# Fossil Fuels, Fertilizer and Food


## A Climate Conversation Podcast

Mercator Energy

June 28, 2024

JOHN HARPOLE
PRESIDENT / FOUNDER

# Progressives don't understand 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."

Source:  *Energy conference leader pans Kerry's 2050 climate goals: 'Going to still be an energy mix,' Tyler Olson, Fox Business, March 15, 2022*


| 2023 | Oil Exports 1000s B/day |
|---|---|
| US | 9108 |
| Saudi Arabia | 8282 |
| Russian Federation | 6736 |
| Canada | 4836 |
| West Africa | 3285 |
| North Africa | 2025 |
| Mexico | 1271 |
| Other Middle East (ex SA) | 15018 |

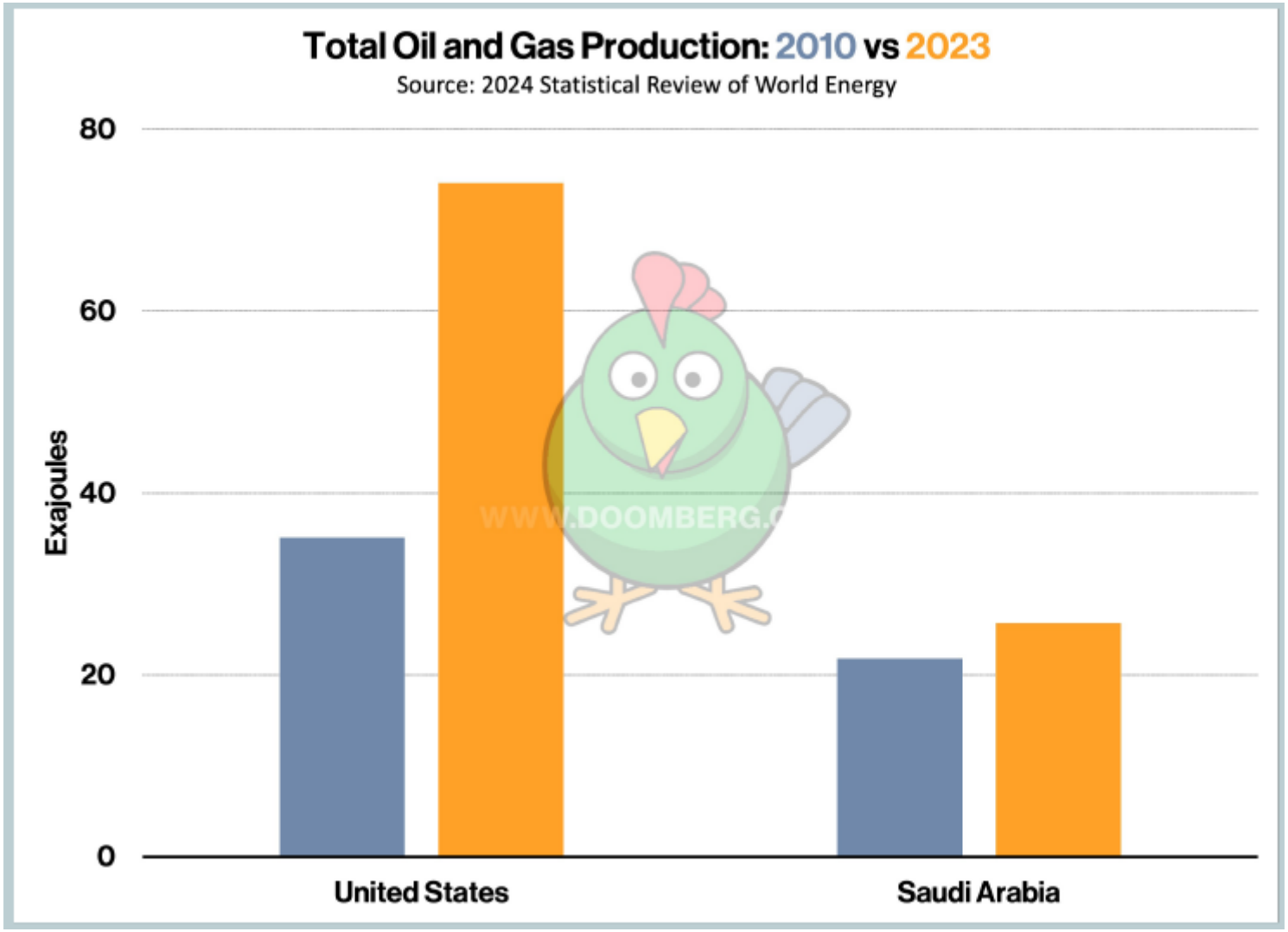
# The US is the world's energy superpower

| 2023 | LNG Exports BCM |
|---|---|
| US | 114.4 |
| Qatar | 108.4 |
| Australia | 107.4 |
| Russian Federation | 42.7 |
| Malaysia | 36.3 |
| Algeria | 19.0 |
| Nigeria | 17.5 |
| Indonesia | 16.1 |
| Oman | 15.3 |
| Papua New Guinea | 11.5 |
| Trinidad & Tobago | 10.5 |

| 2023 | Oil Production 1000s B/day |
|---|---|
| US | 19358 |
| Saudi Arabia | 11389 |
| Russian Federation | 11075 |
| Canada | 5653 |
| Iran | 4662 |
| Iraq | 4355 |
| China | 4198 |
| United Arab Emirates | 3922 |
| Brazil | 3502 |
| Kuwait | 2908 |

Source: "Energy & Climate Realities," Roger Pielke Jr., June 27, 2024

# The U.S. Energy Miracle

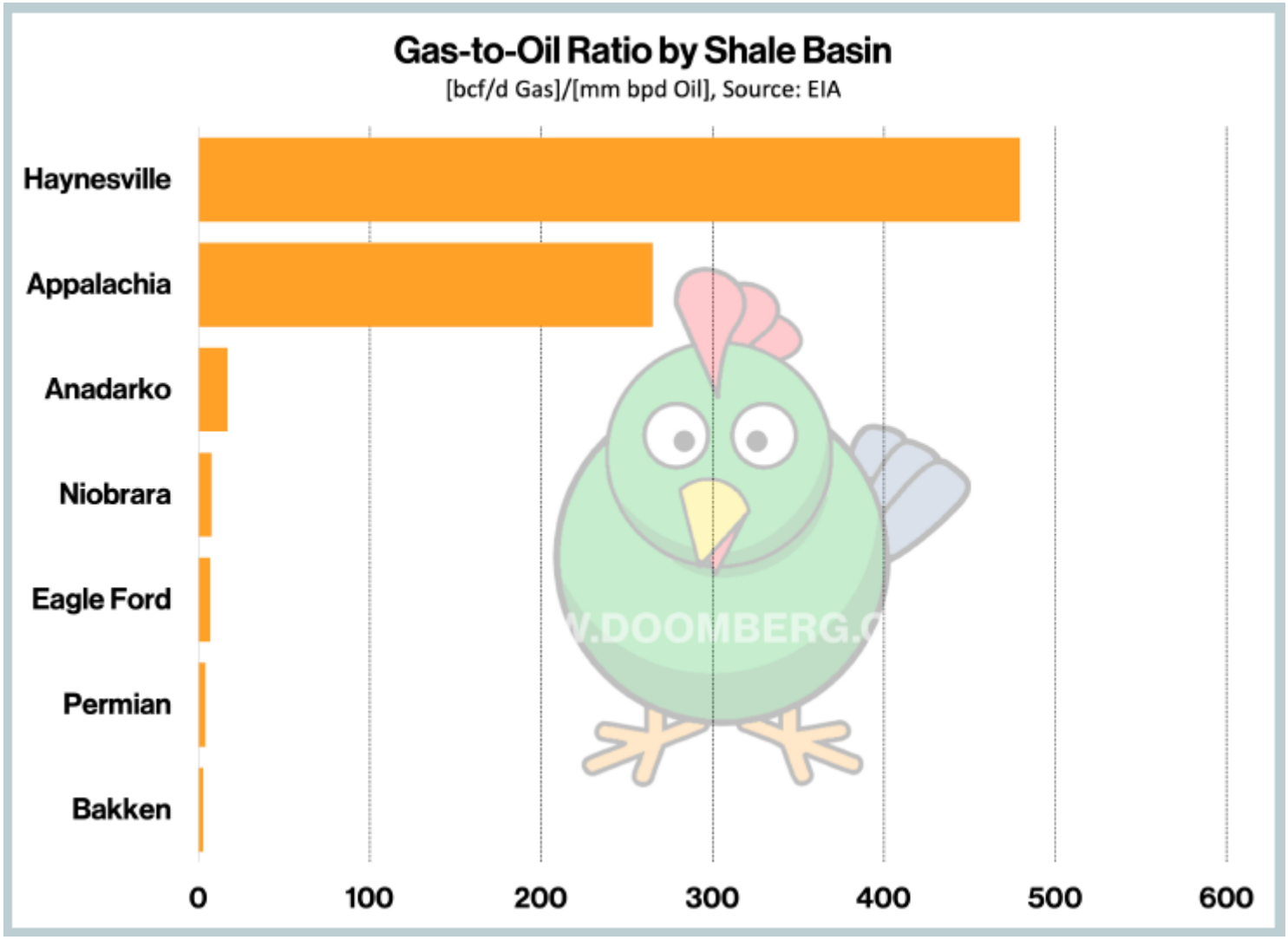



Source: "American Road Trip: A Comprehensive Tour of US Shale Resources," June 2024, Doom Zoom

# Shale in the U.S.

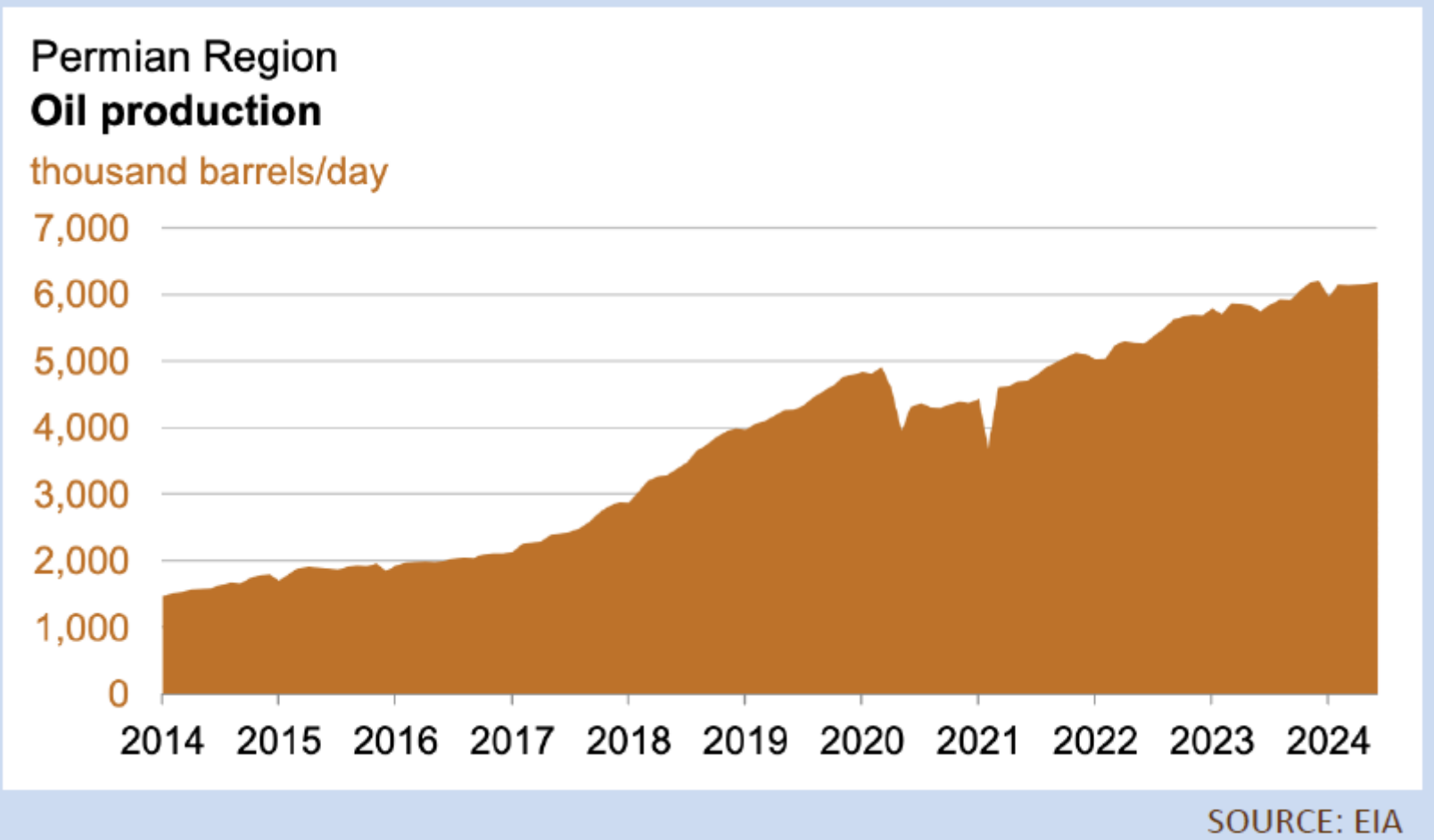

Source: “American Road Trip: A Comprehensive Tour of US Shale Resources,” June 2024, Doom Zoom

# Gas-to-Oil Ratio: Production



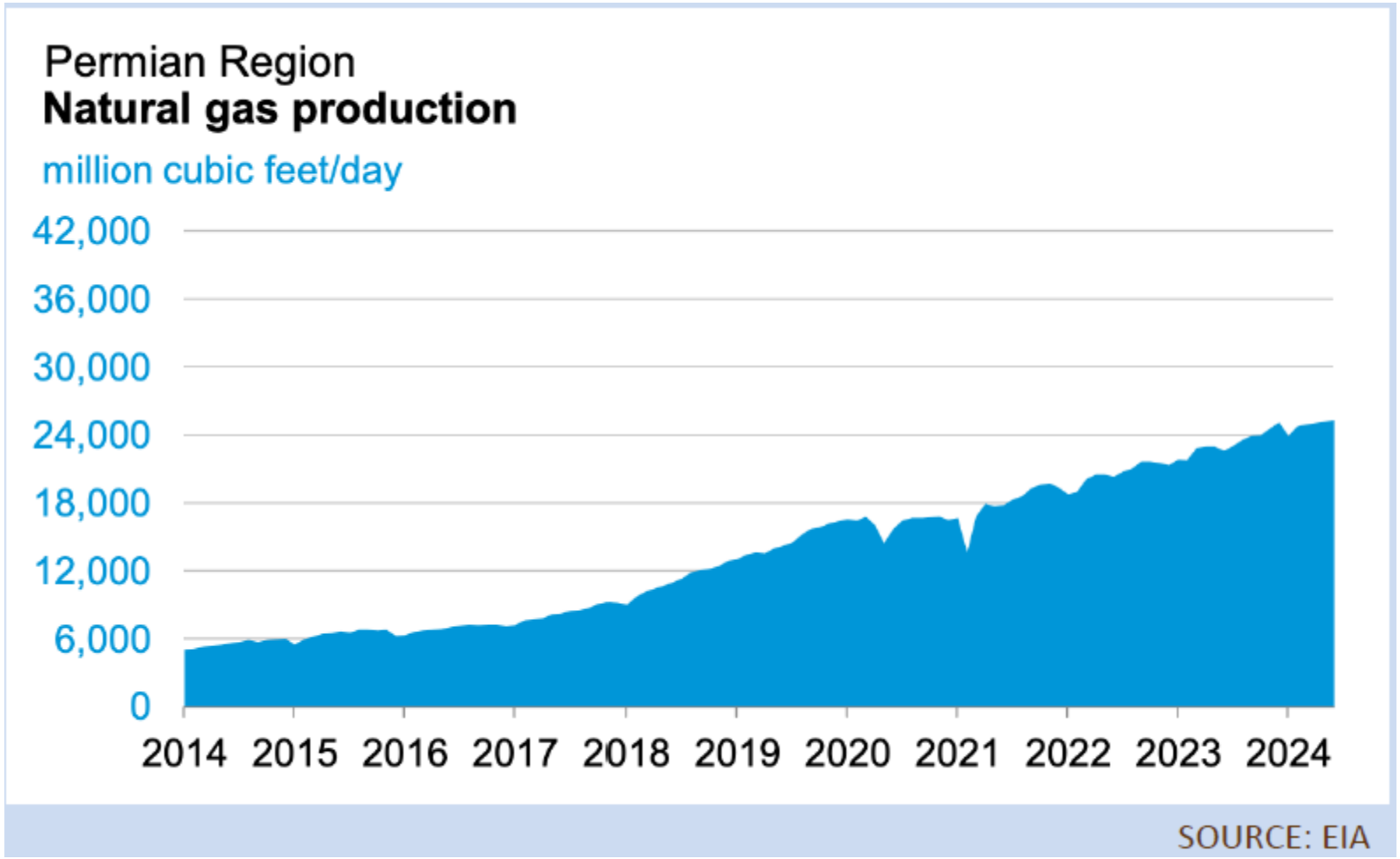

Source: "American Road Trip: A Comprehensive Tour of US Shale Resources," June 2024, Doom Zoom

