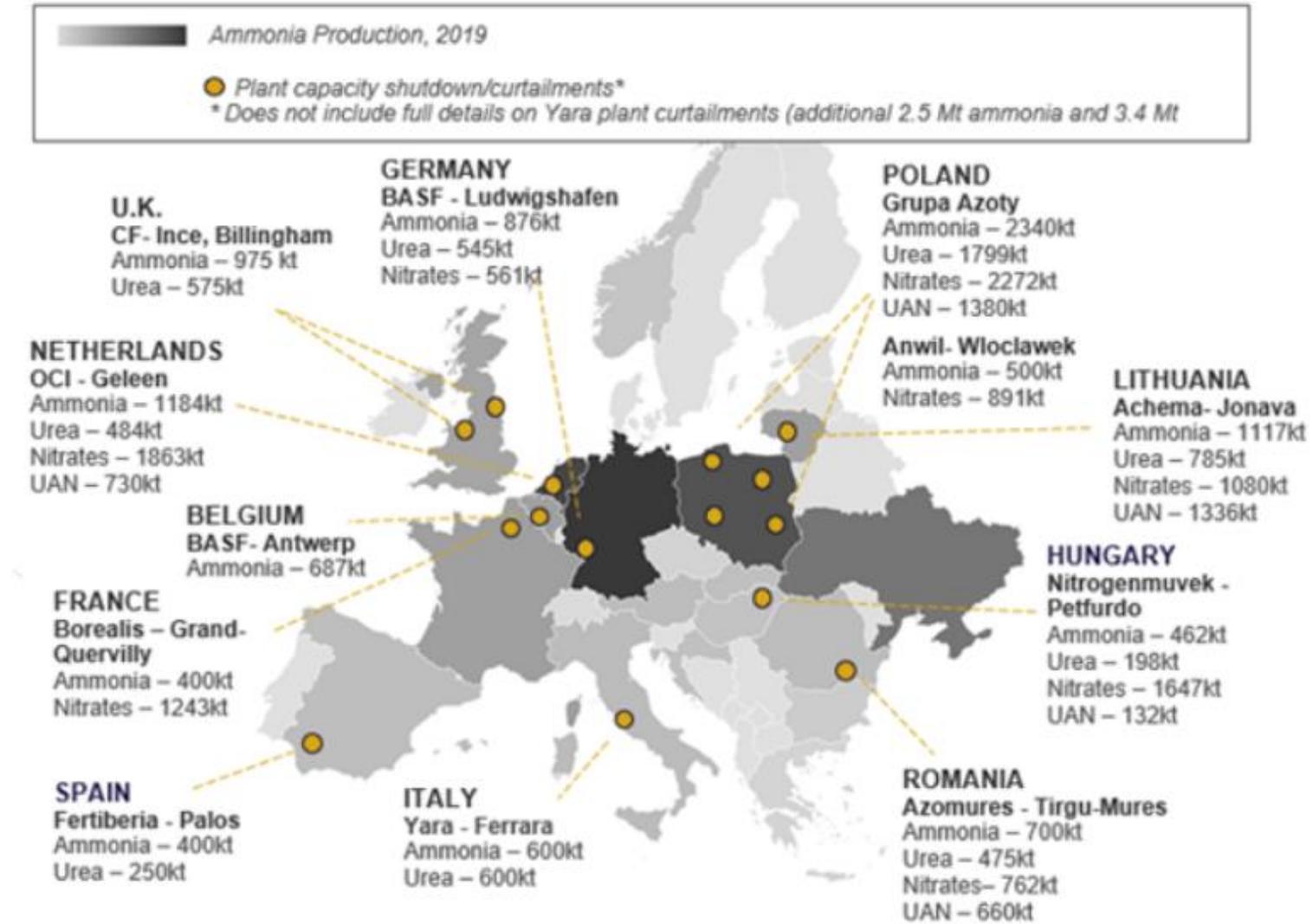


Without fossil fuel-based fertilizers, agriculture can support, at most, 3 billion people on plant-based diets, vs. today's 8 billion on mixed diets.

Sources: Vaclav Smil, FAO, World Bank, Statista,

# 70% of Europe's nitrogen fertilizer plants have closed

Figure 1: European nitrogen production shutdowns and curtailments



DATA: CRU, IFA

# Surging Fertilizer Prices Set to Exacerbate African and Mid-East Food Crisis

- Use of nutrients may shrink by a third in sub-Saharan Africa
- Import-dependent region may face increasing food shortages

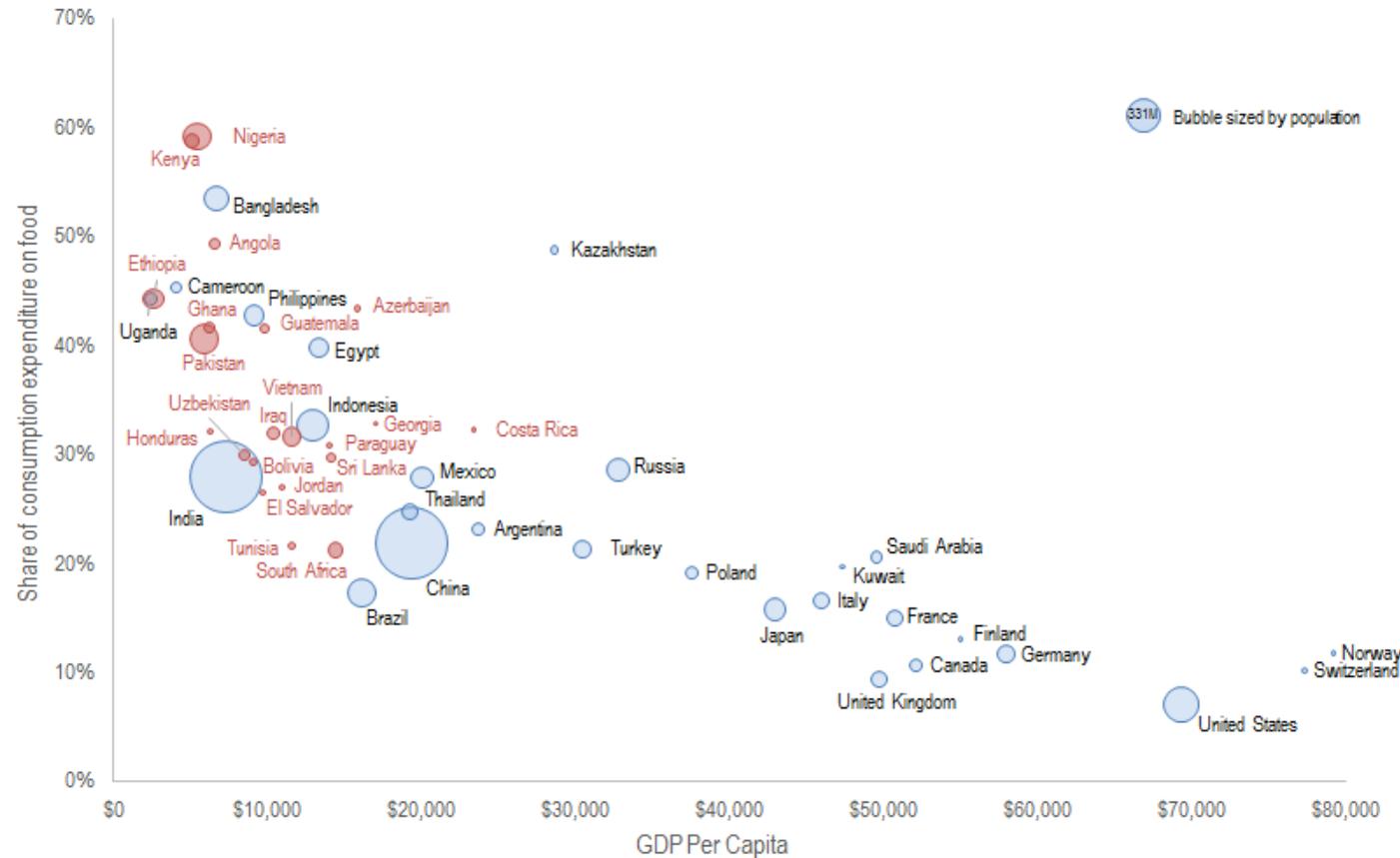


“That could potentially curb cereals output by 30 million tons, enough to feed 100 million people.”

– Sebastian Nduva, Program Manager at AfricaFertilizer.Org

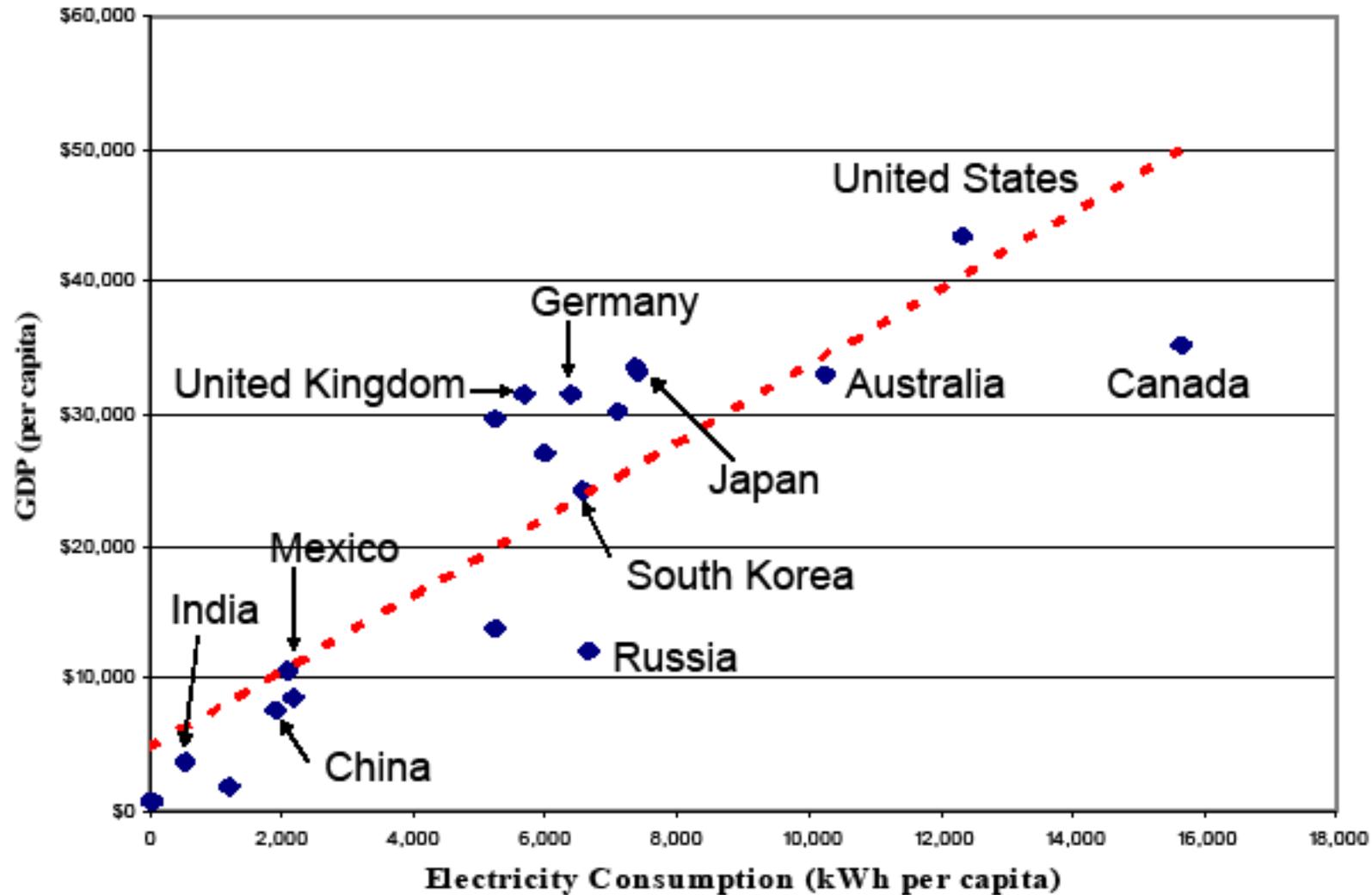
### Figure 3: Low- and middle-income countries are most vulnerable to rising food prices given a larger share of income is spent on food

Share of consumer expenditure spent on food (2020, latest data available) vs. GDP per capita, 2021. Food expenditure relates only to food bought for consumption at home (i.e., it excludes out-of-home food purchases) and excludes alcoholic beverages and tobacco products.



\*Countries highlighted in red are currently in NEXGEM

# Quality of Life is Strongly Correlated with Electricity Consumption



Source: CIA World Factbook, 2007

# The essentiality of electricity to modernity

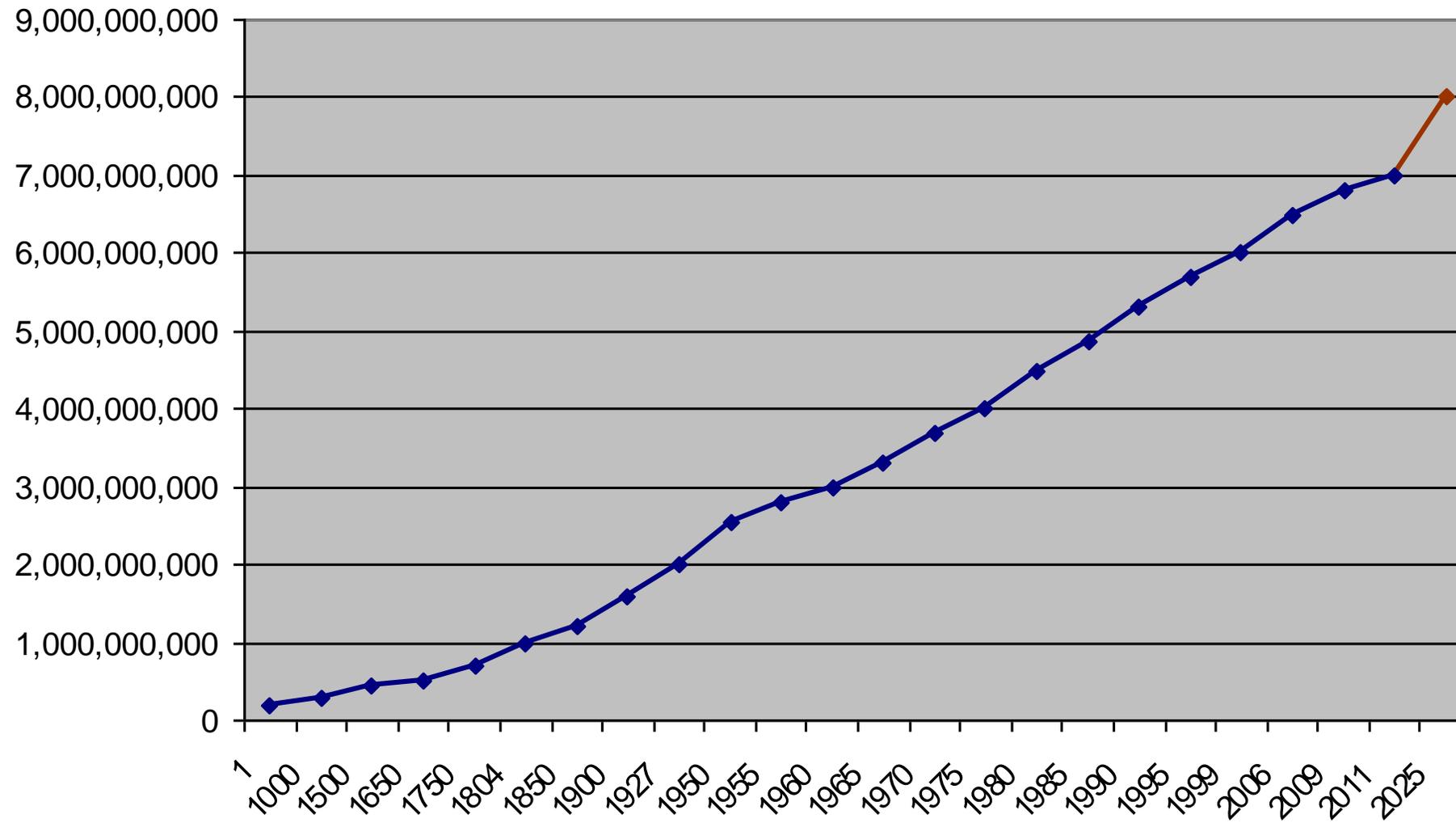
Over 1.2 billion people – 20% of the world's population – are still without access to electricity worldwide, almost all of whom live in developing countries. This includes about 550 million in Africa, and over 400 million in India.



3 Billion people in the world currently use less electricity than a typical American refrigerator



# World Population Growth



Source: About.com; <http://geography.about.com/od/obtainpopulationdata/a/worldpopulation.htm>



In a single year, the average US home uses 84 MCF or 84 MMBtu of natural gas.

100 BCF	Average U.S. Daily Production and Demand
70 BCF	Russian Daily Production
50 BCF	European Union average daily usage
18 BCF	Russian export volume to Europe (2021)
12 BCF	U.S average daily LNG Export volume (2022)
12 BCF	Expected growth in U.S. LNG export capacity next 4 years
11 BCF	Worldwide daily volume of natural gas that is converted to fertilizer
11 BCF	Anticipated 24-hour swing in natural gas demand in California by 2035

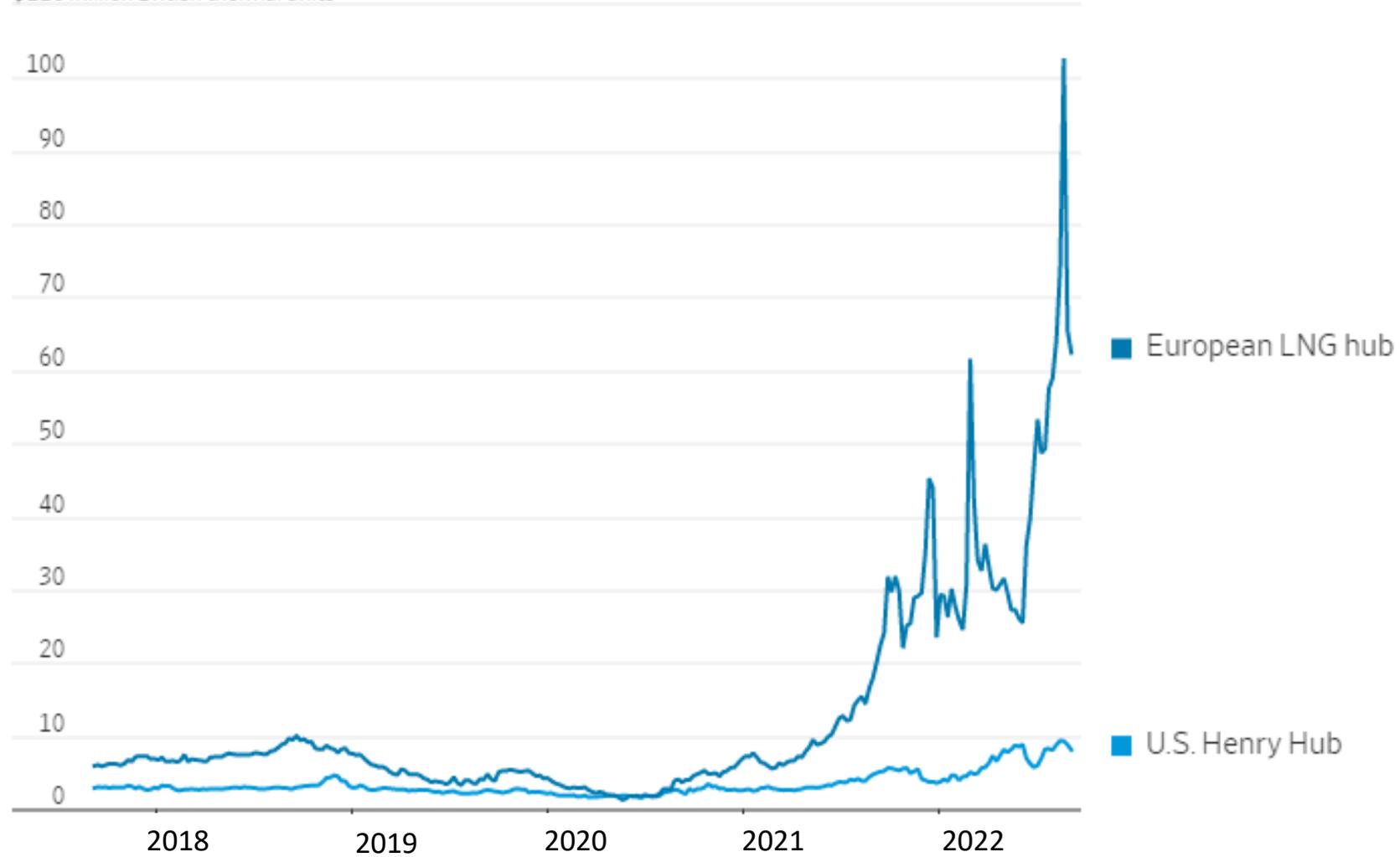
- 7-8 BCF California peak day natural gas usage (2022)
- 4 BCF Colorado peak day natural gas usage
- 3 BCF Volume contained in the average LNG tanker
- 2.5 BCF Daily volume of natural gas managed by Mercator Energy
- 2 BCF Xcel Energy peak day natural gas usage (CO)
- 84 Dth Typical annual average use per U.S household
- 1 Dekatherm (Dth) = 1 MMBtu = 1 MCF (approx.)
- 10 Therms = 1 Dekatherm
- 4/10 of 1%: Percentage of total U.S. gas stove usage vs. total U.S. gas usage

# Part 2: What Happened in Europe/Germany?

- Over reliance on renewables
- Retired coal plants too early
- Retired nuclear plants too early
- Under reliance on fossil fuels

## Natural gas price

\$110 million British thermal units



Source: FactSet

## One-Year Forward Strip

NYMEX Henry Hub	\$ 7.725
LNG Delivered Price to Europe	\$97.993

## One-Year Forward Strip

NYMEX Henry Hub	\$ 3.20
LNG Delivered Price to Asia	\$20.13
LNG Delivered Price to Europe	\$20.33

## Three-Year Forward Strip

NYMEX Henry Hub	\$ 3.91
LNG Delivered Price to Asia	\$18.02
LNG Delivered Price to Europe	\$19.25

\* Settled price as of February 3, 2023, prices in \$/MMBtu

# The Former Chancellor Who Became Putin's Man in Germany



Gerhard Schröder, Chancellor of Germany from 1998 to 2005

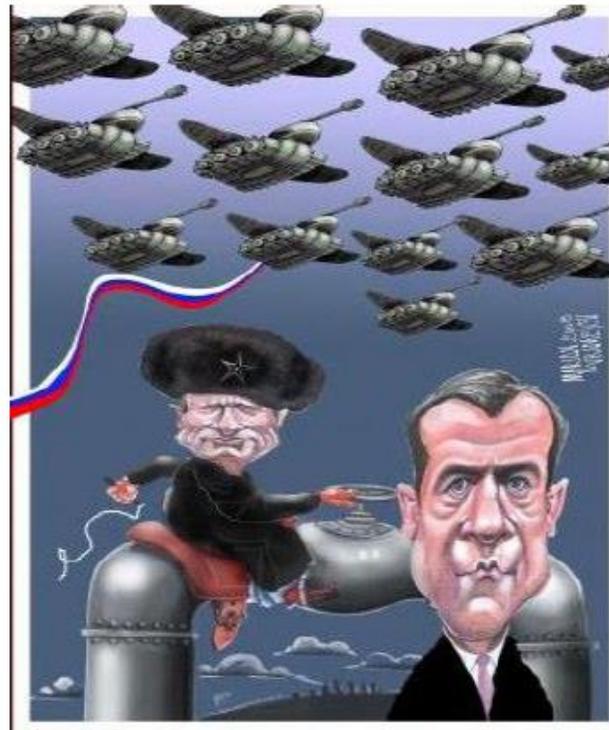
Title	Term	Income
Chancellor of Germany	1998 – 2005	? currently receives \$9,000/month stipend
Nord Stream I Chairman/Shareholder	2005 – 2022	\$270,000/year
Nord Stream II Board Member	2011 - ?	?
Rosneft Board President	2017 – present	\$600,000/year
Gazprom Board Member	2022 - ?	?

“Germany’s reliance on Russian gas surged to 55 percent before Russia’s attack on Ukraine began in February, from 39 percent in 2011, amounting to 200 million euros, or about \$220 million, in energy payments every day to Russia.”



