

Renewables, The Energy Transition, And The Future Of Natural Gas

**Robert Bryce presentation to:
Florida Gas Utility Annual Meeting
Naples, FL
October 12, 2023**

“We’re going through **an incredible transition that is taking place that, God willing, when it’s over, we’ll be stronger and the world will be stronger and less reliant on fossil fuels when **this is over.**”**

- **President Joe Biden, May 23, 2022**

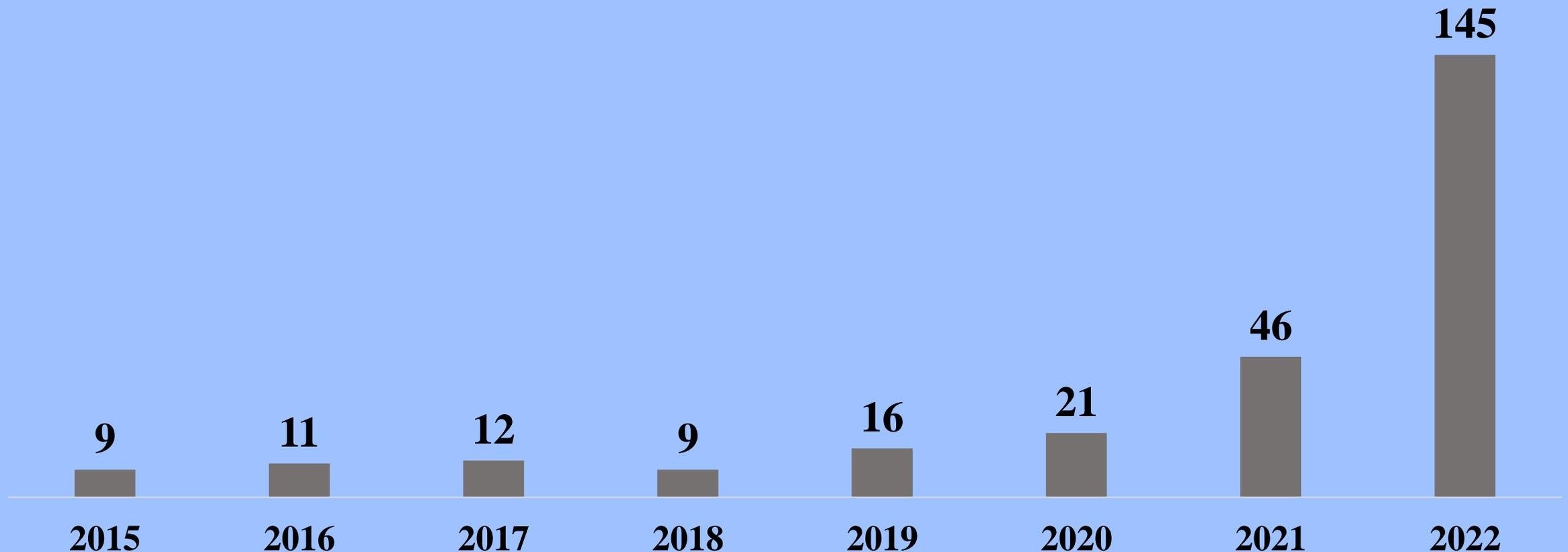
“The energy transition is well underway.”

● *Politico*, March 3, 2023

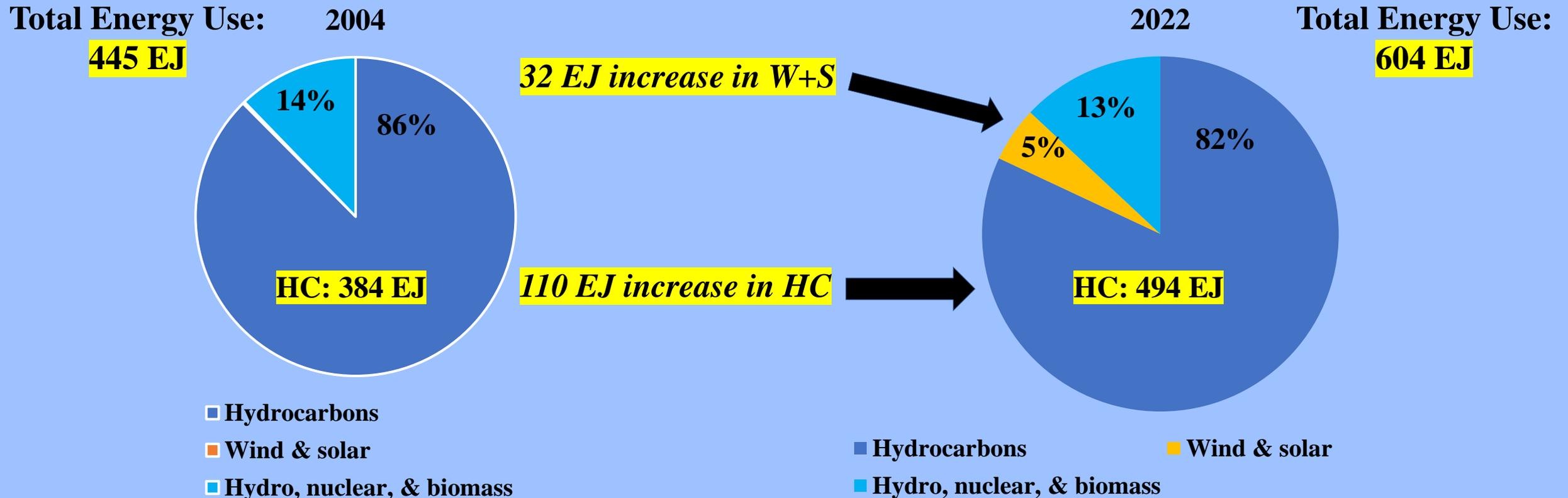
“The Administration is continuing to implement the Inflation Reduction Act, which is already galvanizing our **clean energy transition and making clean and energy efficient technologies more affordable for American families.”**

- **White House Press release, March 9, 2023**

Occurrences Of “energy transition” In *New York Times*, 2015 to 2022



What Energy Transition? Since 2004, **Global Spending On Wind + Solar Totaled \$4.1 Trillion**, Yet **Hydrocarbon Use Increased 3.4x Faster**



Shares Of Primary Energy

Know Your SI Units & Exajoules!