# Permian Oil Production




Source: “American Road Trip: A Comprehensive Tour of US Shale Resources,” June 2024, Doom Zoom

# Permian Natural Gas Production

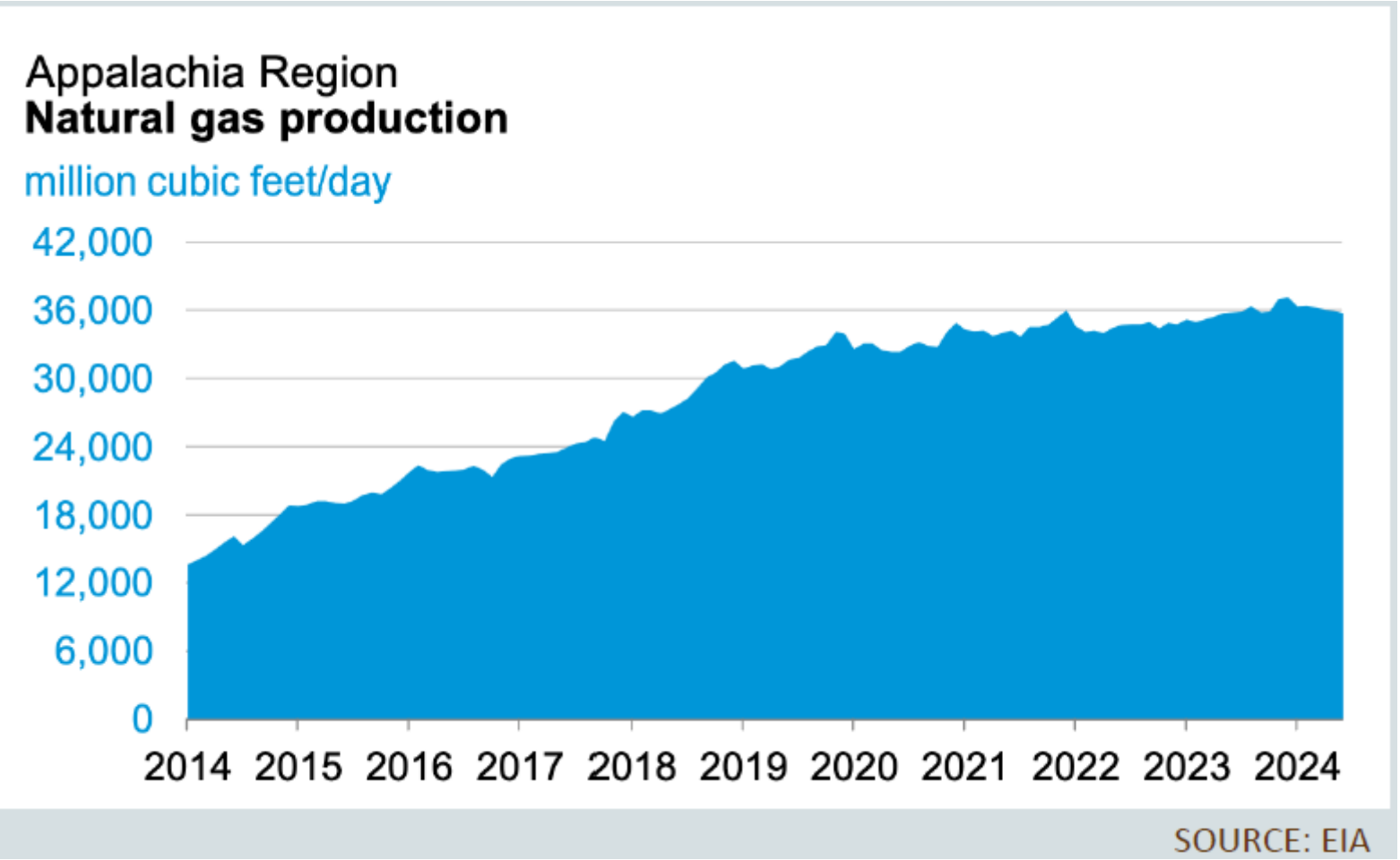



Source: “American Road Trip: A Comprehensive Tour of US Shale Resources,” June 2024, Doom Zoom

# Permian Basin

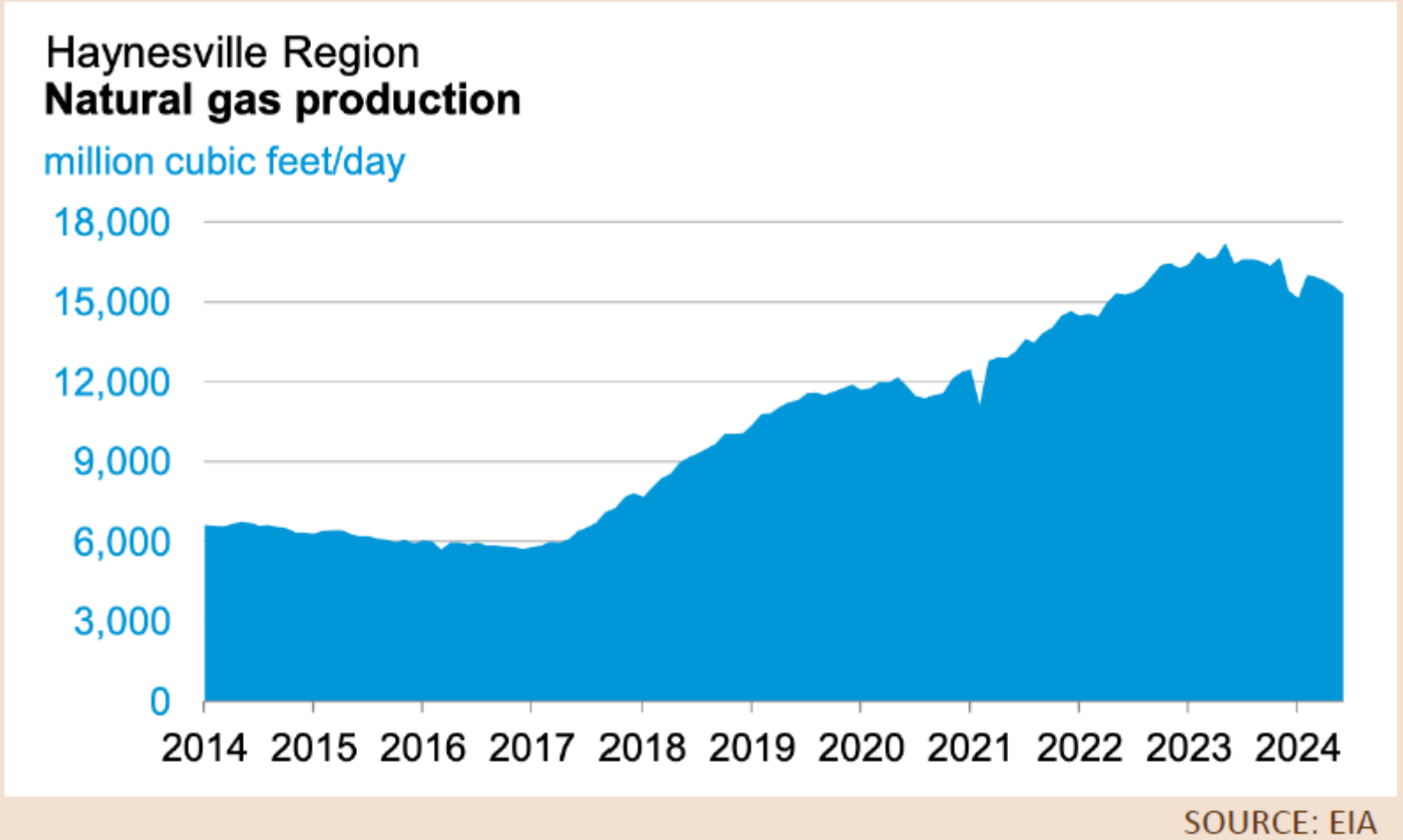
- 3rd in global natural gas production if standalone country
- 50% more daily natural gas production than Qatar

# Appalachia Natural Gas Production (Marcellus and Utica)



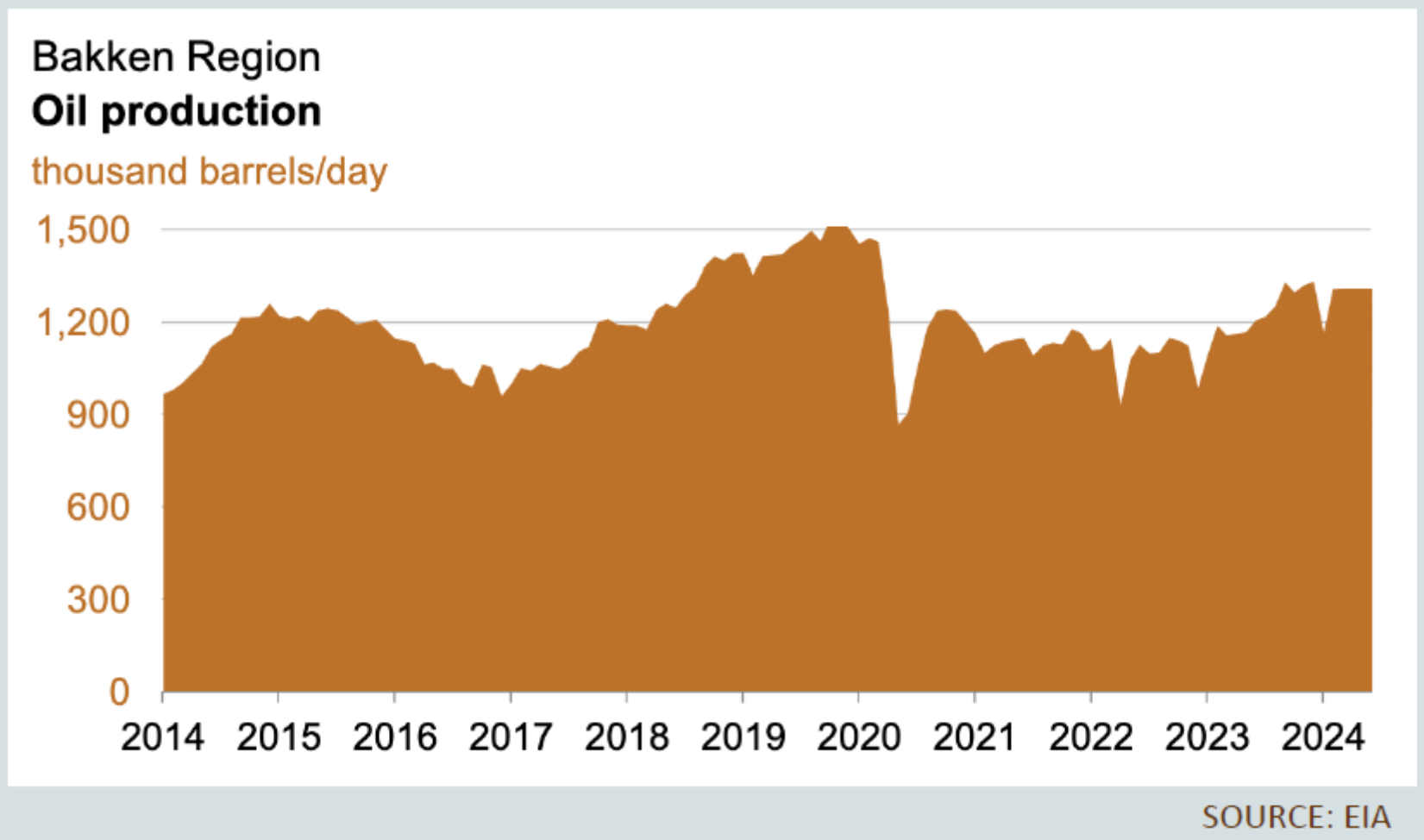

Source: "American Road Trip: A Comprehensive Tour of US Shale Resources," June 2024, Doom Zoom

# Haynesville Natural Gas Production



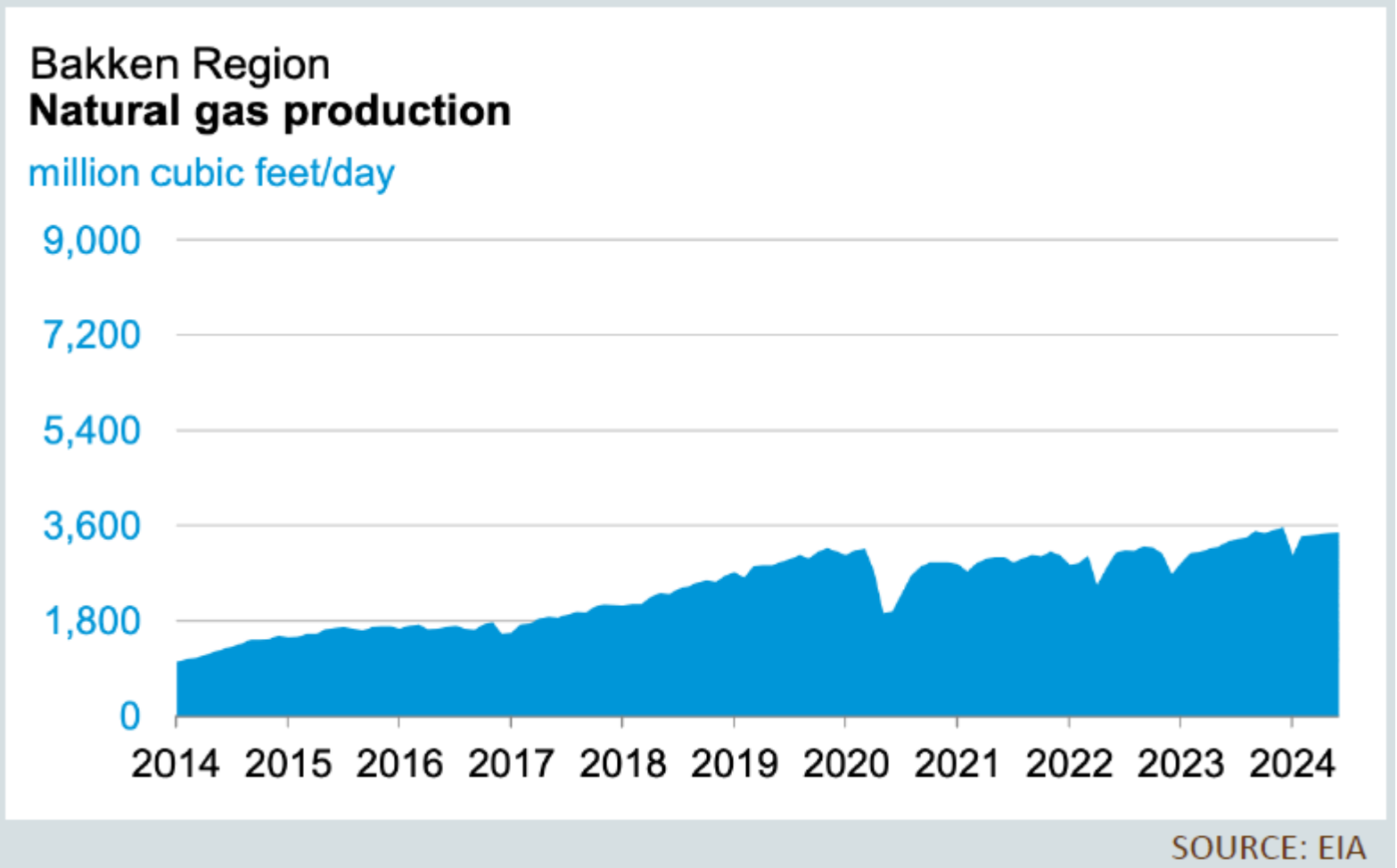

Source: “American Road Trip: A Comprehensive Tour of US Shale Resources,” June 2024, Doom Zoom

# Bakken Oil Production




Source: “American Road Trip: A Comprehensive Tour of US Shale Resources,” June 2024, Doom Zoom

# Bakken Natural Gas Production




Source: “American Road Trip: A Comprehensive Tour of US Shale Resources,” June 2024, Doom Zoom

# Four Pillar of Civilization – Vaclav Smil

1. Cement
2. Steel
3. Plastics and Petrochemicals
4. Fertilizer

Let’s just take a look at one of those four pillars.