## Russia's Energy Muscle

- Energy Used Over 55 times Against Former Soviet Nations Since 1990



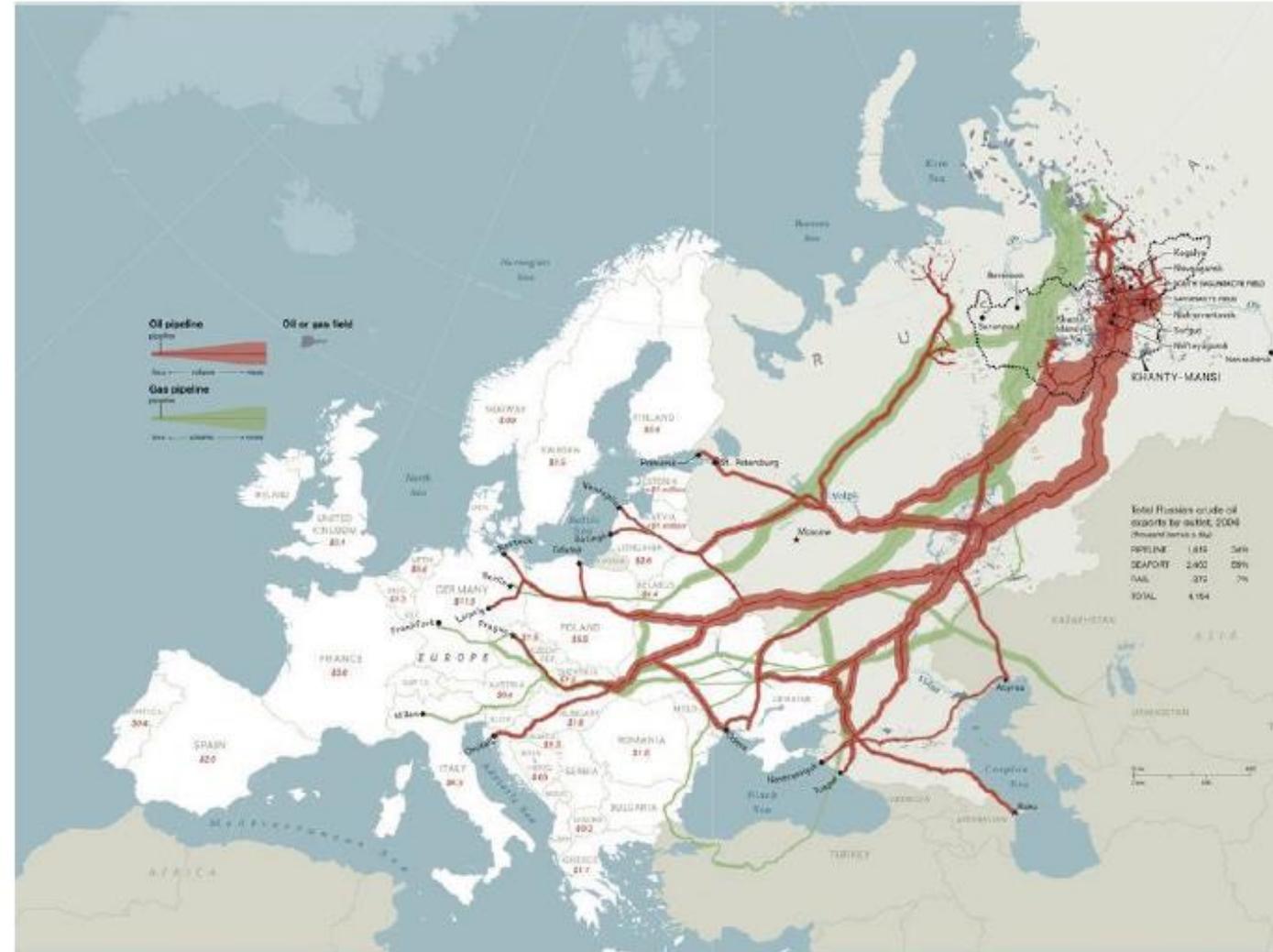
Source: *Europe Doubles Down on Russian Gas to Feed its Energy Appetite*, by Andrew Haney, Ricardo Bracho, Nick Wolfe and Max Faith

## Russian Energy Figures

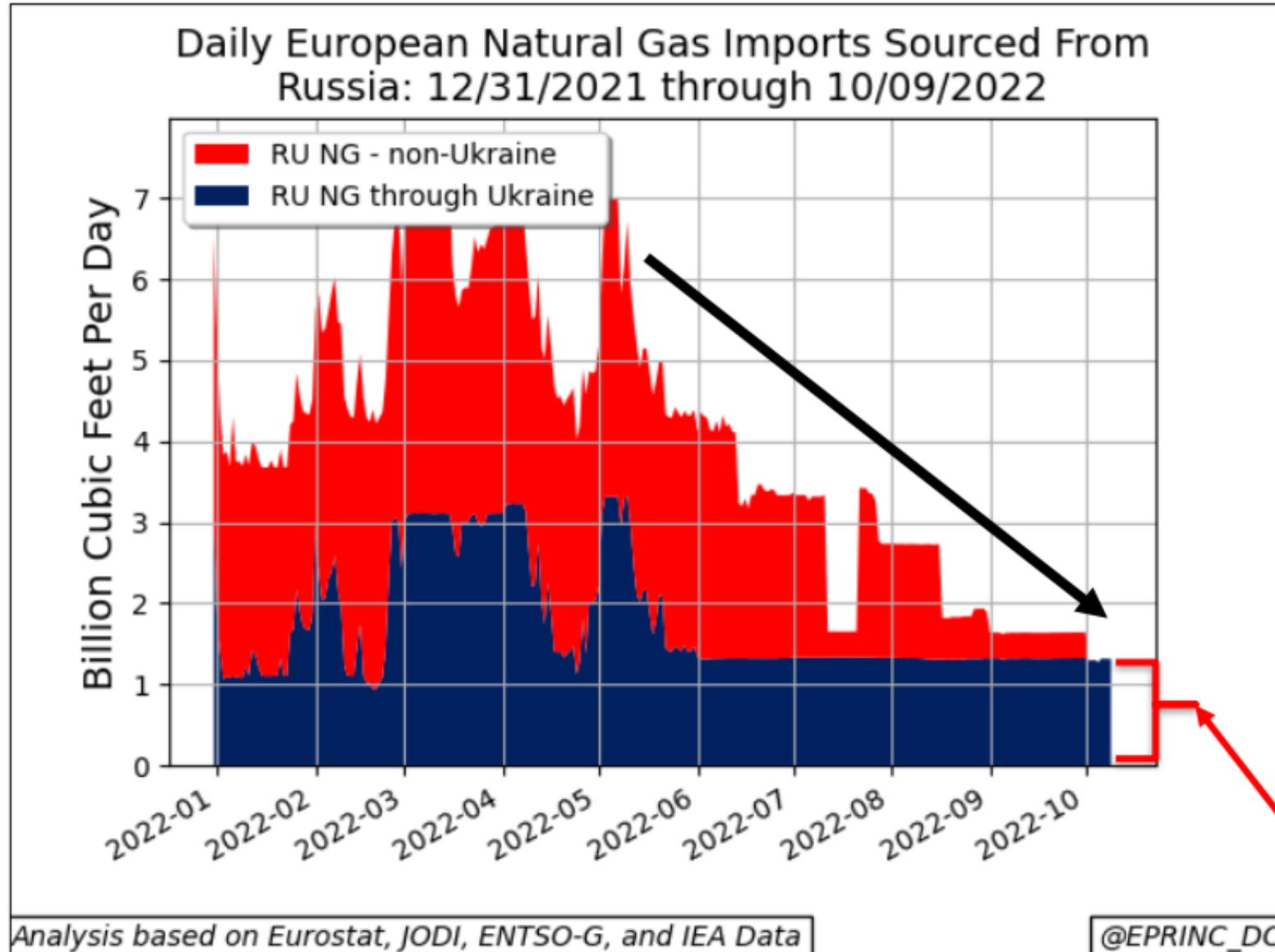
- Natural gas production: 70 Bcf/d (2<sup>nd</sup> largest)
- Natural gas pipe exports: 19 Bcf/d (1<sup>st</sup> largest)
- Oil production: 10.6 MMBpd (3<sup>rd</sup> largest)
- Oil exports: 7.5 MMBpd (2<sup>nd</sup> largest)

## Europe's Reliance on Russian Energy

- ~40% of EU's gas demand met by Russia
- ~45% of EU's coal imports from Russia
- ~30% of EU's oil imports met by Russia



# Europe – Daily Natural Gas Receipts During 2022



European supply diversification away from Russia  
takes **17 BCF/d** out of **50 BCF/d** market



Source: Wood Mackenzie, "Wellhead to LNG: Producers & Export Deals," September 2022, Image: Reuters

## ***Goldman Sees \$2 Trillion Surge in European Household Energy Bills by 2023***

- September 6, 2022, Bloomberg.com

3,500 energy intensive industries are surveyed, only half have hedges in place for energy requirements

- July 25, 2022, Oilprice.com

## ***Energy Prices Trigger Deindustrialization In Germany***

- August 19, 2022, Oilprice.com

## ***Germany Risks a Factory Exodus as Energy Prices Bite Hard***

August 18, 2022, Bloomberg.com

## ***Germany's Natural Gas Crunch Could Cause Supply Chains to Collapse***

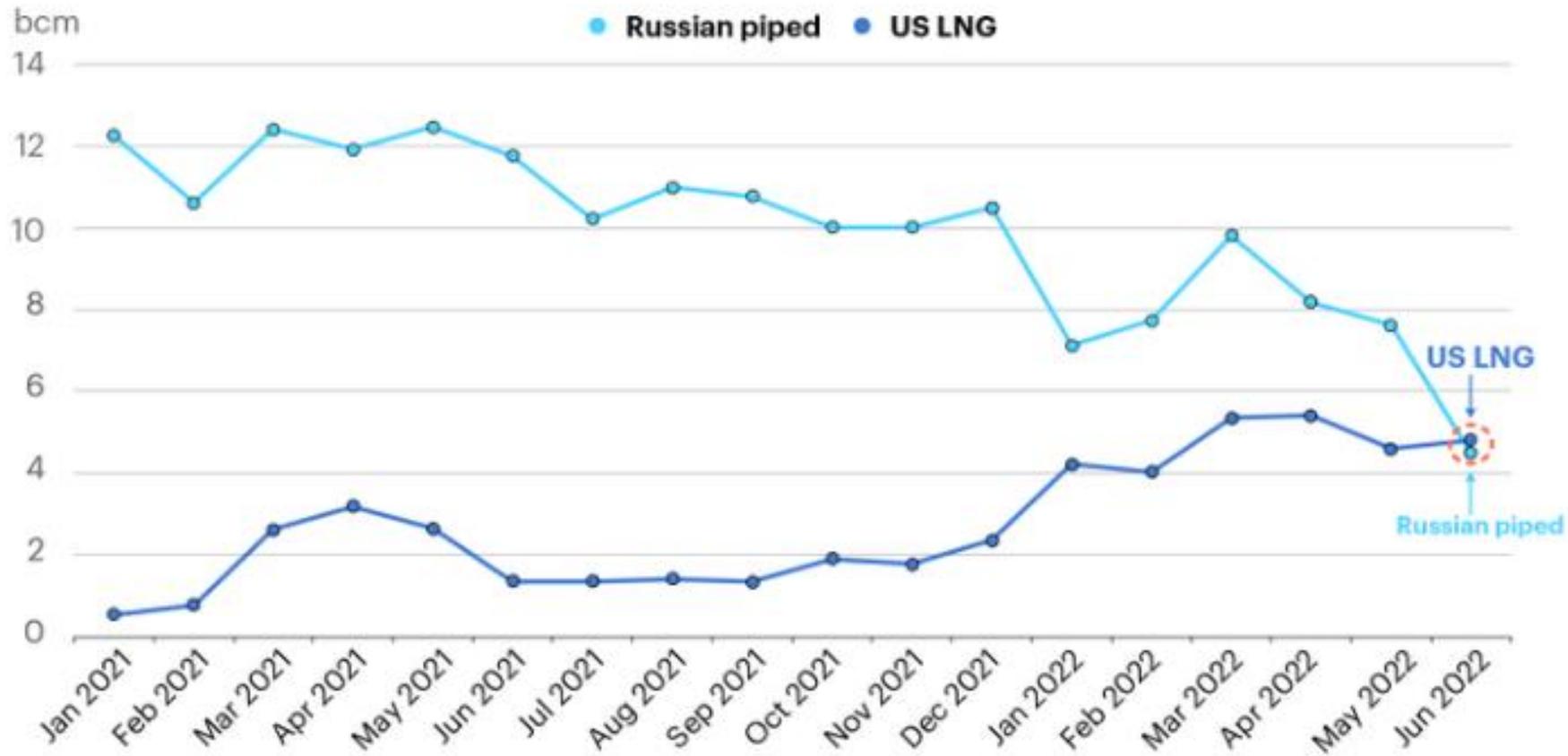
- August 3, 2022, Oilprice.com

## ***Europe's metals industry warns of existential threat to their future***

- September 2022, Eurometaux

## US liquefied natural gas (LNG) overtakes Russian piped gas in EU gas imports in June 2022

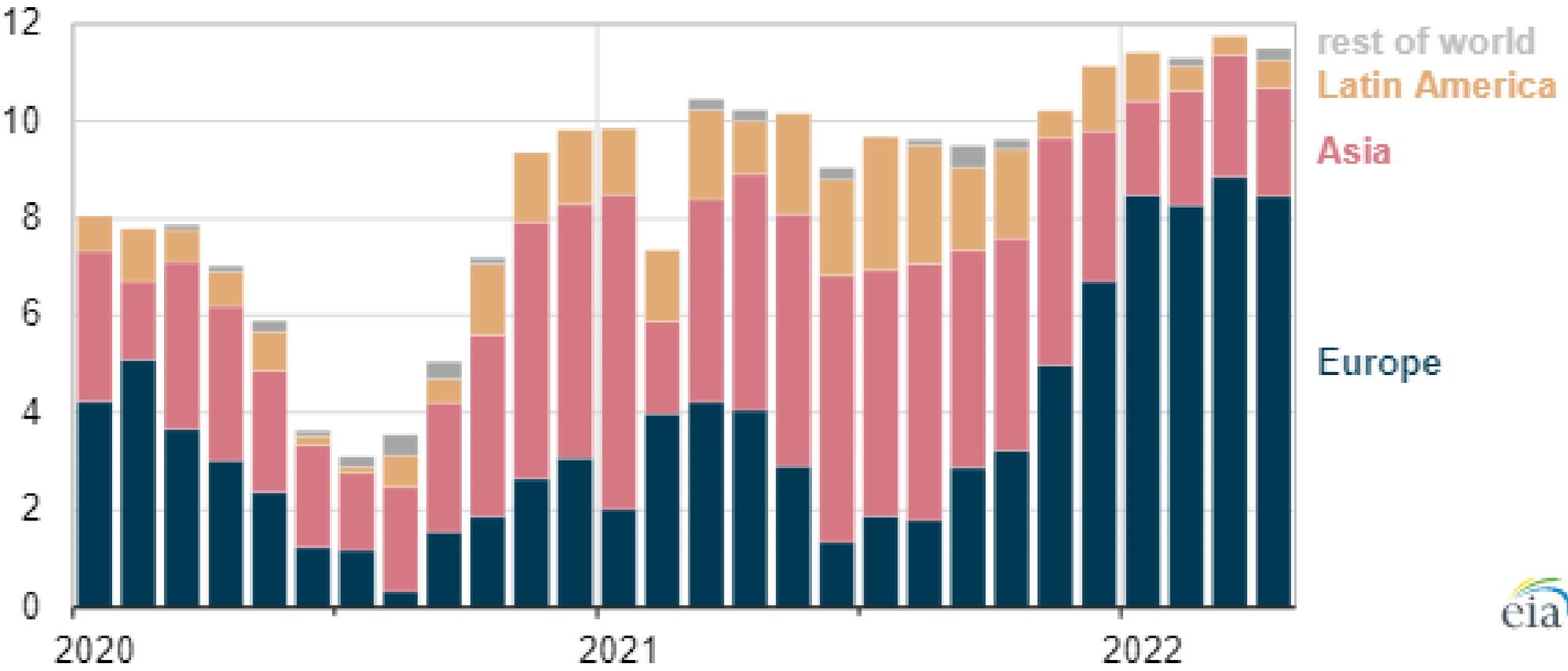
IEA analysis



International Energy Agency

# U.S. liquefied natural gas exports to Europe increased during the first 4 months of 2022

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

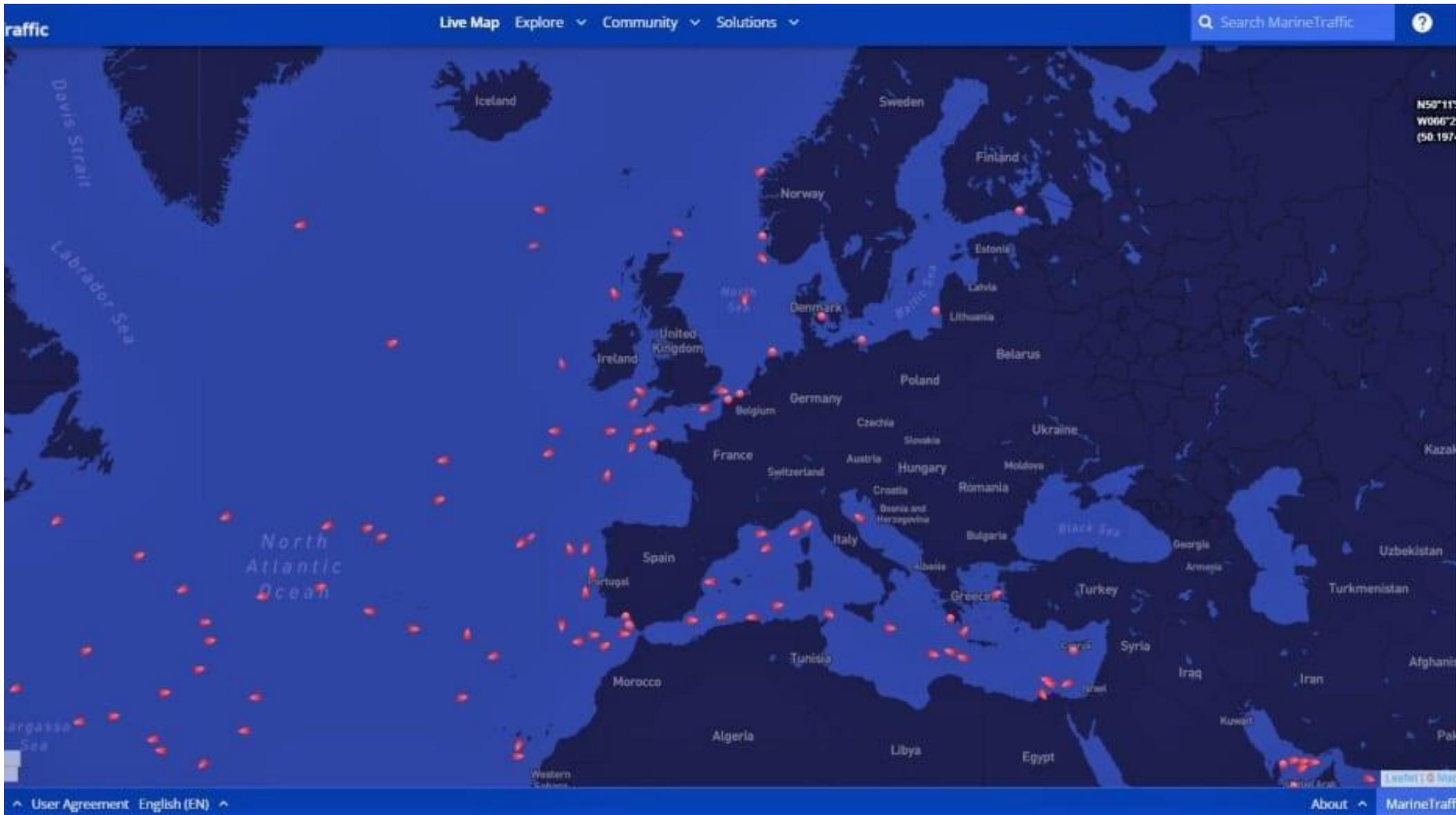


Note: Europe includes Turkey



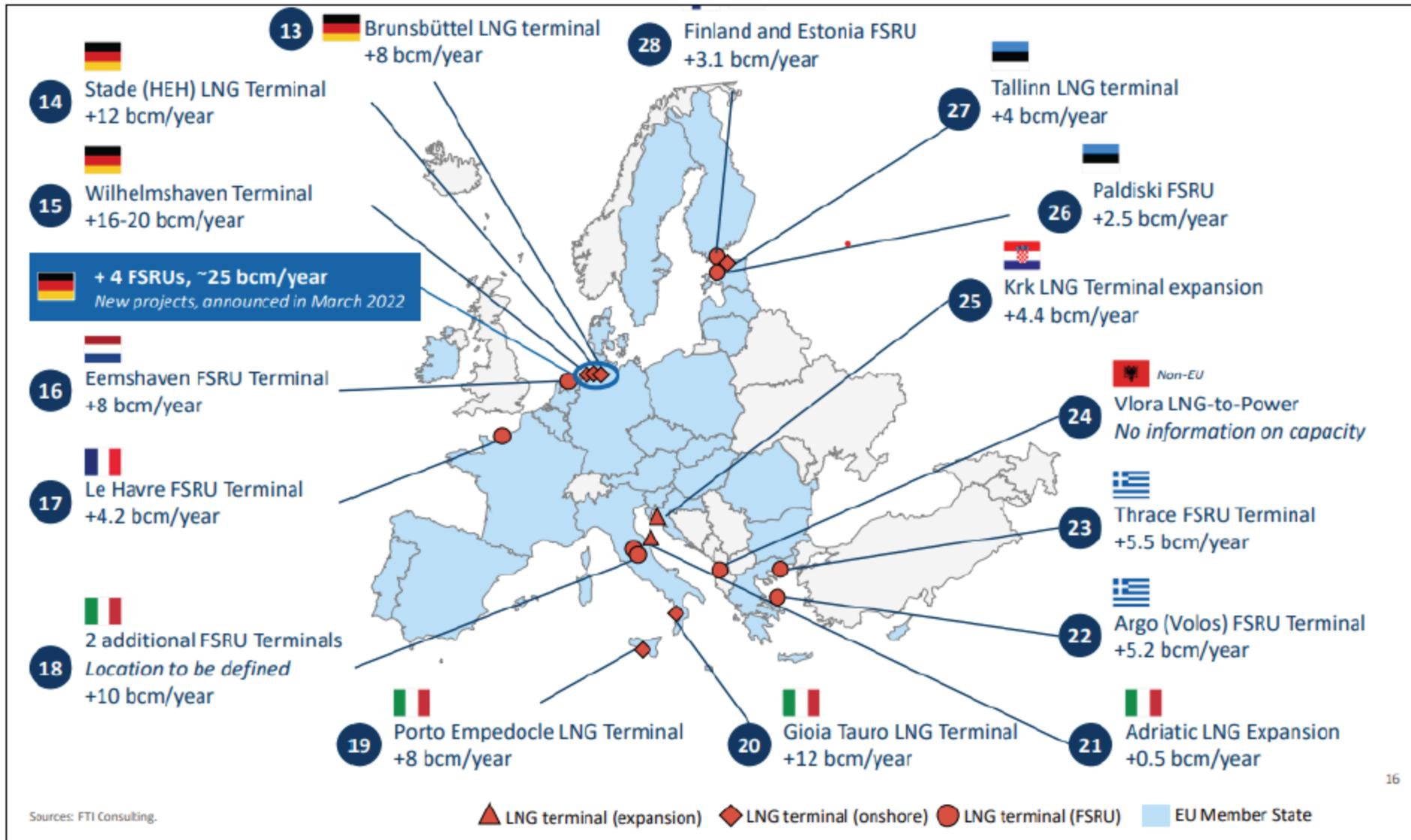


# Wave of LNG Tankers is Overwhelming Europe, 10/24/22



Source: CNBC, Lori Ann LaRocco, October 24, 2022, MarineTraffic

# Europe has authorized 21 new LNG projects

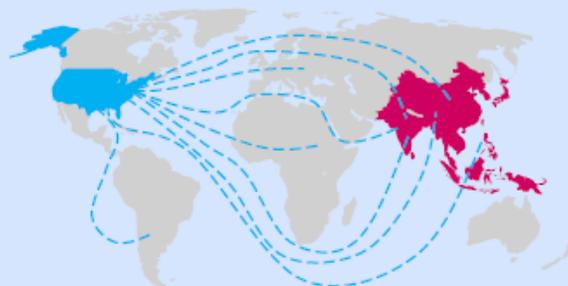


<https://www.fticonsulting.com/-/media/files/emea-files/insights/white-papers/2022/may/new-lng-regasification-terminals-europe.pdf>



