The Great Energy Reset ?

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3 Forces: Proverbial "Perfect Storm"

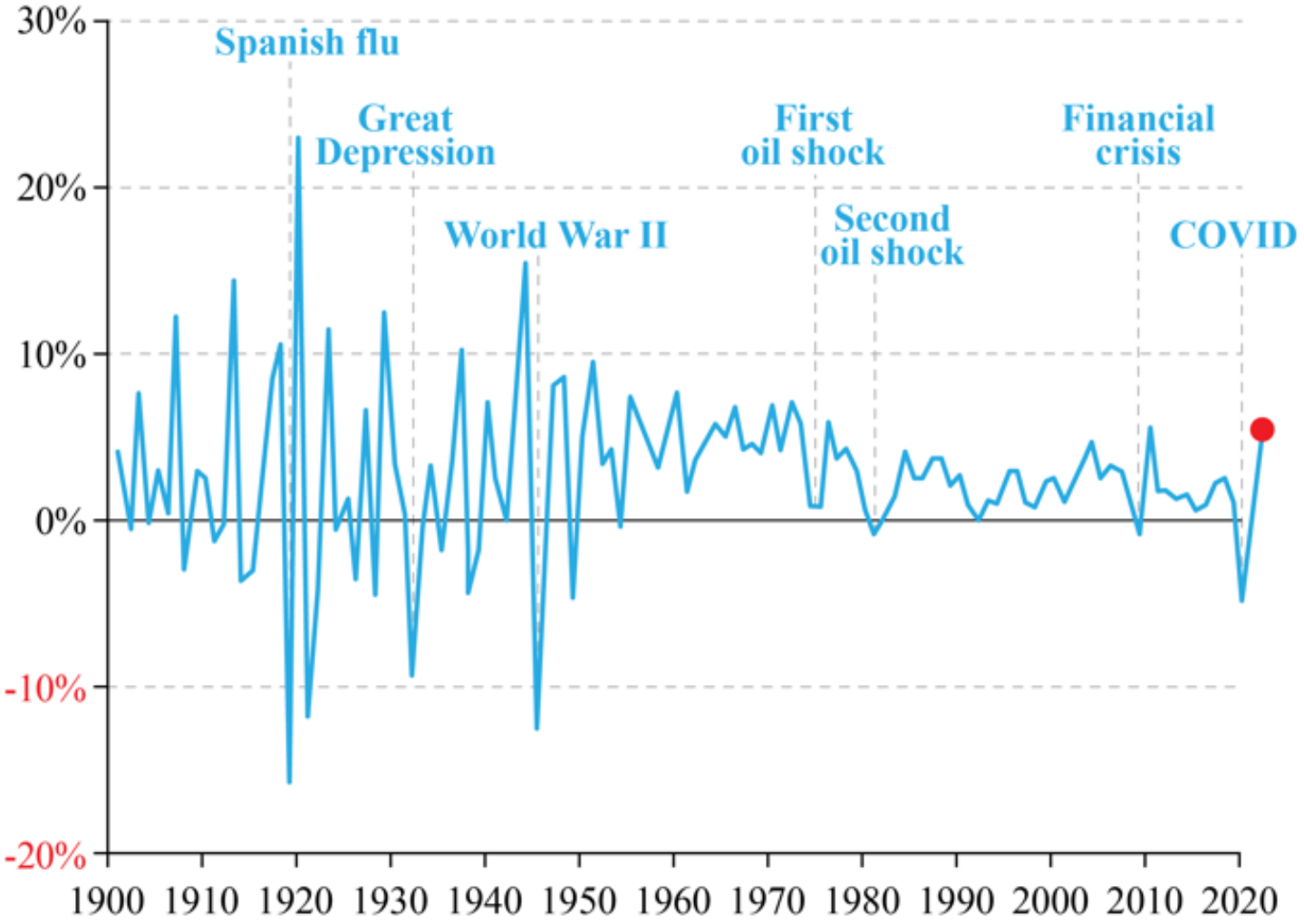
Demand disruption: Global lockdowns

Money disruption: Congress & IRA