Source: “Bettering Human Lives,” Chris Wright, Liberty Energy, 2024

# There are only four types of grain.

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

- Wheat
- Rice
- Corn
- Soybeans

All require intense use of nitrogen fertilizers

# Can we live without Fossil Fuels?... Food Facts

- The goal of fertilizing grains is to increase the yield

# There are only three types of fertilizers:

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

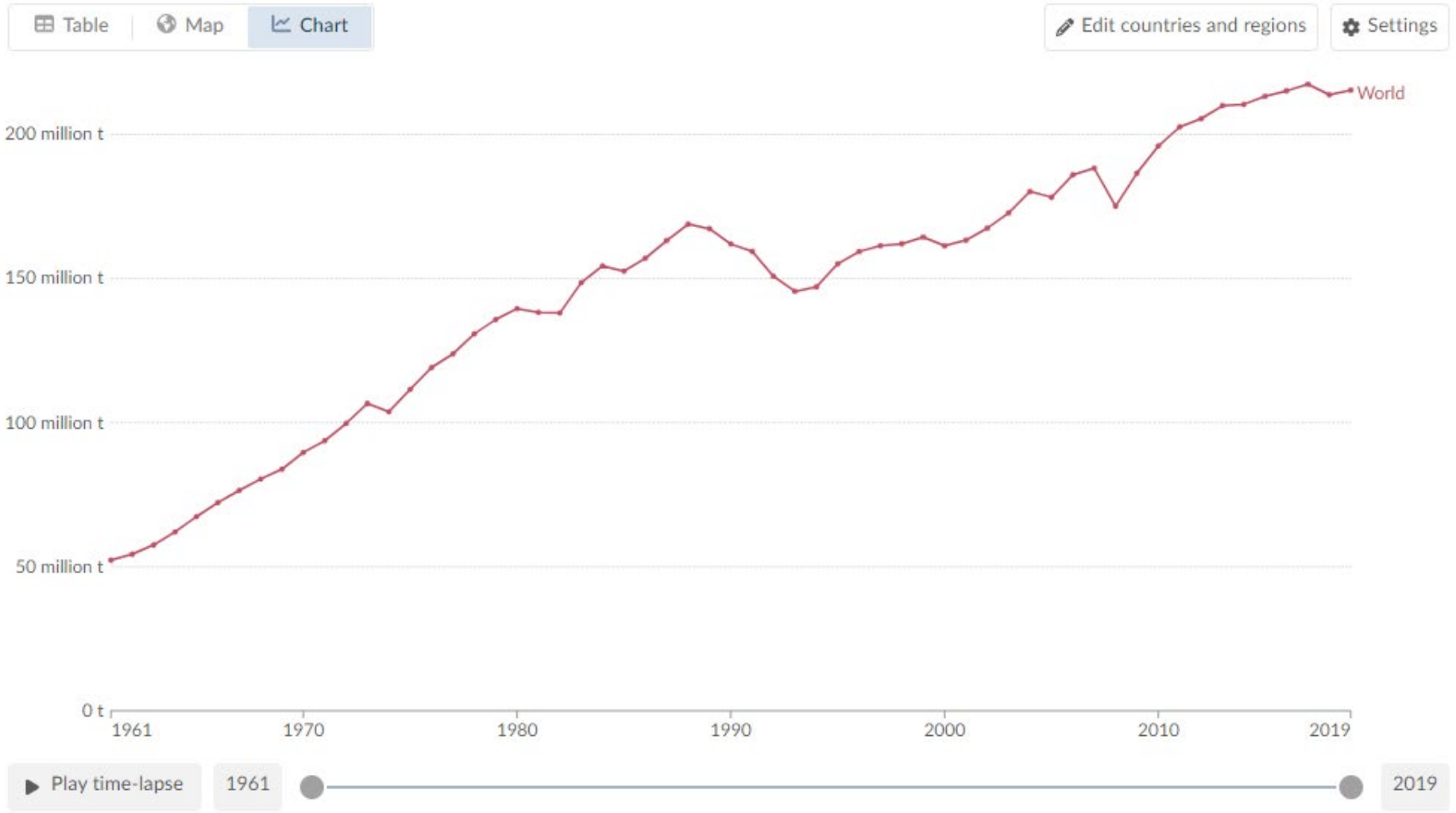
These numbers represent the amount of nutrients being supplied.

# Haber-Bosch Process

- The Haber-Bosch Process involves the synthesis of fossil fuels, primarily natural gas, into ammonia.
- Ammonia based fertilizers produce 40-60% of the food we eat by making plant nutrients more widely available.
- The expansion of the world's population from 1.6 billion people in 1900 to today's 8 billion would not have been possible without the synthesis of ammonia.

# Fertilizer consumption, 1961 to 2019

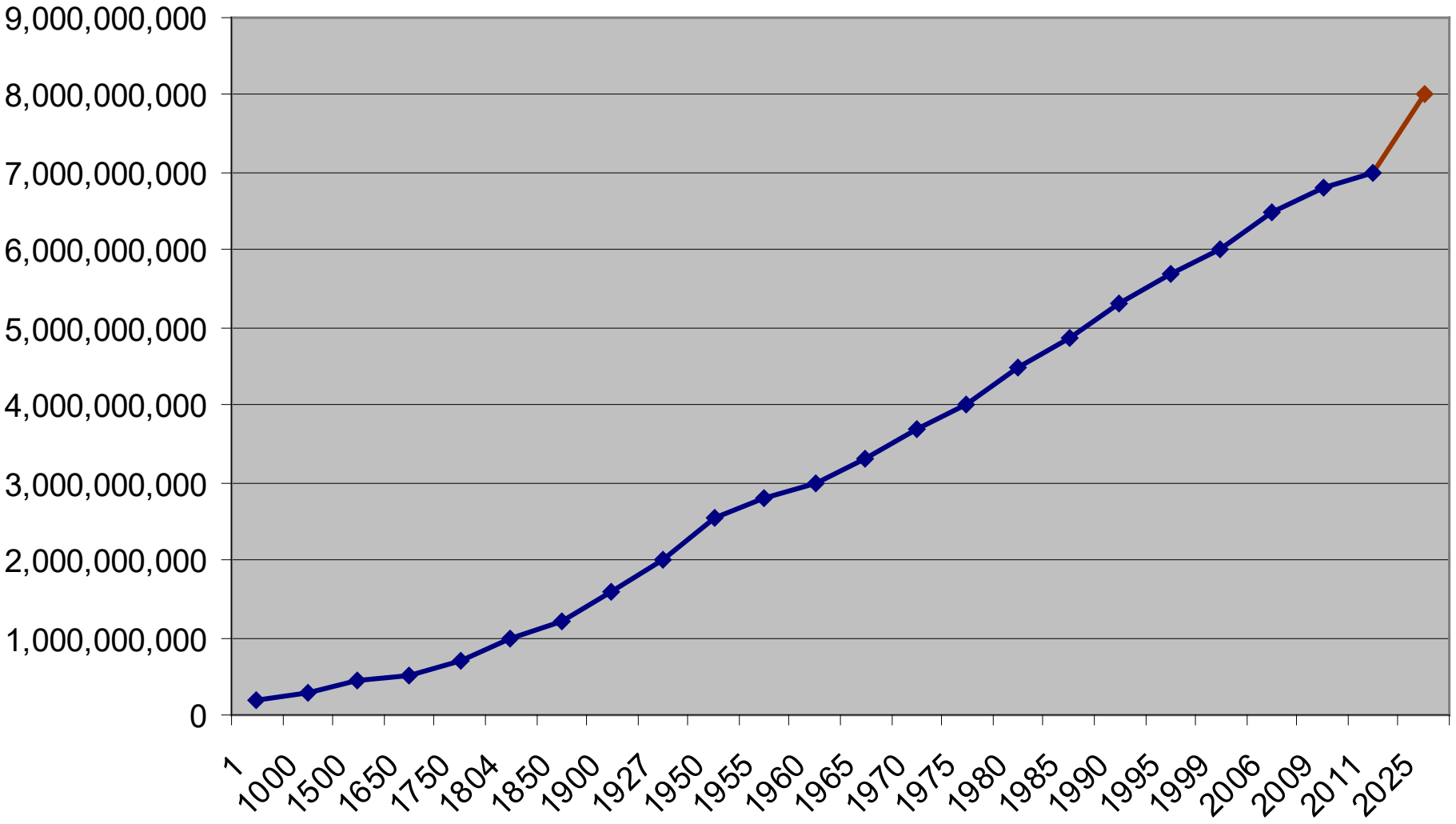
Total fertilizer consumption is the sum of synthetic inputs of nitrogen, potassium and phosphorous, plus organic nitrogen inputs.




**Data source:** Food and Agriculture Organization of the United Nations via the United States Department for Agriculture (USDA) – Learn more about this data

OurWorldInData.org/fertilizers | CC BY

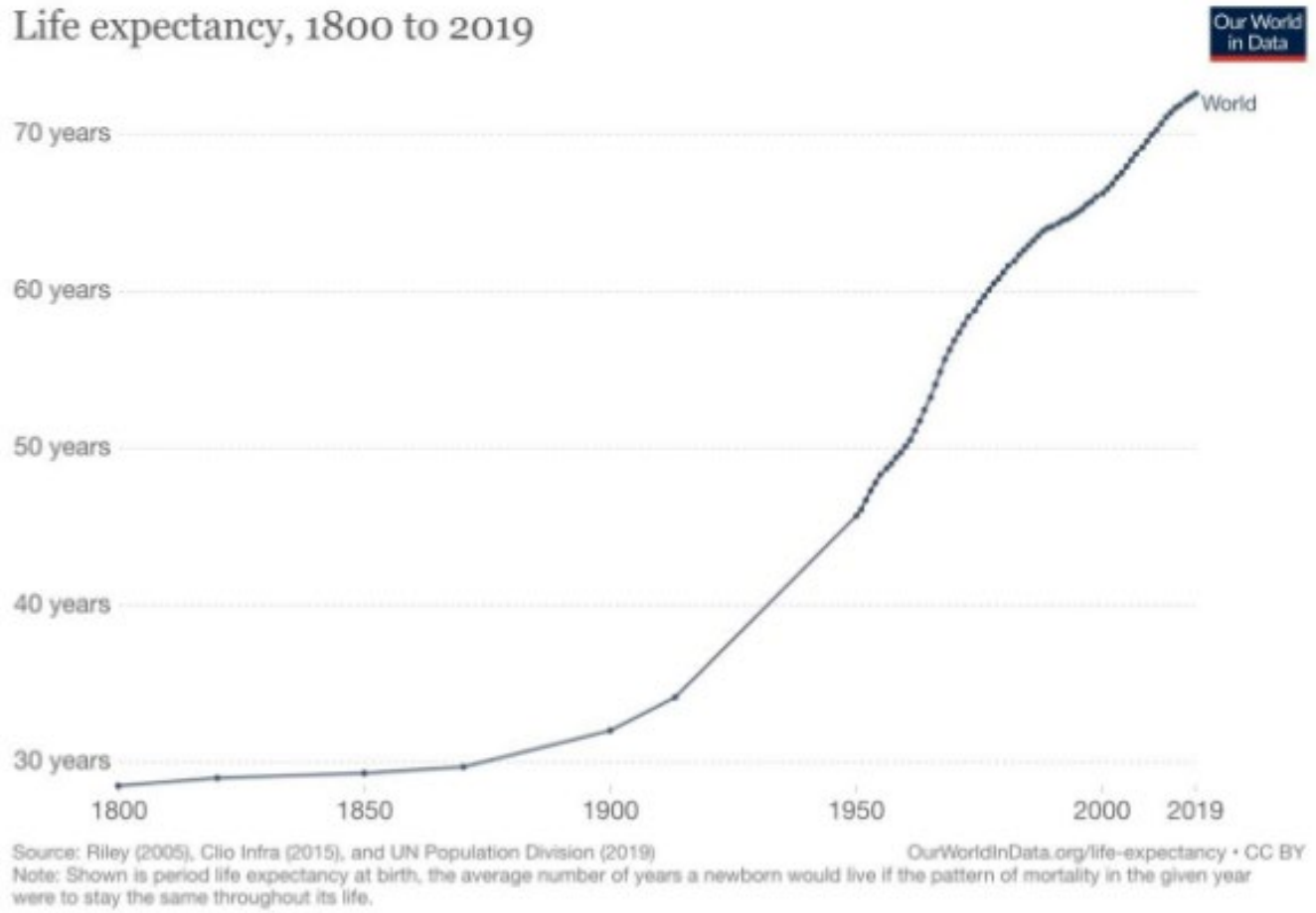
# World Population Growth




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

# Life Expectancy Since the Year 1800

Urbanization, industrialization, and energy consumption have contributed to an extension of life expectancy of **over 40 years...**

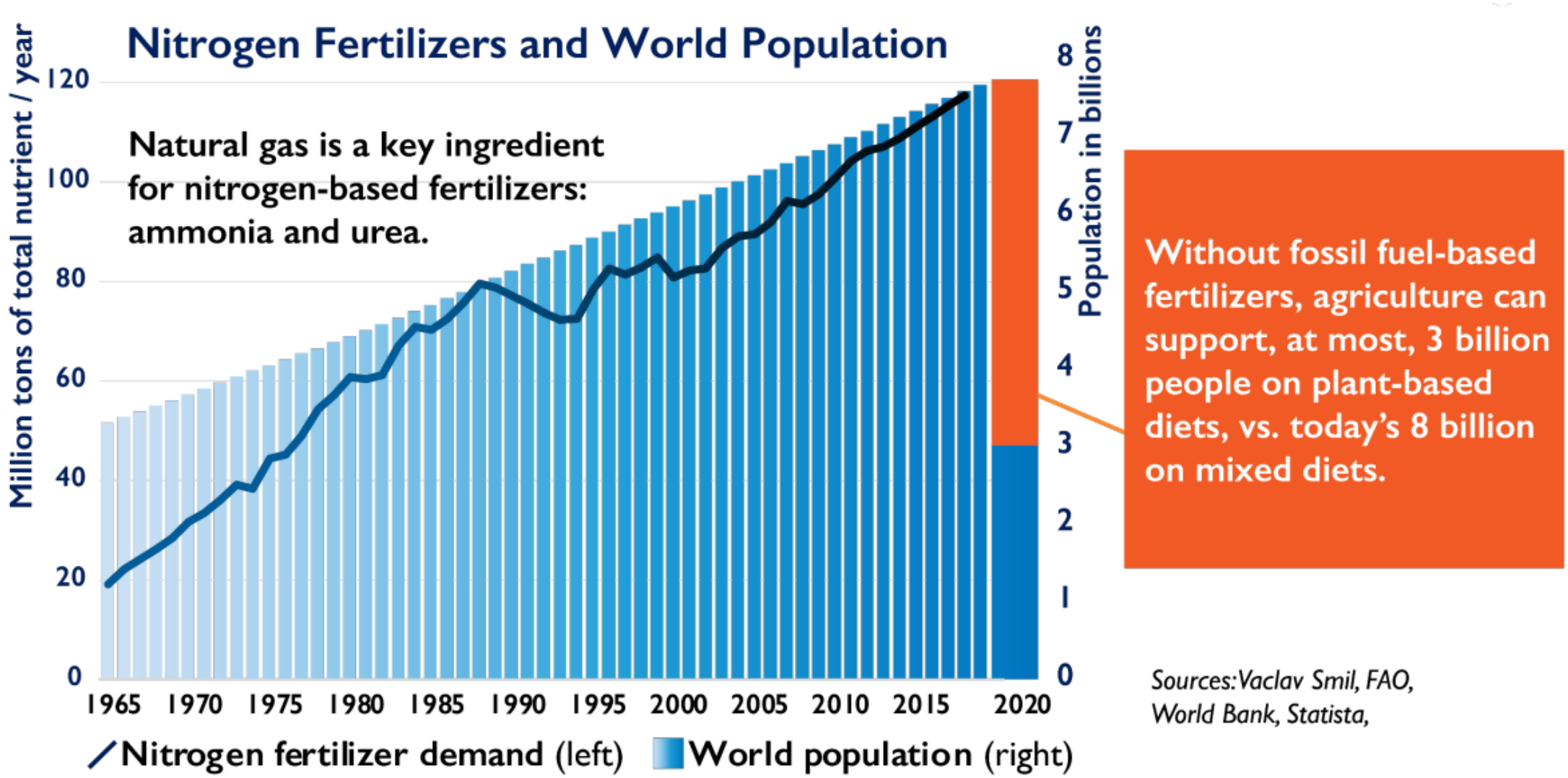



ENVIRONMENTAL PROGRESS

**Source**: Nikos Alexandratos and Jelle Bruinsma, "World Agriculture Towards 2030/2050: The 2012 Revision," ESA Working Paper no. 12-03, Agricultural Develop- ment Economics Division, Food and Agriculture Organization of the United Nations, June 2012, http://www.fao.org/3/a-ap106e.pdf.