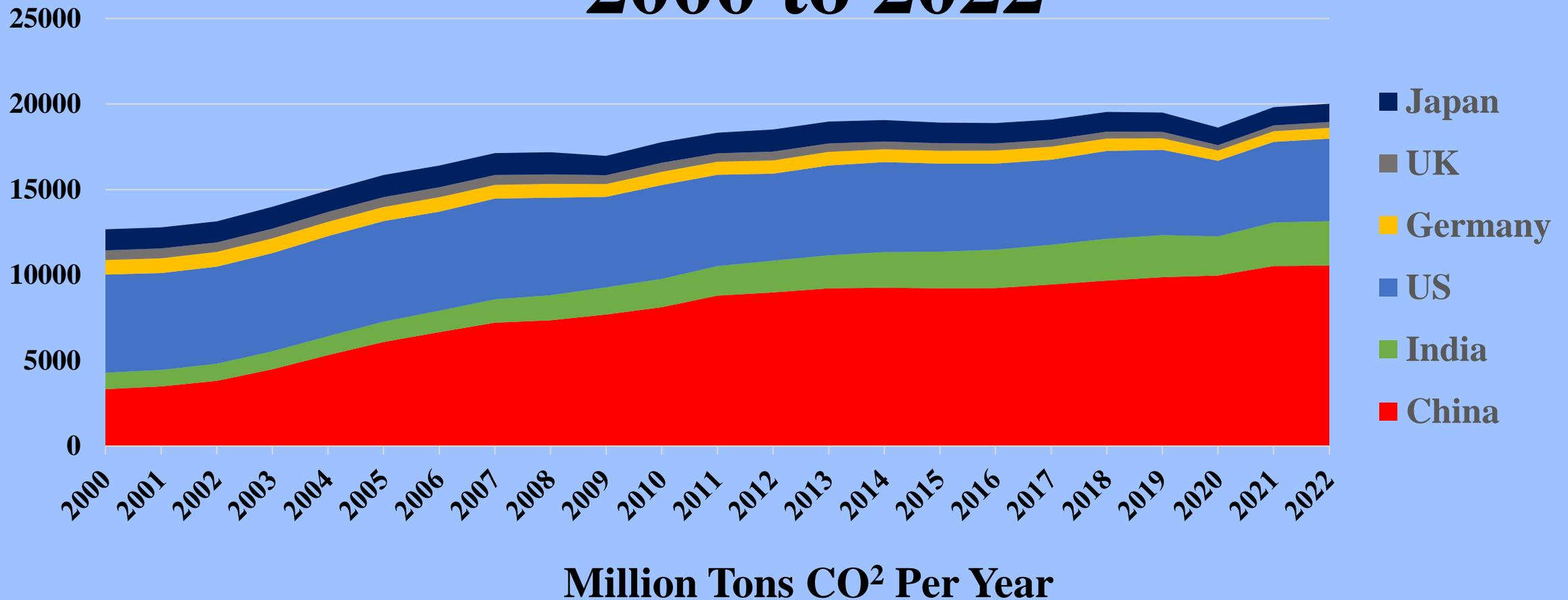
1 Btu \approx 1,000 Joules

1 EJ (10^{18} Joules) \approx 1 Quad (10^{15} Btu) \approx 1 Tcf of nat gas

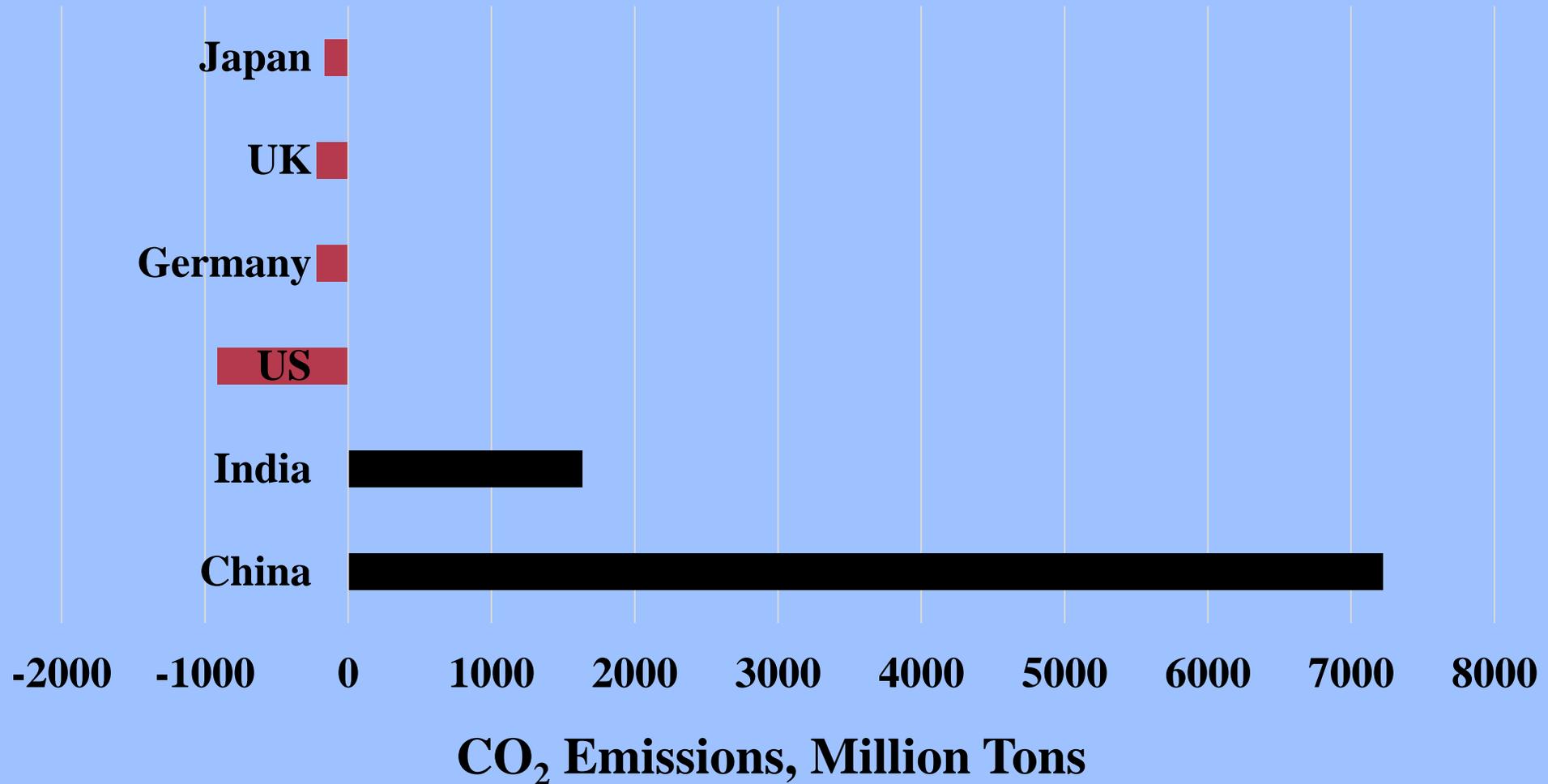
● Kilo (k)	Thousand	10^3
● Mega (M)	Million	10^6
● Giga (G)	Billion	10^9
● Tera (T)	Trillion	10^{12}
● Peta (P)	Quadrillion	10^{15}
● Exa (E)	Quintillion	10^{18}
● Zetta (Z)	Sextillion	10^{21}
● Yotta (Y)	Septillion	10^{24}

What Energy Transition?

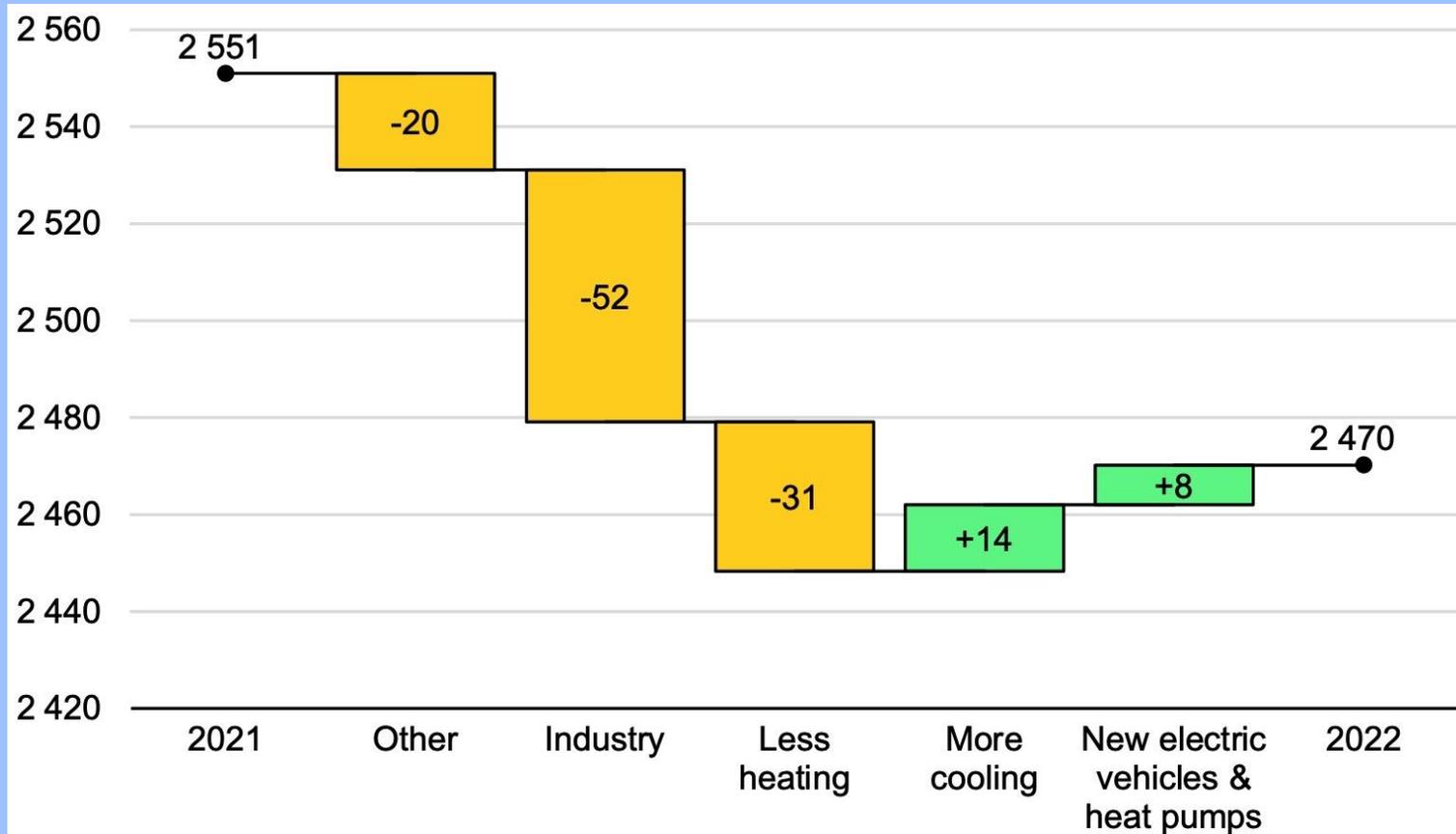
CO₂ Emissions In Six Largest Economies, 2000 to 2022



Change In CO₂ Emissions In The Six Largest Economies, 2000 to 2022



The De-Industrialization Of Europe: Electricity Use Fell 3.2% in 2022



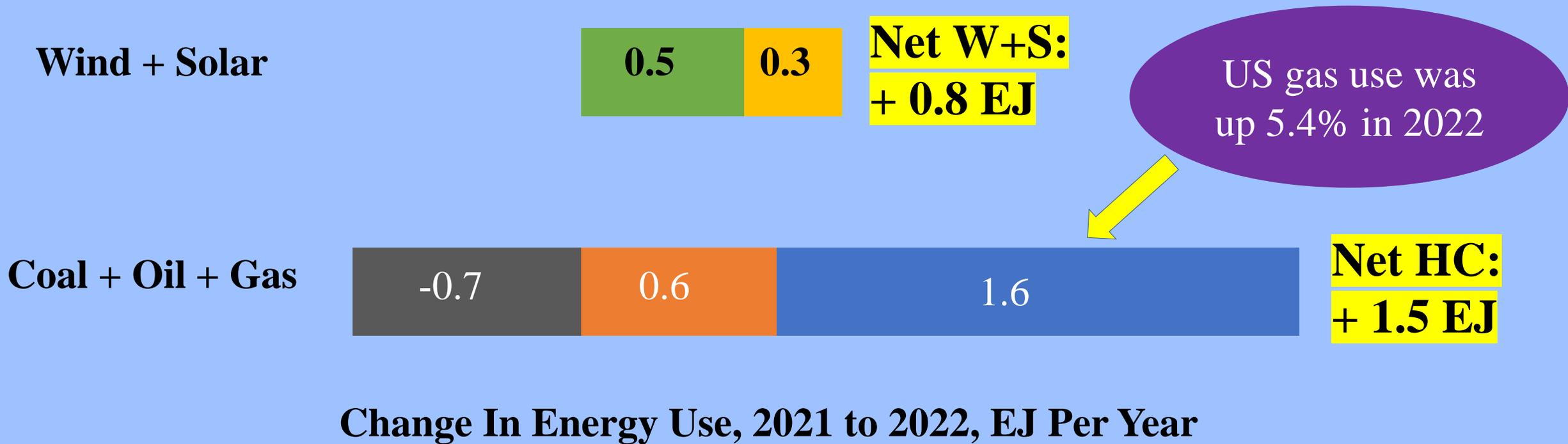
“Many energy-intensive industries reduced or ceased production in 2022...”