Supply disruption: Russia invades

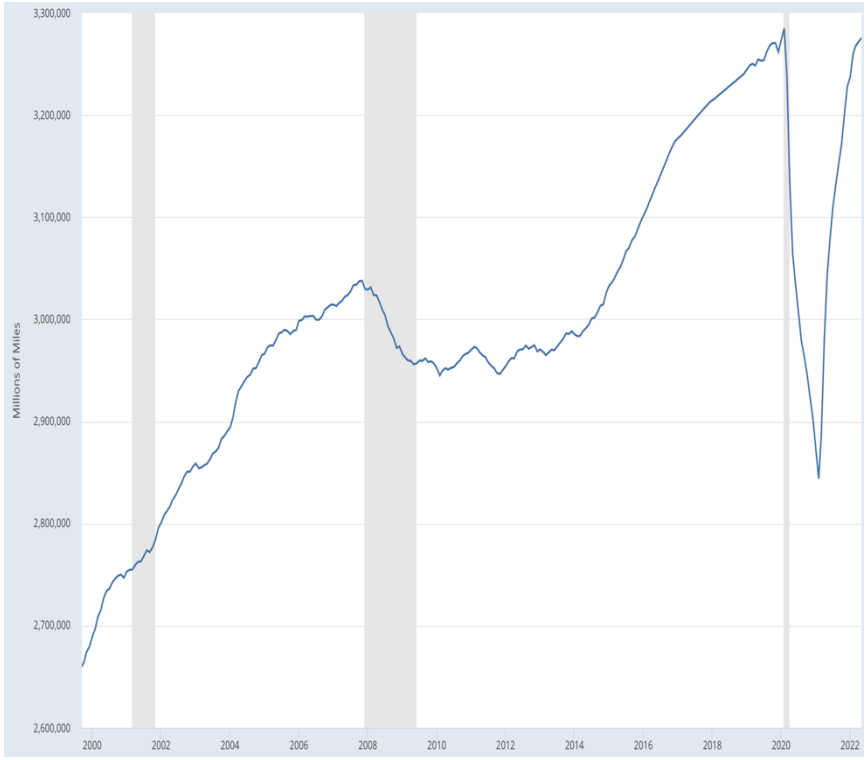
Lockdowns & Epic Demand Destruction

Change in Annual Energy Demand

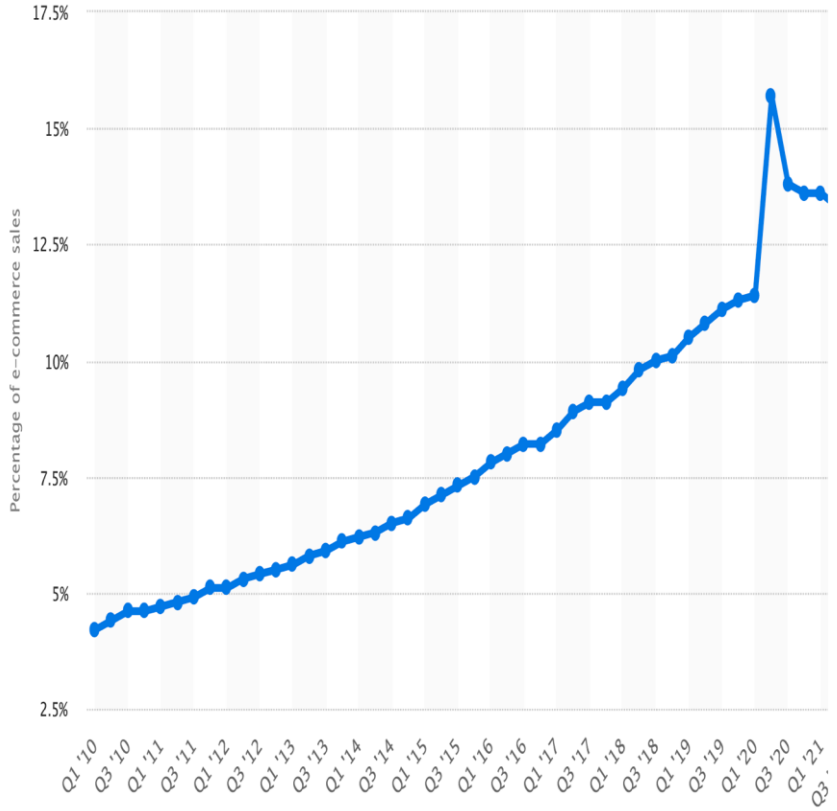


It Didn't "Change Everything"