Source: "Why Everything They Said About The Environment Was Wrong," Michael Shellenberger speech to the Alliance for Responsible Citizenship (ARC) in London, October 31, 2023

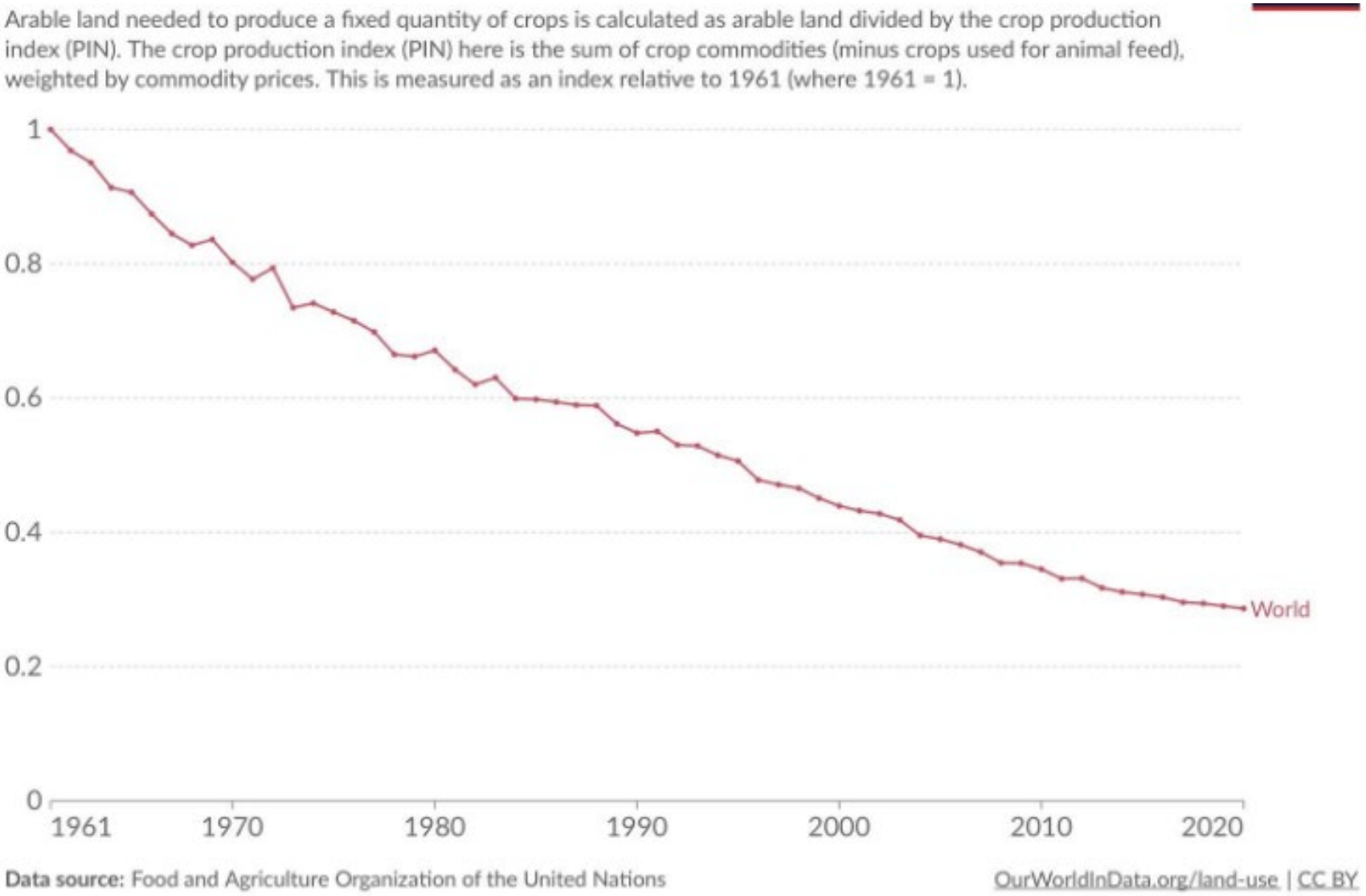
# Food for Thought: Natural Gas is Critical for Global Food Production






Source: *Chart of the Week #2022-23 Natural Gas and Global Food Production,* Batt Odgerel, Max Pyziur, Lucian Pugliaresi, EPRINC, June 29, 2022

# Arable land needed to produce a fixed quantity of crops, 1961 to 2020




Source: "Why Everything They Said About The Environment Was Wrong," Michael Shellenberger speech to the Alliance for Responsible Citizenship (ARC) in London, October 31, 2023

# Nitrogen wars: the Dutch farmer's revolt that turned a nation upside-down

Source: "Nitrogen wars: the Dutch farmers' revolt that turned a nation upside-down," The Guardian, Paul Tullis, November 16, 2023

# Not Everything is Possible… ???

- Dutch farmers gathered to protest a governmental advisory committee's recommendation to take "drastic measures" to reduce emissions of nitrogen.
- The largest share of nitrogen deposited on Dutch land comes from agriculture.
- Committee recommended buying out and shutting down livestock farms



Source: "Nitrogen wars: the Dutch farmers' revolt that turned a nation upside-down," The Guardian, Paul Tullis, November 16, 2023

# Fertilizer: The Fuel of the Green Revolution

1970 Nobel laureate Norman Borlaug, “the Father of the Green Revolution,” and his colleagues developed wheat varieties that were resistant to a wider variety of insects and diseases

“This is a basic problem, to feed 6.6 billion people. Without fertilizer, forget it. The game is over.”

# A Case Study – A Warning from Sri Lanka

"In April 2021, Sri Lankan President Gotabaya Rajapaksa imposed a nationwide ban on the importation and use of natural gas-based, synthetic fertilizer and pesticides. This forced two million farmers to adapt to organic farming."

Source: "Bettering Human Lives," Chris Wright, Liberty Energy, 2024

# A Case Study – The Impact was Rapid and Brutal

- 20% decline in domestic rice production in the first 6 months
- 50% surge in domestic rice prices
- $450 million paid by Sri Lanka for rice imports
- $425 million loss in nation's tea crop
- $40 billion foreign debt default by Sri Lanka

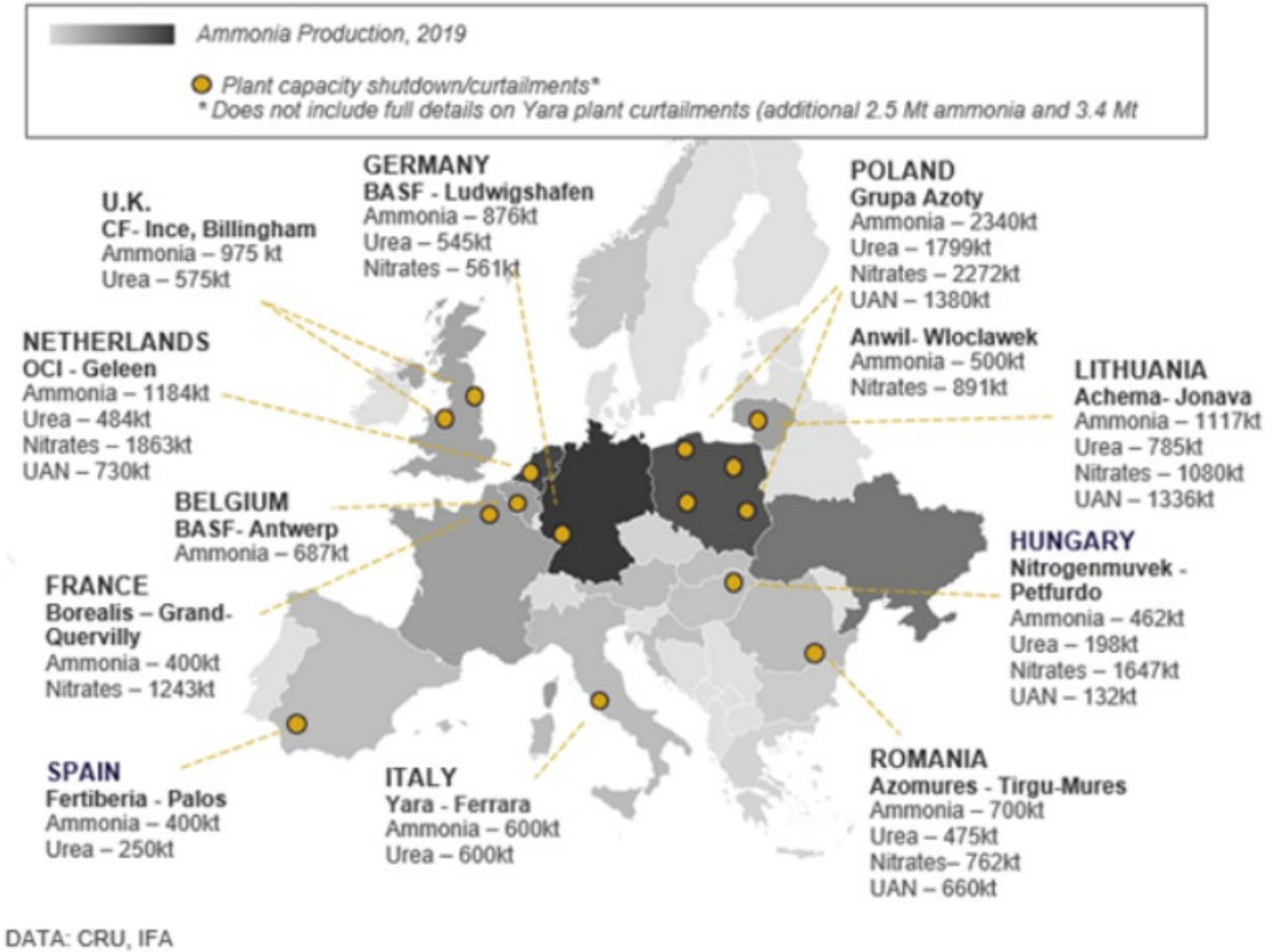
Source: "Bettering Human Lives," Chris Wright, Liberty Energy, 2024

# Fertilizer Demand Scale: 11 Bcf/d

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$^{th}$ in the world for daily natural gas demand

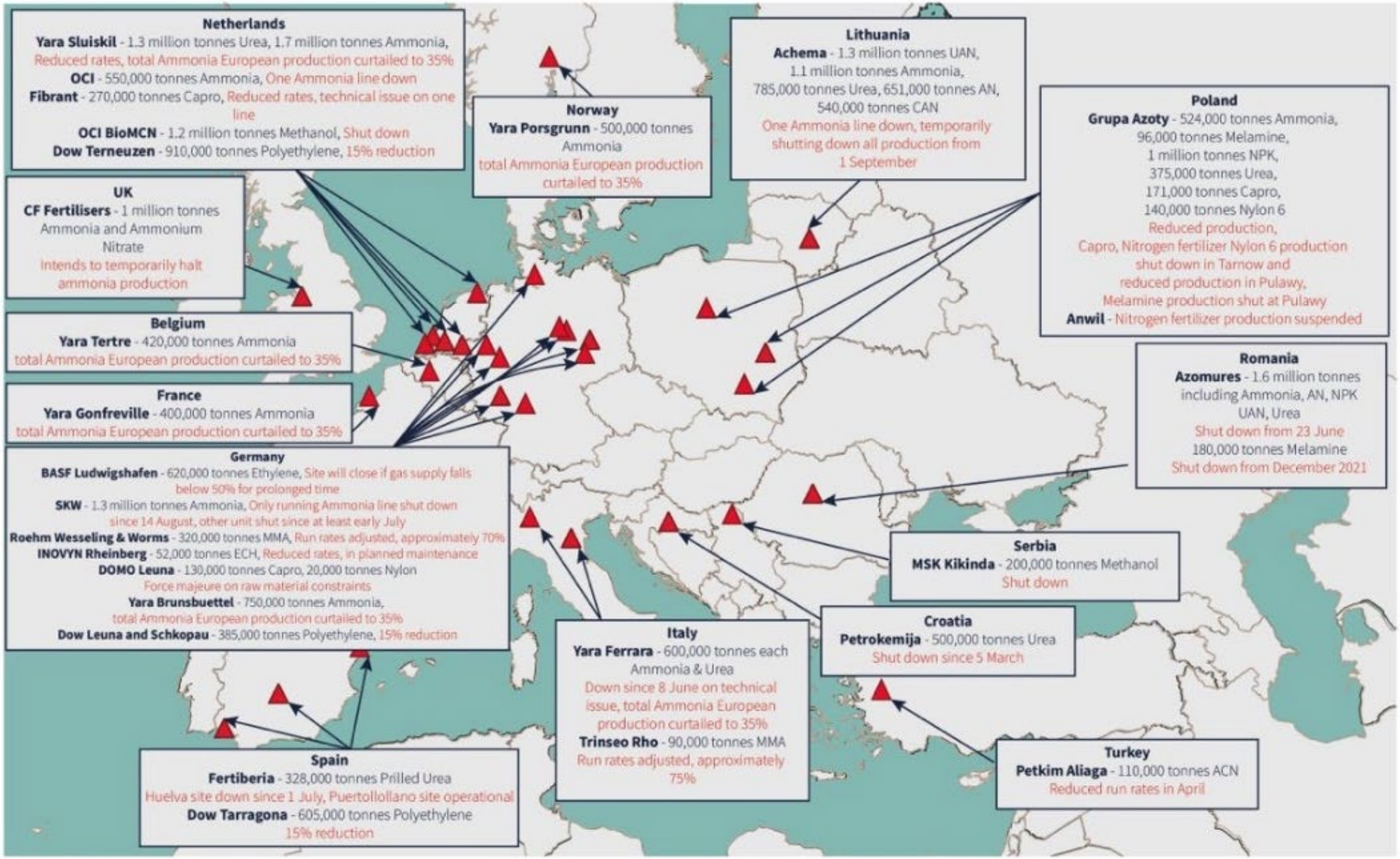
# 70% of Europe's nitrogen fertilizer plants closed during 2022

Figure 1: European nitrogen production shutdowns and curtailments




Source: *Europe nitrogen capacity closure and cost tracker, Chris Lawson,* CRU, August 25, 2022 and *Higher gas prices deepen Europe's fertilizer crunch, threaten food crisis,* Business Standard, Samuel Gebre & Elizabeth Elkin, Bloomberg, August 27, 2022, Fertilizers Europe

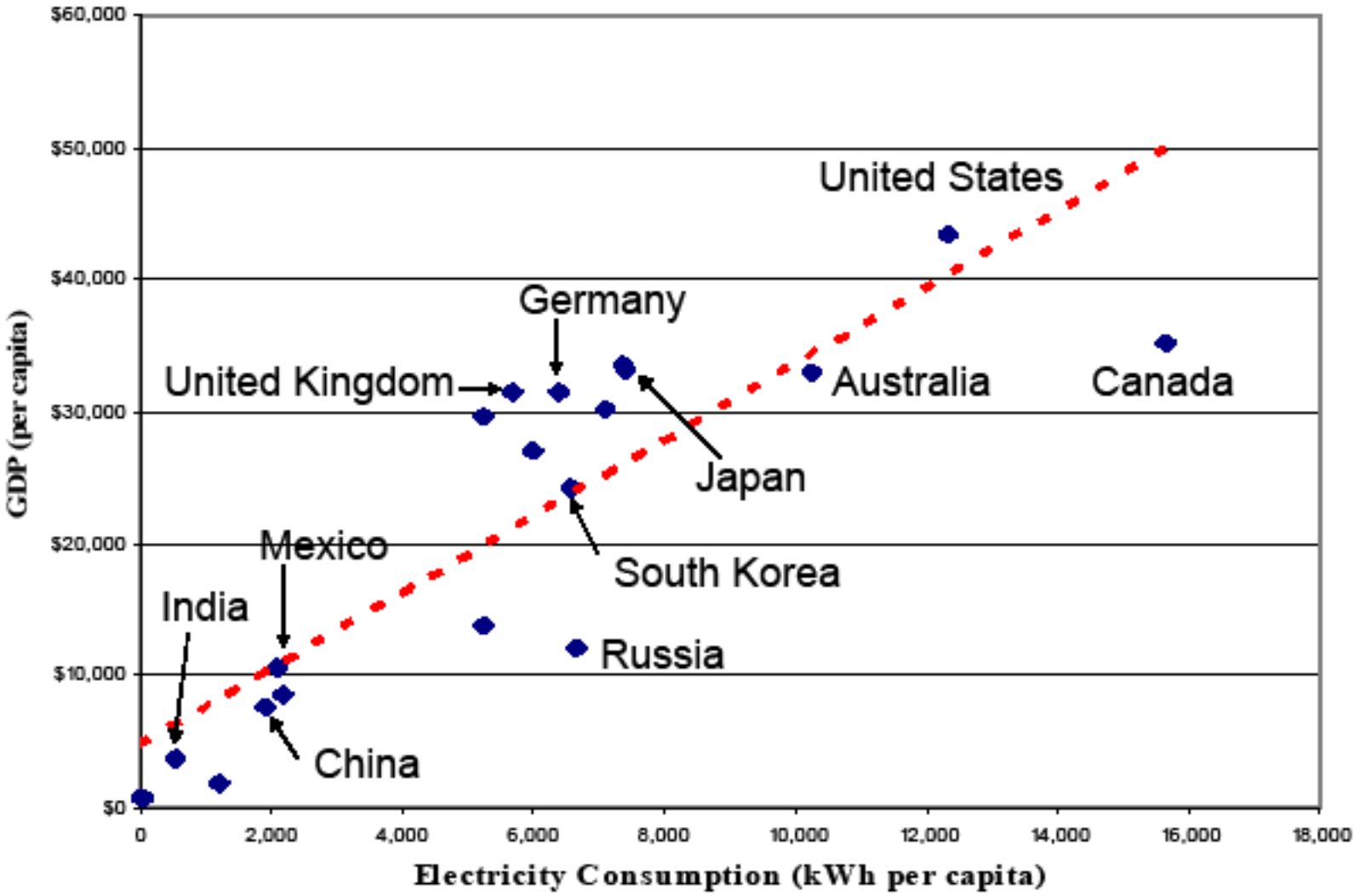
# Soaring gas prices hit Europe fertilizers, chemicals