- aluminum (-12%)
- crude steel (-10%)
- paper (-6%)
- chemicals (-5%)

-- IEA, July 2023

Change in electricity used in EU, 2021-2022, in TWh

In 2022, US Natural Gas Use Grew 2x Faster Than W & S Combined



Florida By The Numbers

- **Second-largest electricity user after Texas**
- **Half of electricity is used in homes, largest share in US**
- **Nat gas generation provides 75% of FL electricity**
- **Fifth-largest nat gas consumer**
- **In-state gas production is tiny (< 1 Bcf/yr)**
- **Residential gas in Miami (\$3.01/therm) may be most expensive in continental US (US avg: \$1.40)**

Electrify Everything Is A War On Gas

**76 California communities
have banned natural gas**

**Los Angeles joins movement to ban
new natural gas hookups to fight
climate change**

**Seattle bans natural gas in new
buildings**

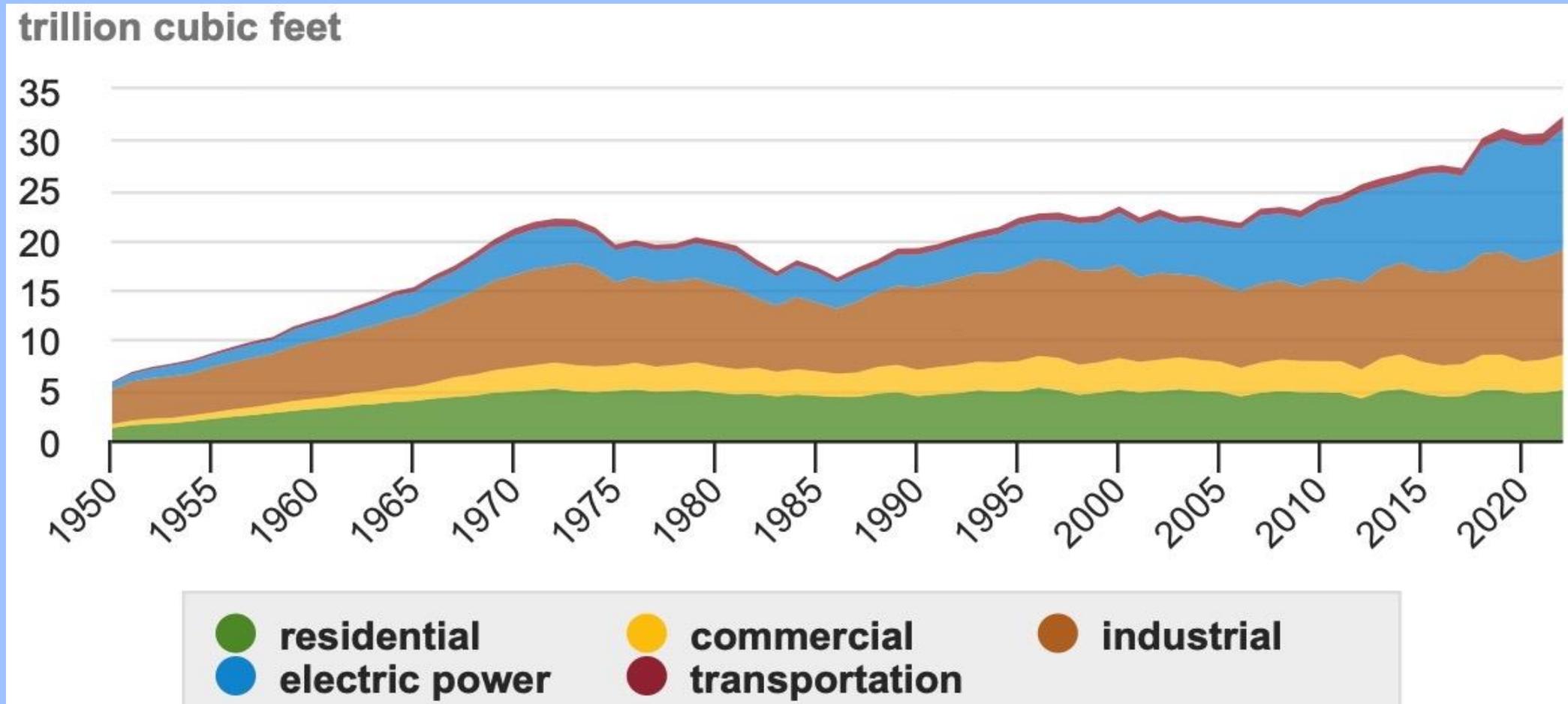
SF bans natural gas in new
city buildings, plans all
construction ban

**Mayor Wu bans fossil fuels in
new City of Boston buildings
and major renovations**

**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**

US Residential Natural Gas Use: No Growth In 52 Years!

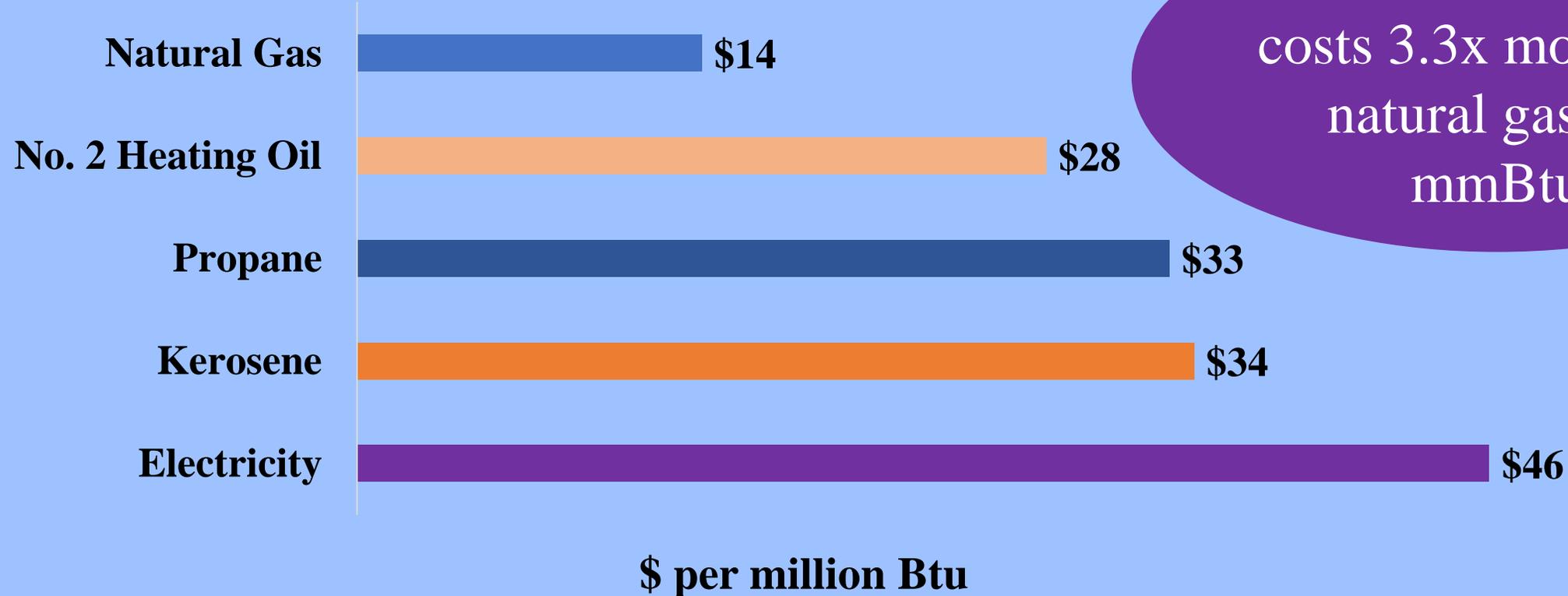


Dark Money NGOs Pushing Gas Bans & Electrify Everything Are Spending Hundreds Of Millions Per Year

Climate Imperative Foundation	\$221
The Energy Foundation	\$186
Windward Fund	\$273
Rocky Mountain Institute	\$140
Total	\$820

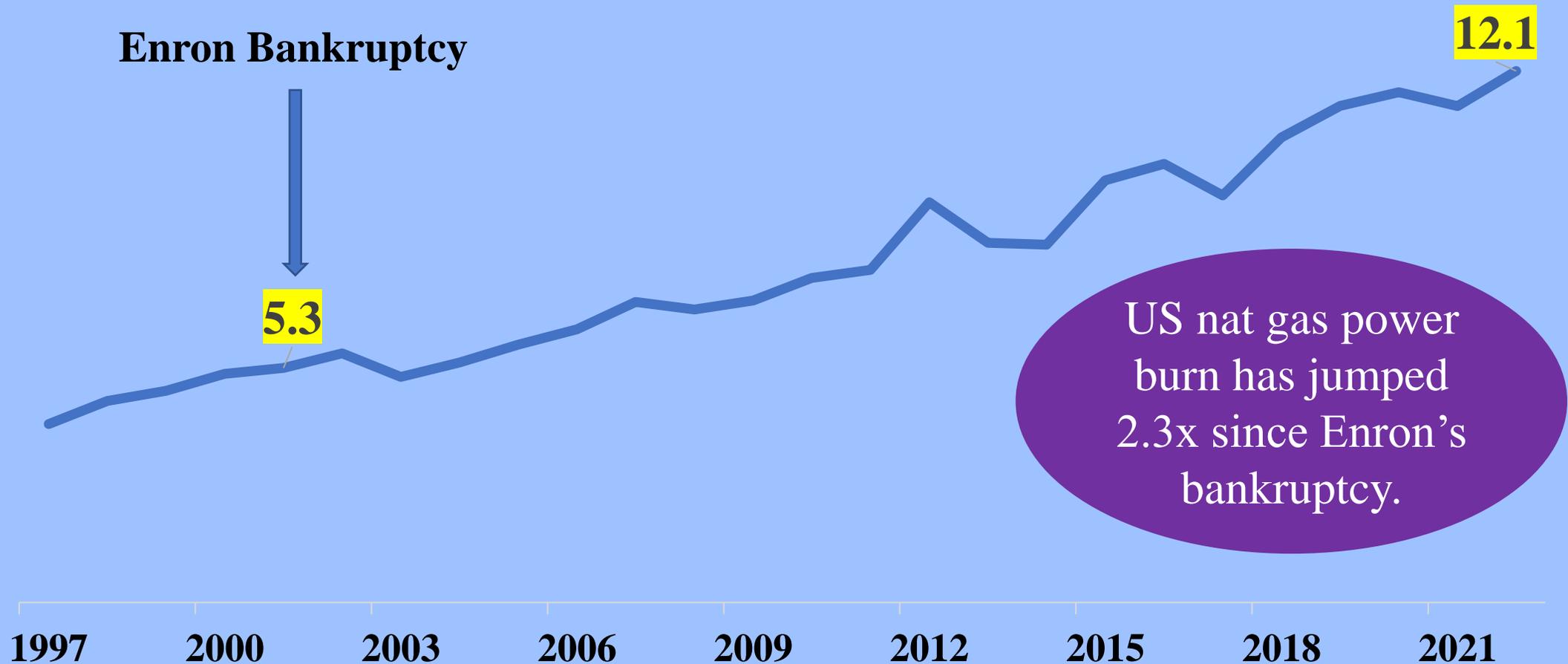
2021 Revenue, \$Millions

What About Affordability? Energy-Equivalent Residential Energy Costs, 2023



DOE: electricity costs 3.3x more than natural gas per mmBtu

US Natural Gas Power Burn, 1997 to 2022, Tcf/year



What About Resilience?