U.S. Annual Road-Miles

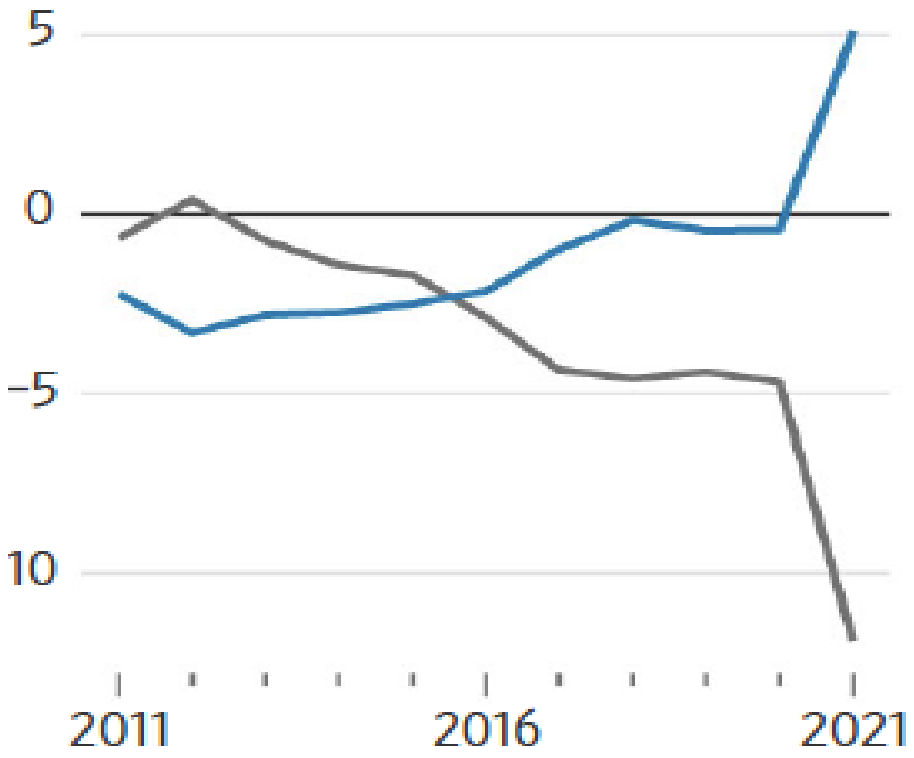


E-Commerce Share



It Did Accelerate Some Things

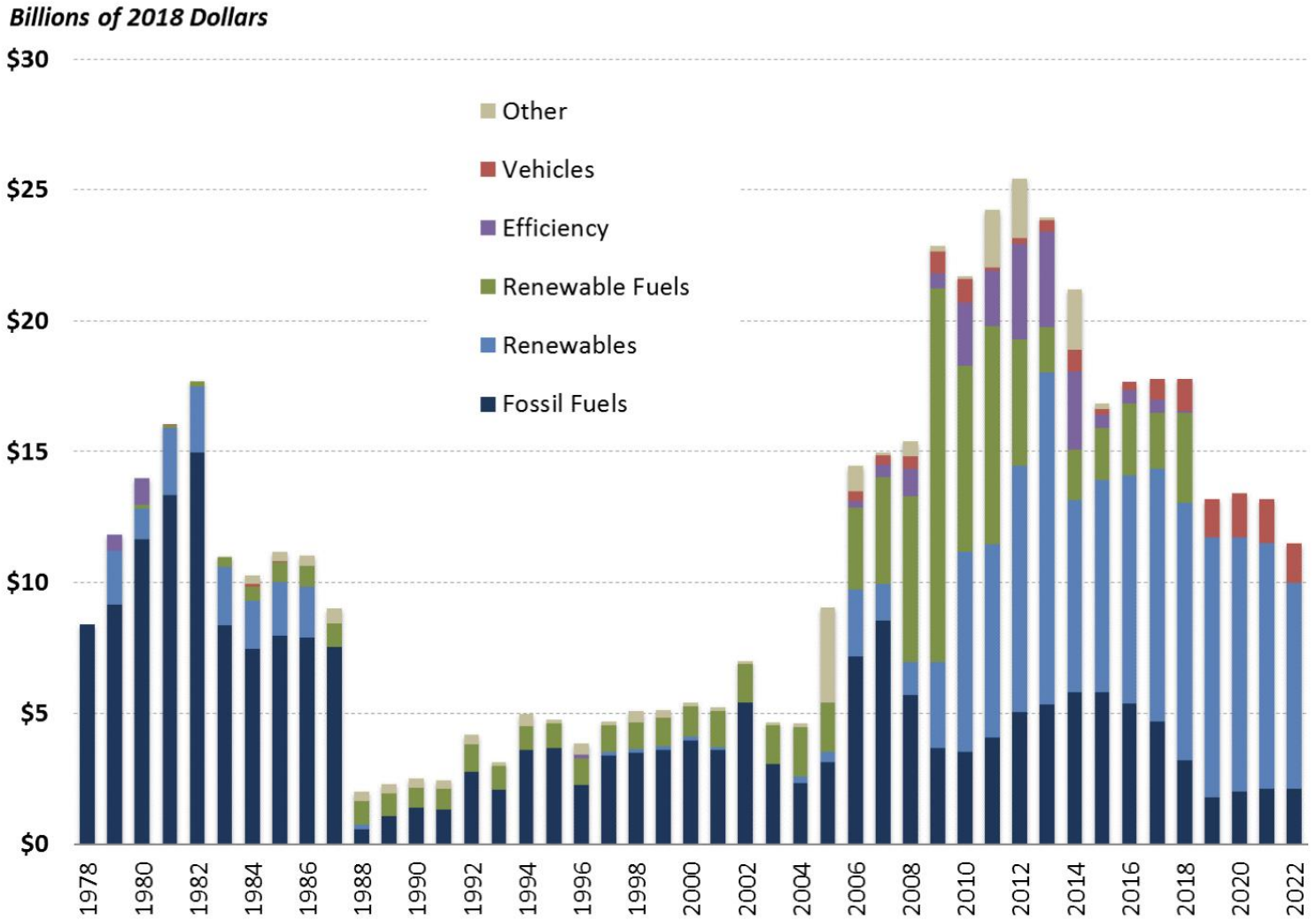