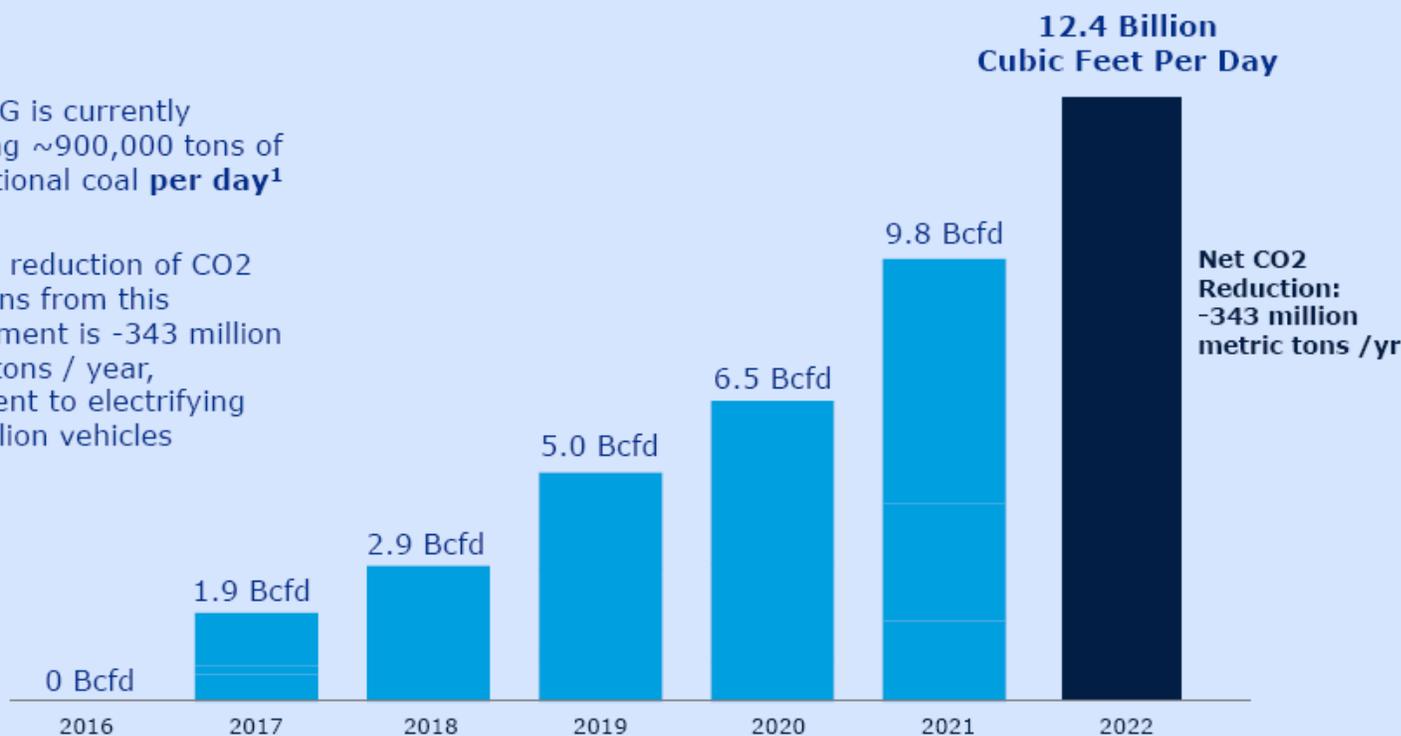
## U.S. LNG Export Capacity

LNG export facilities are currently located predominantly on the Gulf Coast



U.S. LNG is currently replacing ~900,000 tons of international coal **per day**<sup>1</sup>

The net reduction of CO2 emissions from this replacement is -343 million metric tons / year, equivalent to electrifying 125 million vehicles

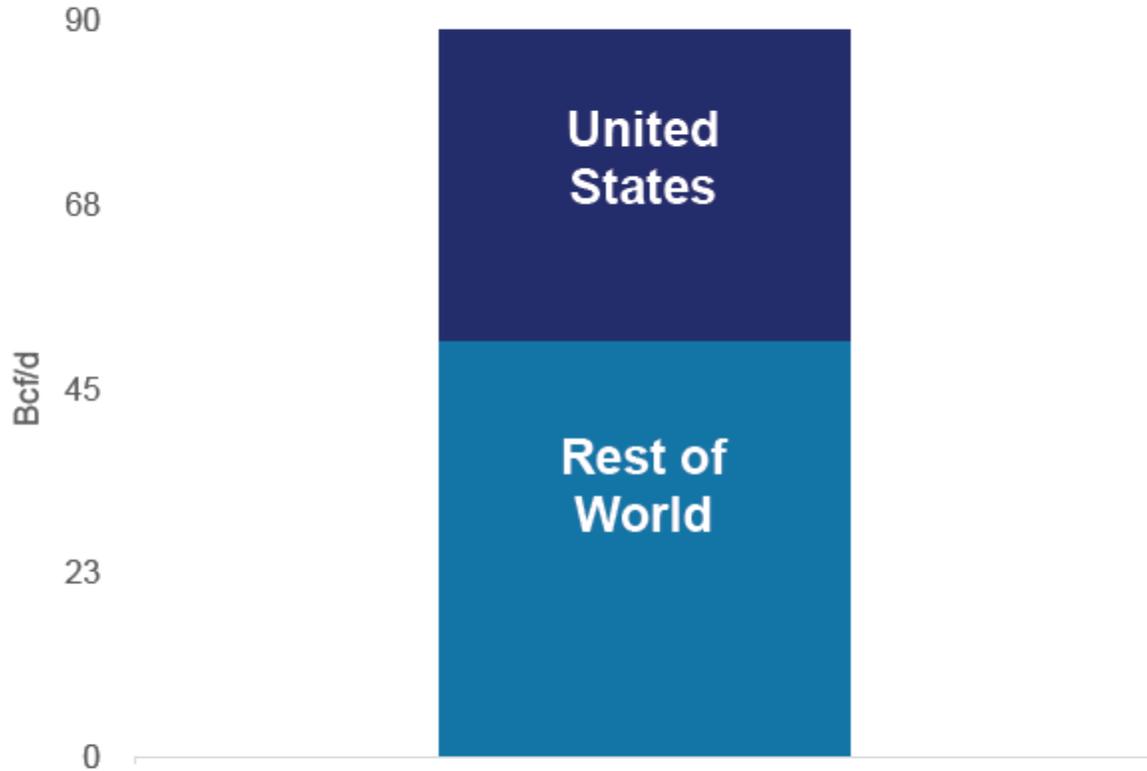


1. International coal displaced is calculated by total thermal unit generated by gas divided by average heating content of coal (~19.8 mmbtu/short ton) // Net GHG reduction is calculated based on the emission differential between coal and natural gas (~560 CO2e kg/MWh) based on a study from ICF.

Source: EIA U.S. Natural Gas Exports and Re-Exports by Point of Exit, Reuters, EIA CO2 emission coefficient.

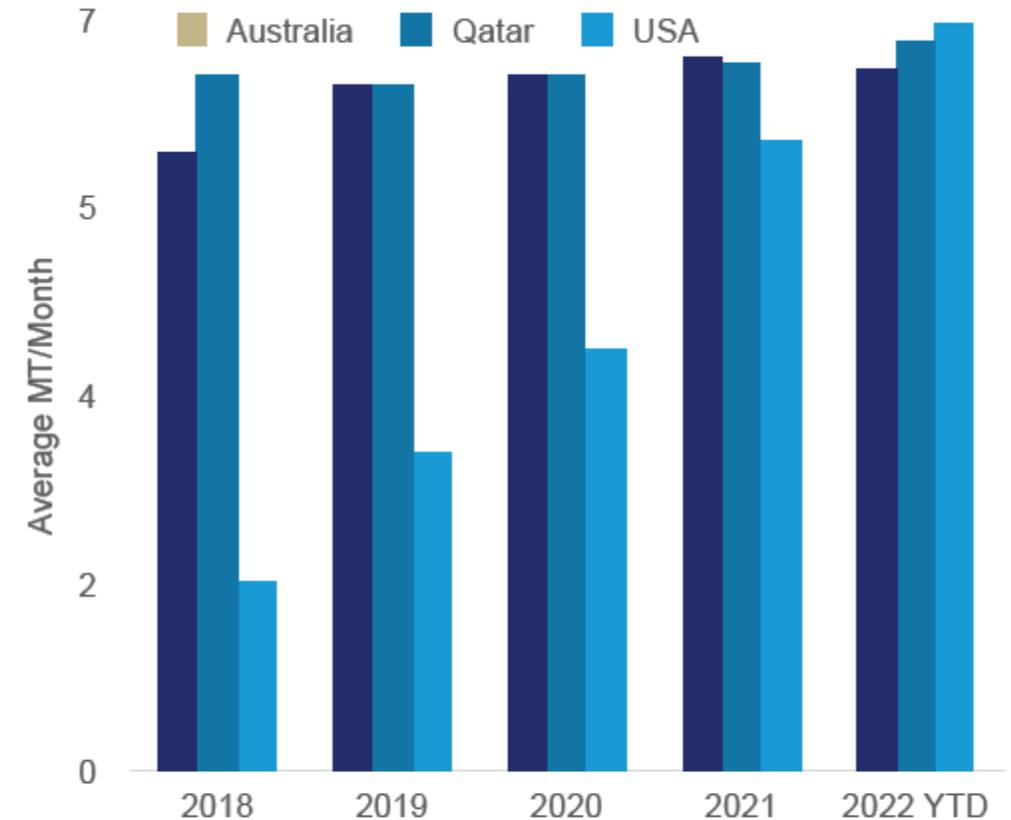
# The United States has been the key driver of global natural supply growth

## Net Global Natural Gas Supply Growth Since 2007



- Since 2007, 42% of global natural gas supply growth has come from the United States

## Top 3 LNG exporters

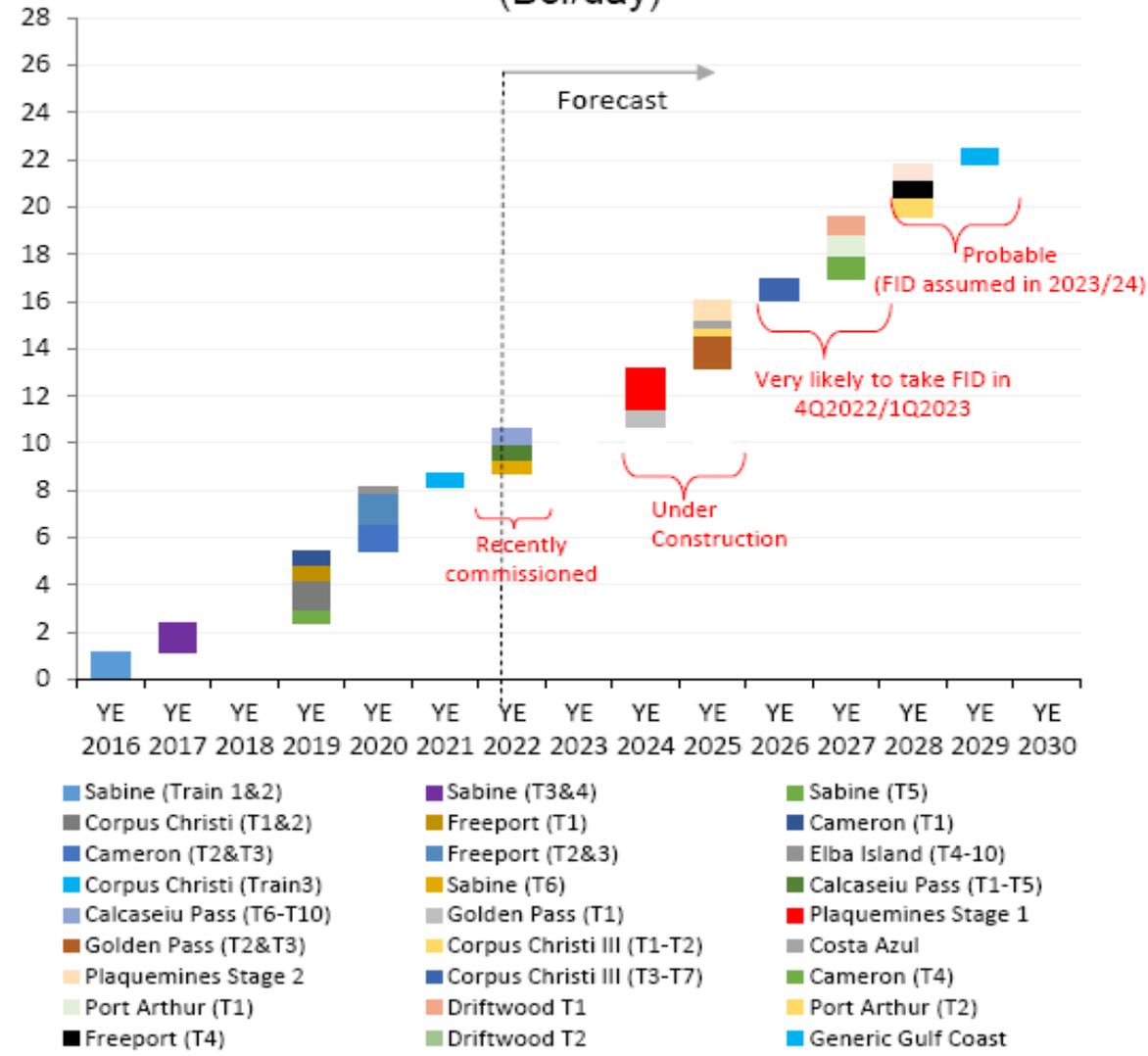


- US natural gas supply growth has supported LNG exports, with the US overtaking Qatar this year

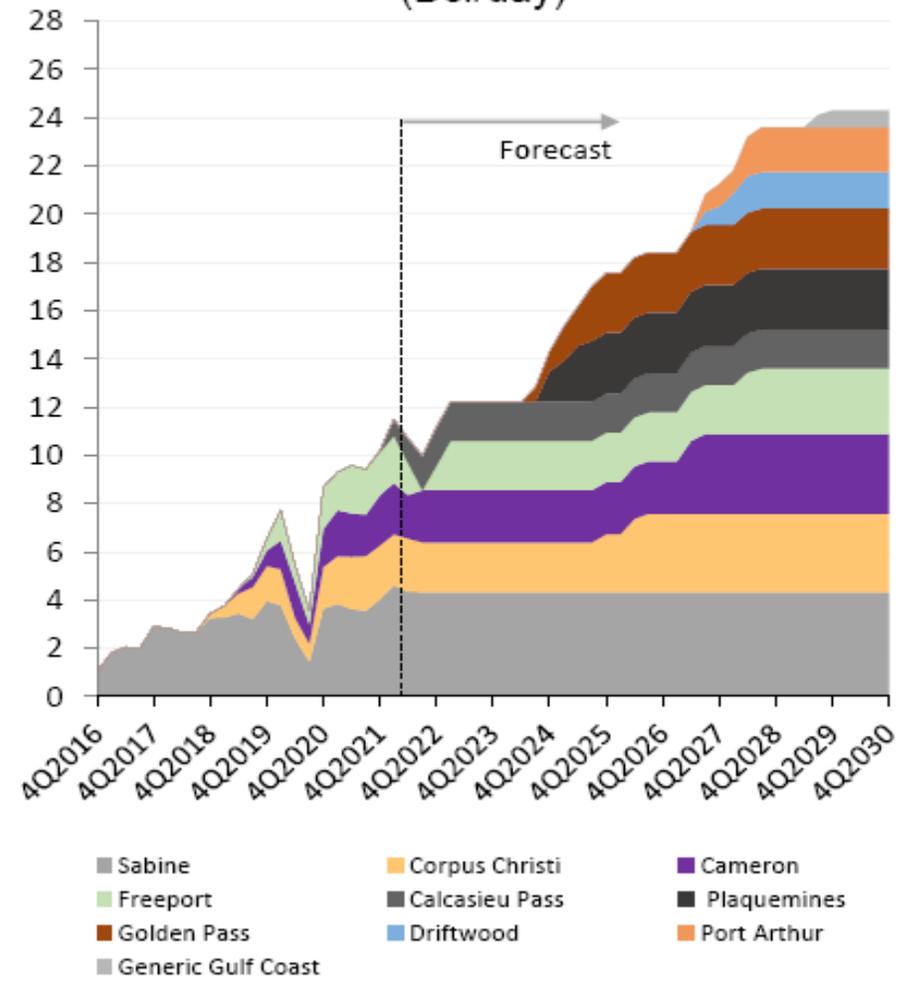
Source: Wood Mackenzie, IHS Markit  
 Note: 2022 YTD = January 1 to June 15, 2022

# USGC LNG feed gas is expected to reach ~24 Bcf/d by 2030, adding ~14 Bcf/d to regional demand (from 2021 average of ~10 Bcf/d)

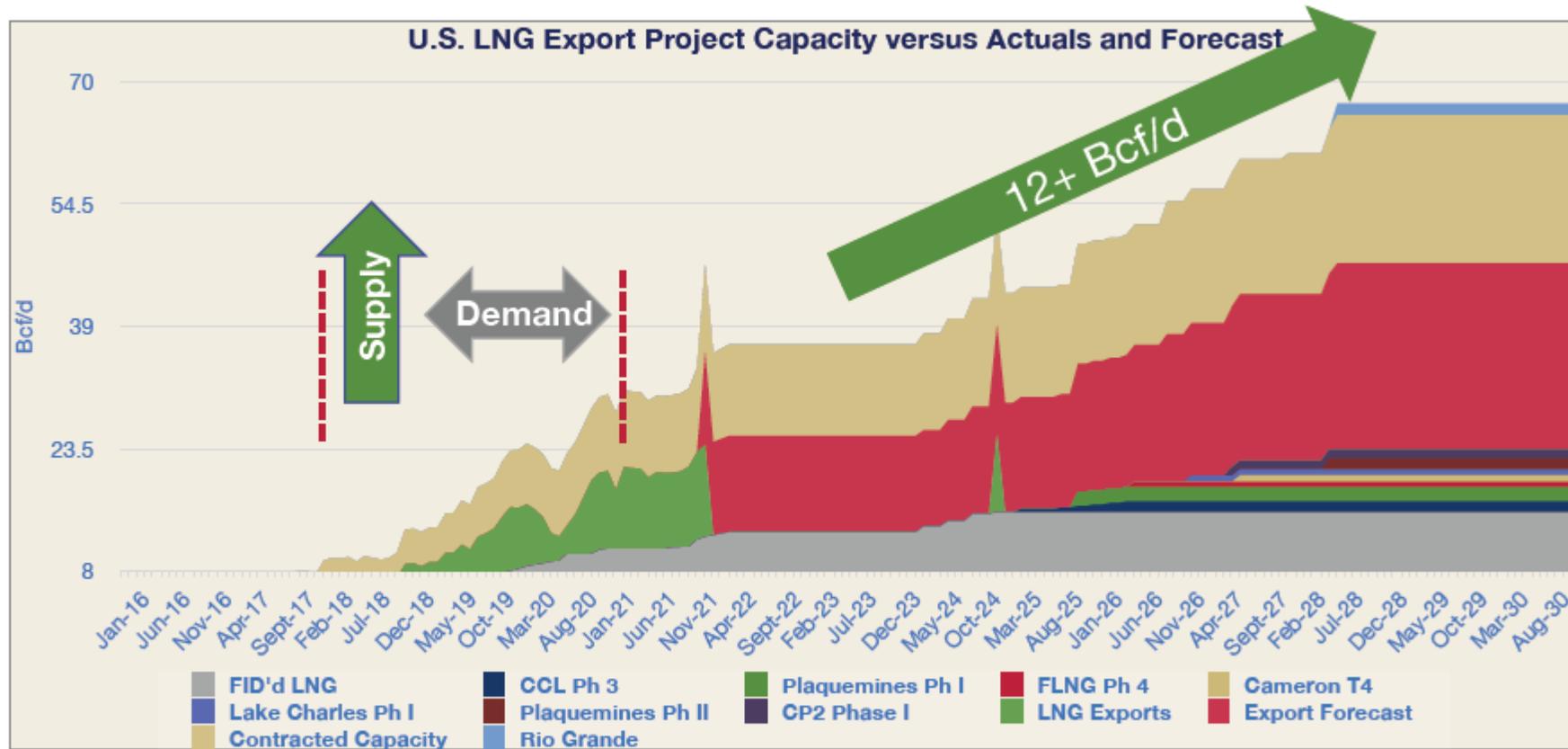
### USGC LNG Export Nameplate Capacity Forecast (Bcf/day)



### USGC LNG Feed Gas Volume Forecast (Bcf/day)

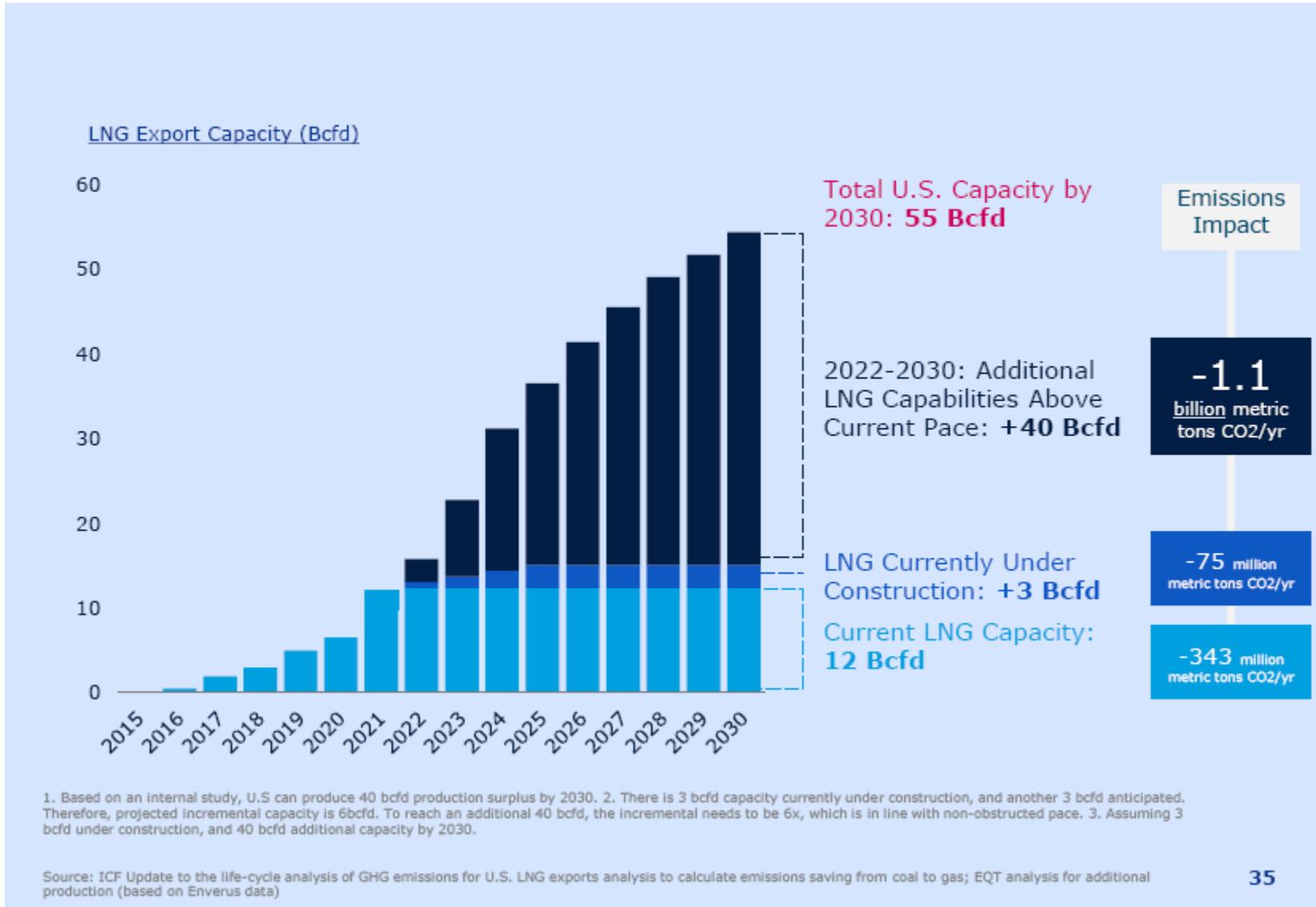


# 2024 to 2030



Where will all the gas come from to meet this massive increase in Demand?