During Winter Peaks, The Gas Grid Delivers 1 TW of Power

- During peaks, gas grid delivers 80 Bcf/d to homes & businesses
- 80 Bcf/d = 83 Trillion Btu/d
- 83 Trillion Btu/d @ 3.4M Btu/MWh = 24.3 TWh/d
- Generating 24 TWh/d requires 1 TW of generation capacity
- Total 2023 electric generation capacity: 1.25 TW
- ***Thus, meeting peak winter heating demand with electricity alone will require duplicating entire US electric grid!***

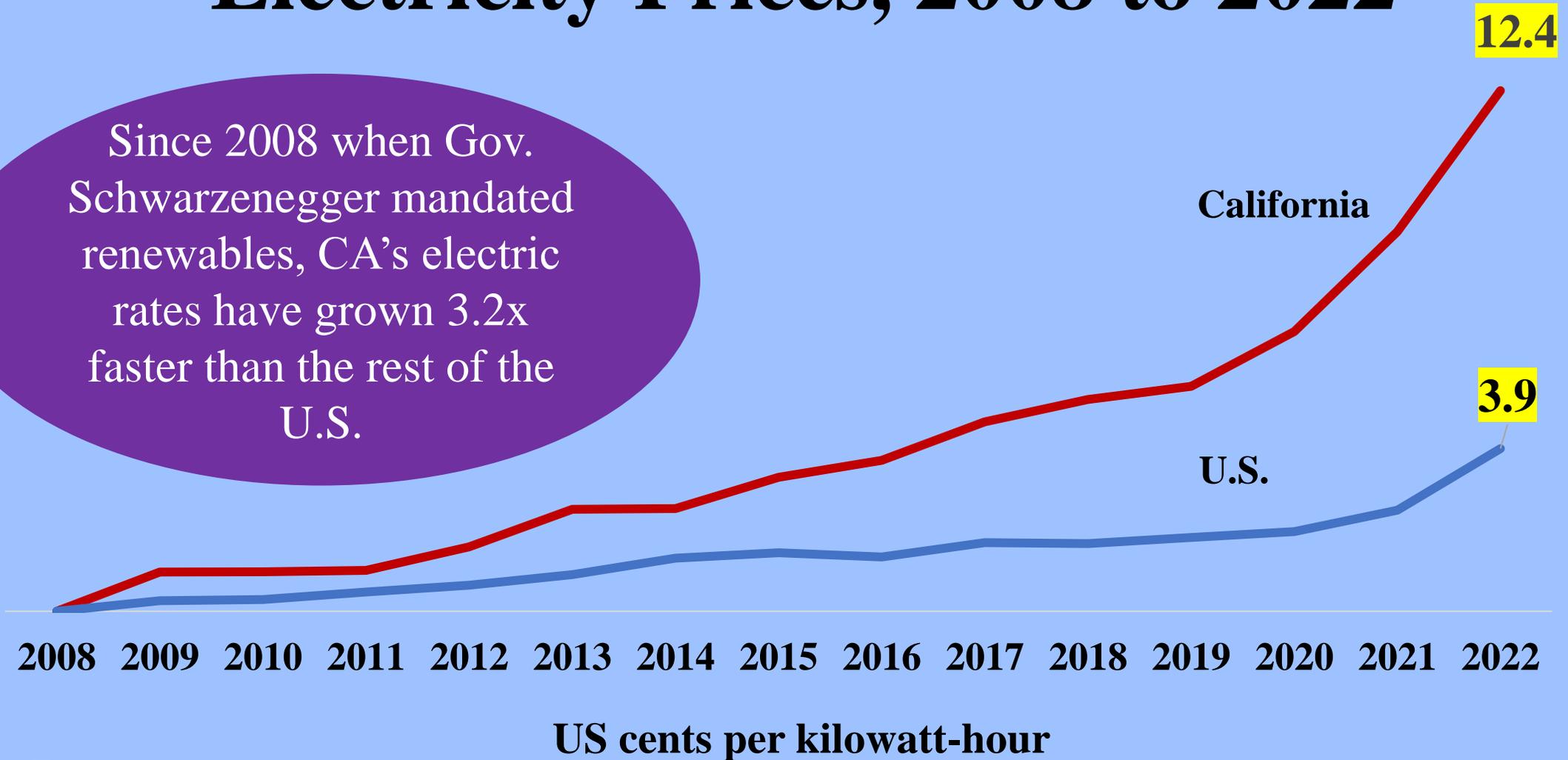
Gas Bans & EVs Will Further Strain The Grid. Who Pays For Upgrades?

- EPRI: One Amazon depot with 200 EV trucks = 5 MW of new load
- Boston Consulting Group: A model utility with 2 to 3 million customers will need to invest between \$1,700 and \$5,800 in grid upgrades per EV through 2030

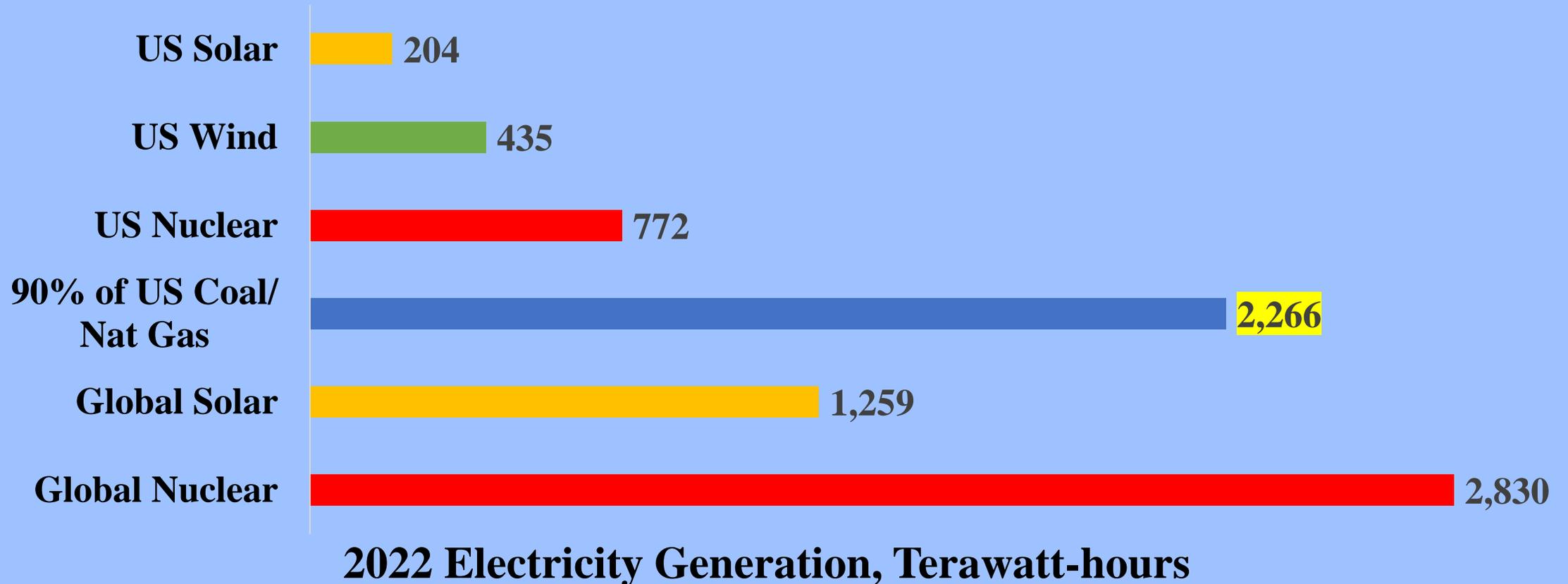


Who Pays? Change In California Residential Electricity Prices, 2008 to 2022

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



EPA Proposed GHG Rule Aims To Cut Electric Sector Emissions **By 90%** Where Will We Get The Juice?