Updated on 25 August 2022

Source: *ICIS, Natural Earth*

# Quality of Life is Strongly Correlated with Electricity Consumption

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Source: CIA World Factbook, 2007

# Fun Facts on the Other Three Pillars

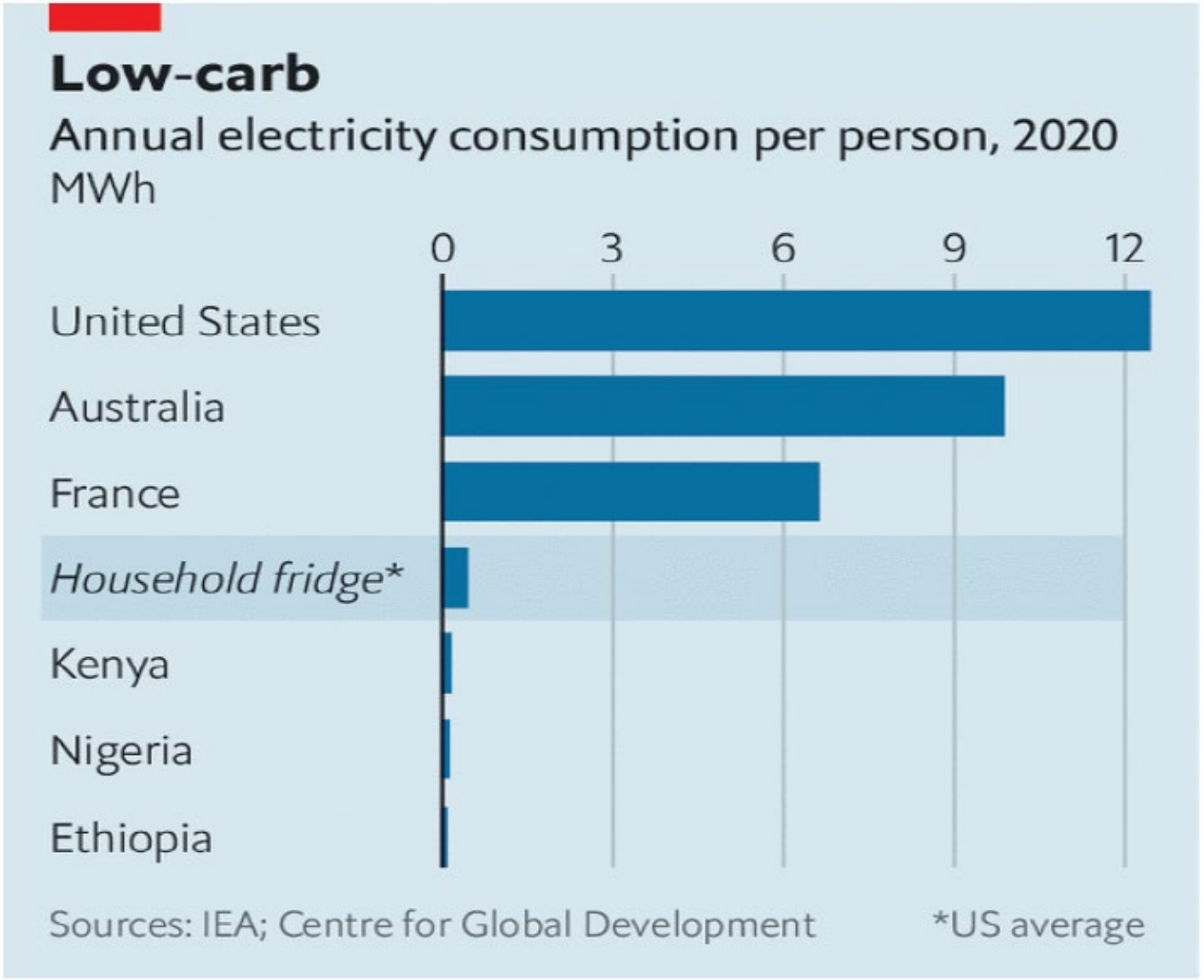
- In 2019, the world used a staggering 4.5 billion tons of cement, 1.8 billion tons of steel, 370 million tons of plastics, 200 million tons of fertilizer
- China produced more cement in 2020 and 2021 than the United States consumed in the entire 20$^{th}$ century
- 14% of worldwide oil demand and 8% of natural gas demand are used, not for energy, but as building blocks to make petrochemicals such as plastics and pharmaceuticals
- Steel alone accounts for 99% of metal consumption and is also 100% recyclable

Source: “Bettering Human Lives,” Chris Wright, Liberty Energy, 2024

# Worldwide Electricity Use in Context

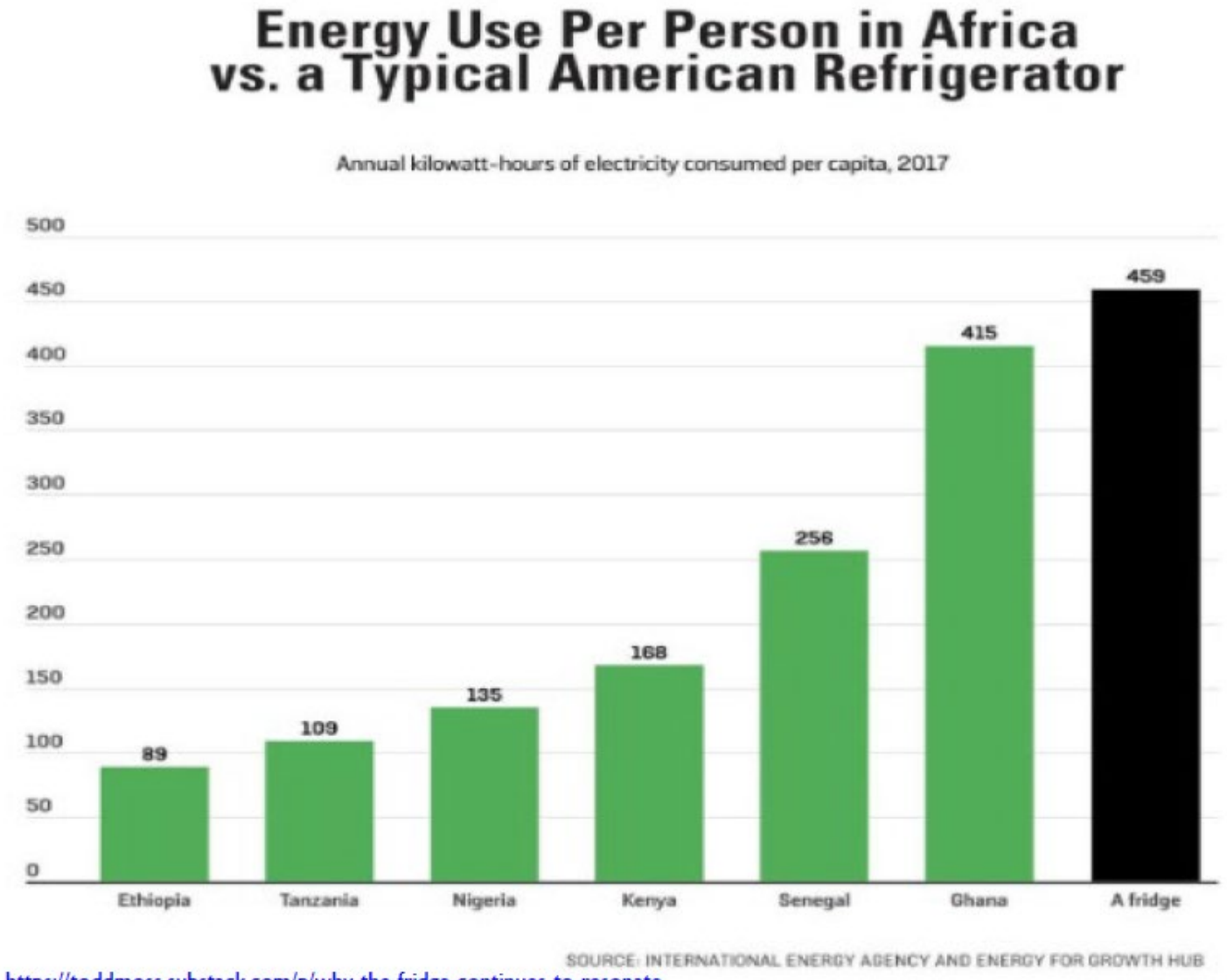
3 Billion people in the world currently use less electricity than a typical American refrigerator

# Annual Electricity Consumption per Person, 2020 MWh




Source: "Energy & Climate Realities," Roger Pielke Jr., June 27, 2024

# Energy Use Per Person in Africa vs. a Typical American Refrigerator




Source: "Energy & Climate Realities," Roger Pielke Jr., June 27, 2024

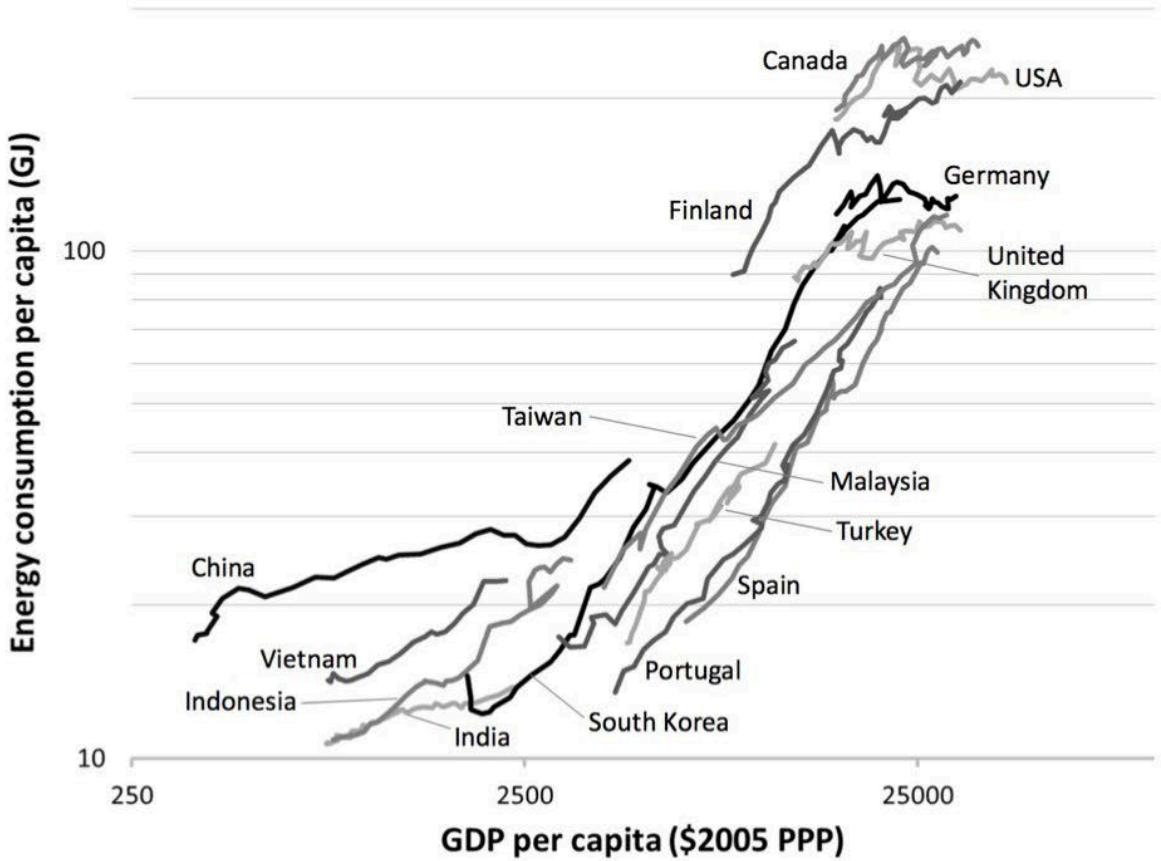
# The essentiality of electricity to modernity

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.

Source: The World Bank, *Energy – The Facts*

# Energy consumption tightly tied to GDP

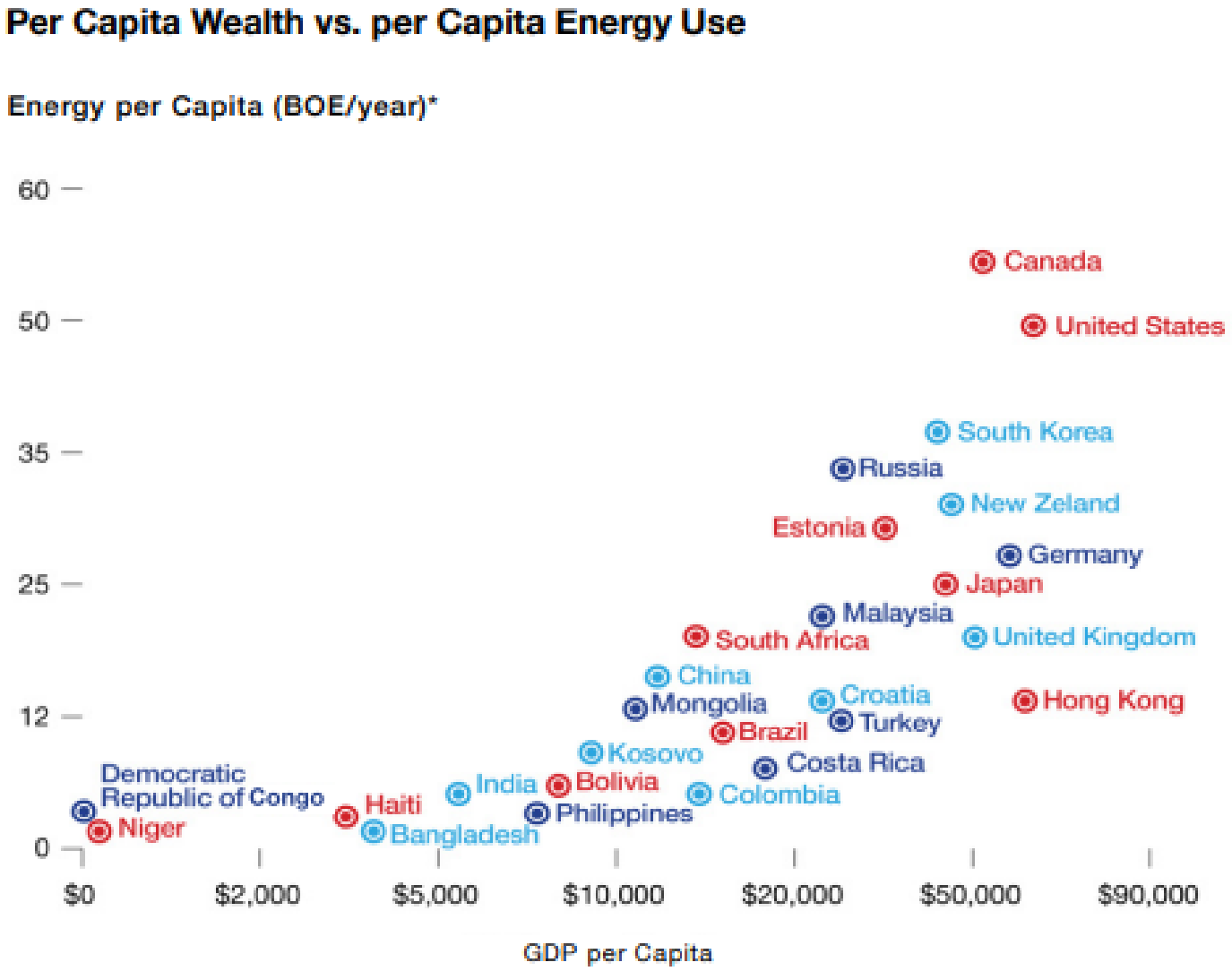
**Figure 1:** The *Energy Ladder*: Per Capita Final Energy Consumption and GDP at PPP, 1960 – 2006




*Notes:* Both axes have a logarithmic scale. Energy consumption data are obtained from the International Energy Agency's Extended Energy Balances, GDP per capita from the World Bank's World Development Indicators.