Net U.S. Domestic Migration



Rural vs Urban Counties
(per 1,000 residents)

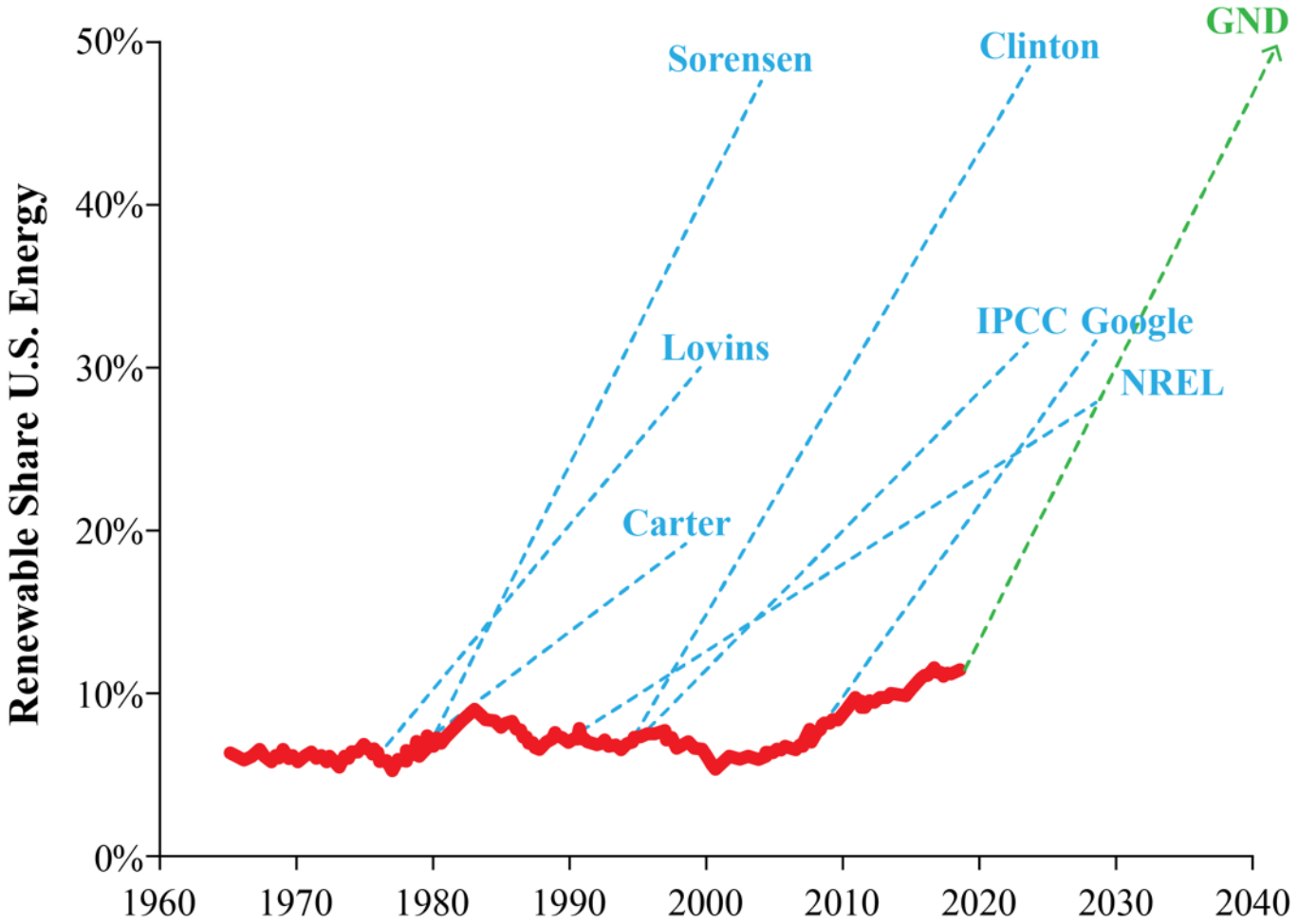
Accelerated: GND & "Christmas For Climate Tech"