Big Wind: Friction From Norway to Nebraska



Gage County extends ban on new wind or solar permits, through mid-July

County planning and zoning commission to consider potential wind energy regulation changes

Wednesday, January 13th 2021, 12:50 PM CST

MidAmerican Energy Abandons Plan To Add 30 Wind Turbines, Madison County Residents Celebrate: 'How Awesome'

Cherokee County panel adopts 1-year wind farm moratorium

Reno Commission approves moratorium on wind, to consider development ban in zoned areas

4 Druze seriously injured, 12 cops hurt in massive riots against Golan wind farm

San Bernardino County bans large-scale solar, wind in some areas

No large wind projects are under consideration in Vermont for the first time in years

[April McCullum](#), Burlington Free Press Published 10:14 a.m. ET Jan. 27, 2020 | Updated 5:13 p.m. ET Jan. 27, 2020

Controversial wind farm rejected after Shasta supervisors back commission, cite fire risks

[David Benda](#) Redding Record Searchlight
Published 12:03 a.m. PT Oct. 27, 2021 | Updated 12:17 p.m. PT Oct. 27, 2021

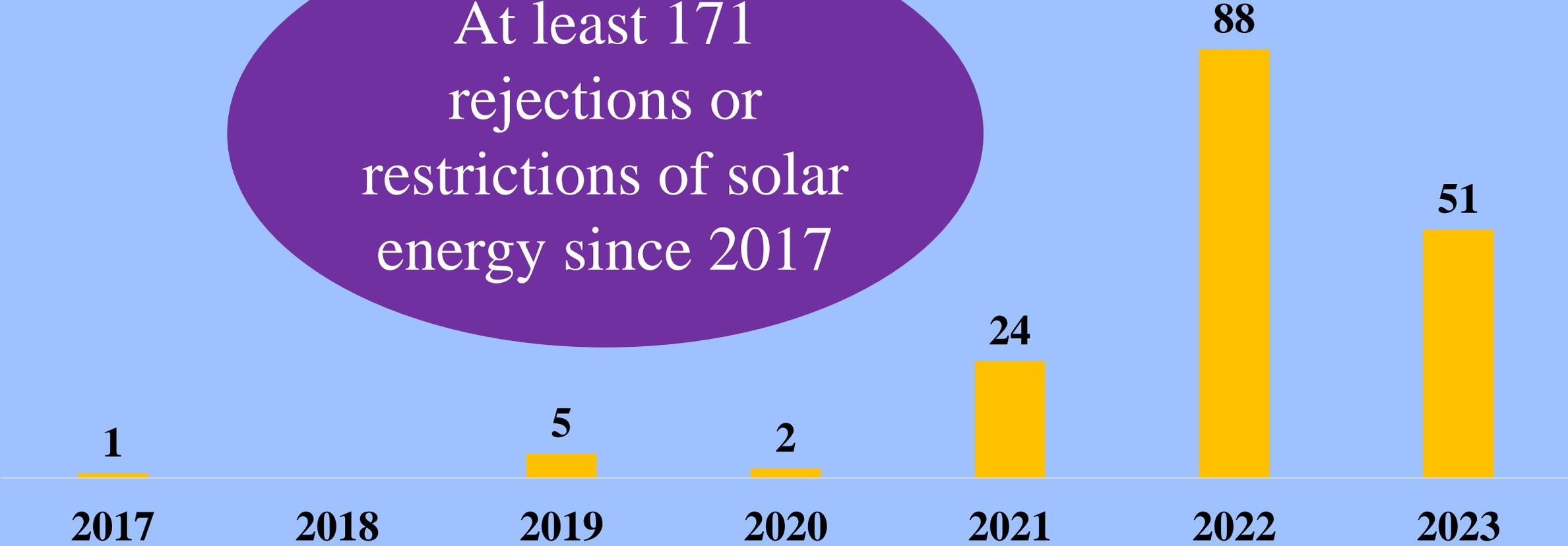
US Wind Energy Rejections, 2015 to 2023

At least 407
rejections or
restrictions since
2015



US Solar Energy Rejections, 2017 to 2023

At least 171 rejections or restrictions of solar energy since 2017



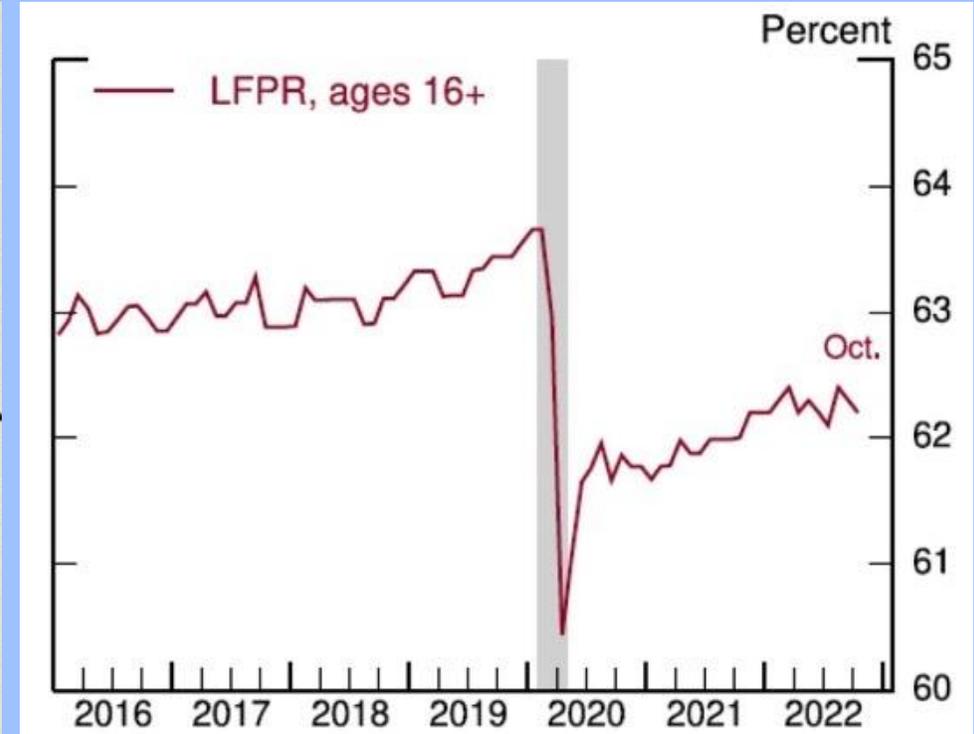
Source: Renewable Rejection Database

Grow The High-Voltage Transmission System By 57%? That'll Take 80 Years!



- DOE in February 2023: US needs “57% growth” in HV transmission
- US has 240,000 miles of HV transmission
- From 2008 to 2021, US built 1,700 miles of HV transmission per year
- At that rate, **building 136,800 miles will take 80 years**

Where Will We Get The Linemen?



Labor Force Participation Rate

“The US has a labor force shortfall of roughly 3.5 million people.”

**-- Fed chairman Jerome Powell,
November, 2022**

EVs Are The Next Big Thing...



- “The electric automobile will quickly and easily take precedence over all other kinds of motor carriages ***as soon as an effective battery of light weight is discovered.***”

-- *Los Angeles Times*, **1901**

- “Prices on electric cars will continue to drop until they are within reach of the average family.”

-- *Washington Post*, **1915**

Fleet Is Getting Older, New Car Prices Are Rising: ICEs Will Stick Around

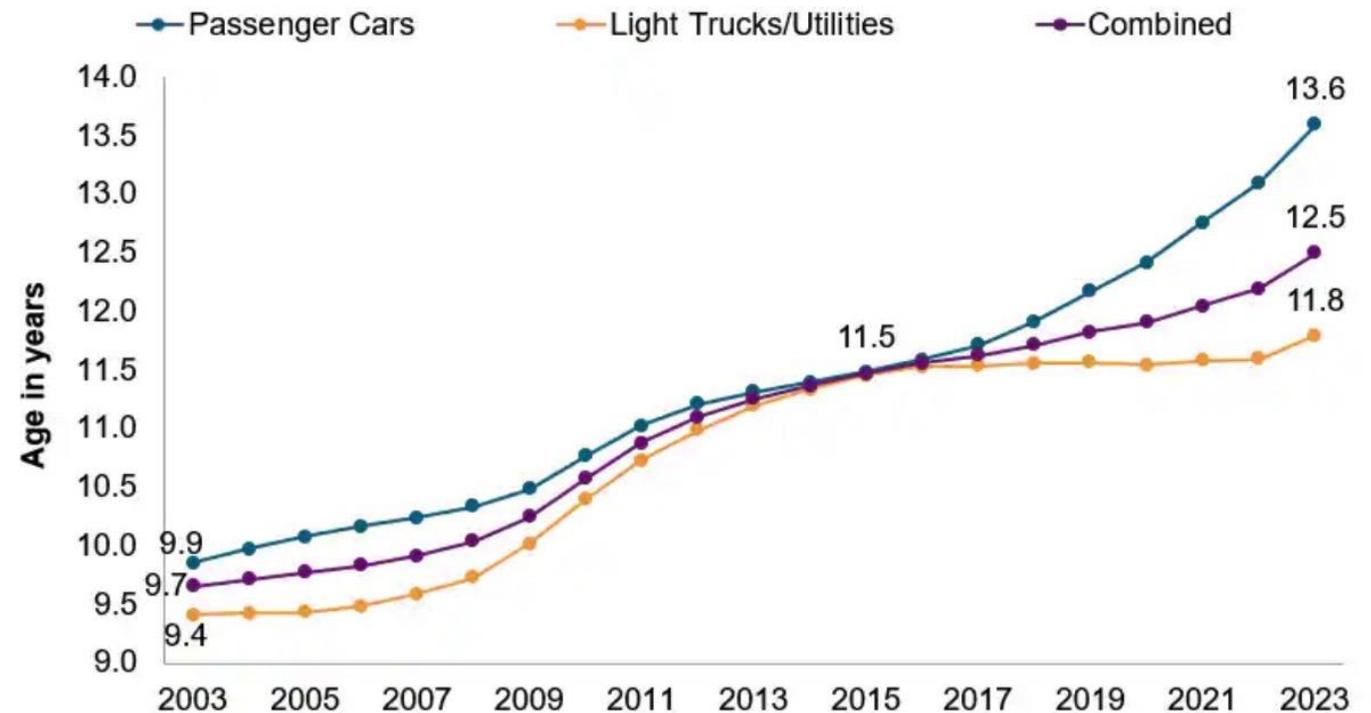
Average Age of Light Vehicles in the US Hits Record High 12.5 years, according to S&P Global Mobility

“With more than 284 million vehicles in operation on US roads, the average age of cars and light trucks in the US has risen again this year to a new record of 12.5 years...the sixth straight year of increase in the average vehicle age of the US fleet”