Source: "Why Everything They Said About The Environment Was Wrong," Michael Shellenberger speech to the Alliance for Responsible Citizenship (ARC) in London, October 31, 2023

# Economic Growth Creates Demand for More Energy

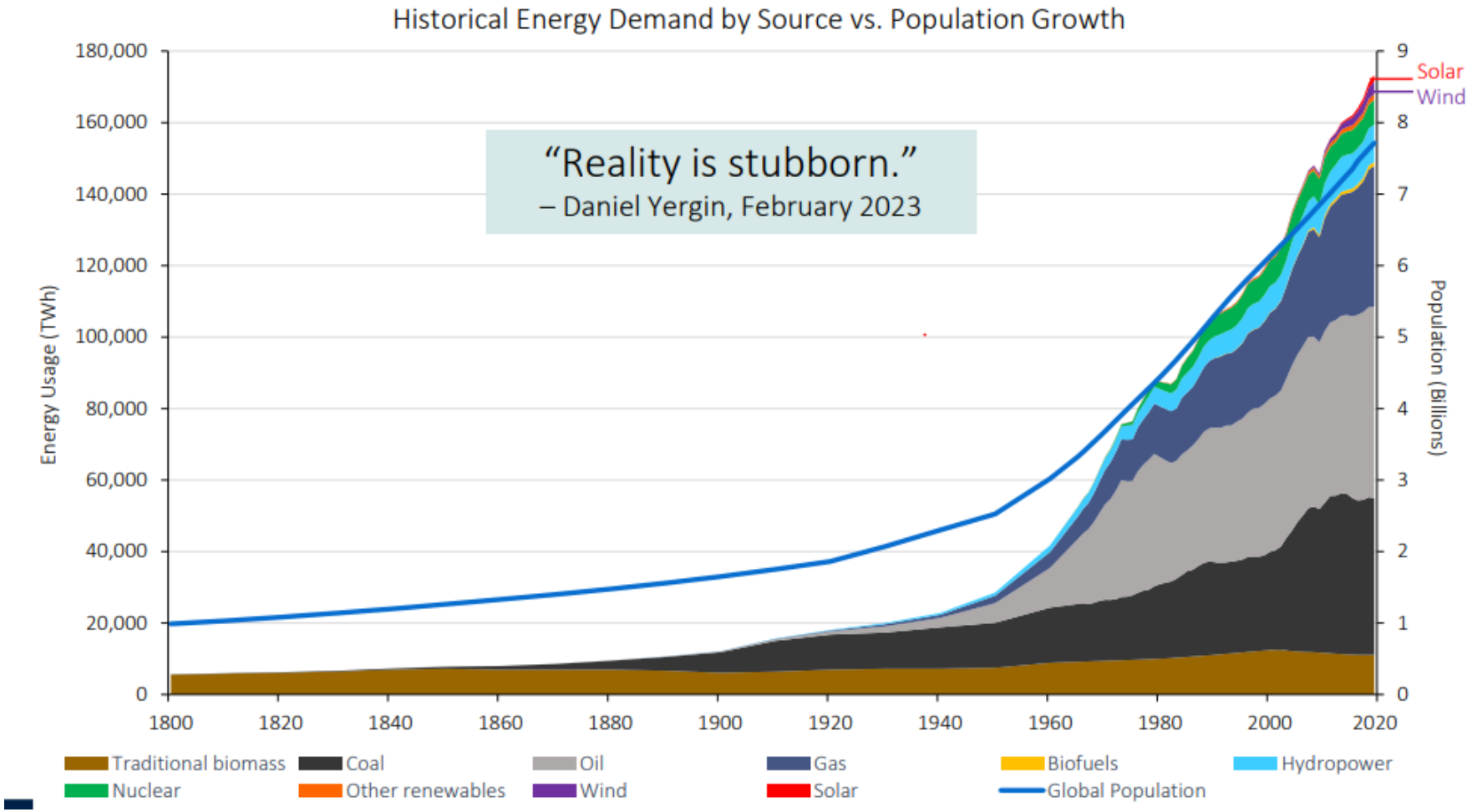



Note: Total energy measured as barrels-of-oil-equivalent (BOE). Thus, the average person in Japan, where GDP/capita is about $50,000 uses about 25 BOE per year vs. about 5 BOE in India, where GDP per capita is around $5,000

Source: World Bank; Our World in Data
The "Energy Transition" Delusion: A Reality Reset, Mark P. Mills, The Manhattan Institute, August 2022

# Global Population Growth Drives Energy "Addition"

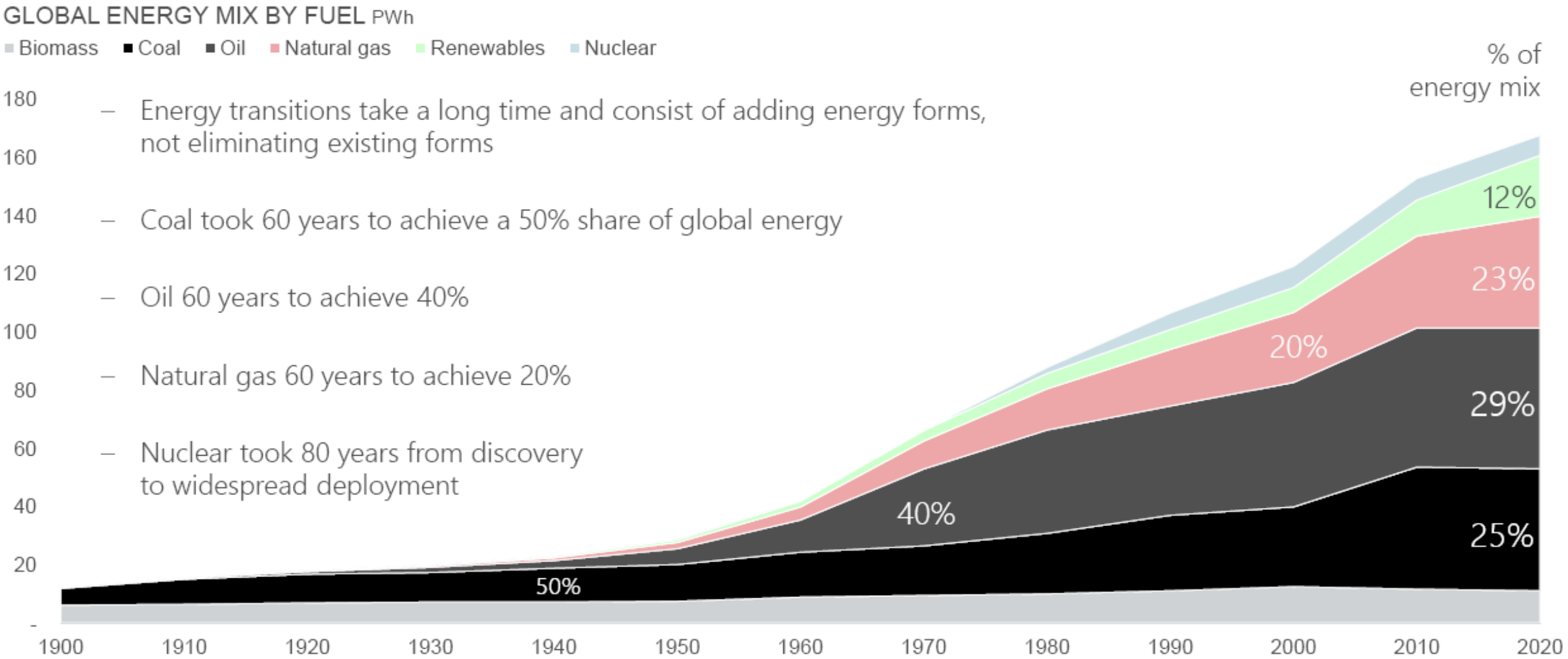
Over the past century, global energy usage increased rapidly in connection with industrialization and rising global population. Further, from 1965 to 2021, per capita energy consumption grew 61%.



# Energy Transitions Take Time

KINDER MORGAN

Our assets and services will be needed for a very long time

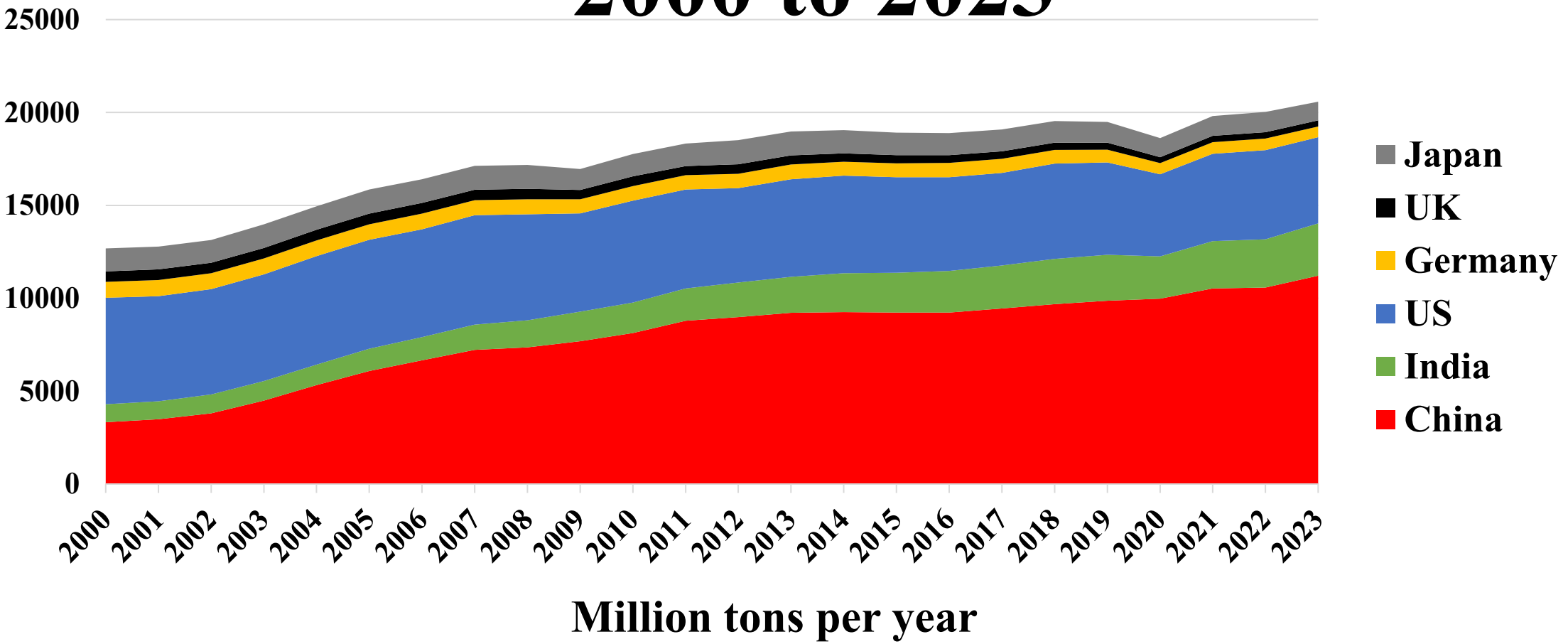



Source: Pre-1965 from *Energy Transitions: Global and National Perspectives*; 1965 and beyond from BP's Statistical Review of World Energy.

Source: KinderMorgan Investor Presentation 3Q 2023

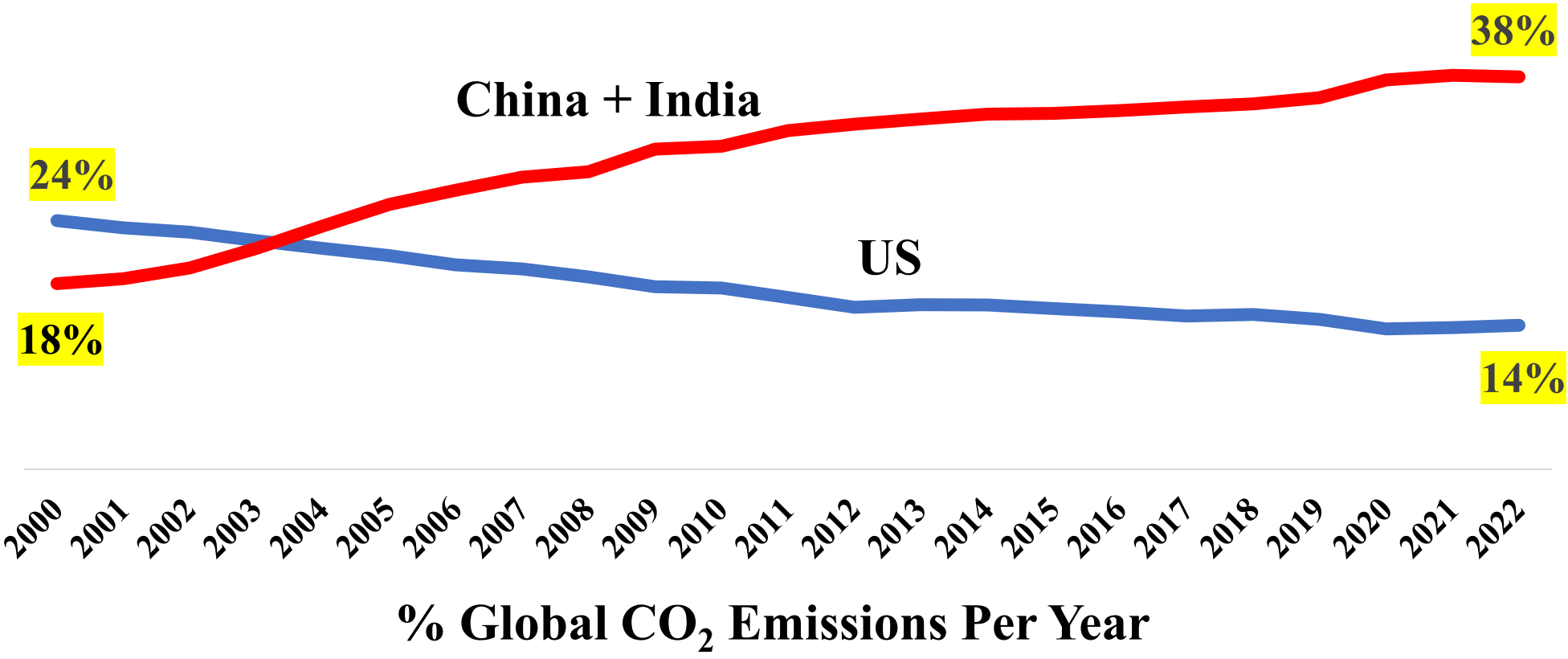
# What Energy Transition?