# Projected LNG Export Capacity Through 2030<sup>1</sup>



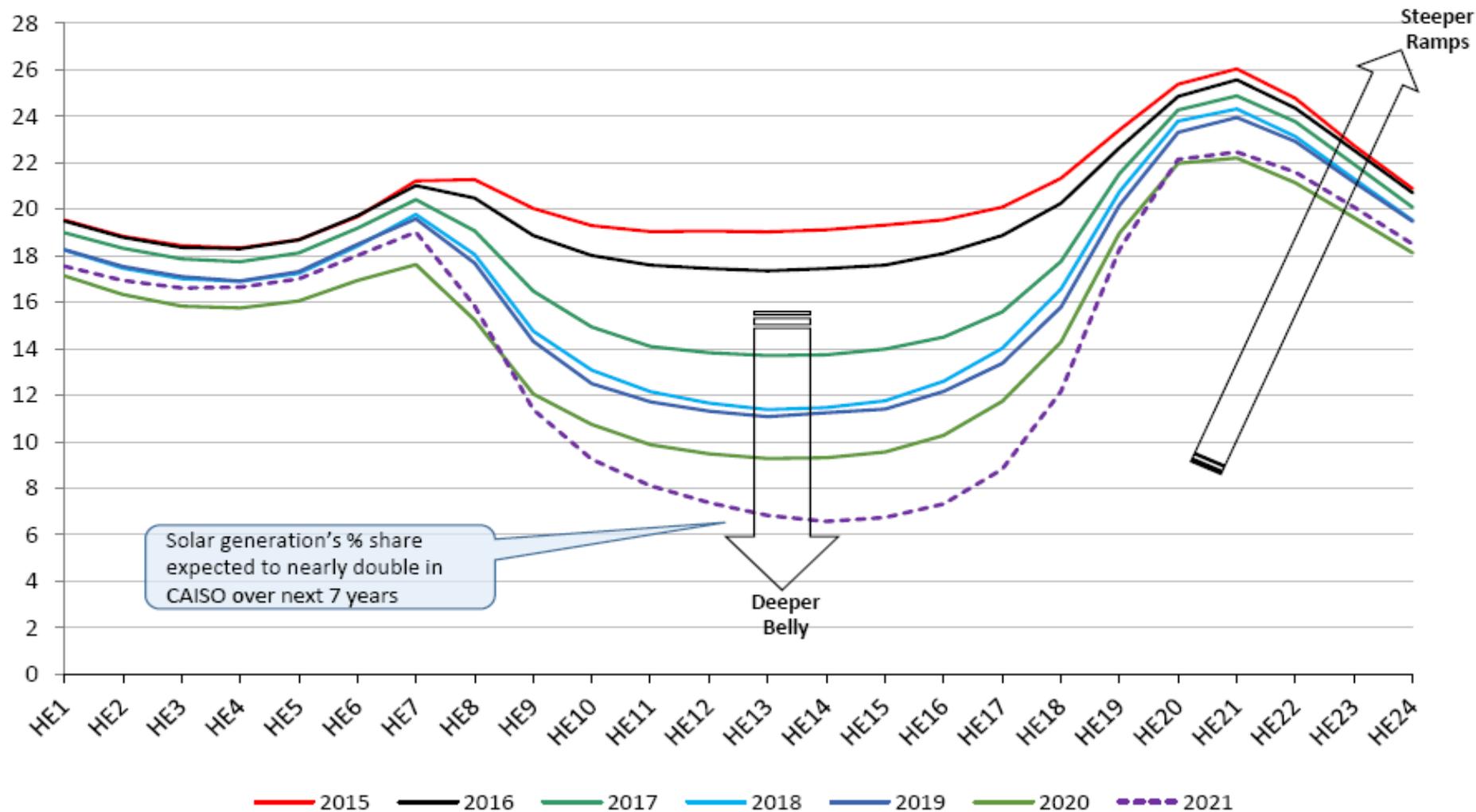
Part 3:  
What is Happening in the  
Western/U.S California?

- Over reliance on renewables
- Retired coal plants too early
- Retired nuclear plants too early
- Under appreciation for fossil fuels

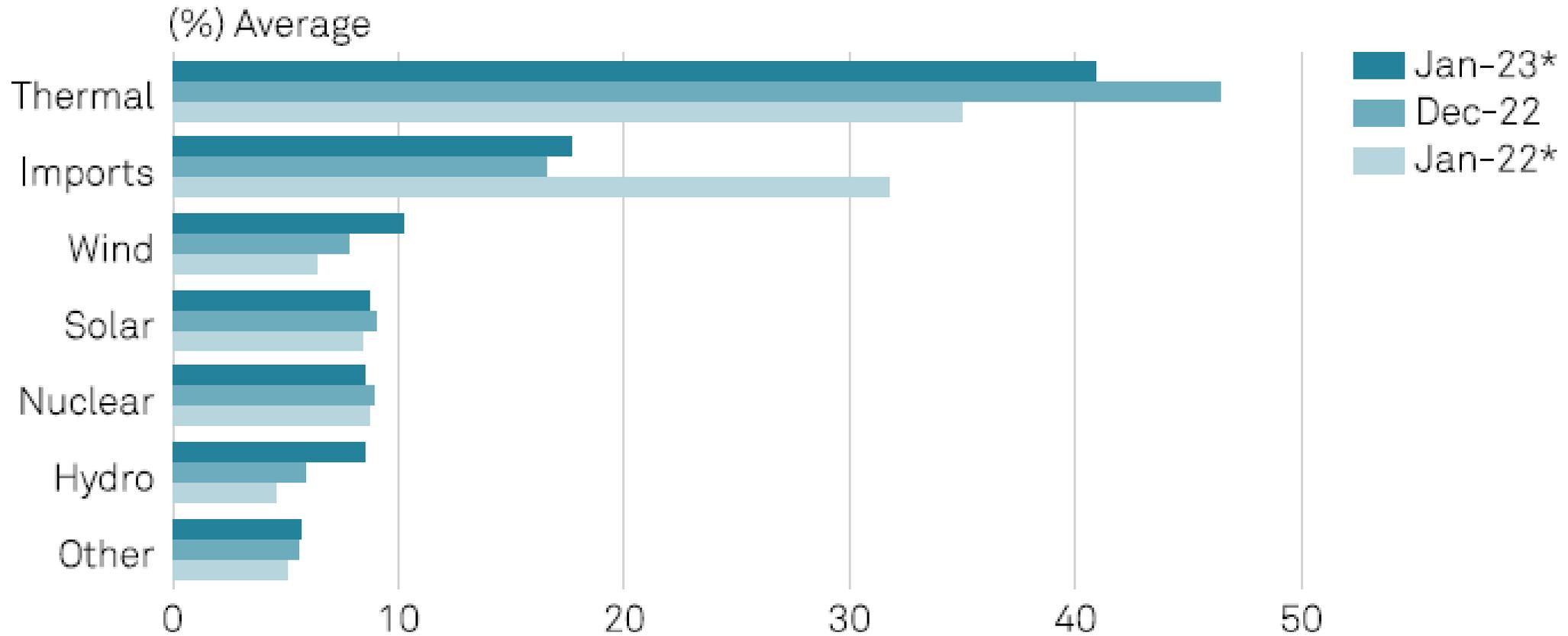
Déjà vu?

# Growth in wind/solar resource will amplify hourly swings in net load stressing pipeline systems that rely on ratable 1/24 deliveries

Average Hourly Net Load Profile (April)  
(GW)



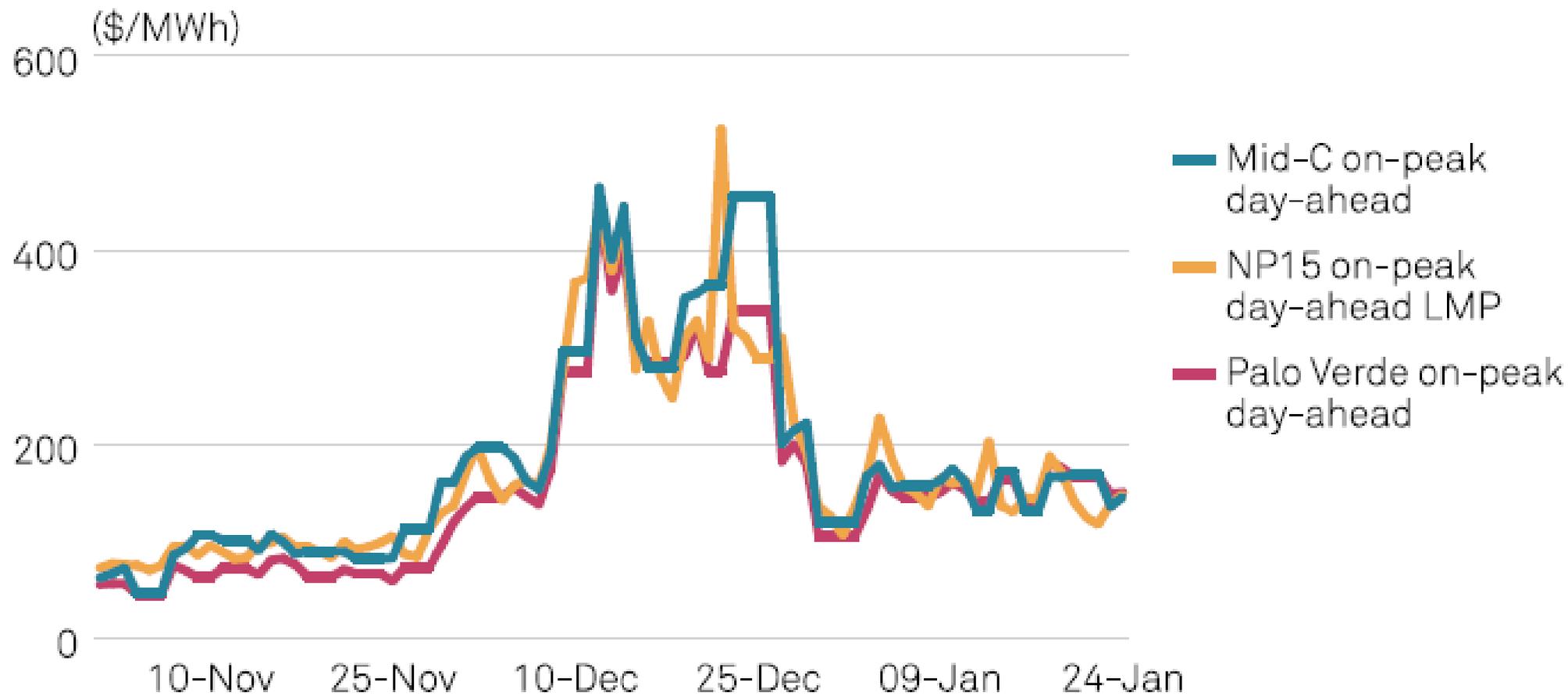
# CAISO generation mix comparison



\*Data through 23-Jan

Source: CAISO

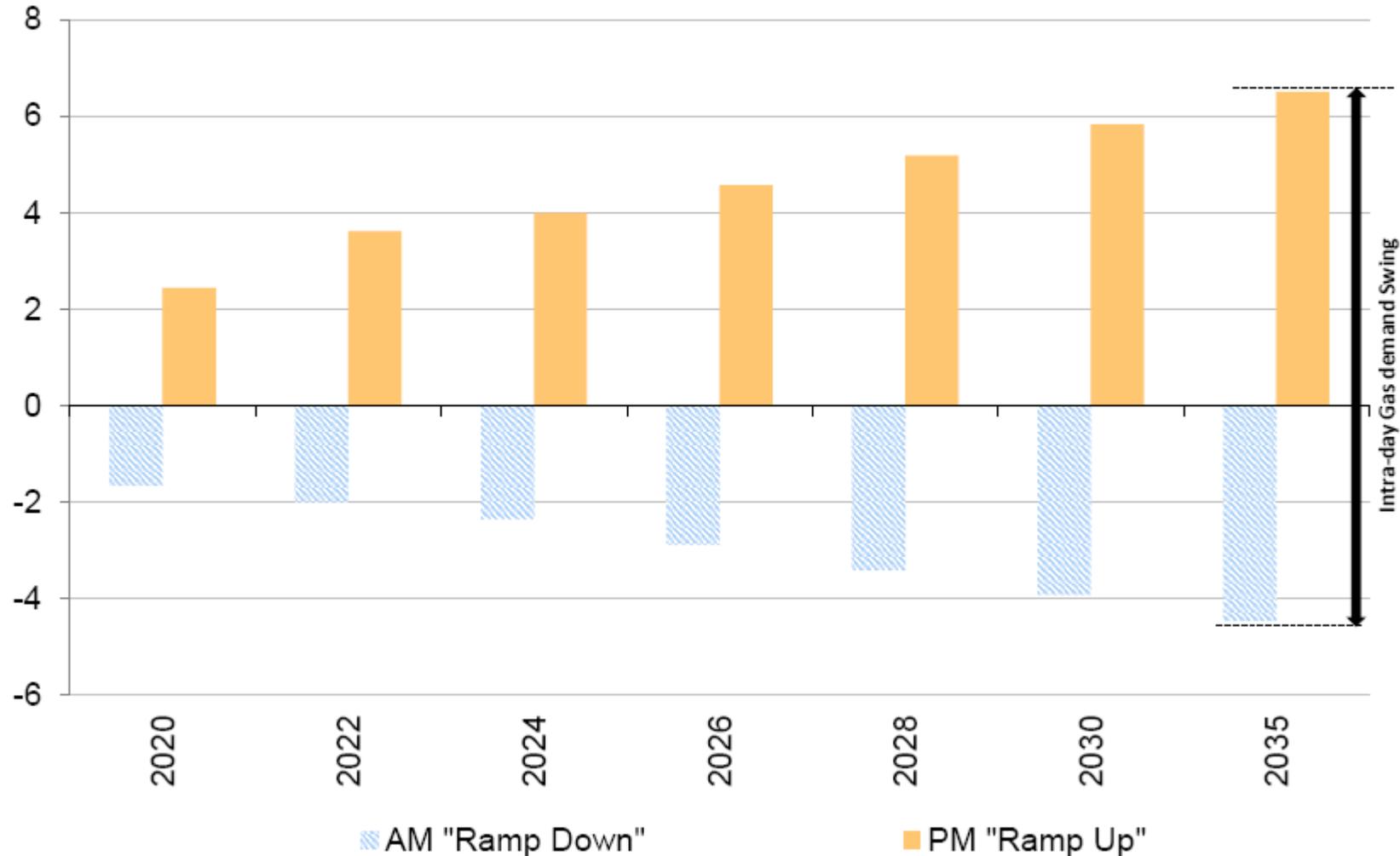
# Western power prices retreat after December highs



Source: CAISO, S&P Global Commodity Insights

# ...resulting in ~11 Bcf/d of swing in gas burn by 2035, all within a period of 24 hour in California gas market

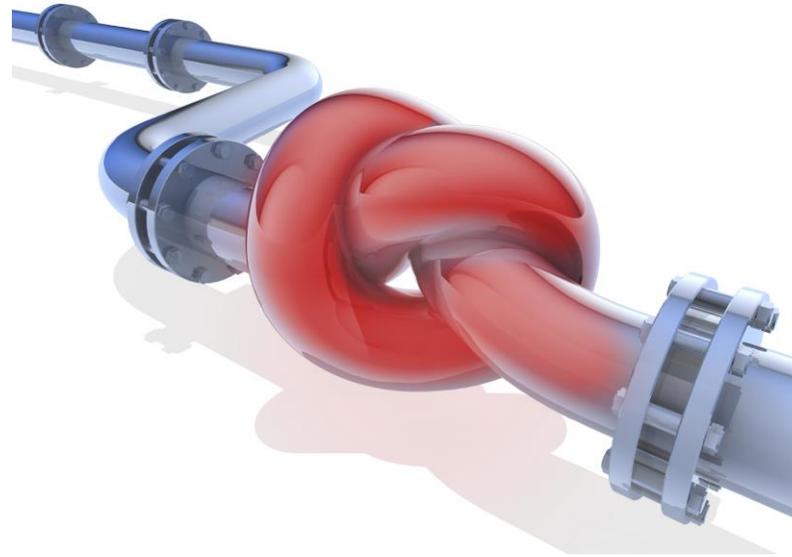
### Intra-day Power Burn Swing in California (Bcf/d)



Note: AM "Ramp Down" from approx. 8 AM to 1 PM as solar output increases while PM "Ramp Up" or late Afternoon Ramp Up from approx. 3 or 4 PM as sun sets

Source: Enkon Energy Advisors, "Are Stars Aligning for U.S. Natural Gas Storage Assets?" September 27, 2022, Enkon Leidos forecast

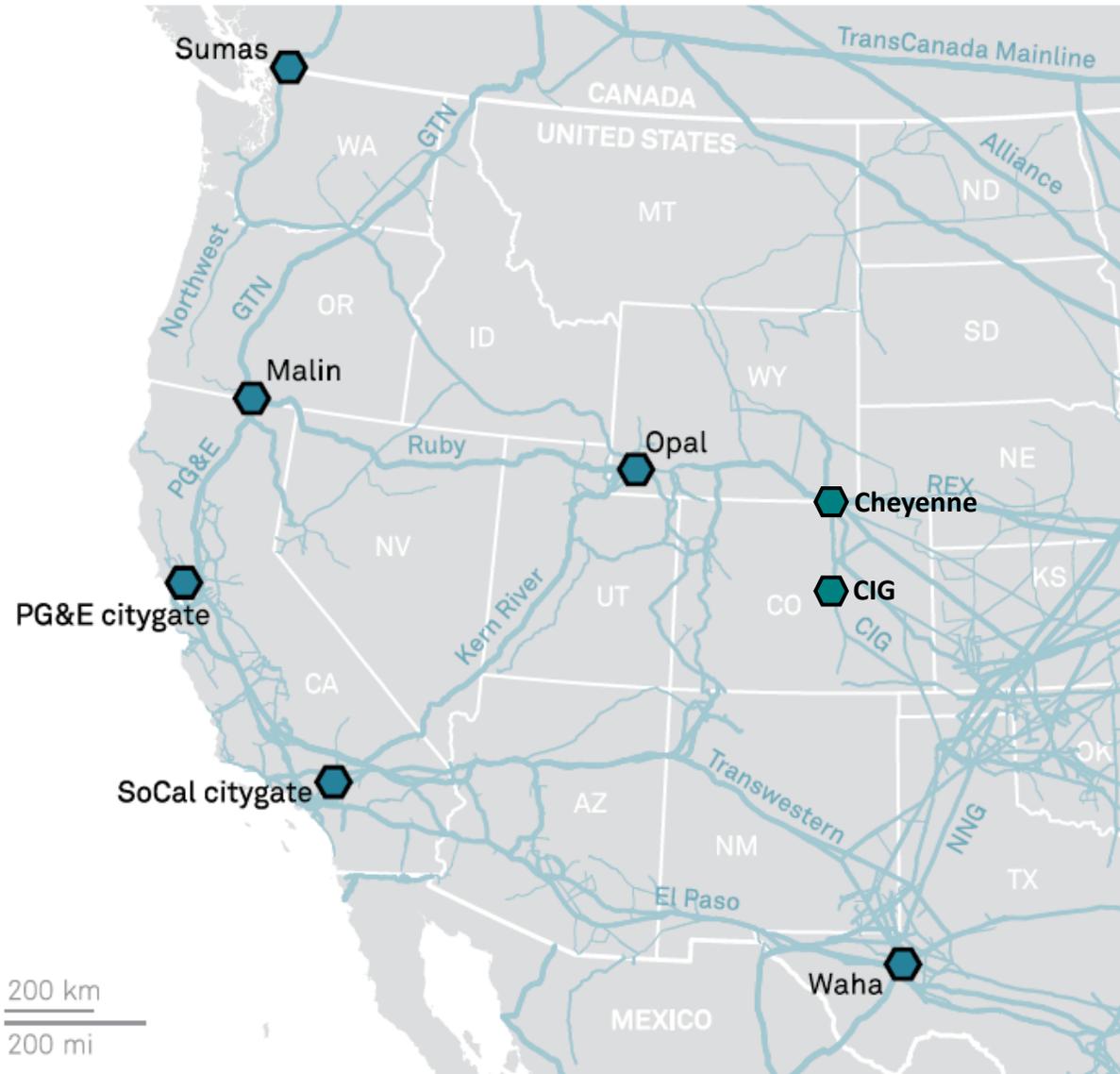
# NO.



Lack of political and regulatory willingness to invest in the minimum required fossil fuel infrastructure

## Major natural gas trading hubs in the West

Gas trading hubs in the US West have featured steep premiums in recent months, highlighted by prices above \$50/MMBtu at a few locations in mid-December of last year.



Source: S&P Global Commodity Insights

# Continental Divide: West vs. East, Index Prices First of the Month

	December 2022	January 2023	2021 Average
Sumas	\$14.98	\$45.25	\$4.07
Opal (Kern)	\$11.50	\$51.58	\$3.91
Malin	\$13.78	\$40.07	\$3.97
SoCal	\$15.14	\$54.30	\$5.70
PG&E	\$14.08	\$50.06	\$5.03
CIG	\$7.08	\$8.63	\$3.42
Cheyenne Hub	\$7.27	\$8.50	\$3.52
WAHA	\$4.43	\$4.78	\$3.50
NYMEX HH	\$6.712	\$4.709	\$3.841

All prices in \$/MMBtu

Source: Monthly Bidweek Spot Gas prices as reported by Inside FERC's Gas Market Report, an S&P Global Platts publication

\$31 Southern California (SoCal Gas)

\$13 Colorado (Xcel)

\$4.70 NYMEX Henry Hub\*

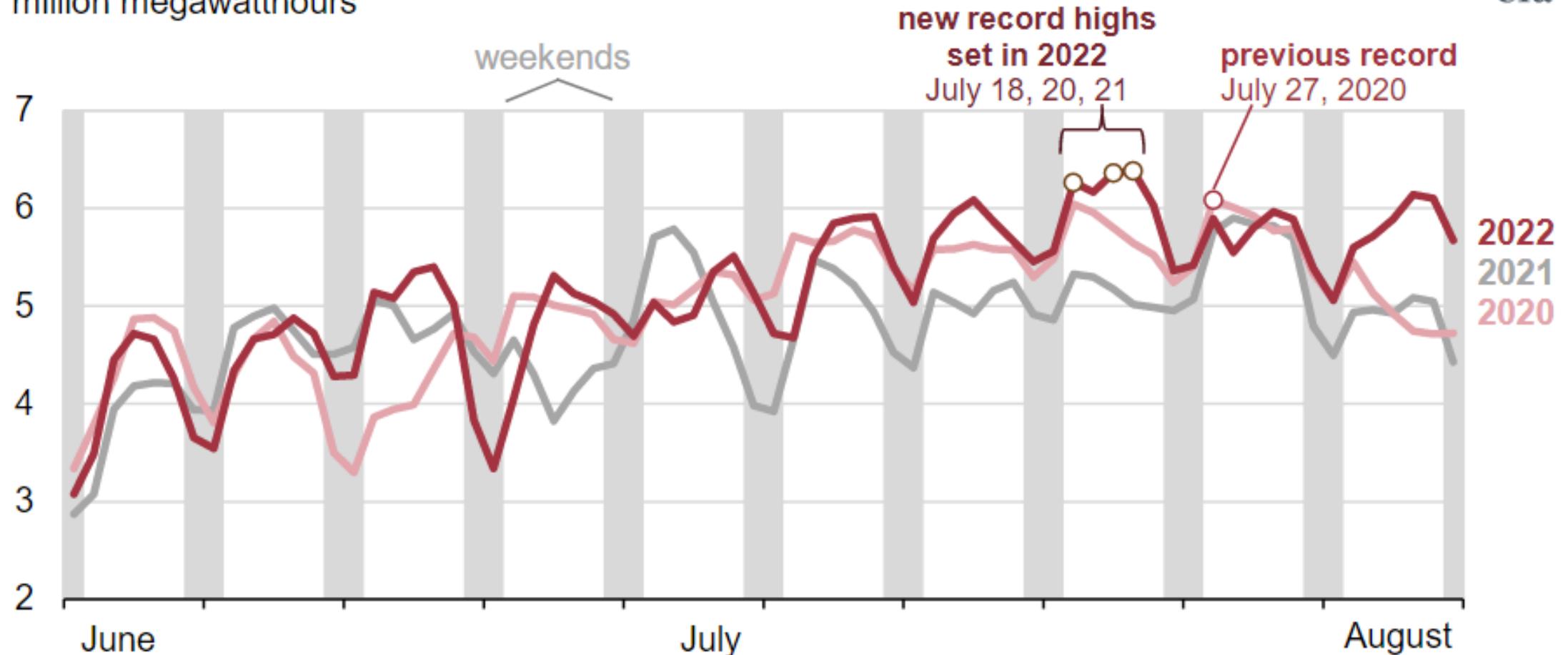


All prices in \$/MMBtu

\* Erath, LA

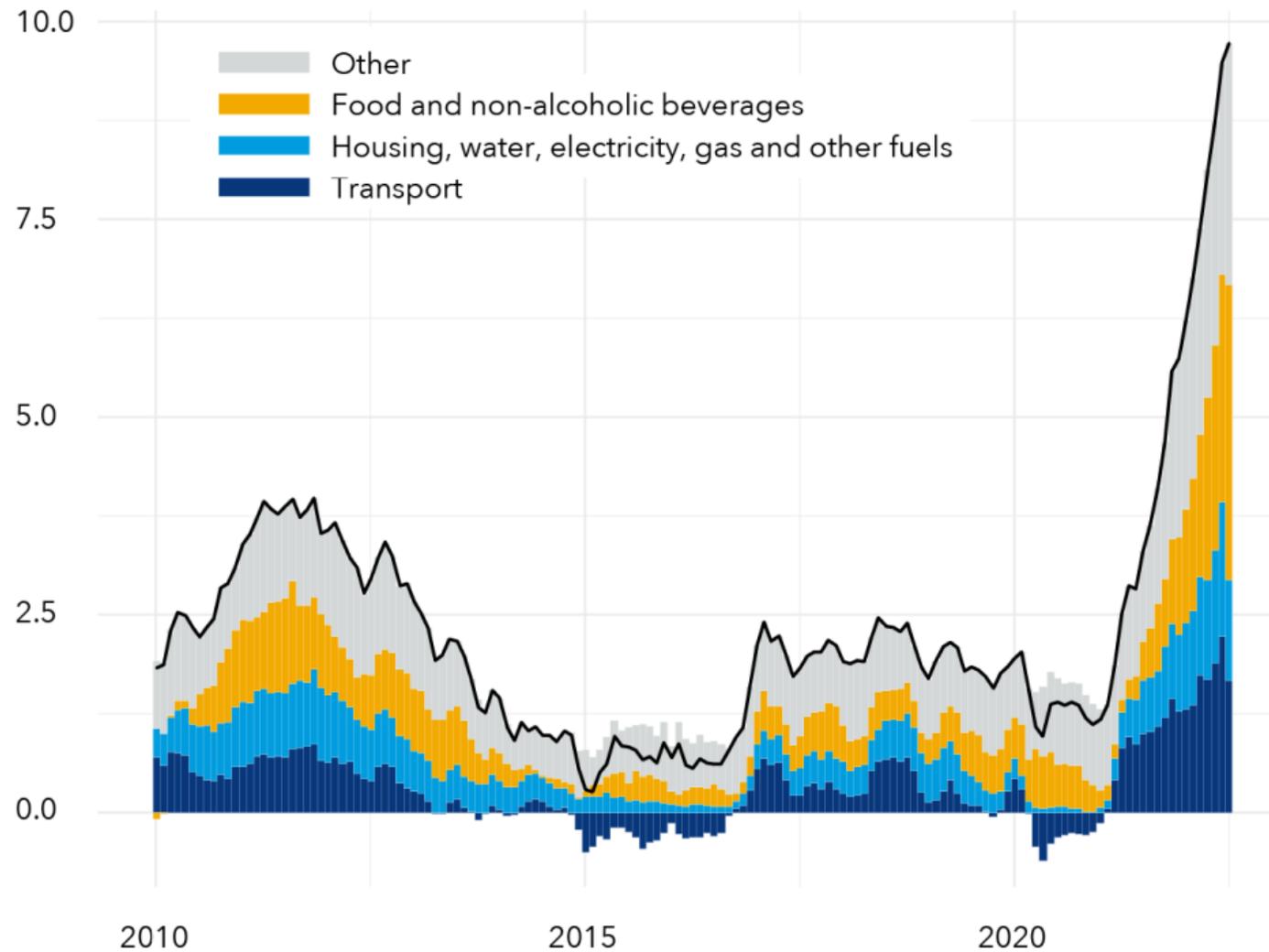
## Daily U.S. electricity generation from natural gas hits a record in mid-July