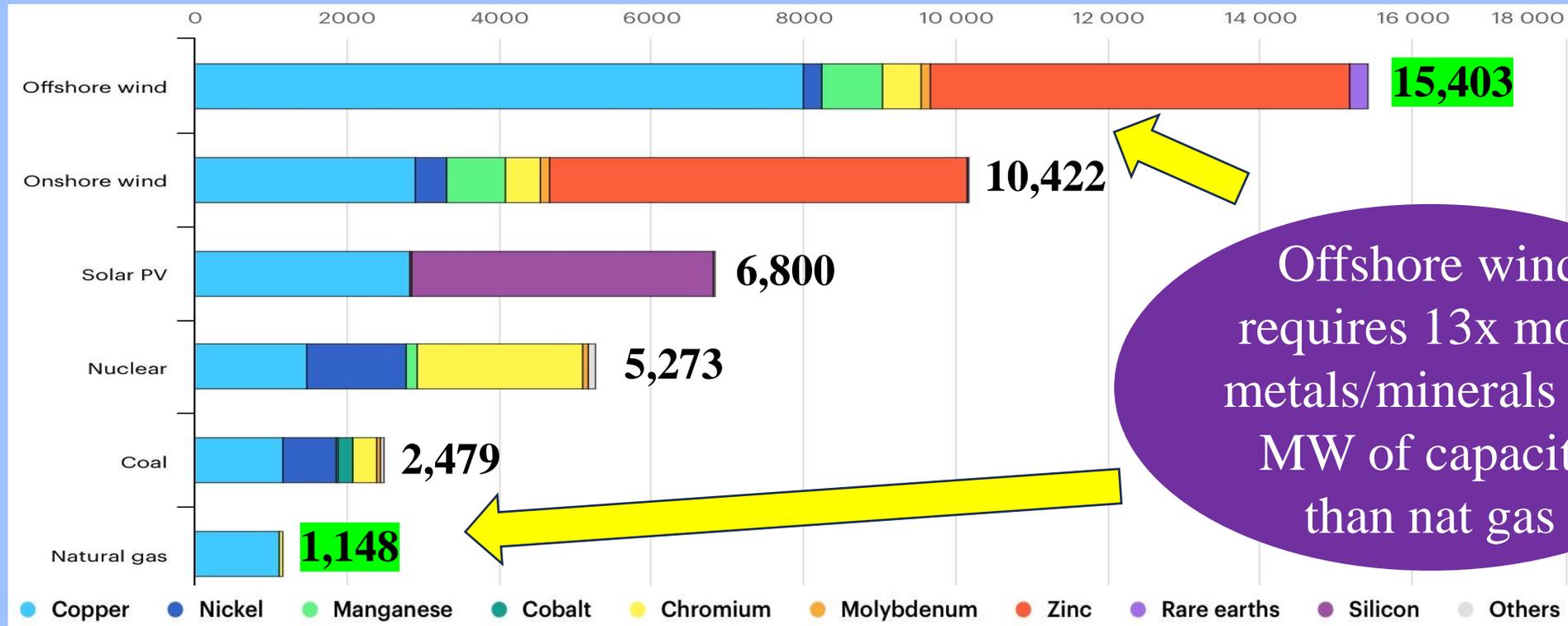
-- S&P Global Mobility, May 15, 2023

Average age by vehicle type

Combined average age rises for the sixth consecutive year

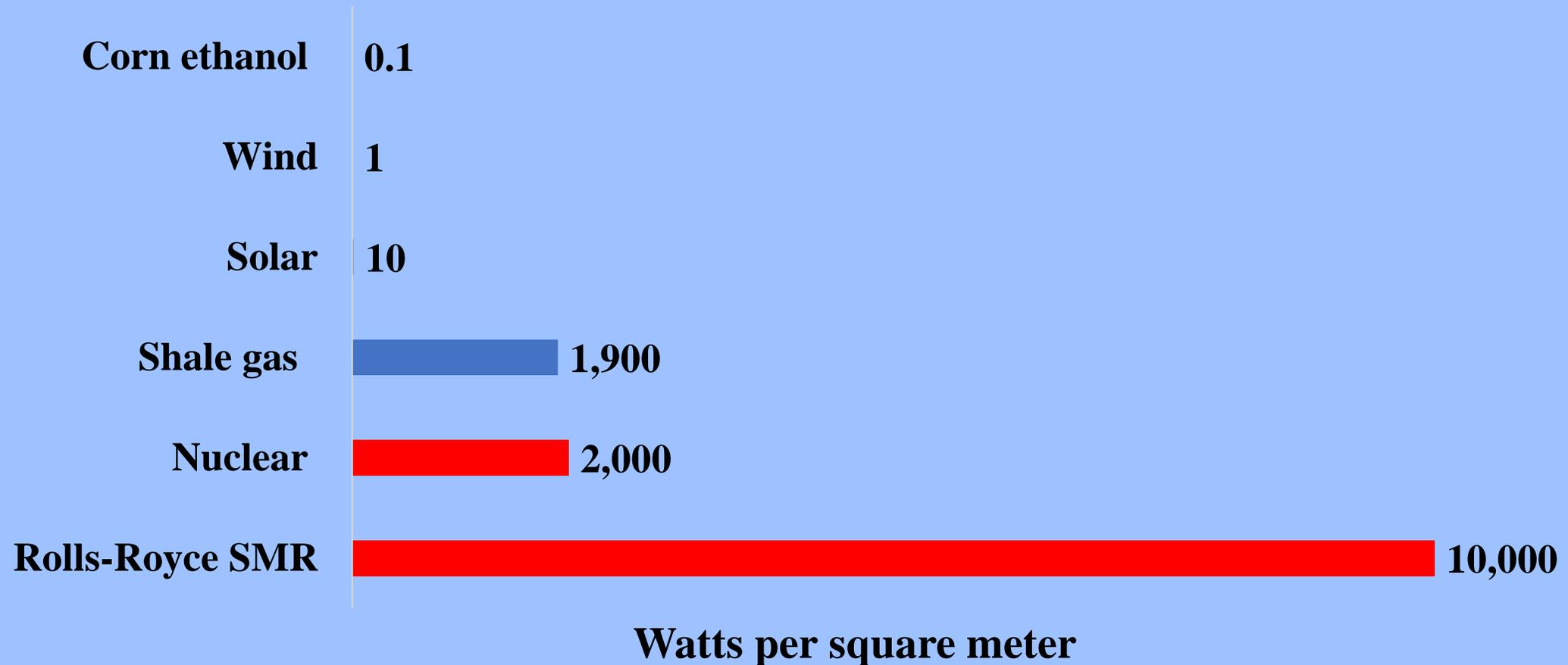


The Iron Law of Power Density: The Lower The Power Density, The Greater The Resource Intensity