IRA → 300%/yr jump in green spending



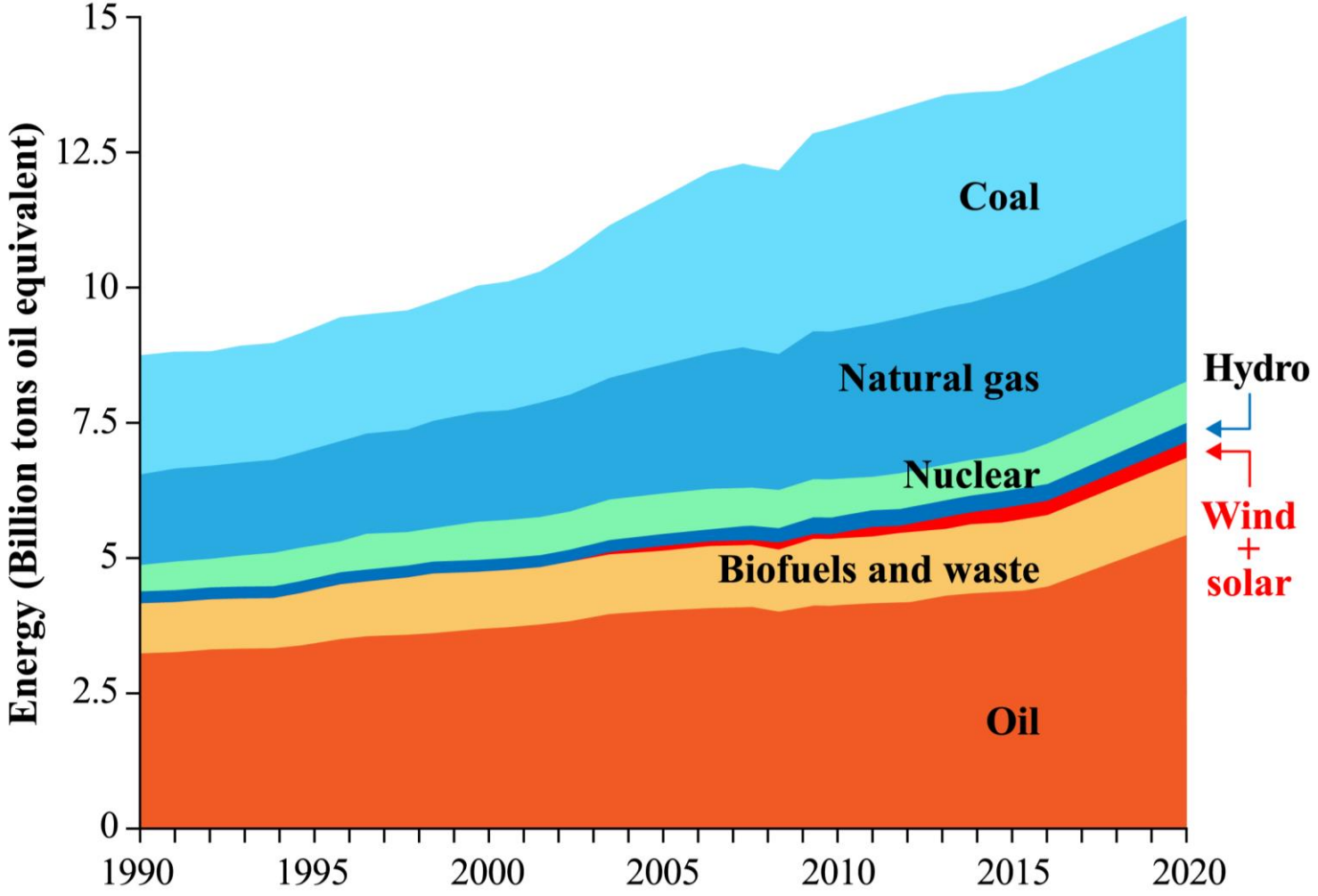
Accelerated: U.S. Energy Transition Forecasts