Daily U.S. natural gas-fired electricity generation (selected weeks in 2020–2022)  
million megawatthours



Data source: U.S. Energy Information Administration, *Hourly Electric Grid Monitor*

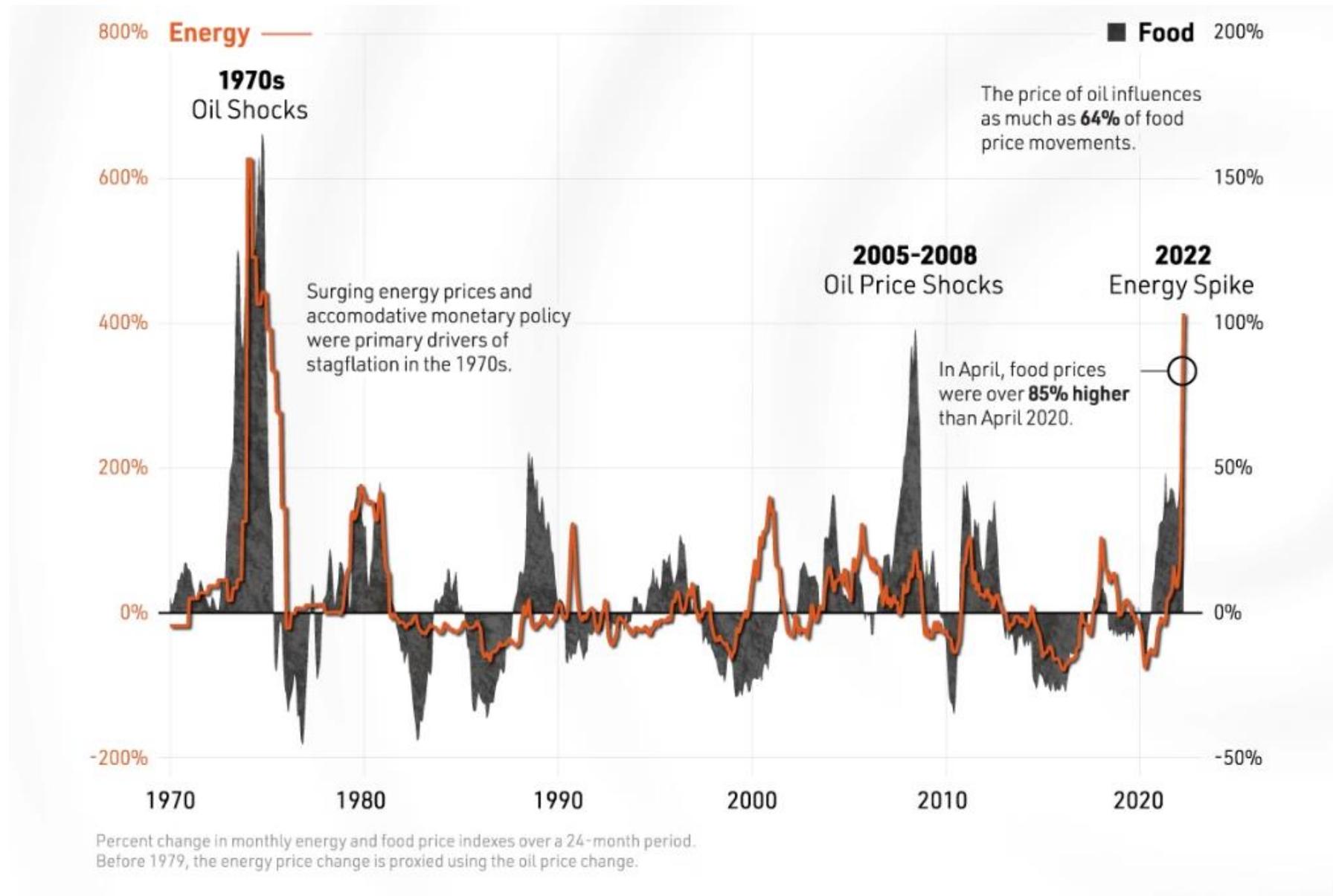
Note: We adjusted values for previous years to align weekdays and weekends.



Source: IMF CPI database and IMF staff calculations.  
Note: Chart shows median total inflation and in select categories across 88 countries, including 28 advanced economies and 60 emerging and developing economies.



# Energy and Food Price Shocks, 50-year Look



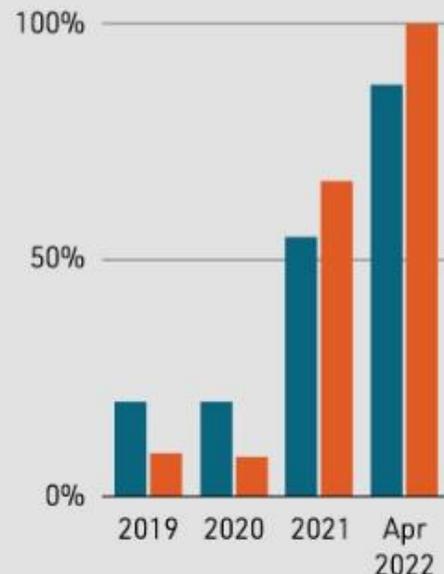
How energy and food price shocks could affect the world economy

## 01 Rising Global Inflation

The vast majority of countries worldwide could see higher levels of inflation.

Countries With Inflation Above Target

- Advanced economies
- Emerging markets and developing economies

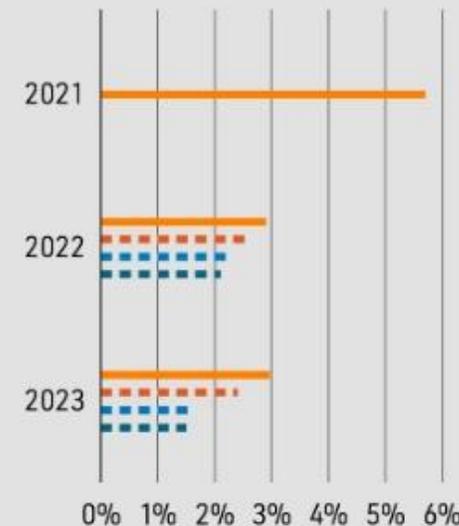


## 02 Slower Global Growth

Growth prospects around the world could face greater headwinds.

Global Growth Scenarios

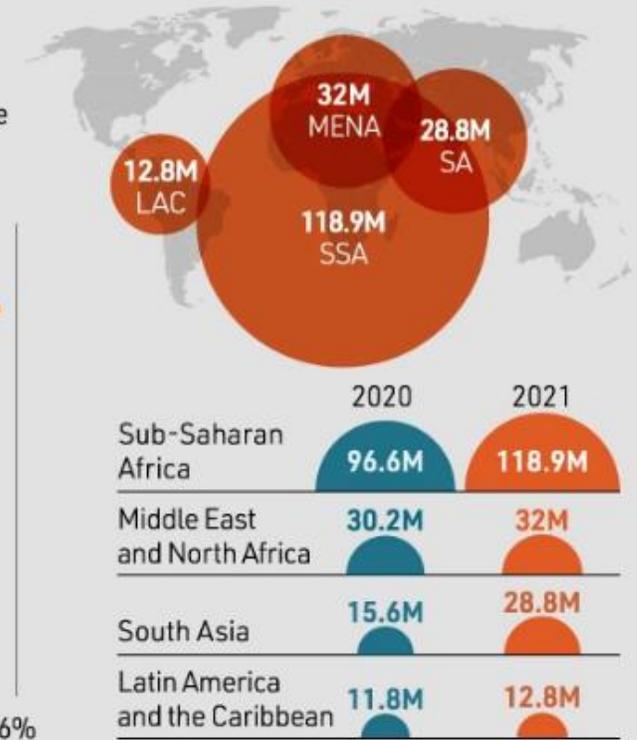
- Baseline
- Including Fed tightening
- Including Energy price spike
- Including China COVID-19



## 03 Rising Food Insecurity and Social Unrest

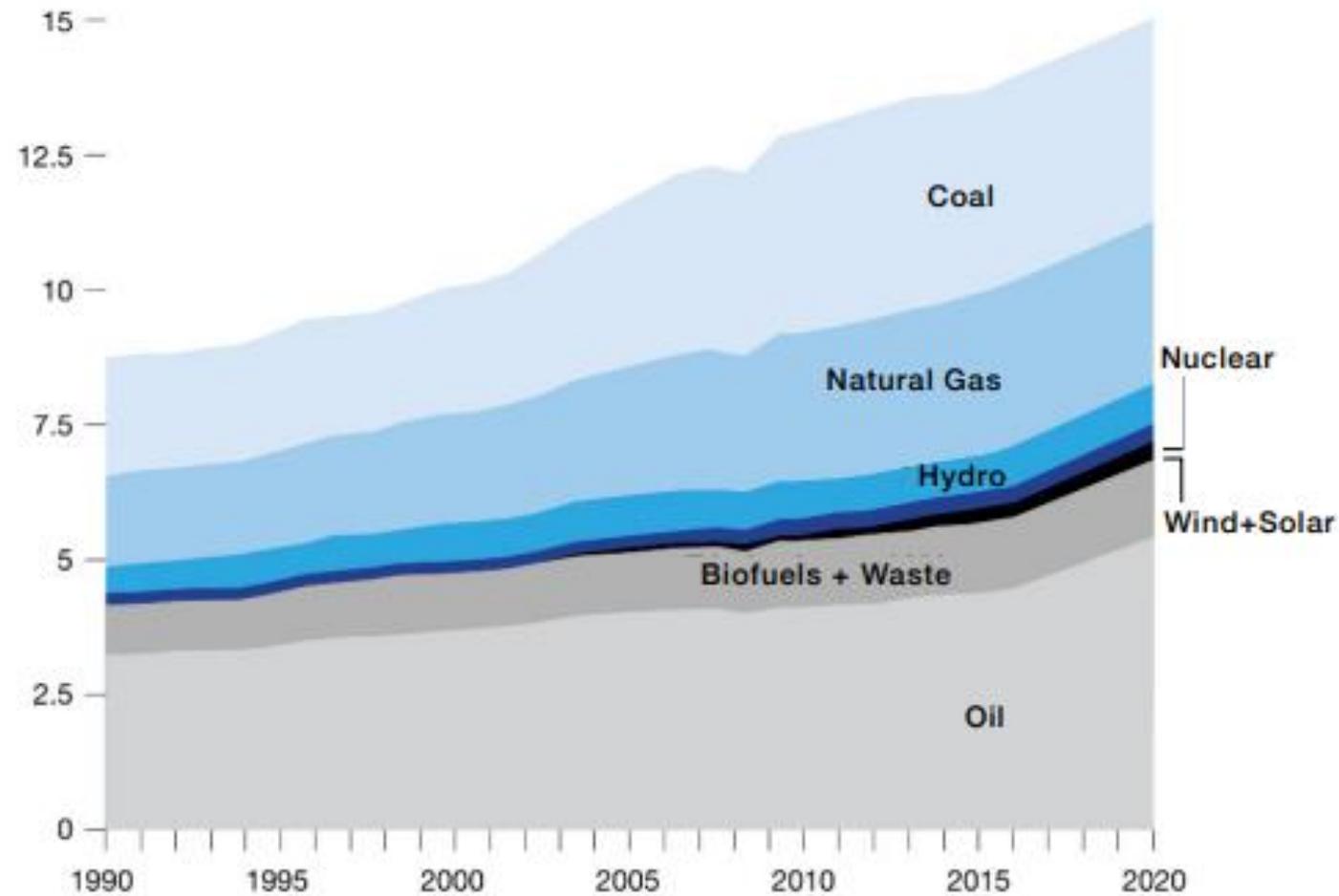
High energy costs could increase food insecurity and social unrest—which was already increasing before the war began.

Global Food Insecurity  
Number of People



# Growth in Global Energy Supplies

(Oil Equivalent Billion Tons/Year)

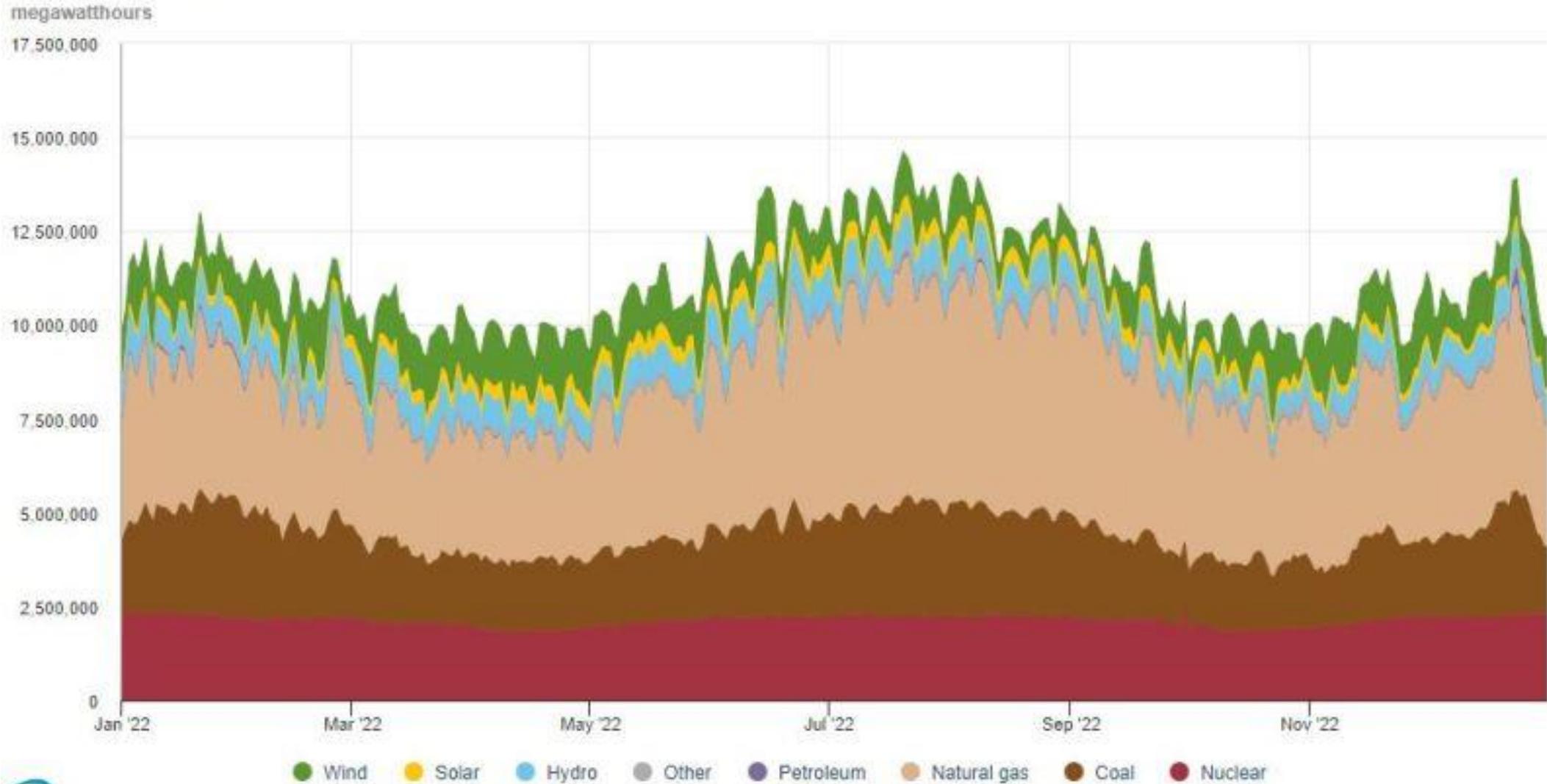


Note: 1 billion tons oil/year = 20 million barrels/day.

Source: BP, Statistical Review of World Energy 2022.

# An All-Electric All the Time Economy is a Myth

U.S. electricity generation by energy source 1/1/2022 – 12/31/2022, Eastern Time

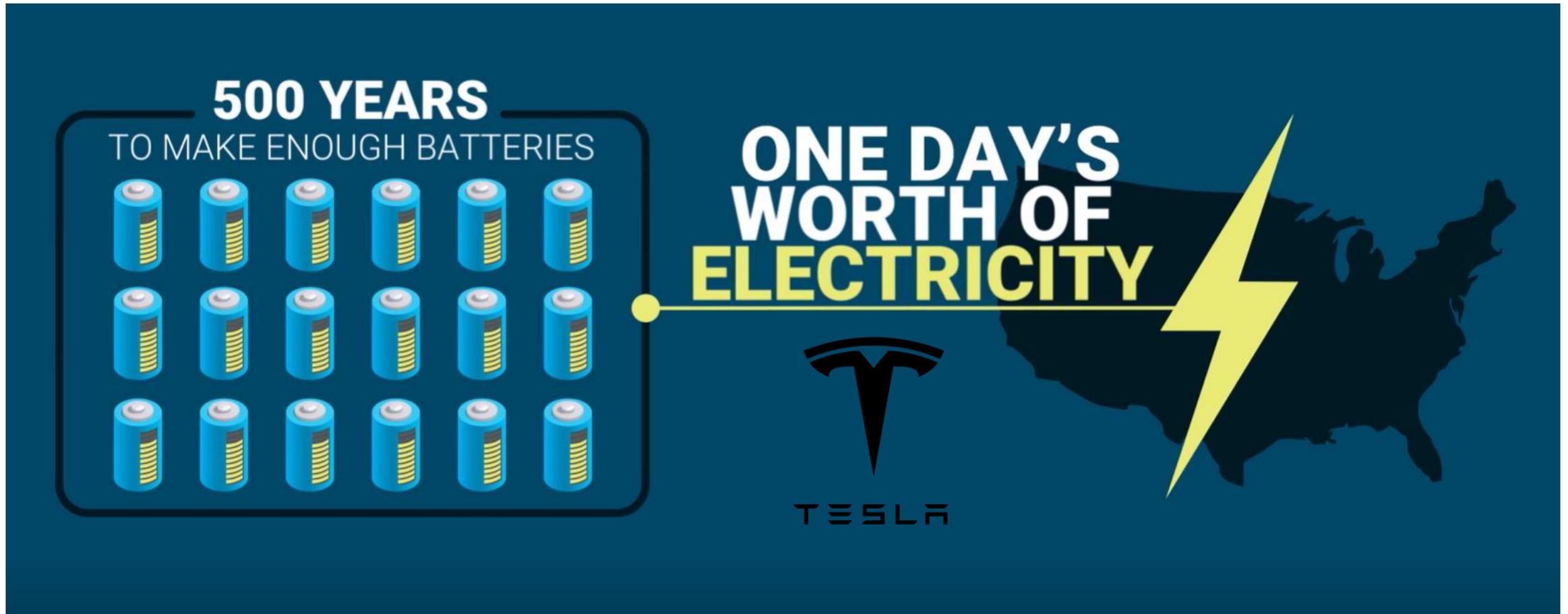


eia Data source: U.S. Energy Information Administration

- 32% growth in CO2 emissions since 2002 (8.4 billion ton increase) nearly all of this in the developing world
- To replace the U.S. 300 billion watts of coal fired capacity would require placing wind turbines over 116,000 square miles...a footprint roughly the size of Italy
- Last year's increase in U.S. oil production is roughly equal to twice the energy equivalent of every solar energy installation on the planet.

# Limited Battery Production and Capacity

- **It would take 500 years** for Tesla's new factory in Nevada, the largest battery factory in the world, to make enough batteries to store **one day's worth of electricity needs for the US**



# Is this a sunset business? No, \$ billions invested

*A leading indicator of a sunset business is the inability to attract capital investments into expensive, long-term projects. This is not happening in natural gas.*



- Over the past year and a half, nearly 50 binding contracts have been signed for LNG offtake from facilities on the U.S. Gulf Coast
- Of these contracts, about 75% contemplate a start date in 2026 or 2027
- Of these contracts, over 70% run for 20 years and about 25% run for 15 years
- Conclusion: **Sophisticated investors are betting material capital that this will remain a good business through at least 2045**

When it comes to energy, many people don't understand the concept of scale.

Daniel Yergin: "... this is a \$90 trillion world economy that gets 80% of its energy from hydrocarbons. It's not going to change overnight."

- Most people have no understanding of scale as it relates to energy supply, distribution and demand.
- Peak day price volatility will continue and increase in frequency as energy transition political and regulatory edicts are adopted.
- Energy transition costs will act as a regressive tax on low and middle-income households.
- The negative economic impact on low-income households of a forced energy transition will inspire and illicit overdue public debate.