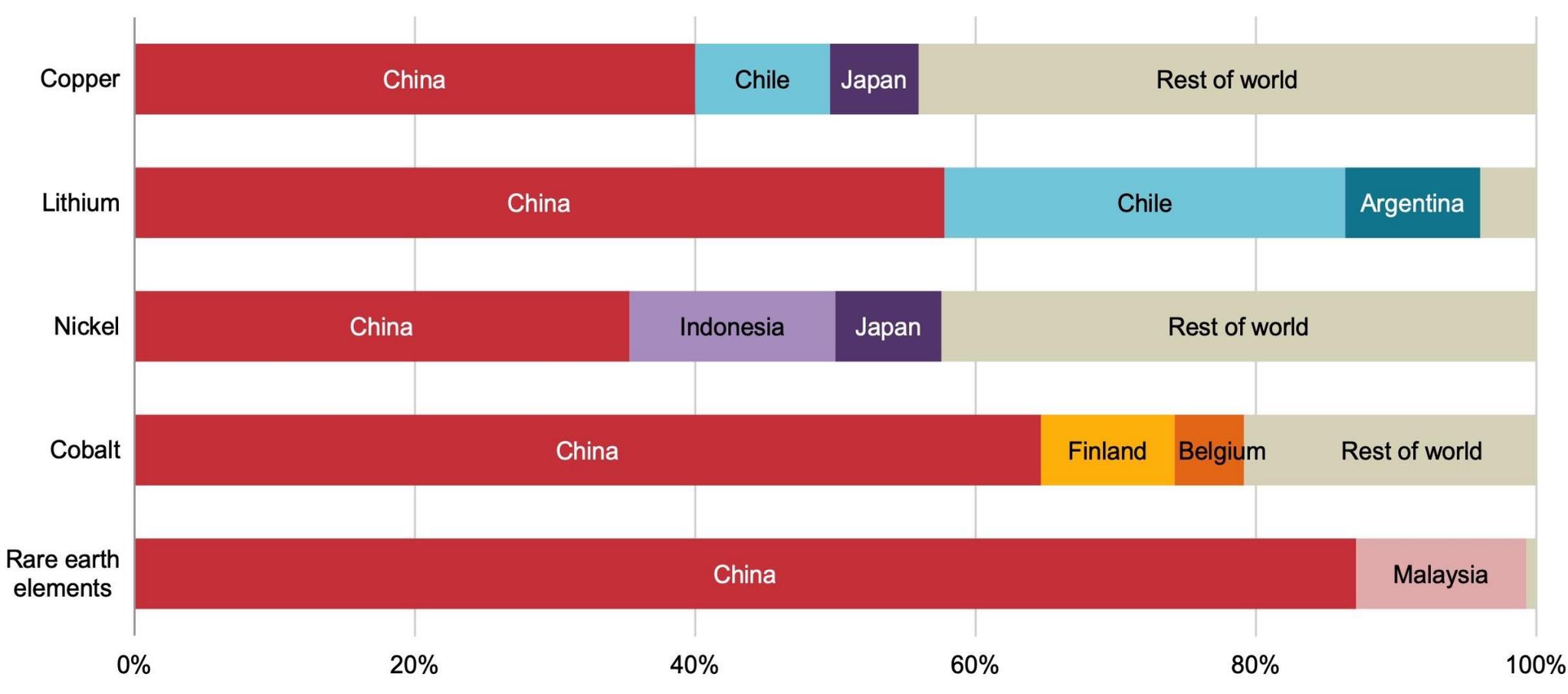


Kilograms of metals & minerals needed per MW of capacity

Areal Power Density (W/m^2) of Alt-Energy vs. Natural Gas & Nuclear



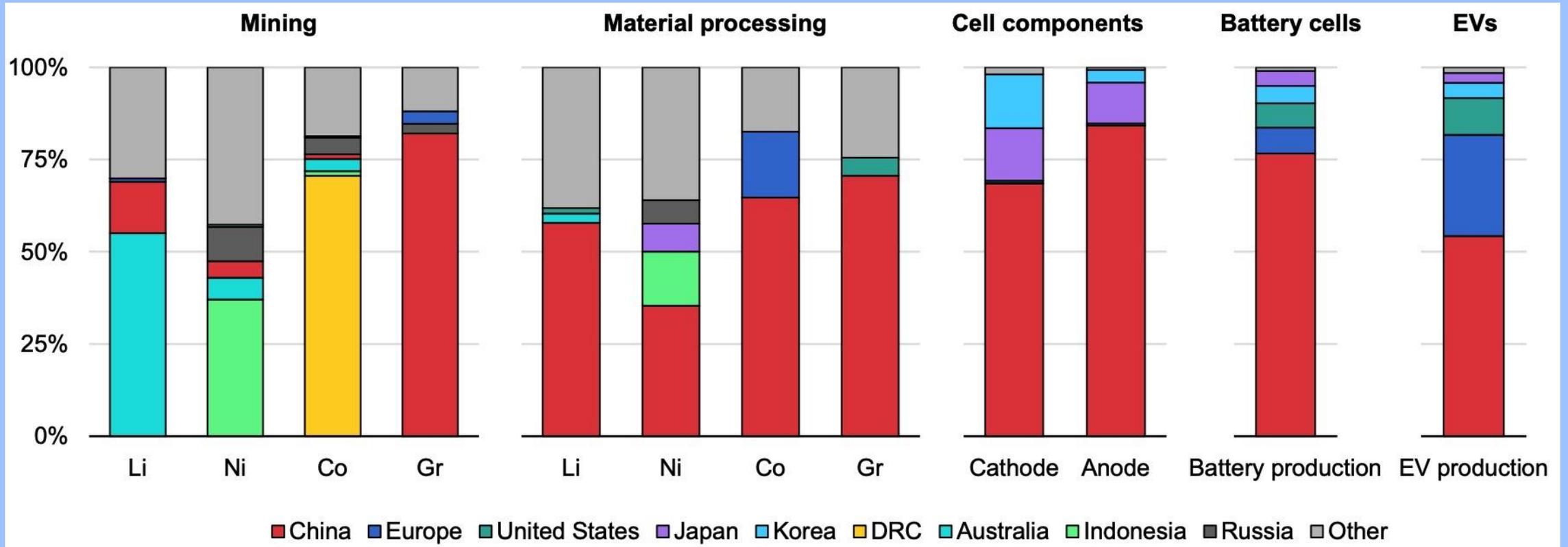
China Dominates Critical Metals



Shares Of Global Processing Market

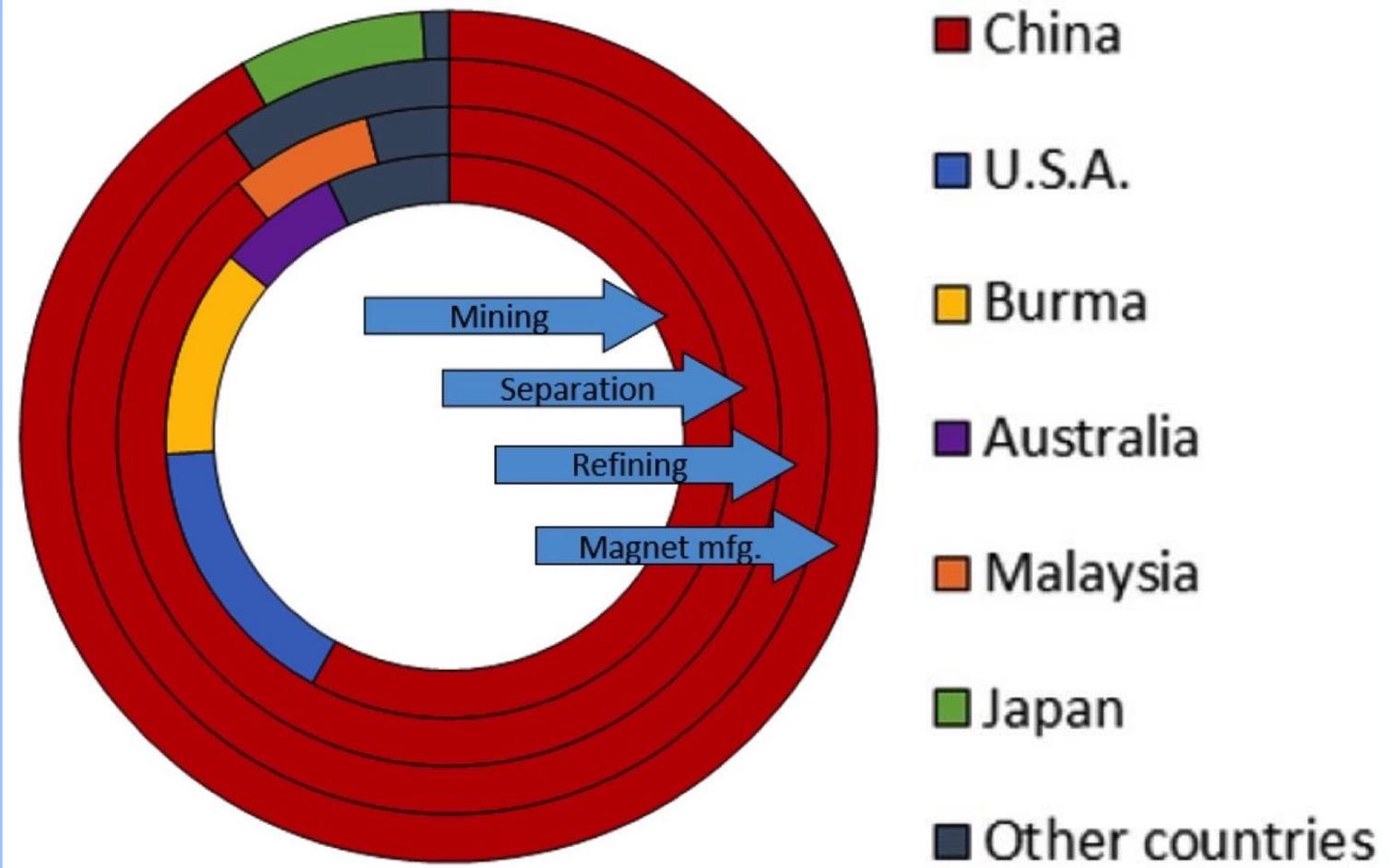
Source: IEA, <https://iea.blob.core.windows.net/assets/ffd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf>, 31.

China Dominates “Entire Downstream EV Battery Supply Chain”



IEA, July 2022: Geographic distribution of the global EV battery supply chain

China Controls >90% Of Global NdFeB Magnet Market & 100% of Dy & Tb



Source: <https://www.energy.gov/sites/default/files/2022-02/Neodymium%20Magnets%20Supply%20Chain%20Report%20-%20Final.pdf>.

Best No-Regrets Strategy Is N2N: Natural Gas to Nuclear

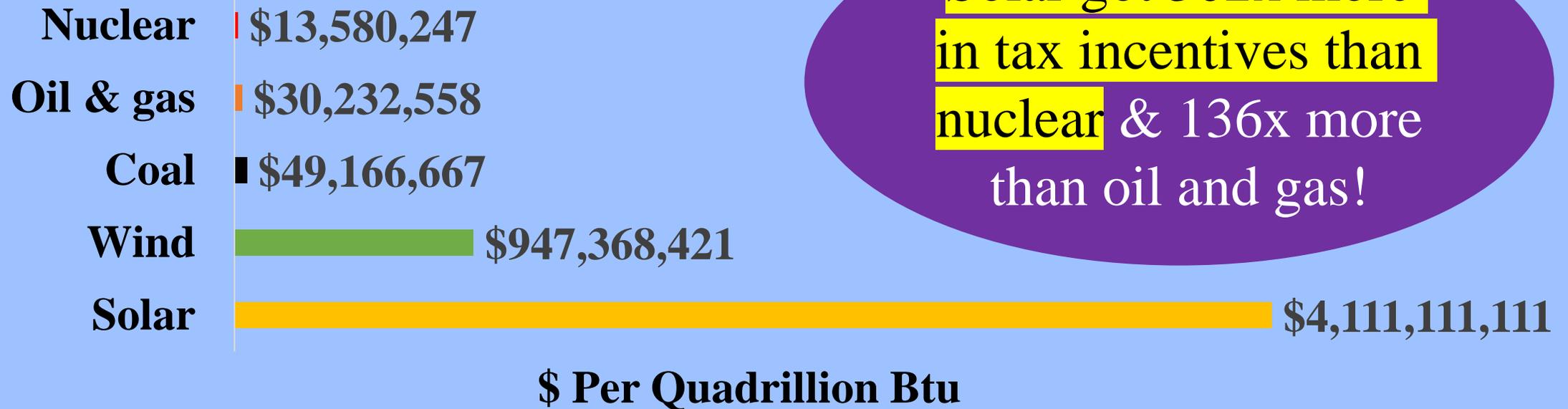
- **3B+ people need a LOT more juice**
- **Renewables can't scale, not dispatchable, land-use**
- **Low resource intensity**
- **High power density & EROEI**
- **Technologies are mature & scalable**

Why Nuclear?