## $CO_2$ Emissions In Six Largest Economies, 2000 to 2023



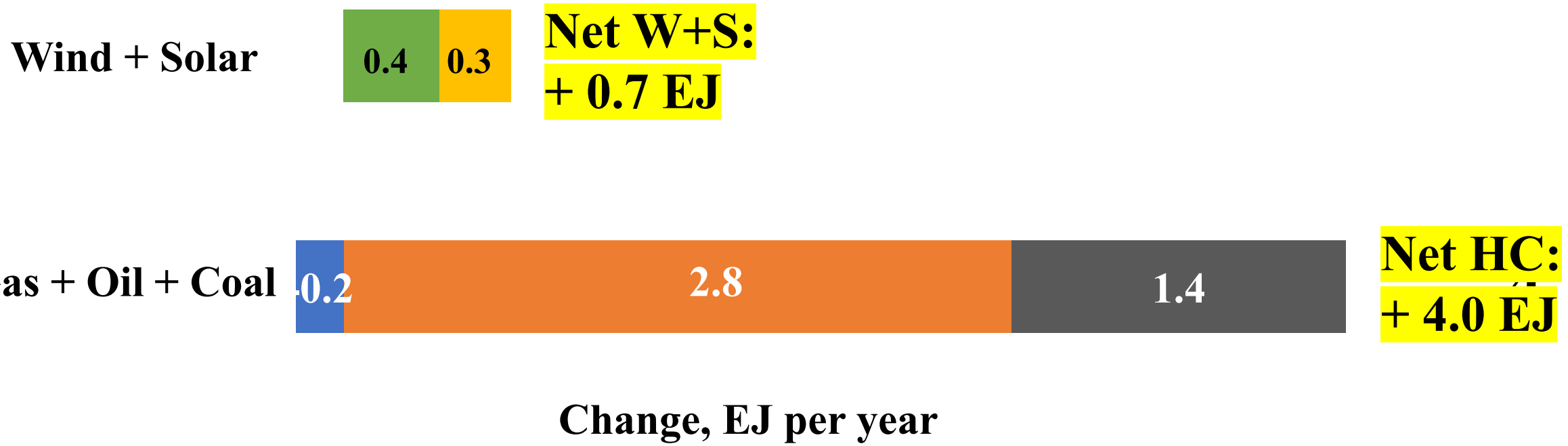

Source: Statistical Review of World Energy 2024

# Share Of Global $CO_2$ Emissions, US Versus China + India, 2000 to 2022



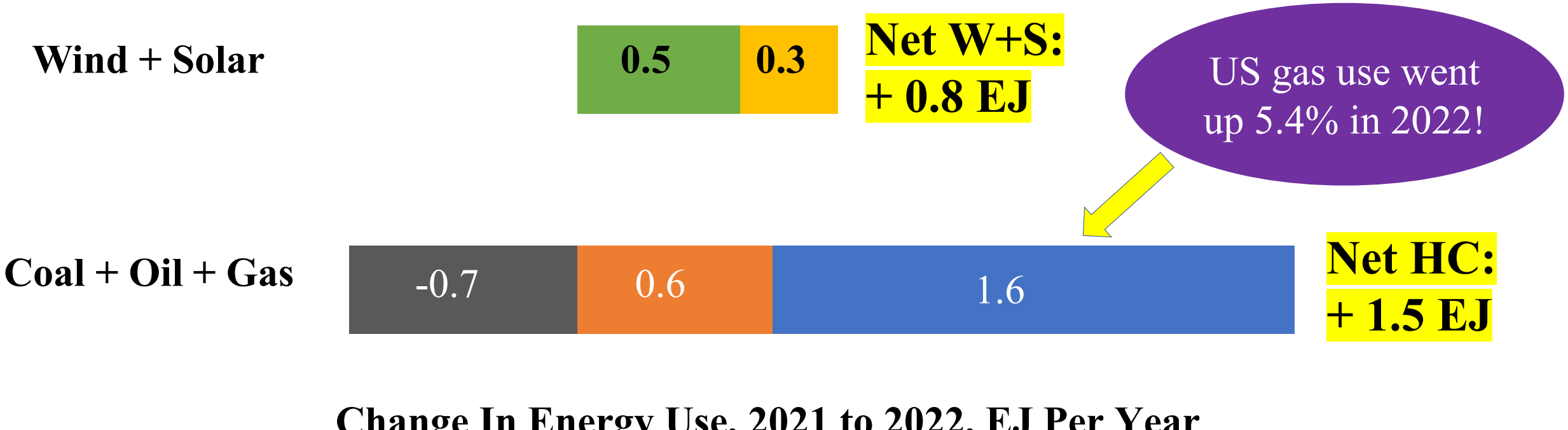

*Source:Statistical Review of World Energy, 2023*

# In 2021, US Hydrocarbon Use Grew ***5.7x Faster*** Than Wind + Solar Combined




*Sources: BP*

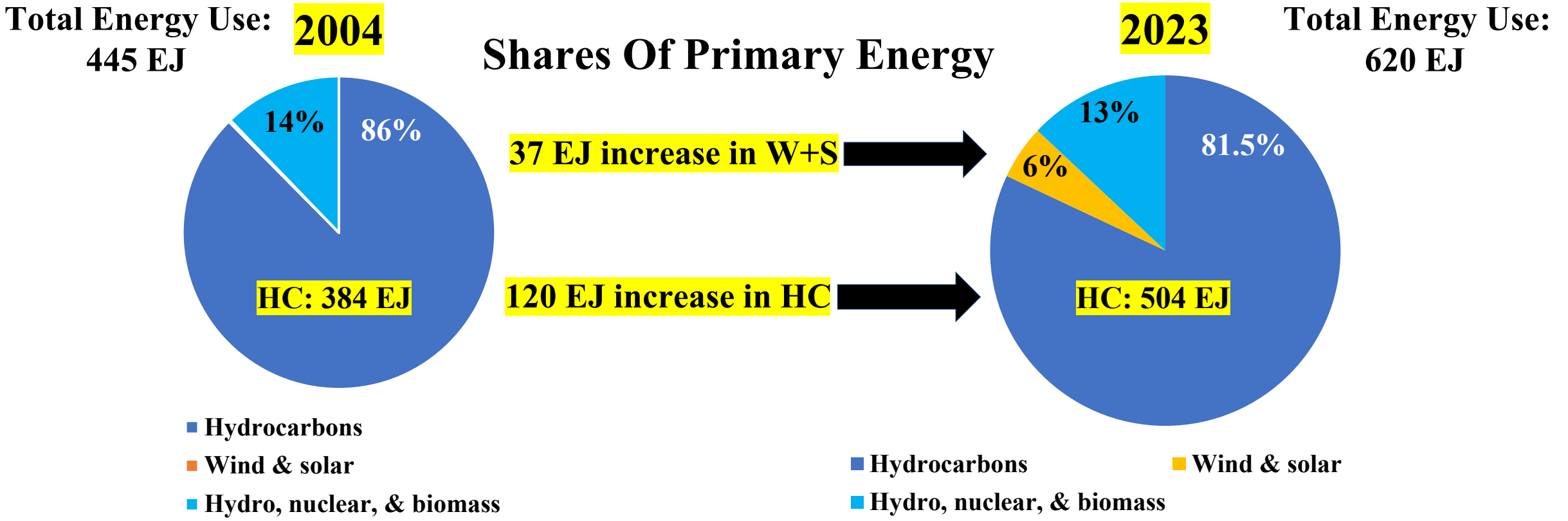
# In 2022, US Natural Gas Use Grew ***2x Faster*** Than W + S Combined




*Sources:BNEF, Statistical Review of World Energy 2023*

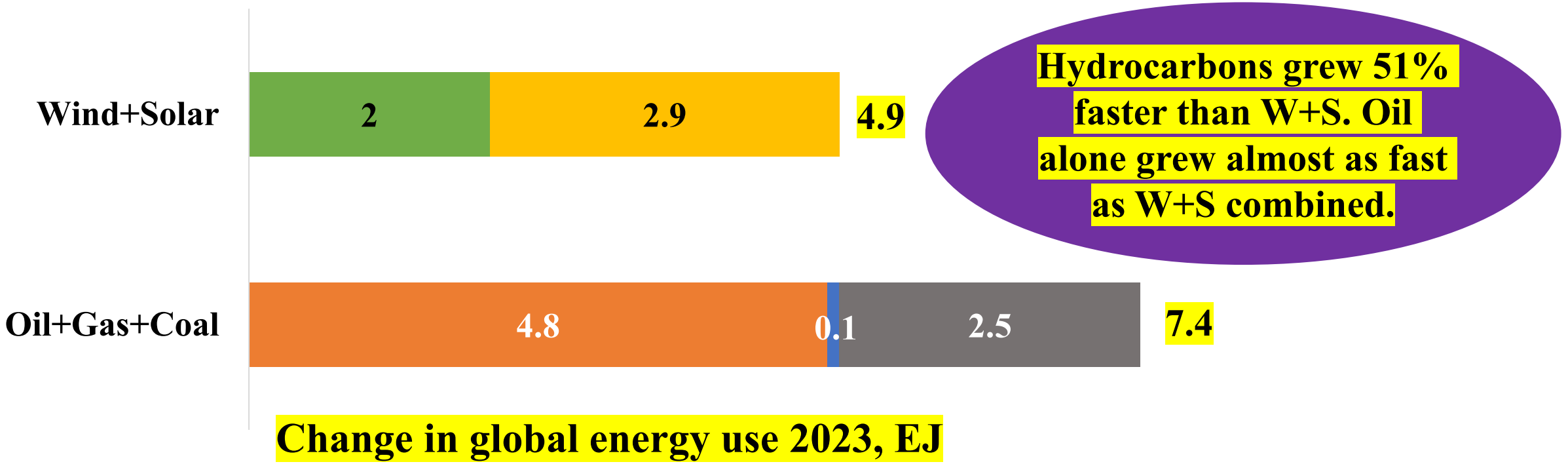
# What Energy Transition? From 2004 to 2023, Global Spending On Wind + Solar Totaled $4.7 Trillion

## Yet Hydrocarbon Use Increased 3.2x Faster



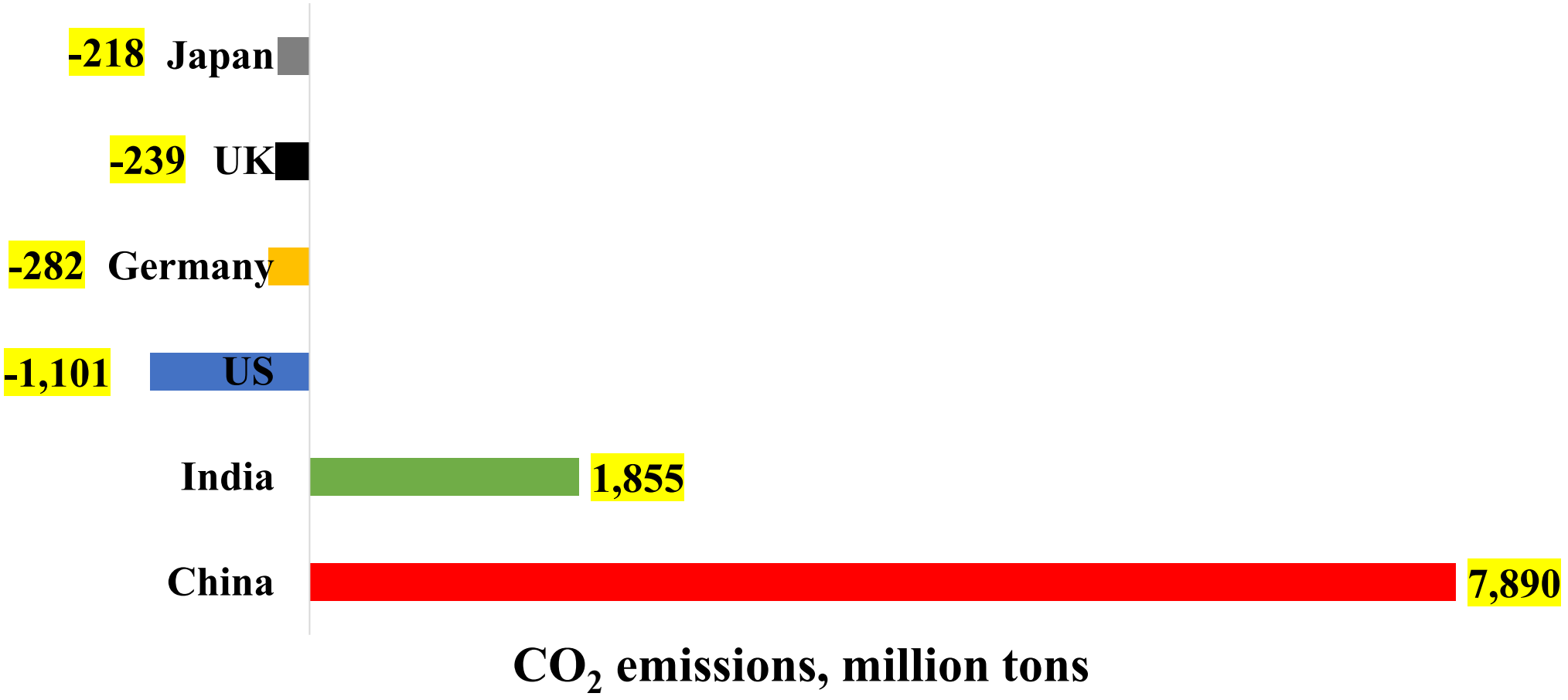

Source: Statistical Review of World Energy 2024, BNEF

# Hydrocarbons Grew Faster Than Wind + Solar Again In 2023



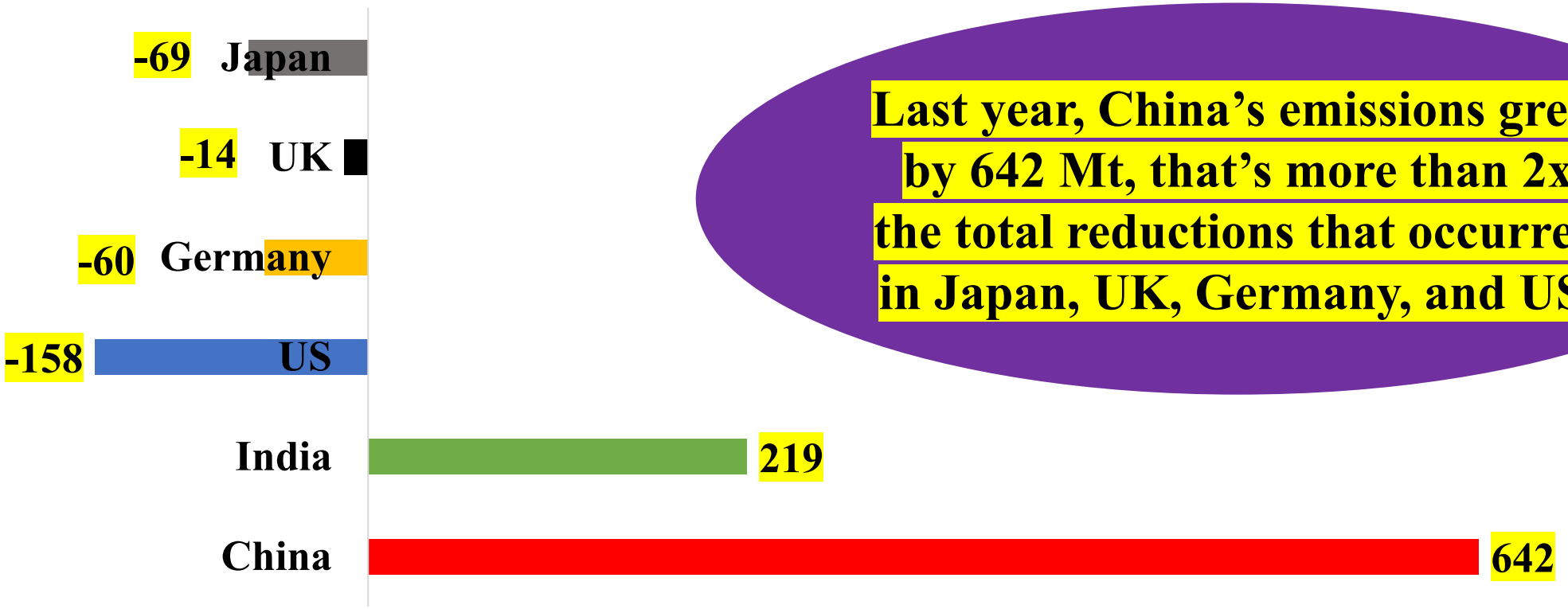

Source: Statistical Review of World Energy 2024

# Change In $CO_2$ Emissions In The Six Largest Economies, 2000 to 2023




Source: Statistical Review of World Energy 2024

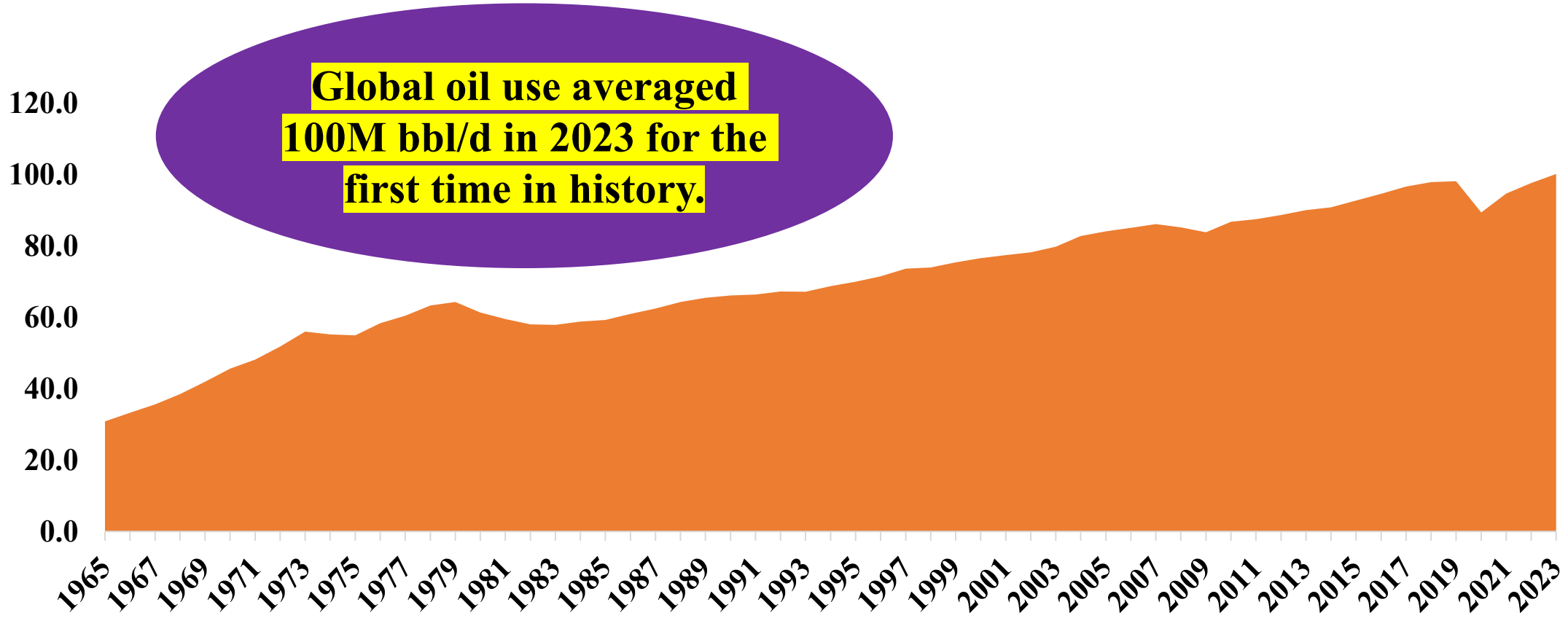
# Change In $CO_2$ Emissions In The Six Largest Economies, 2023