## John Harpole

President

Mercator Energy

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# Alt-Energy NGOs Are Outspending Traditional Energy Associations By More Than 3 To 1

American Petroleum Institute	\$265
Nuclear Energy Institute	\$143
American Gas Association	\$41
Western States Petroleum Association	\$43
Society of Petroleum Engineers	\$37
<b>Total</b>	<b>\$529</b>
Climate Imperative Foundation	\$221
Natural Resources Defense Council	\$415
Sierra Club	\$180
ClimateWorks Foundation	\$425
Environmental Defense Fund	\$524
<b>Total</b>	<b>\$1,765</b>

2021 Revenue, \$Millions

# What Energy Transition?

## Energy Poverty Is Rampant and Deadly

Deaths from Sierra Leone tanker blast rise to 144

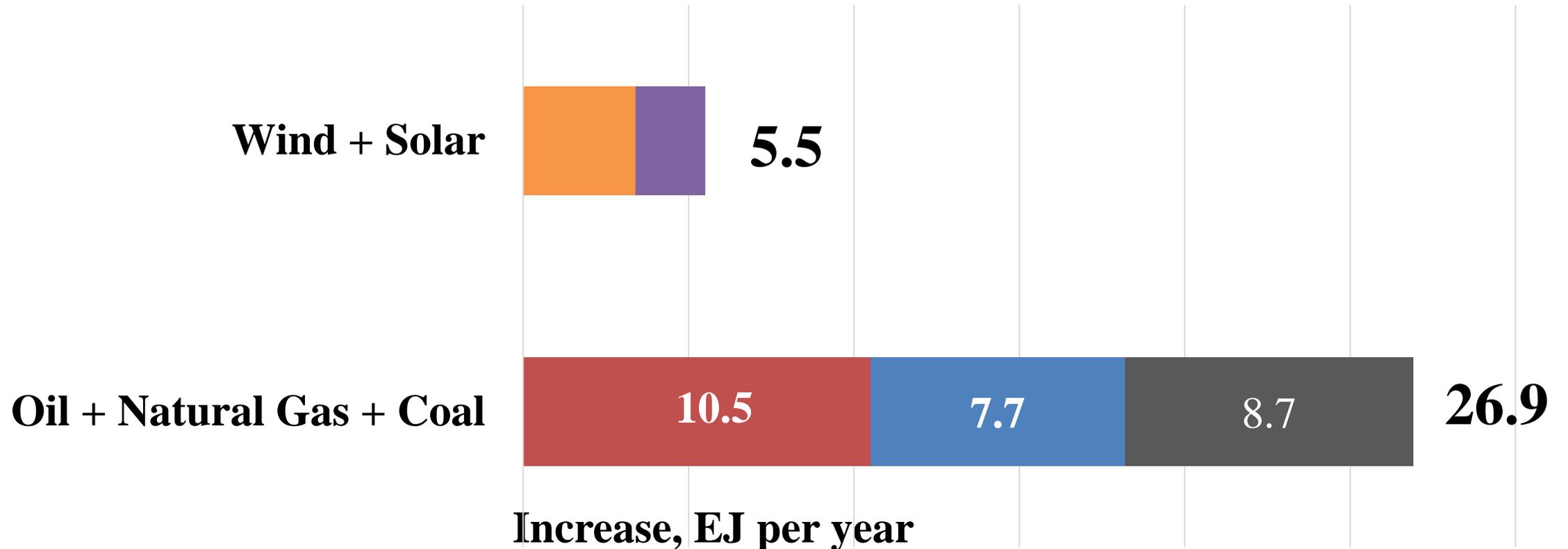


# In 2021, >260 Human Beings Were Burned Alive Due to Extreme Energy Poverty

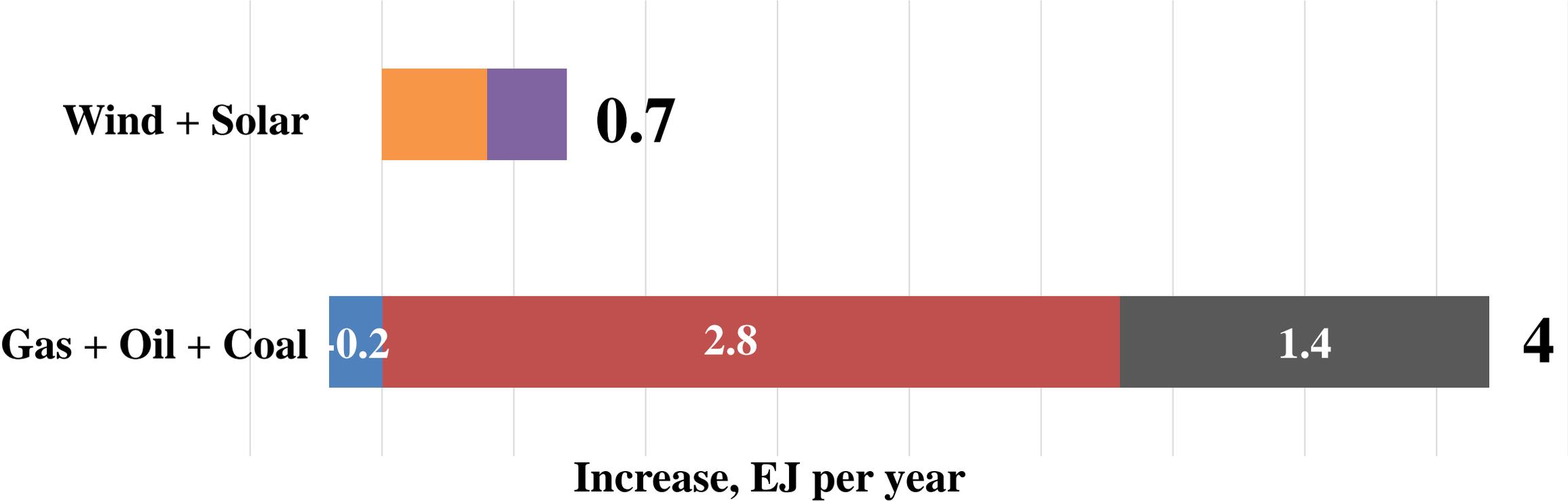


# What Energy Transition?

In '21, Global HC Use Grew 4.9x Faster Than Wind & Solar; Oil Grew Almost 2x Faster



# 2021 US Growth in Wind & Solar Versus Growth in Hydrocarbons



Sources:BP

© Robert Bryce

# Electrify Everything?

## EV Mandates & Natural Gas Bans

**Electrify everything: why we need to go big on going electric**

**California Just Banned Gas-Powered Cars. Here's Everything You Need to Know**

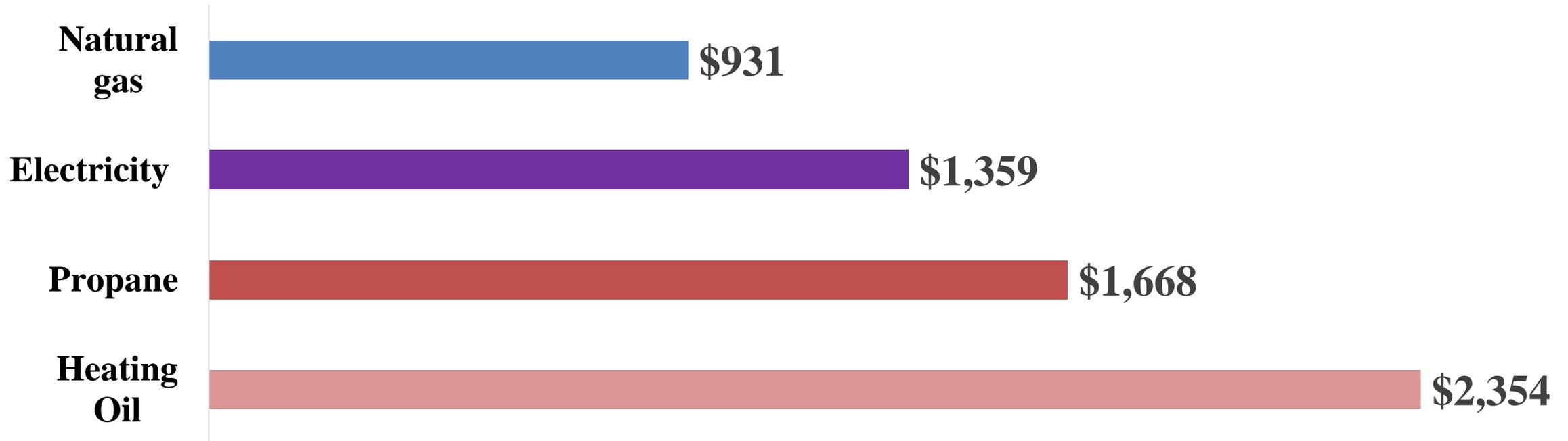
**Amid Heat Wave, California Asks Electric Vehicle Owners to Limit Charging**

California plans to phase out new gas heaters by 2030

**New York City Bans Natural Gas – And Imposes A Regressive Energy Tax On Low-Income Residents**

**Atlantic Coast Pipeline canceled after years of delays, accusations of environmental injustice**

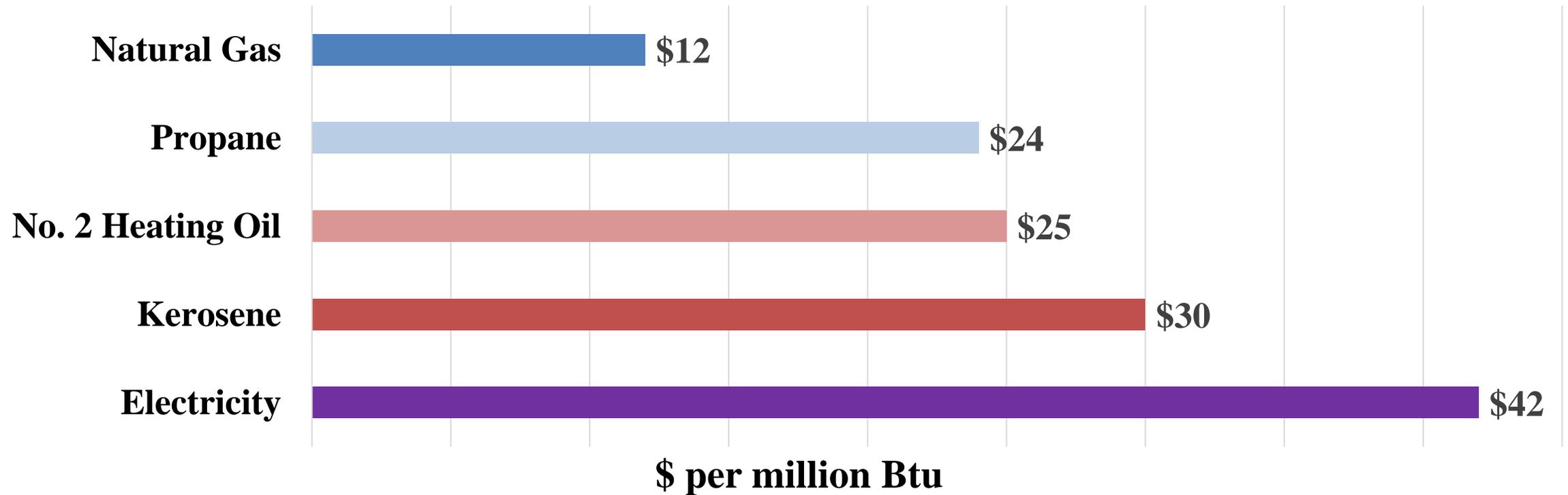
# The Electrify Everything Push Is Regressive Taxation: Electric Heating Costs 46% More Than Heating With Gas



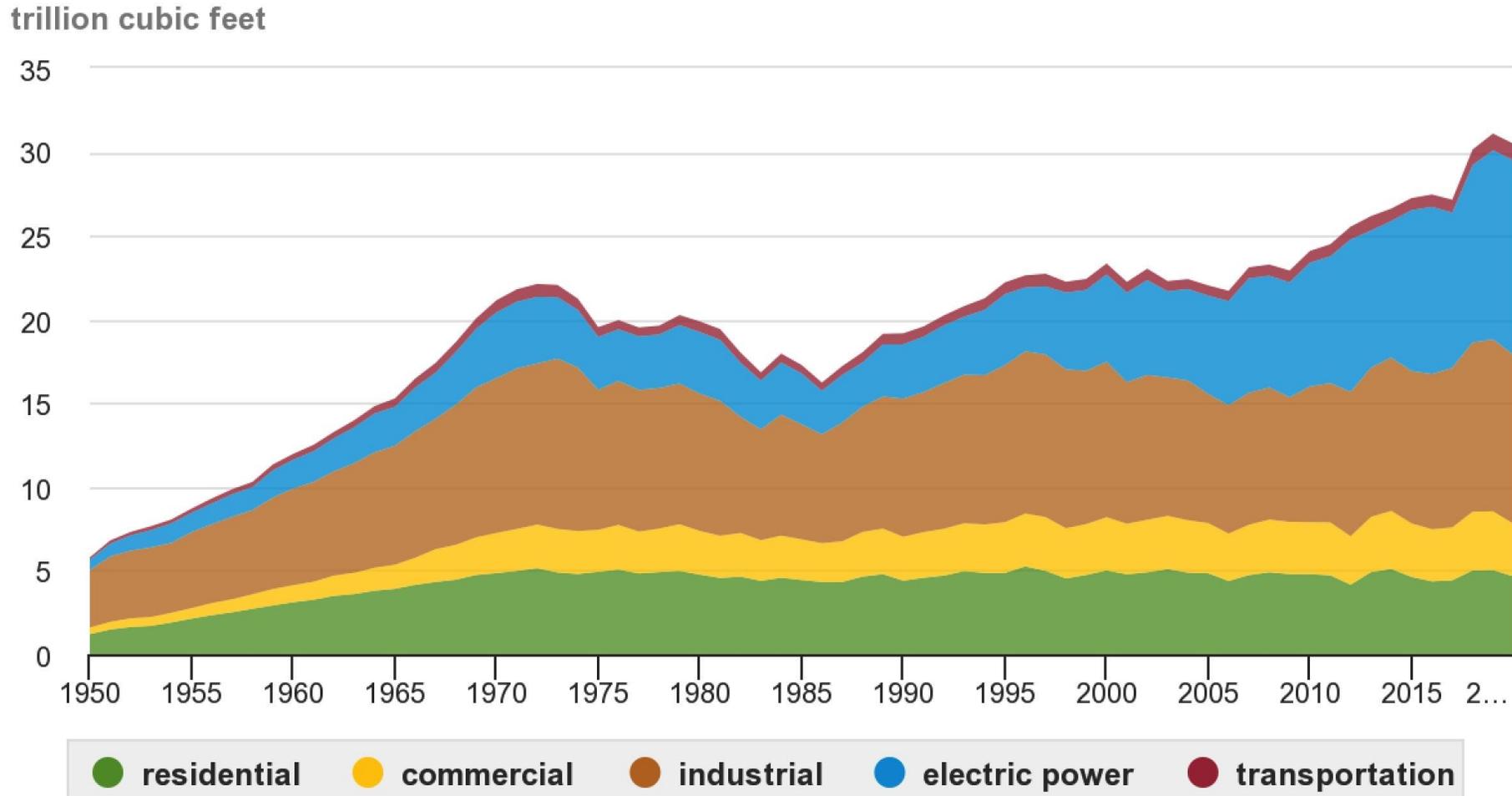
Source: EIA Winter Fuels Outlook 2022-23,  
Expected Average Household Expenditure

# What About Affordability?

## Energy-Equivalent Residential Energy Costs, 2022

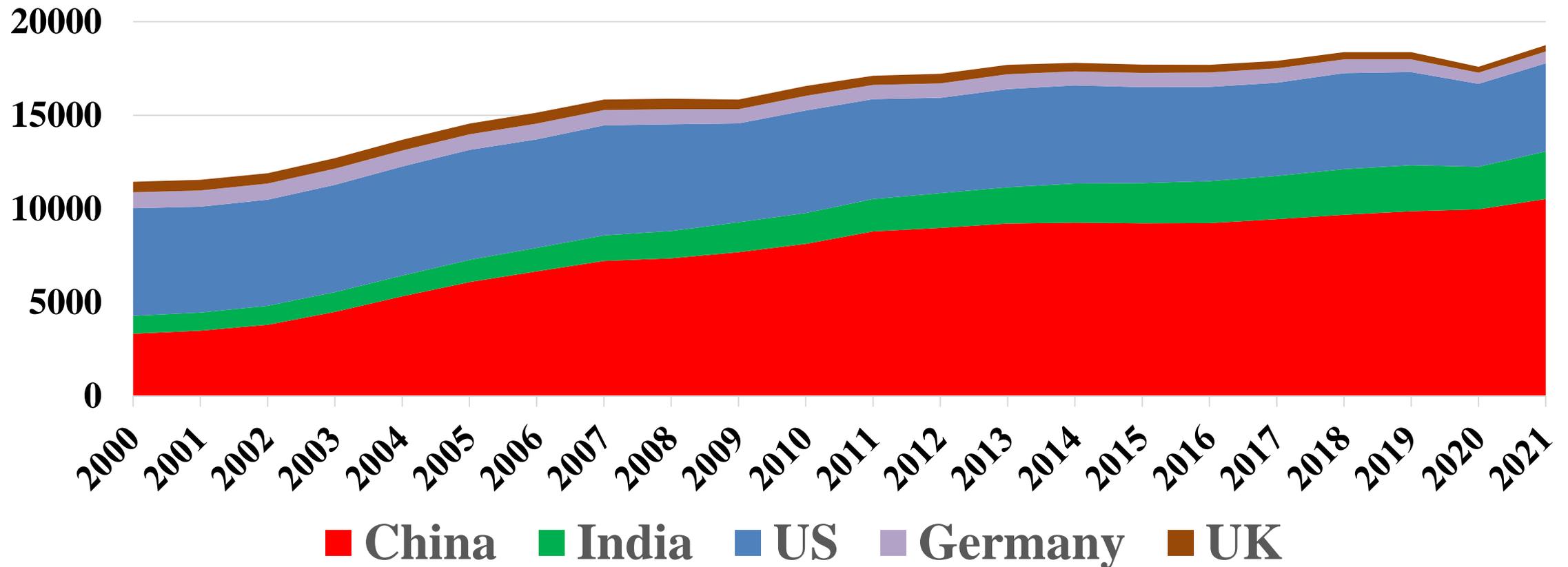


# US Residential Nat Gas Consumption: No Growth In 50 Years!

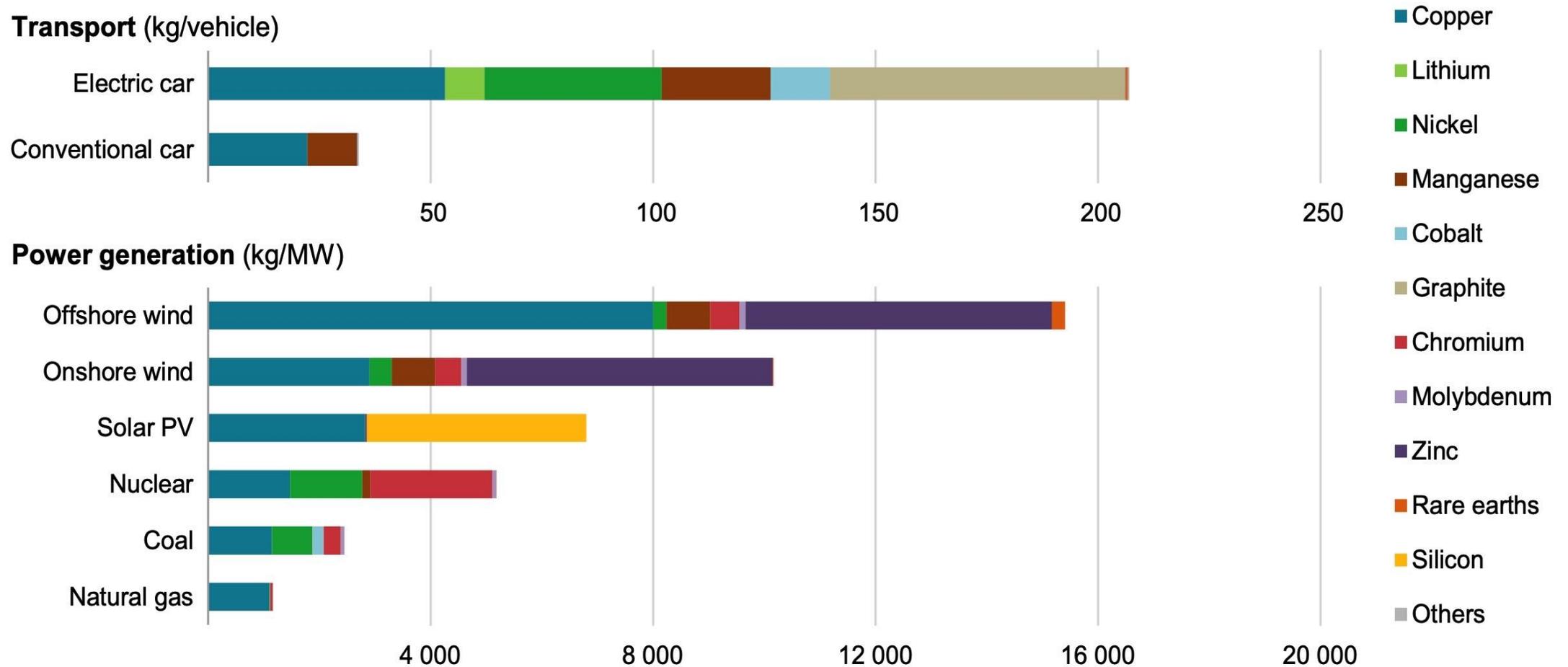


# What Energy Transition?

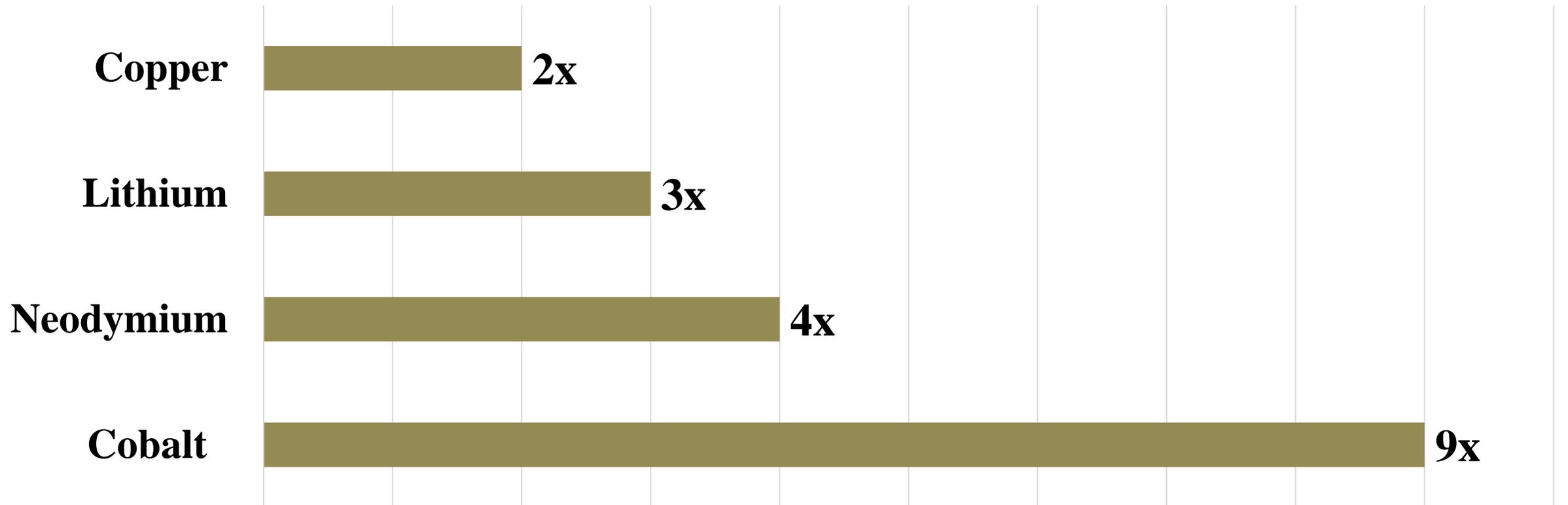
## CO<sub>2</sub> Emissions, In Million Tons Per Year, From Selected Countries, 2000 to 2021



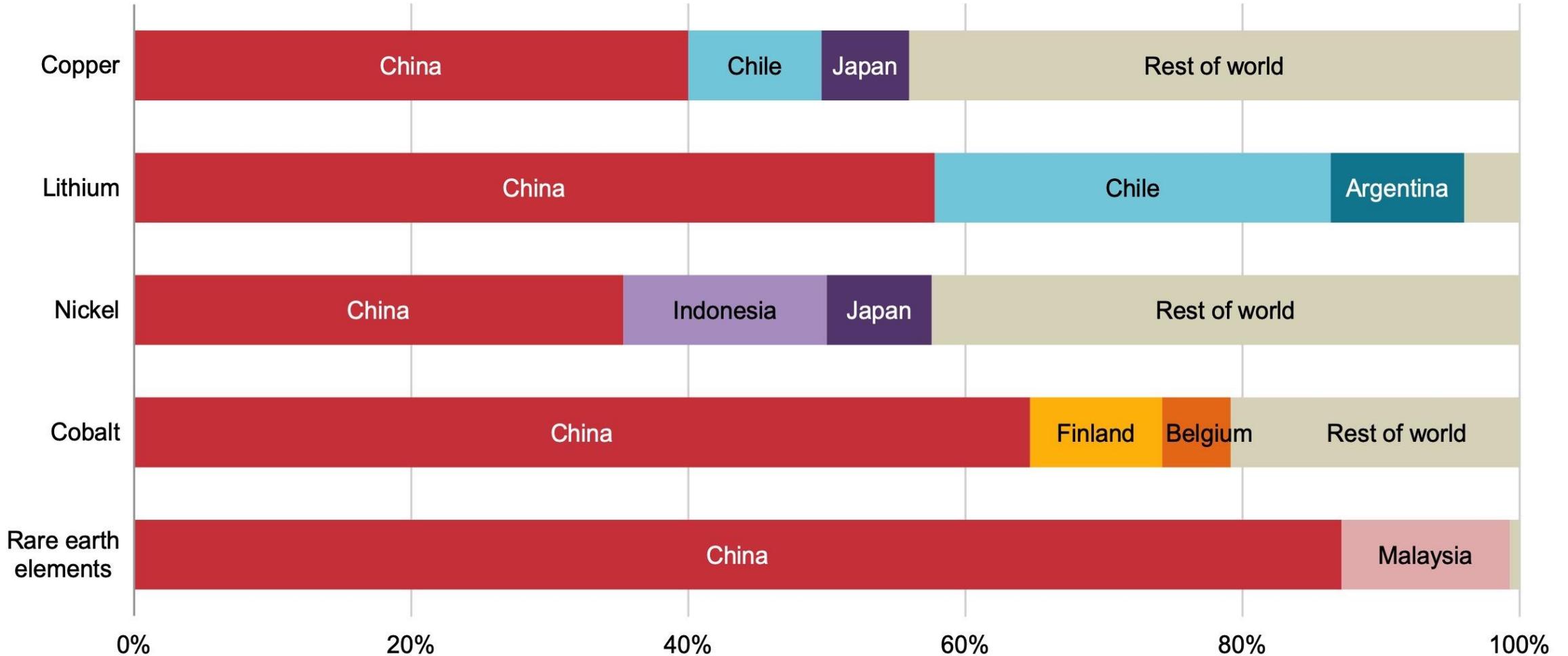
# Alt-Energy Requires Staggering Amounts Of Metals, Minerals, & Magnets