This time it's different?



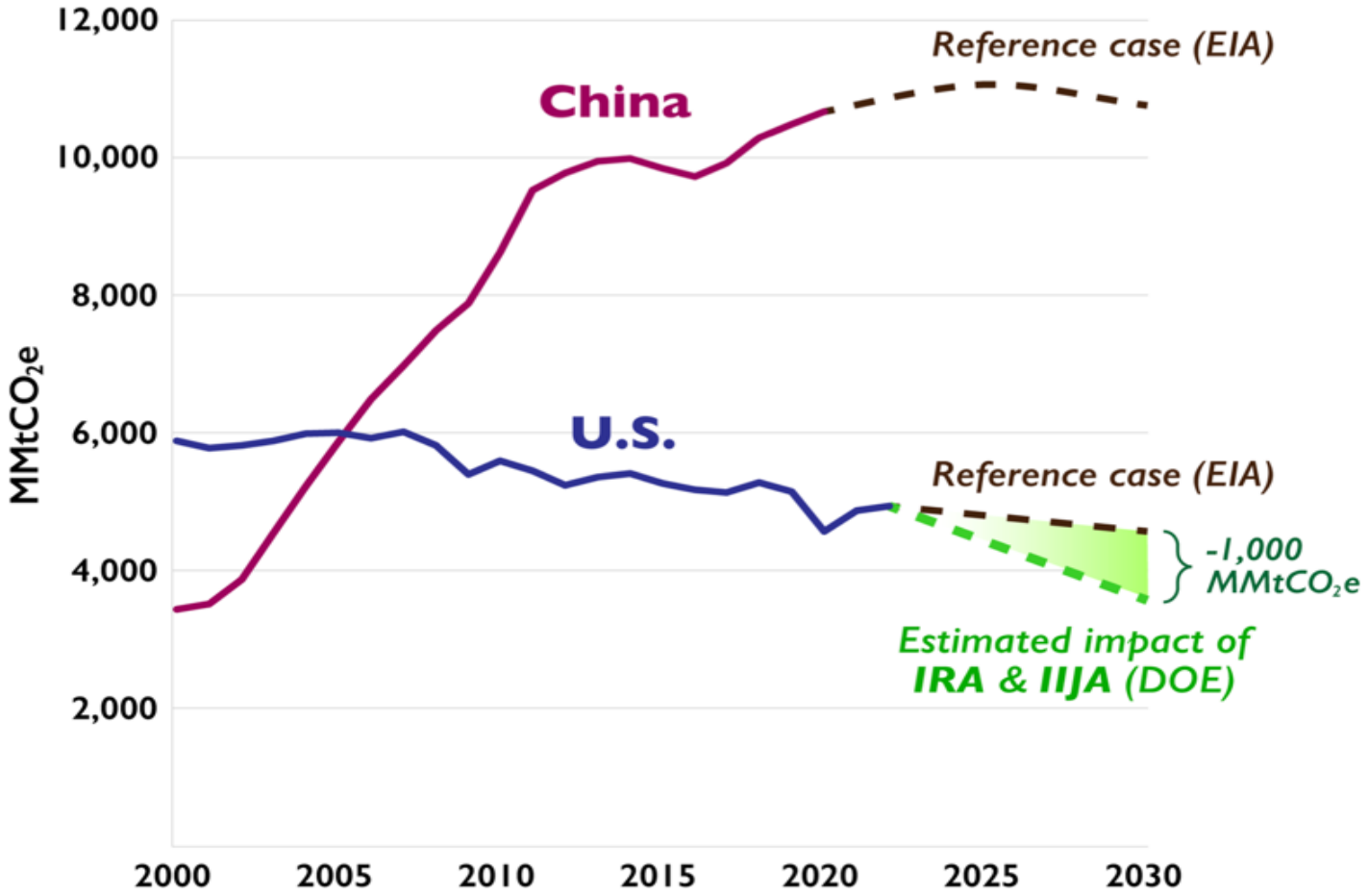
Reality Check: Transition Are Very Slow

$5 trillion & 20 yrs on alternatives



Reality Check: Carbon Impact of U.S. GND