Source: Statistical Review of World Energy 2024

# Just Stop Oil?

## Global Oil Demand Is Going One Direction: Up

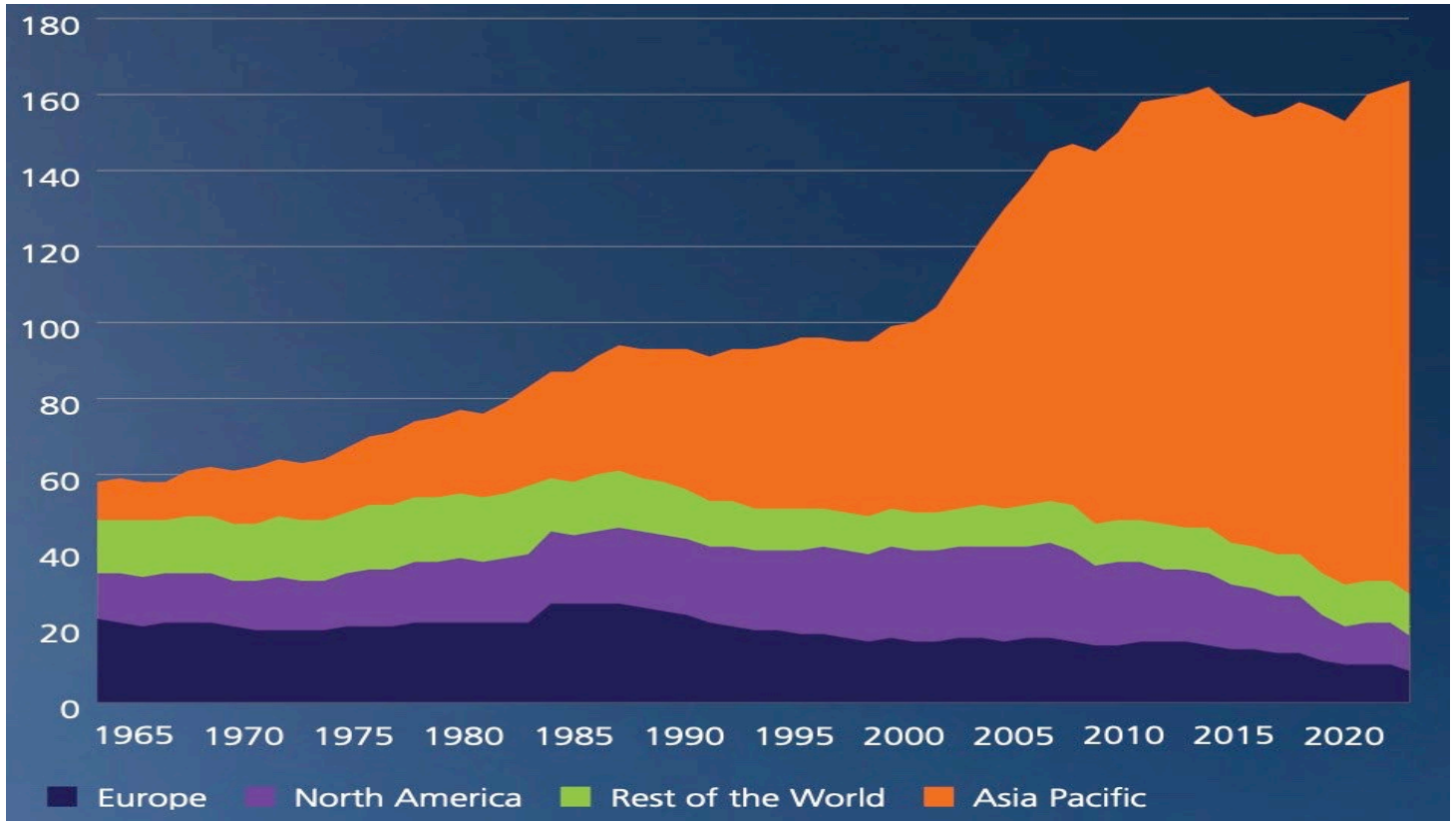



**Oil demand 1965 to 2023, million barrels per day**

Source: Statistical Review of World Energy 2024

# Just Stop Coal?

## Coal use jumped 1.6% to set a new record, & India's use exceeded the combined consumption of Europe & N. America for first time.

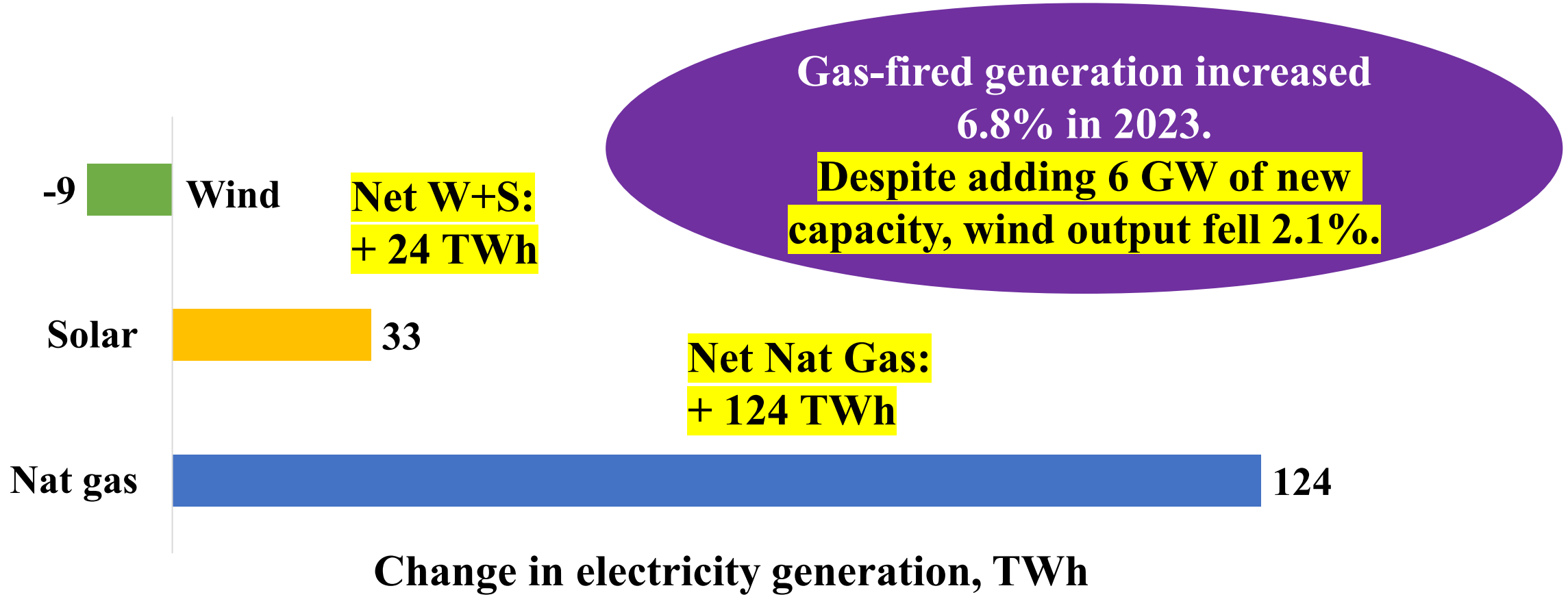



**Global coal use by region, 1965 to 2023, EJ/year**

Source: Statistical Review of World Energy 2024

# In 2023, U.S. Gas-Fired Generation Grew

## *5x Faster* Than W + S Combined



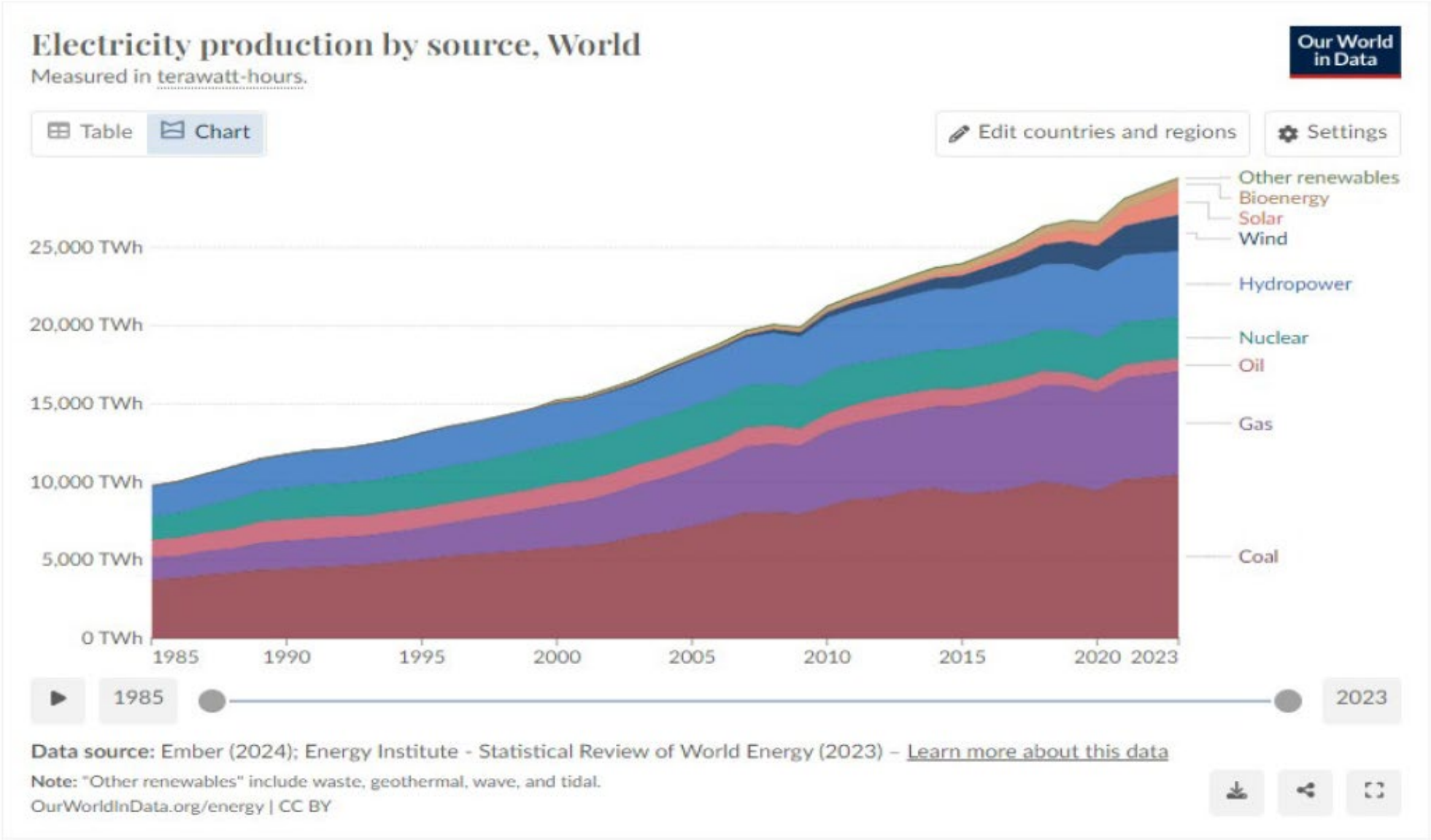

Source: Statistical Review of World Energy 2024

# Again, It's All About Scale

It would require **15,280** storage centers the size of Escondido, the largest in California, to provide just **4 hours** of backup power for the U.S. grid — at an estimated cost of **$764 billion**

Source: "Why Everything They Said About The Environment Was Wrong," Michael Shellenberger speech to the Alliance for Responsible Citizenship (ARC) in London, October 31, 2023

# Electricity production by source, World




Source: "Energy & Climate Realities," Roger Pielke Jr., June 27, 2024

# Don’t be stuck in the mud…

**… be intellectually curious.**

# Contact Information


## John Harpole

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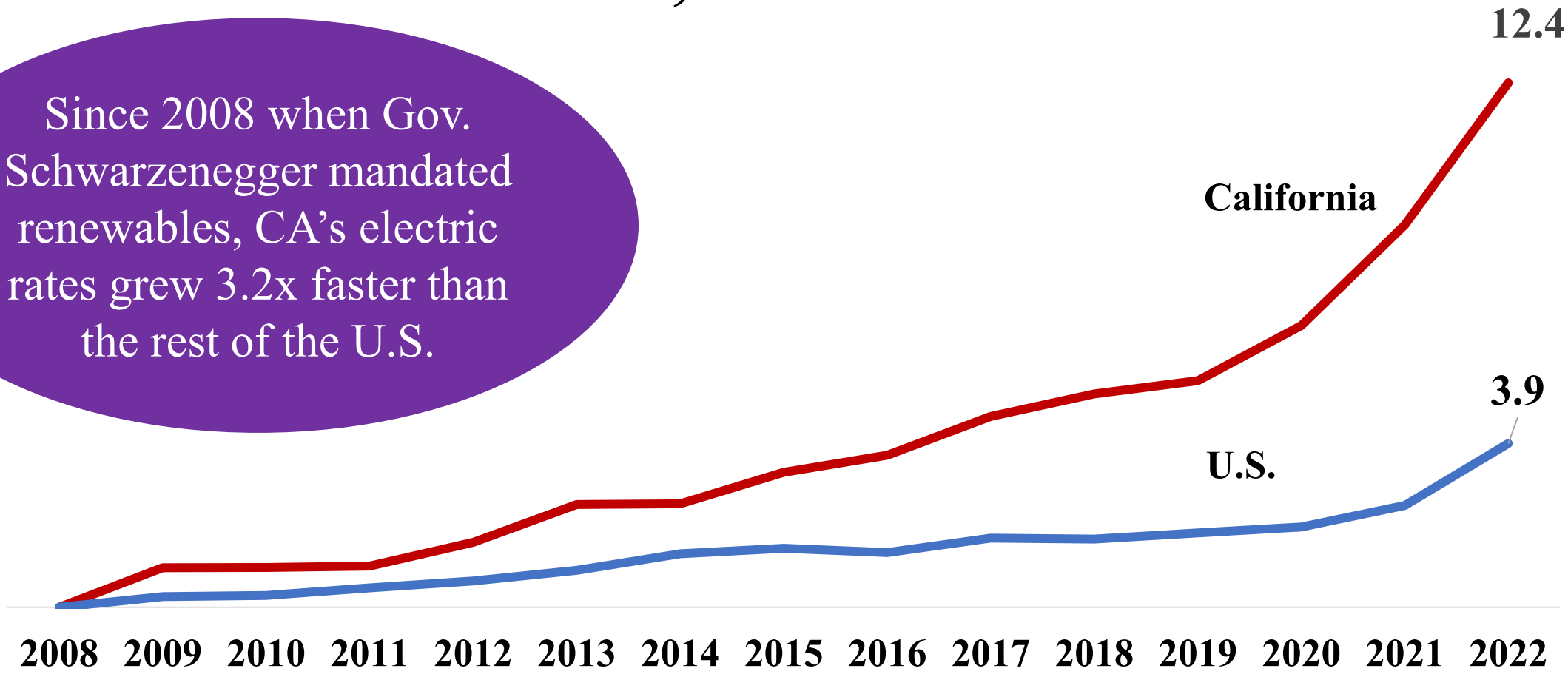
Mercator Energy

# Selected Reading and Podcasts

RobertBryce.substack.com
Doomberg.substack.com
RogerPielkejr.substack.com
AlexEpstein.substack.com
“Energy and Civilization A History,” Vaclav Smil
“Bettering Human Lives,” Chris Wright, Liberty Energy
@Shellenberger
Unreportedstorysociety.com
Committeetounleashprosperity.com

# Change In California Residential Electricity Prices, 2008 to 2022

Since 2008 when Gov. Schwarzenegger mandated renewables, CA's electric rates grew 3.2x faster than the rest of the U.S.




*Sources: EIA,*

# Affordability is Paramount Through the Energy Evolution

- The average per unit fuel cost for natural gas was roughly one-third the cost of electricity for the same on-site energy uses.

- Conversely, transitioning to an all-electric home would imply a two-fold increase to energy bills on average, increasing the financial burden on residential consumers as energy costs would amount to roughly 6.5% of the average household income.

Notes: 1) 2022 AGA Study, based on 2021 data; electricity based on actual generation mix in 2019;"Typical US Home" defined as 2,000 $ft^2$ home in an average climate, using national energy prices for space heating, water heating, cooking and clothes drying; 2) Income data based on U.S. Bureau of Labor Statistics and U.S. Census Bureau; using 5-year average growth data to extrapolate 2021; and 3) Household energy data based on U.S. Energy Information Administration, based on 2021 data; "Energy" defined as electricity and natural gas consumption

Source: "Fundamentally Focused," Investor Presentation, AltaGas