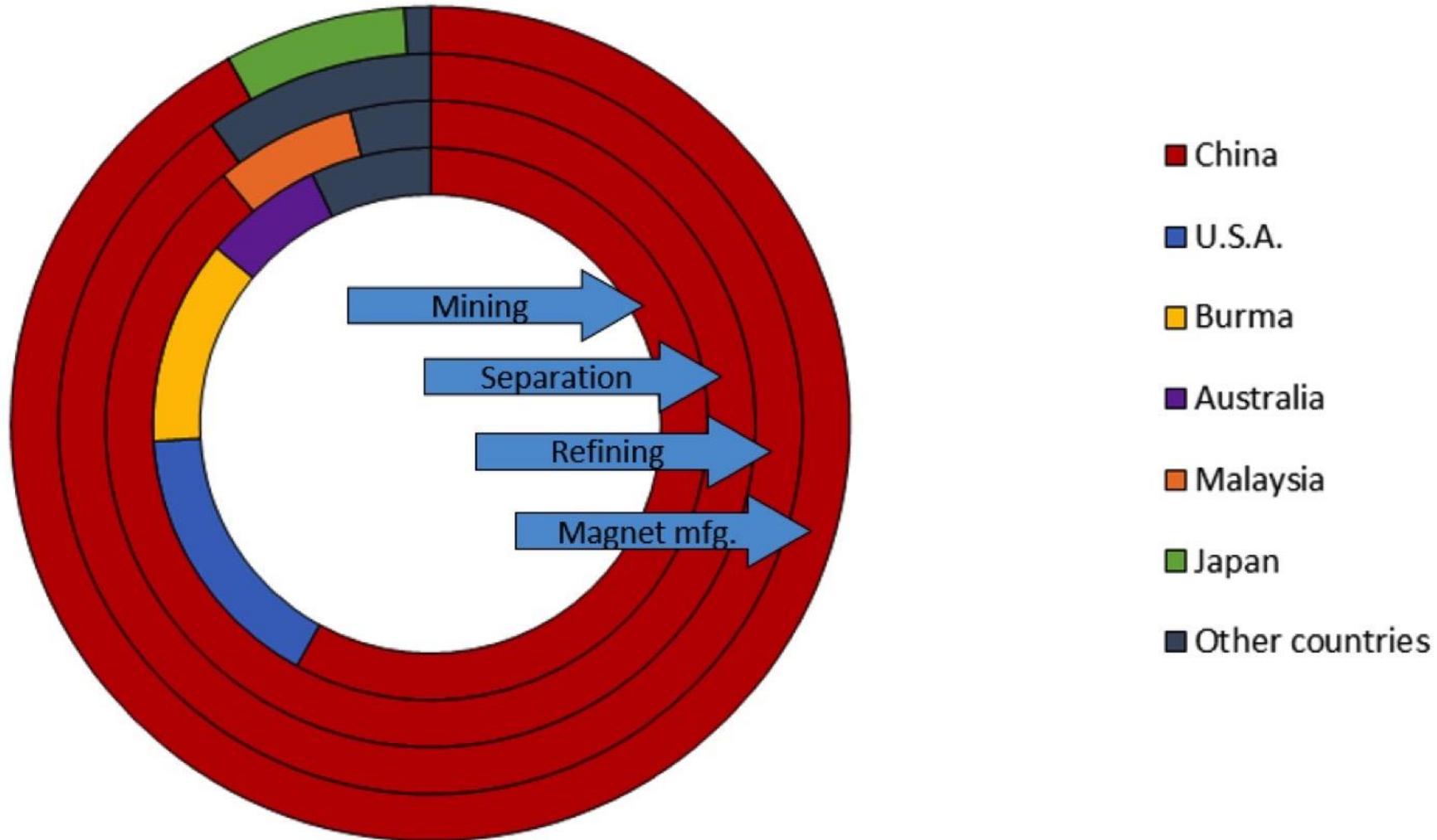
# Increase In Annual Global Production of Metals Needed to Electrify Half of US Motor Vehicles by 2050



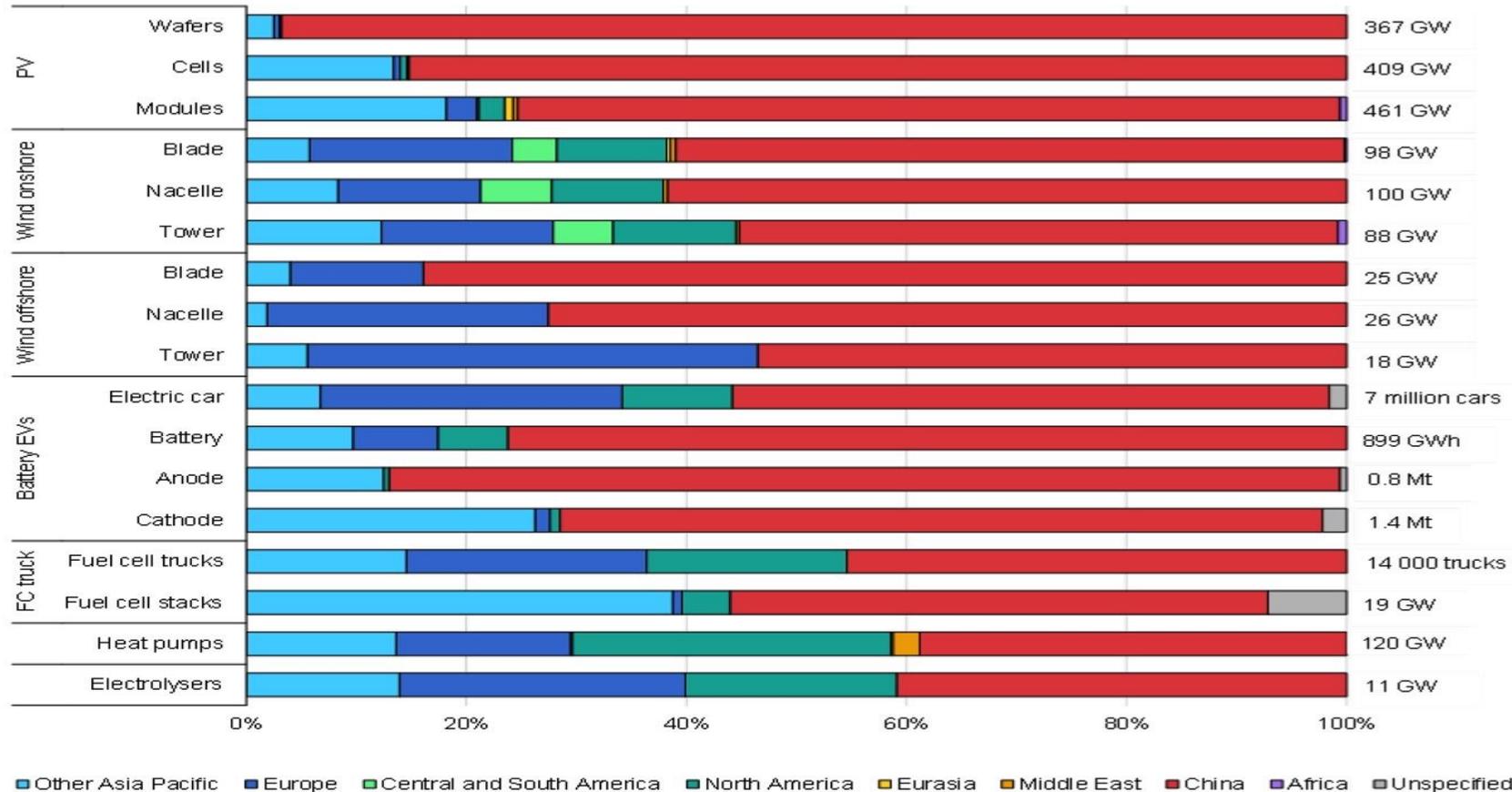
# Who Dominates Metal & Mineral Processing?



# Who Makes NdFeB Magnets?



# China Dominates Alt-Energy Manufacturing



**Regional shares of manufacturing capacity for mass-manufactured alt-energy technologies, 2021**

**Energy Realism**  
**Is**  
**Energy Humanism**



# Reducing Greenhouse Gas Emissions

	Natural Gas	Coal
Carbon Dioxide	117,000	208,000
Carbon Monoxide	40	208
Nitrogen Oxide	92	457
Sulfur Dioxide	0.6	2,591
Particulates	7	2,744
Formaldehyde	0.750	0.221
Mercury	0.000	0.016

Source: EIA – Natural Gas Issues and Trends

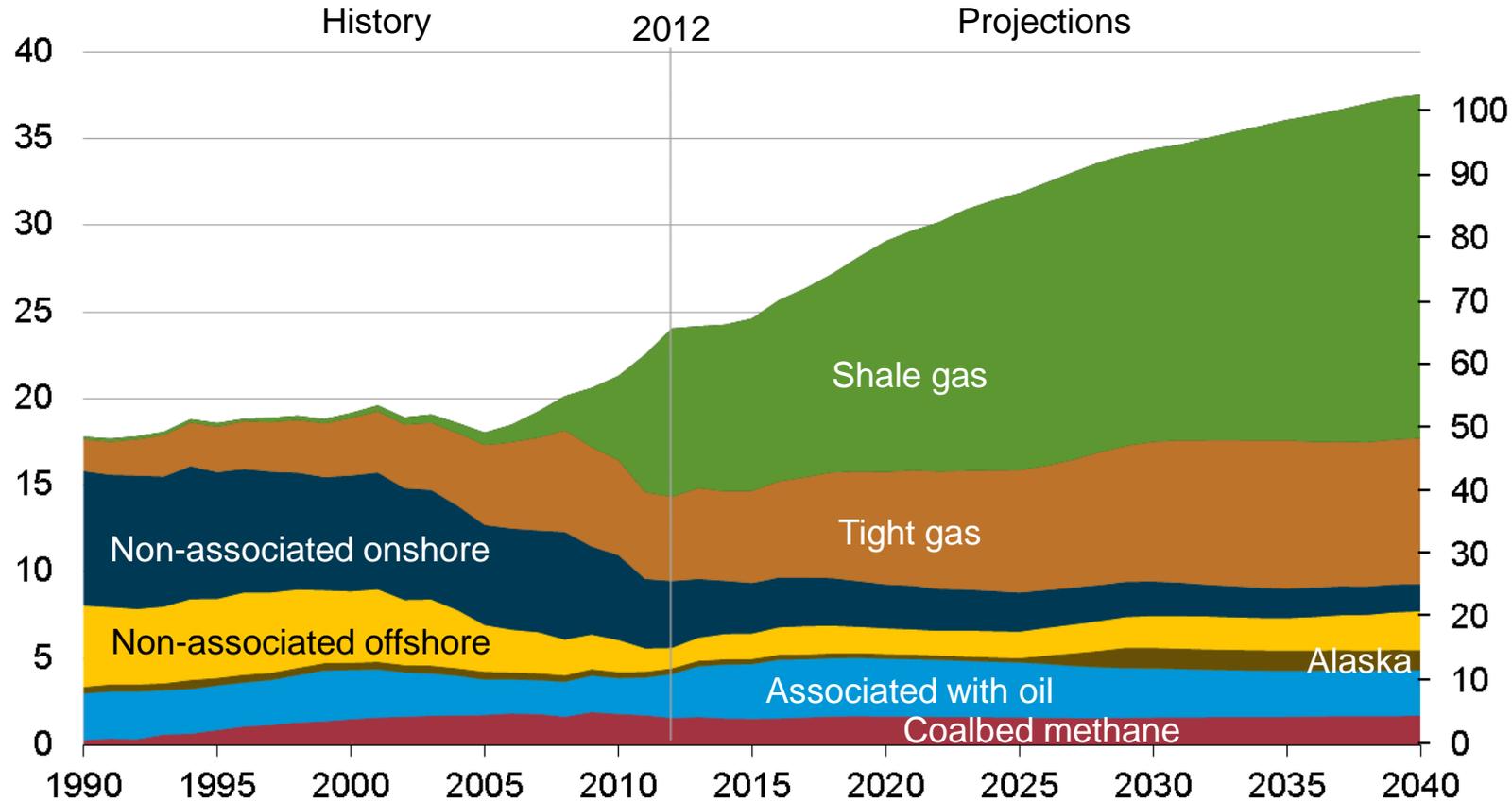
Pounds of air pollutants produced per billion Btu energy

# U.S. shale gas leads growth in total gas production through 2040 to reach half of U.S. output

U.S. dry natural gas production

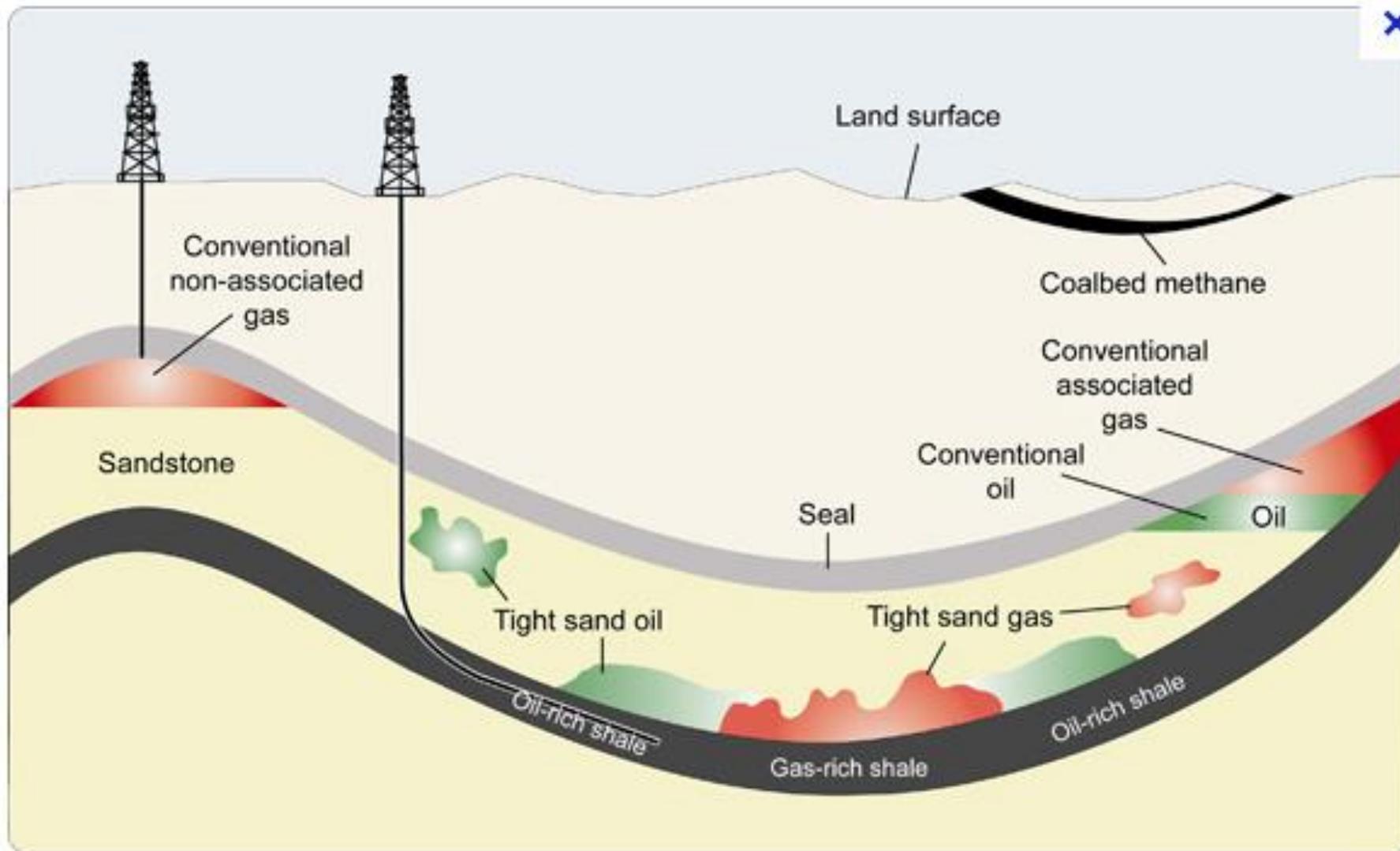
trillion cubic feet

billion cubic feet per day



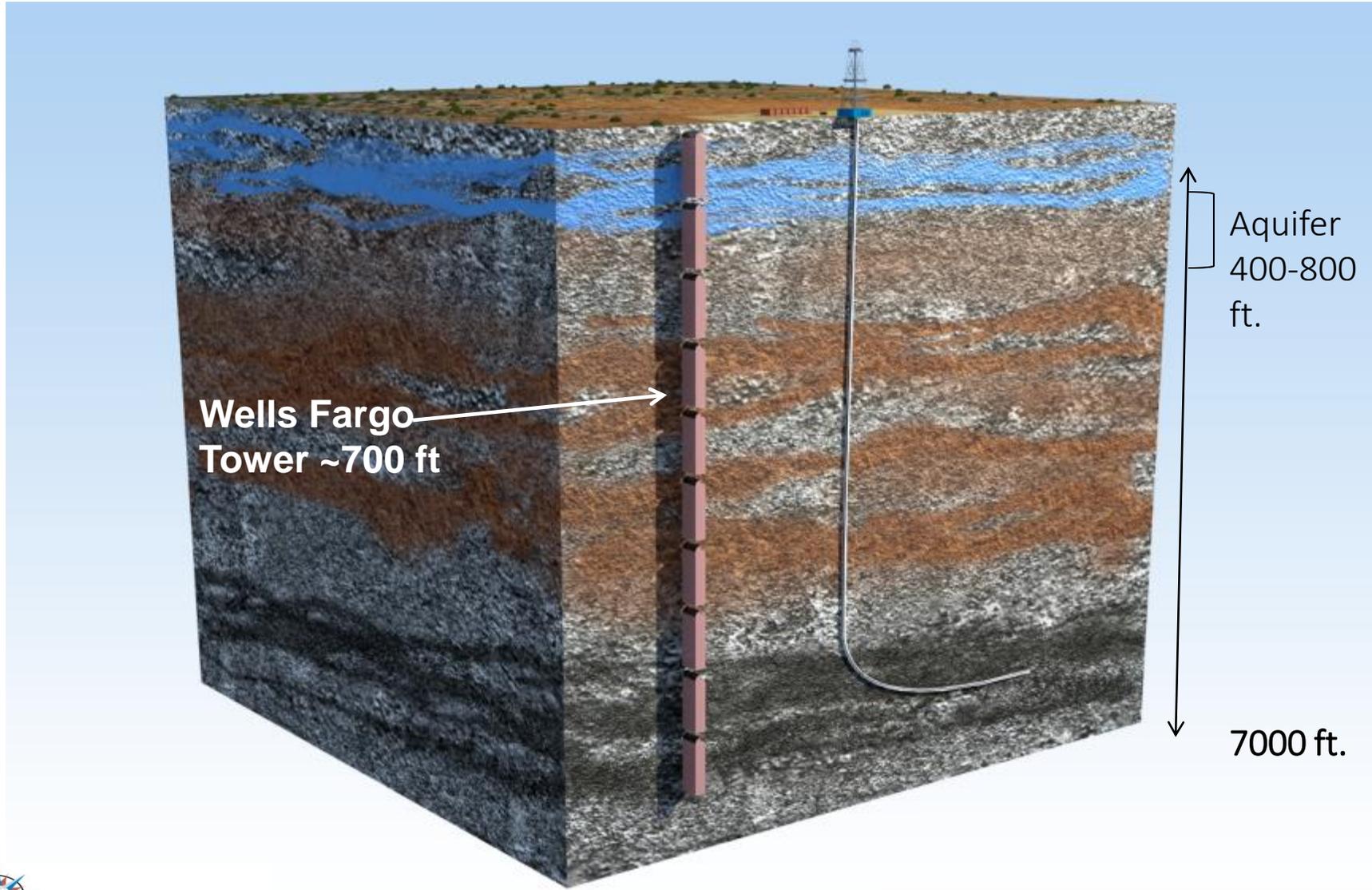
Source: EIA, Annual Energy Outlook 2014 Early Release

# Conventional vs Unconventional Reservoirs



Source: Chris Wright, Liberty Resources Tuesday Lunch Club Presentation, 3/5/13

# Drilling Distance



# Sierra Club and Scale

- “Sierra Club, Greenpeace, and many other groups want to pave the world with low-density wind turbines.”\*
- The world currently get 50 times as much energy (from coal, oil, natural gas, nuclear and hydropower) as we do from wind, solar geothermal and biomass.