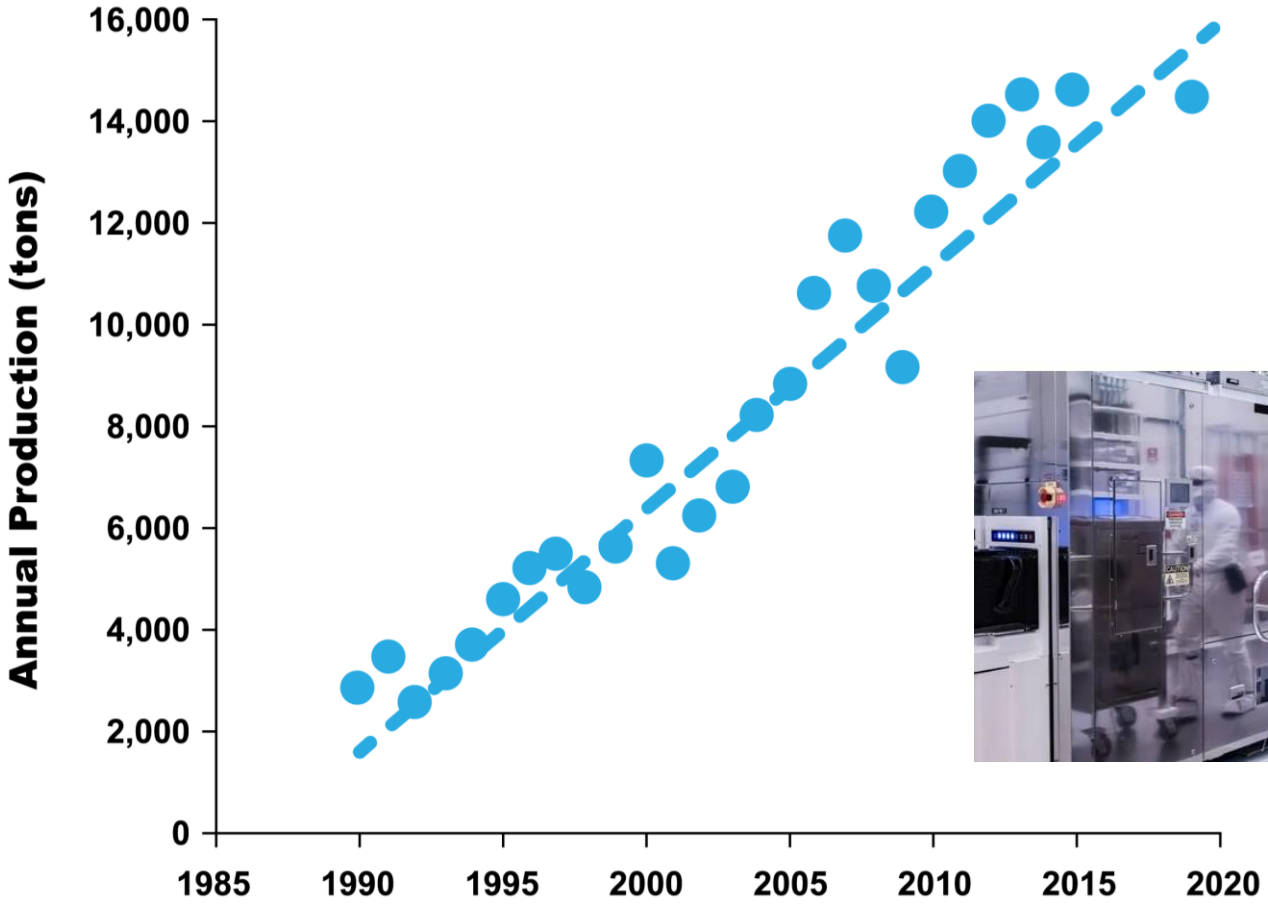
Restore U.S. manufacturing = All GND reductions



Data: DOE, EIA IEO 2021, EIA STEO Aug 2021, Global Carbon Project, IEA.