- Needs 2,000x less land than wind, 200x less than solar
- Low material intensity
- Highest EROEI
- Challenges: NRC, political risk, fuel
- Needs: Capital, regulatory reform, “green” label

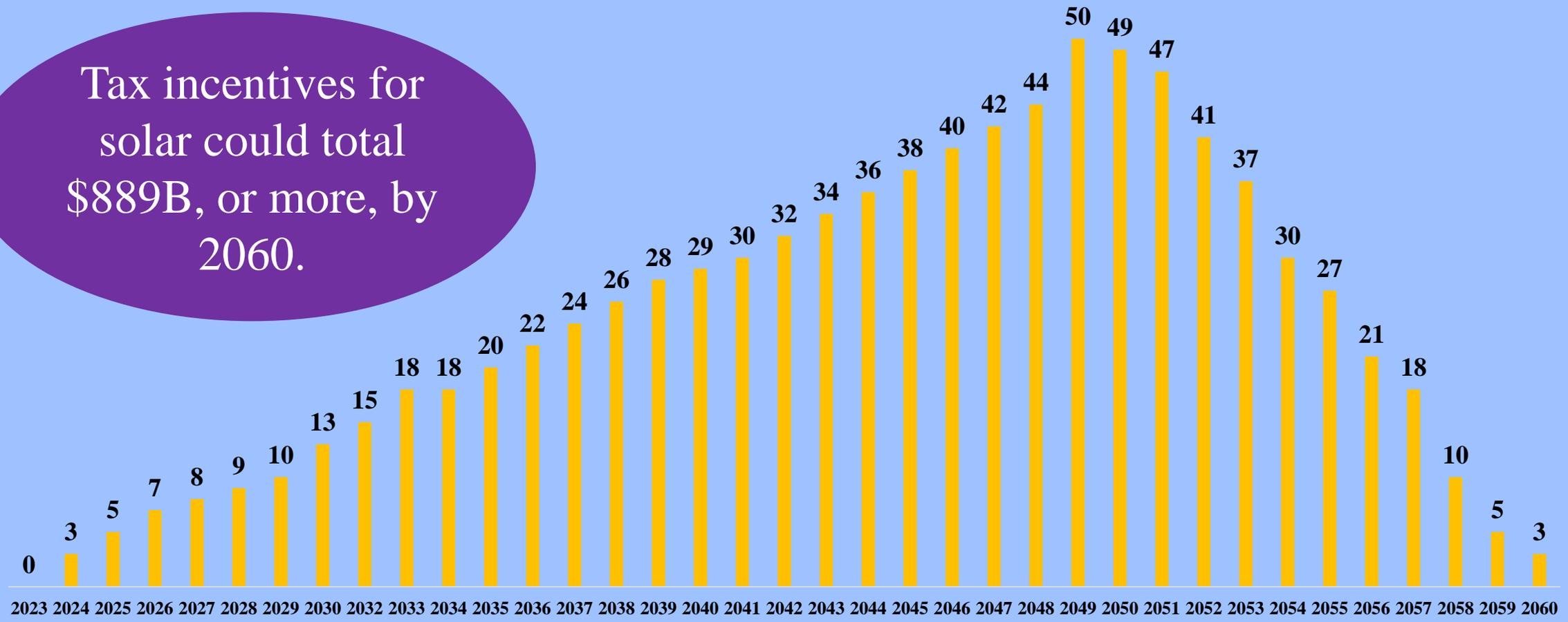
But...Nuclear Gets No Love.

Federal Energy-Related Tax Incentives, Per Unit of Energy Produced, 2022



Solar Subsidies Under Inflation Reduction Act Could Total \$900B!

Tax incentives for solar could total \$889B, or more, by 2060.



Tax incentives, \$Billion per year

Source: Wood Mackenzie, <https://www.woodmac.com/news/opinion/IRA-tax-credits-for-renewables/>

Europe Is Backpedaling On Net Zero

Rishi Sunak announces U-turn on key green targets

Polish state energy giant abandons new carbon-neutral goal after less than a week

Eyeing Inflation, Sweden Relaxes Green Ambitions

Fears of populist climate policy backlash loom over Germany's two southern state elections

“Europe faces growing pushback against policies to address climate change and protect the environment, causing its green agenda to start to fray.”

-- Reuters, Sept 27, 2023

Italy looks to slow green transition drive to shield local firms

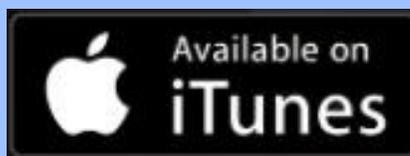
'It's in the EU's interest to pursue a more balanced environmental policy'

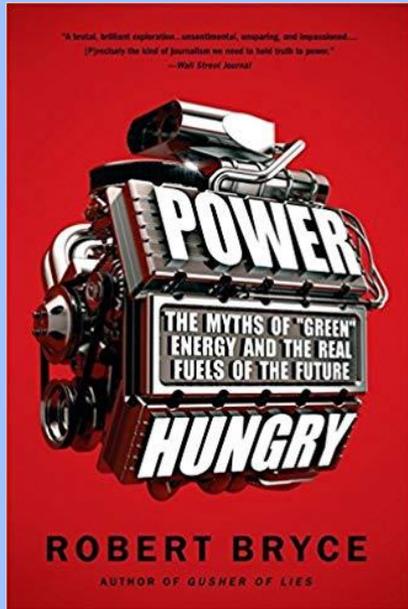
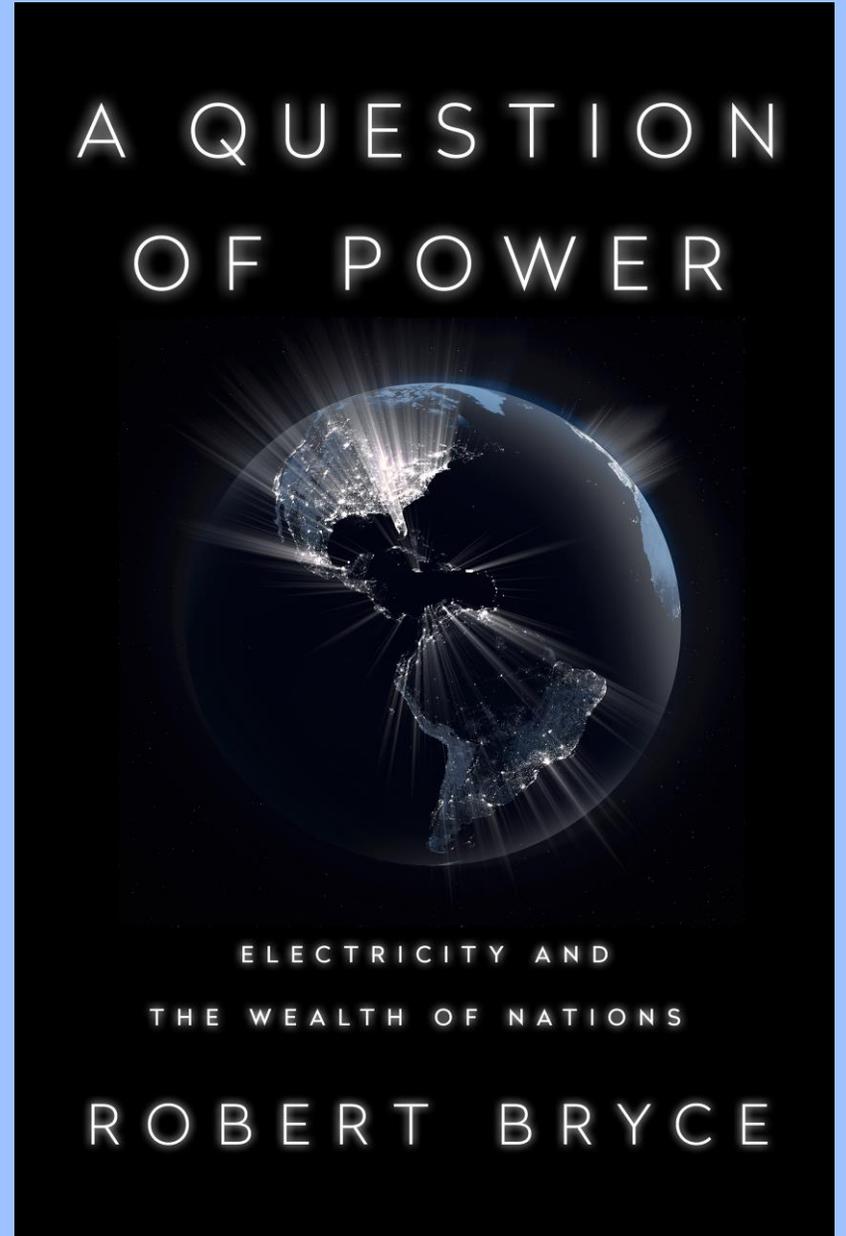
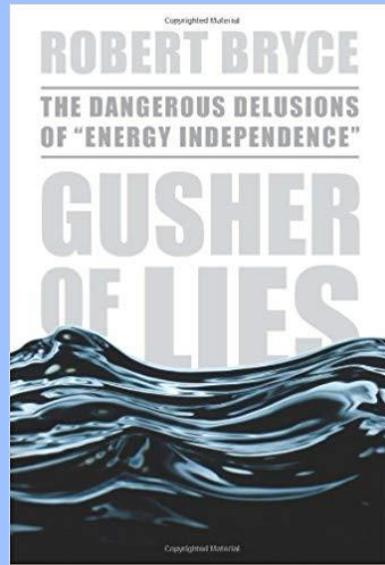
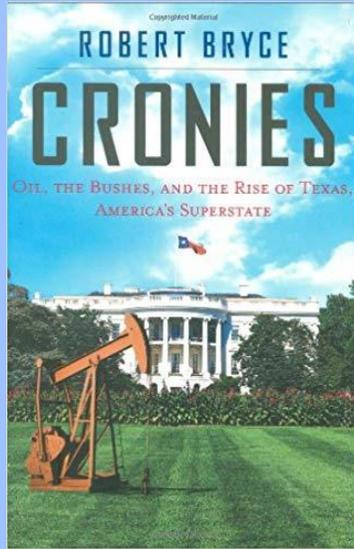
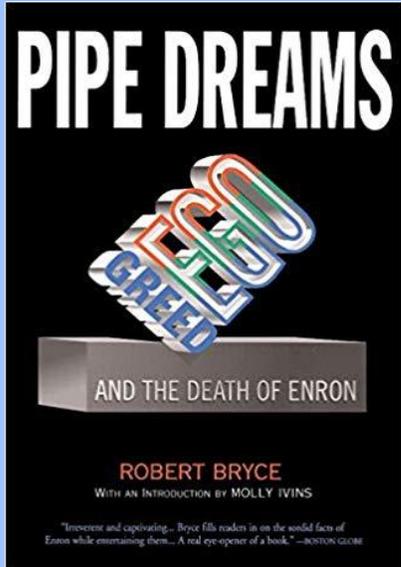
Key Issues For FGU And Nat Gas Sector

- **Affordability, reliability, and resilience**
- **Biden administration anti-HC regs, net zero, who pays?**
- **Nat gas bans are a regressive tax**
- **EU deindustrialization, LNG exports = increased gas demand**
- **Anti-HC NGOs have money, media, & momentum**

Energy Realism
Is
Energy Humanism

Juice: How Electricity Explains the World







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Thank you