\*Source: *Smaller, Faster, Lighter, Denser, Cheaper*, Robert Bryce, May 2014

# Example – Bill McKibben

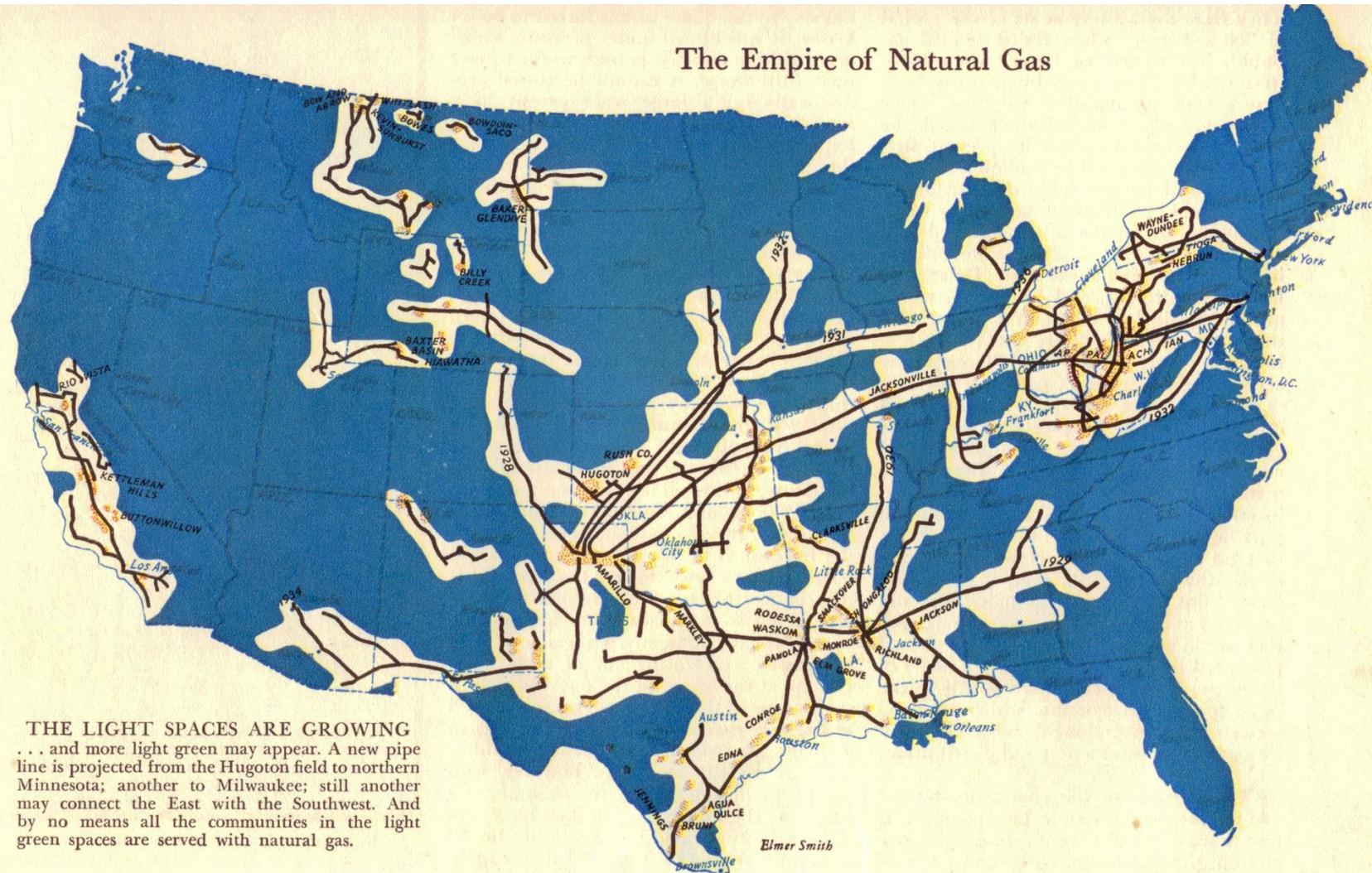
- “perhaps the nation’s most effective grass-roots environmental advocate” (New York Times)
- ...“our systems and economies have gotten too large...we need to start building them back down. What we need is a new trajectory, toward the smaller and more local.” (Bill McKibben)

# Nihilistic Ecotheology

“...apocalyptic fears of ecological collapse, disenchanting notions of living in a fallen world, and the growing conviction that some kind of collective sacrifice is needed to avoid the end of the world”

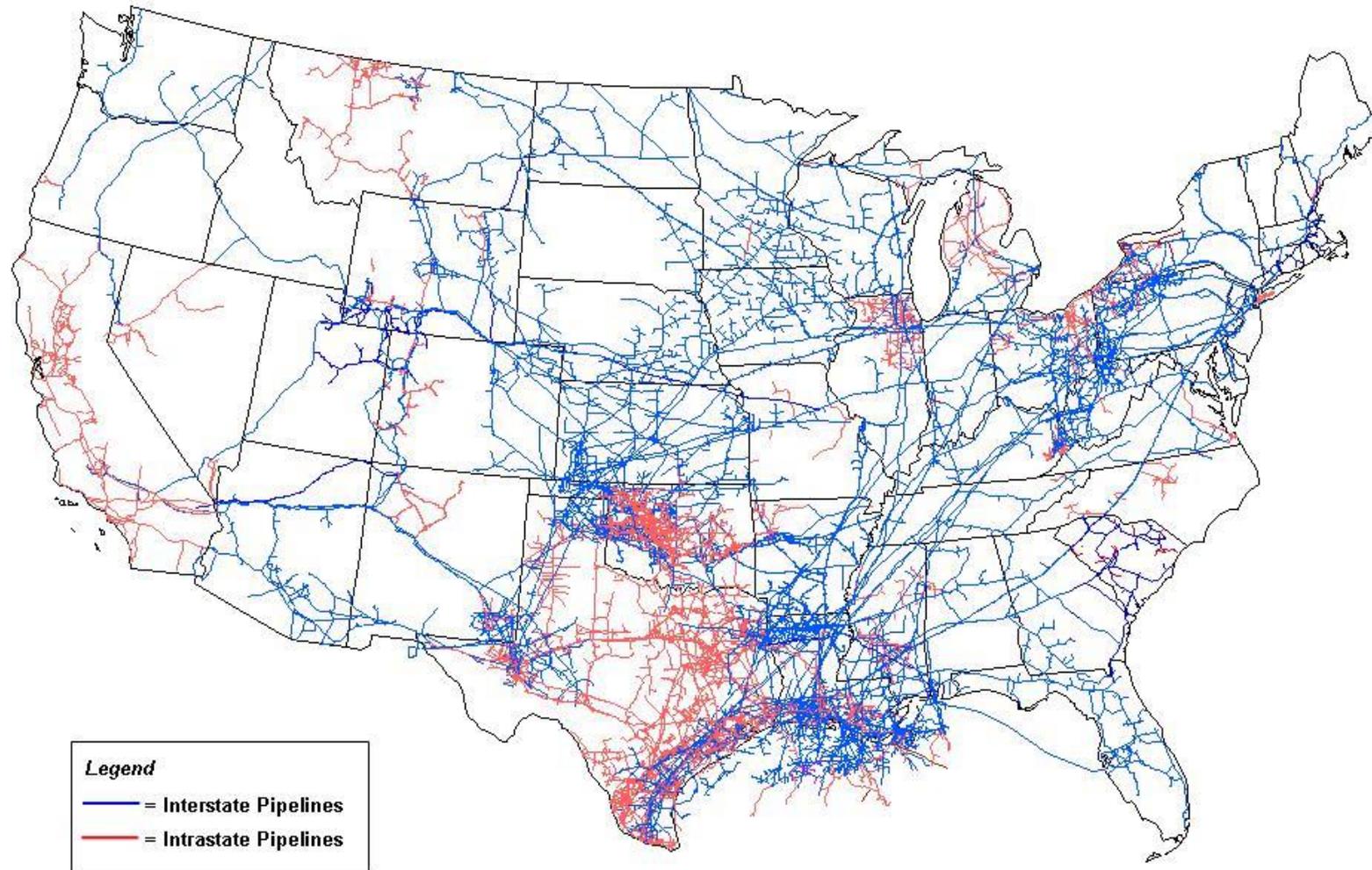
Source: Breakthrough Institute, Ted Nordhaus and Michael Shellenberger, September 2011

# U.S. Natural Gas Pipeline Network – Then (1940)



Source: Fortune Magazine, August 1940

# U.S. Natural Gas Pipeline Network – Now (2009)



Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

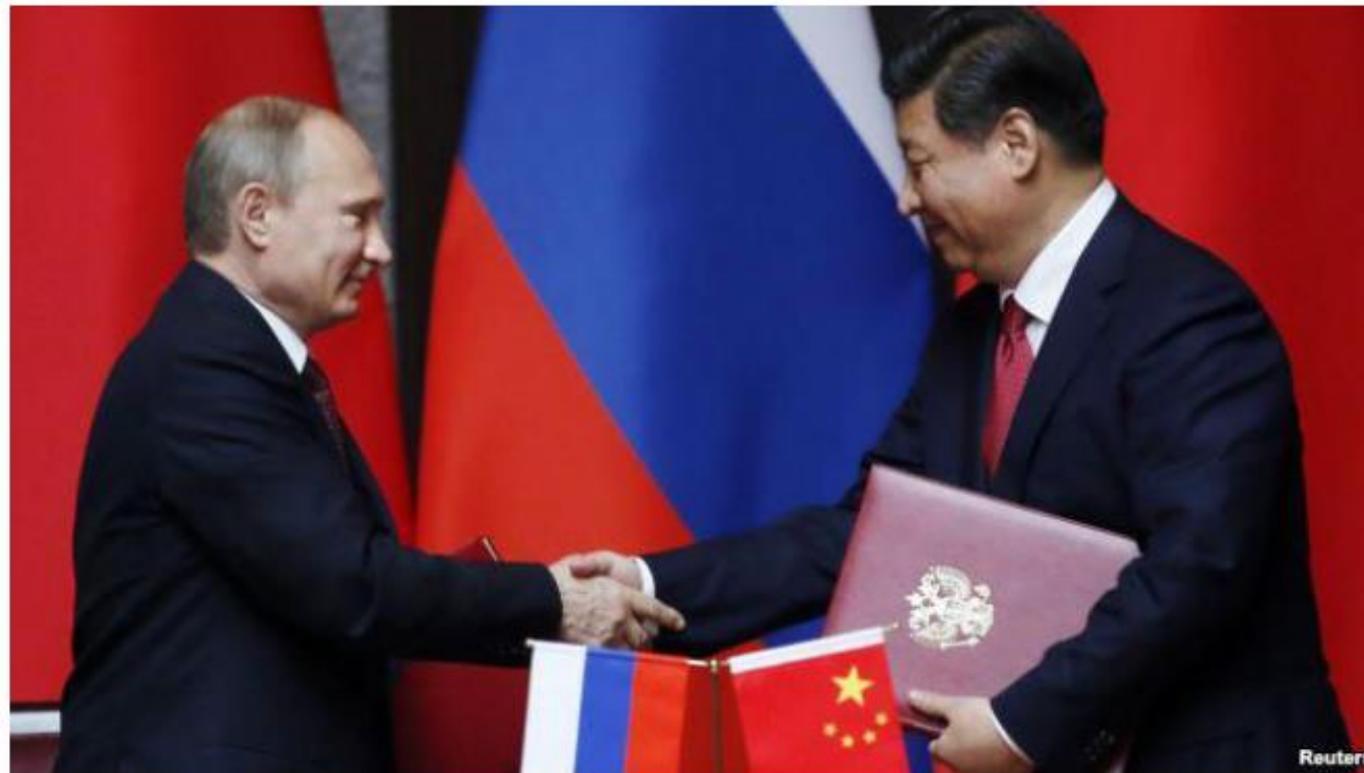
# 1929 Pipe-bending



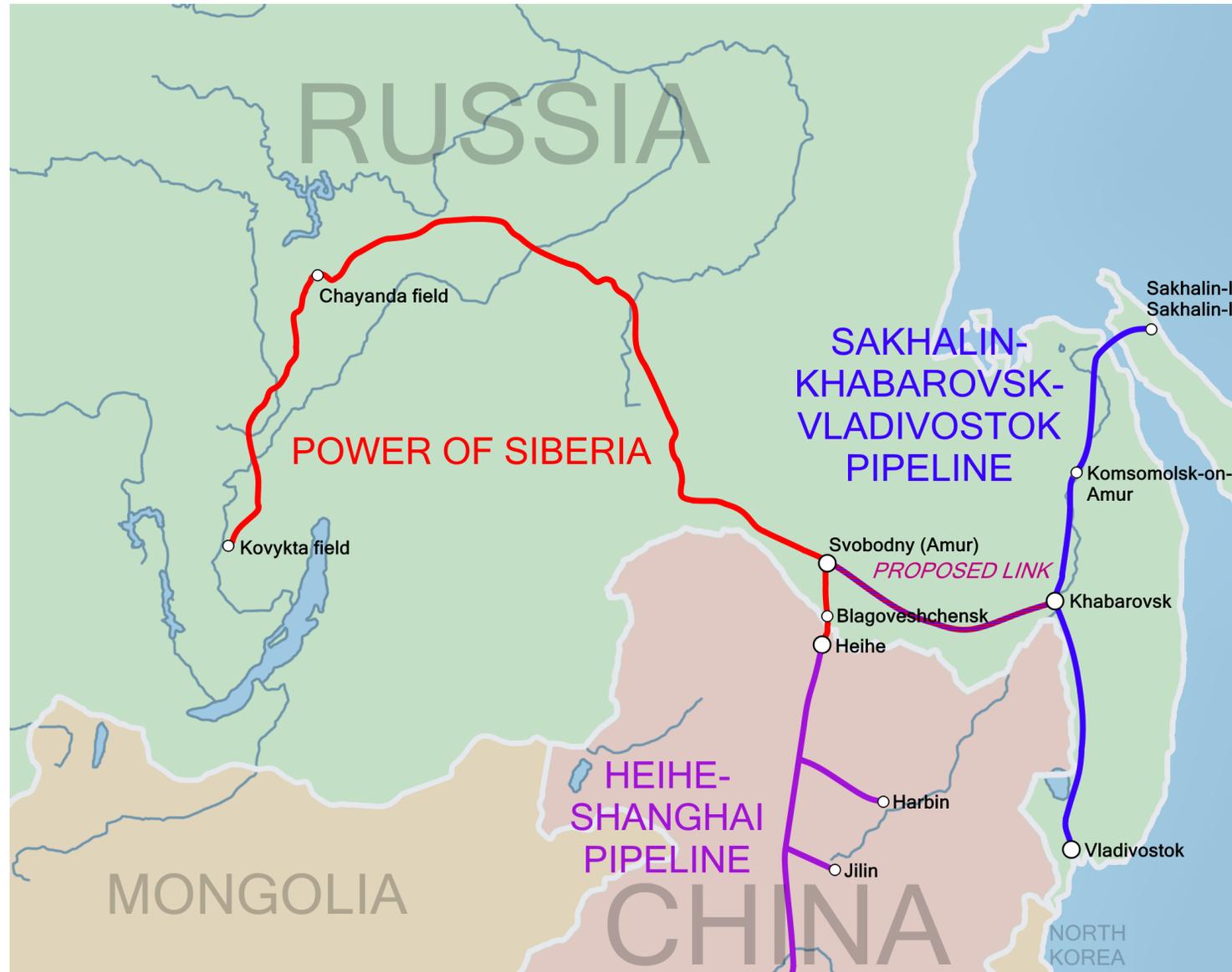
May  
2014 -

*The Washington Post*

## China, Russia sign \$400 billion gas deal

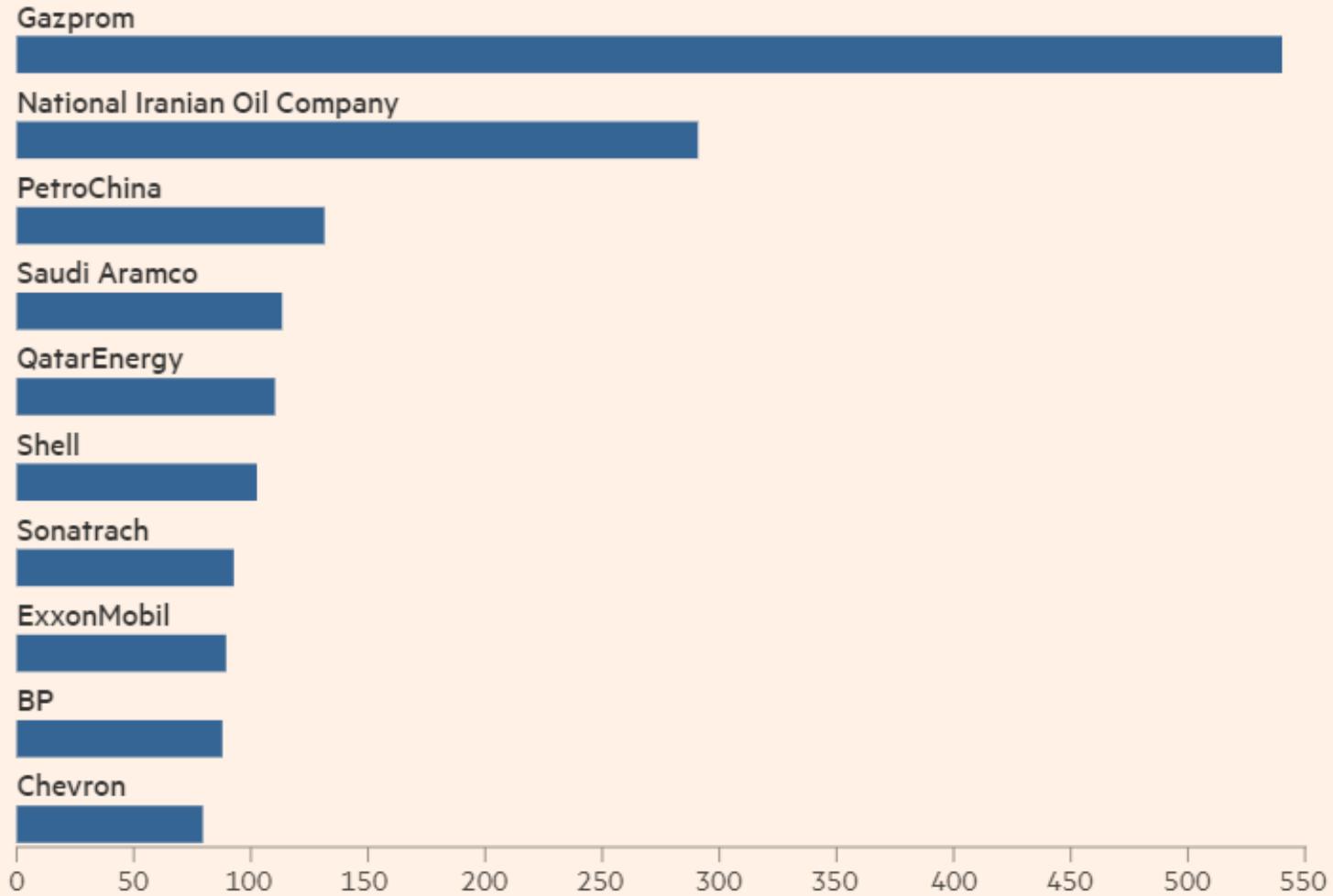


# Power of Siberia Gas Pipeline Map



# The 10 largest gas companies

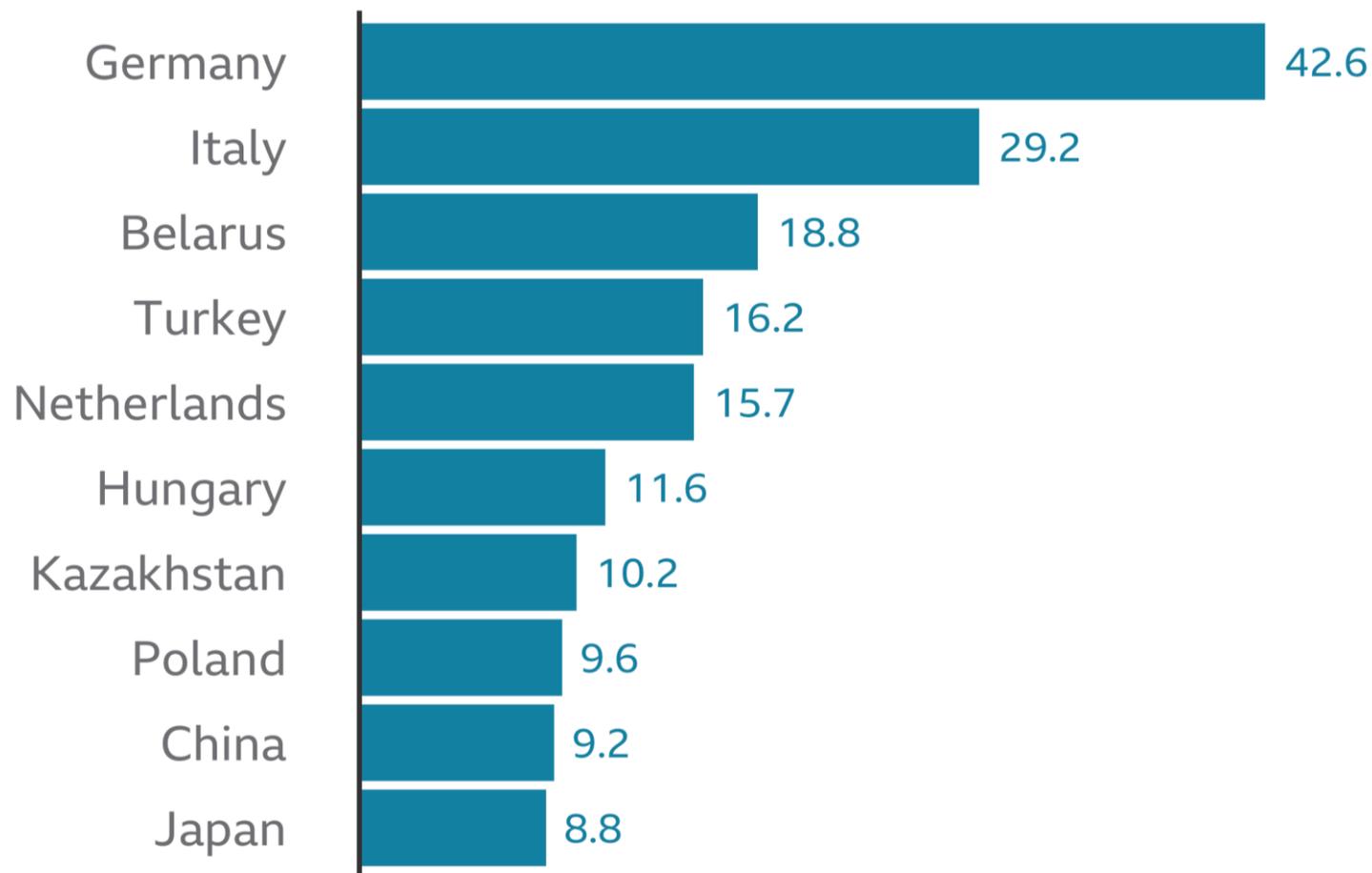
Total gas production (bn cubic metres, 2021)



FINANCIAL TIMES

Source: Wood Mackenzie

## Countries by billion of cubic metres imported from Russia



Source: IEA, Data for 2020



Rosneft and Gazprom represent  
25%-40% of Russia's budget

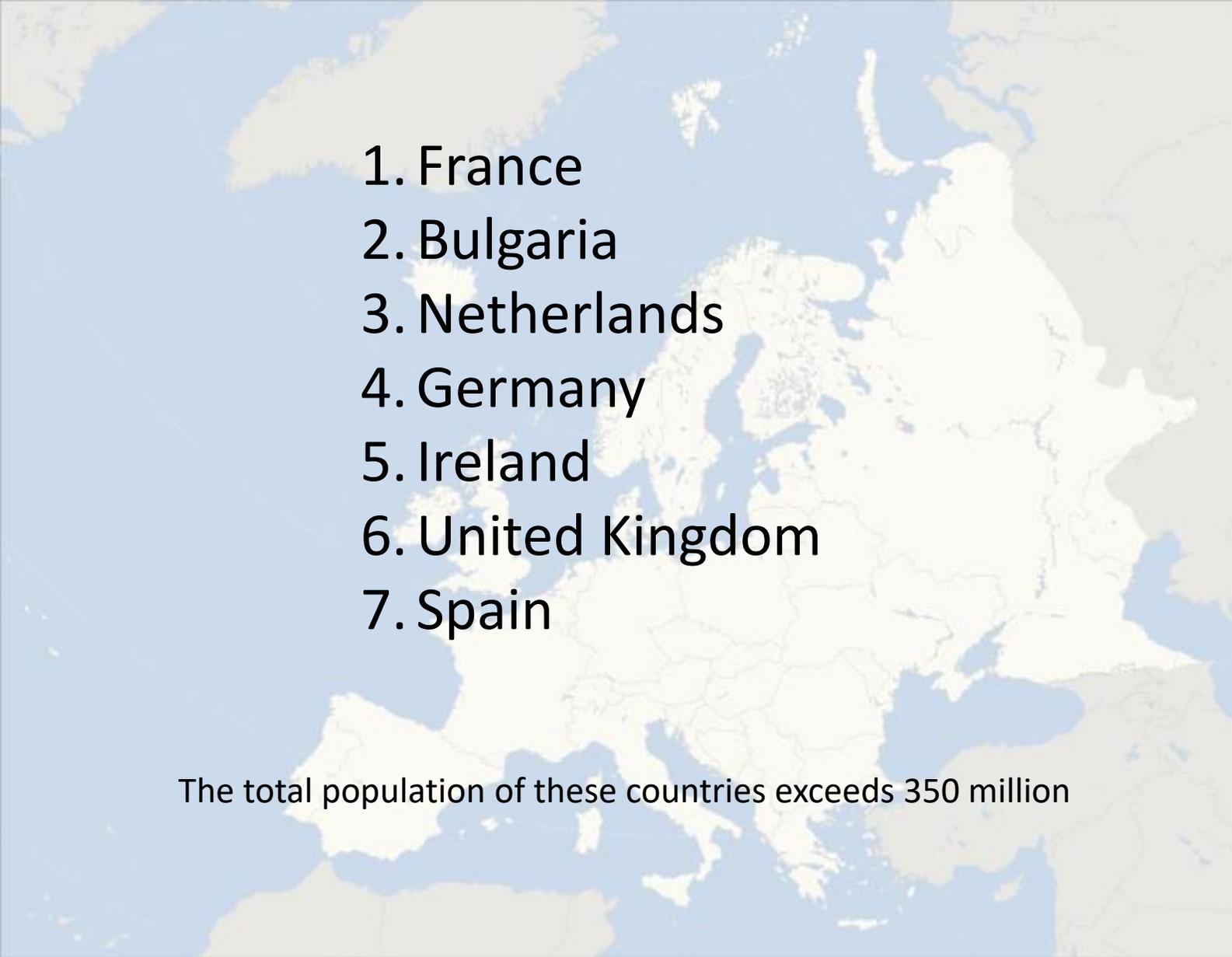




Former NATO Secretary General Anders Fogh Rasmussen backs up the Romanian claim. He said in London recently,

“Russia, as part of their sophisticated information and disinformation operations, engaged actively with so-called nongovernmental organizations – environmental organizations working against shale gas – to maintain [Europe’s] dependence on imported Russian gas.”

- Former NATO Secretary General Anders Fogh Rasmussen

- 
- A map of Europe is shown in the background, with a list of seven countries overlaid in the center. The countries listed are France, Bulgaria, Netherlands, Germany, Ireland, United Kingdom, and Spain.
1. France
  2. Bulgaria
  3. Netherlands
  4. Germany
  5. Ireland
  6. United Kingdom
  7. Spain

The total population of these countries exceeds 350 million

# 1929 Salt Lake City Distribution Pipeline