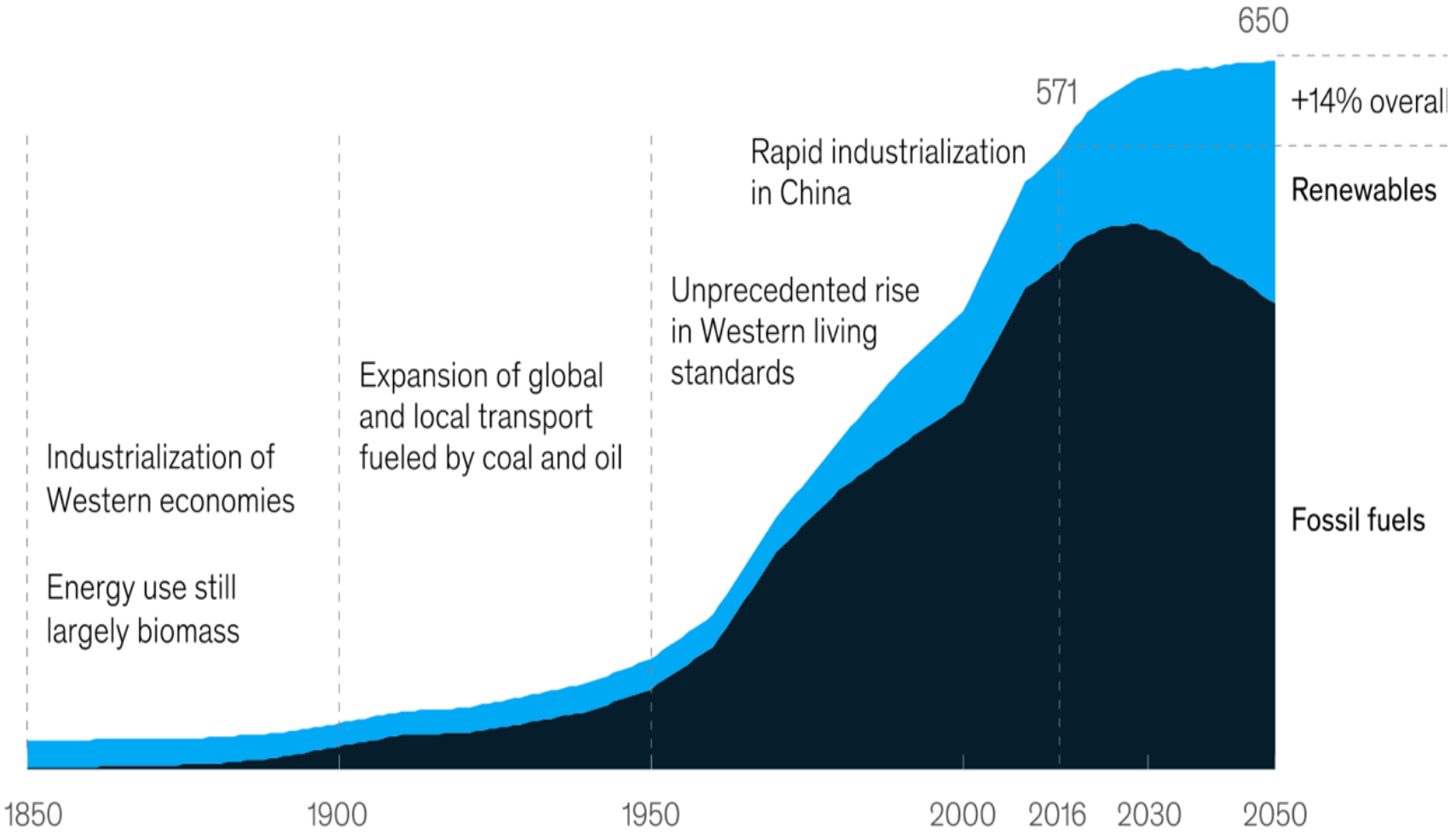
Accelerated: Repatriating Silicon Supply Chain

Global Silicon Production



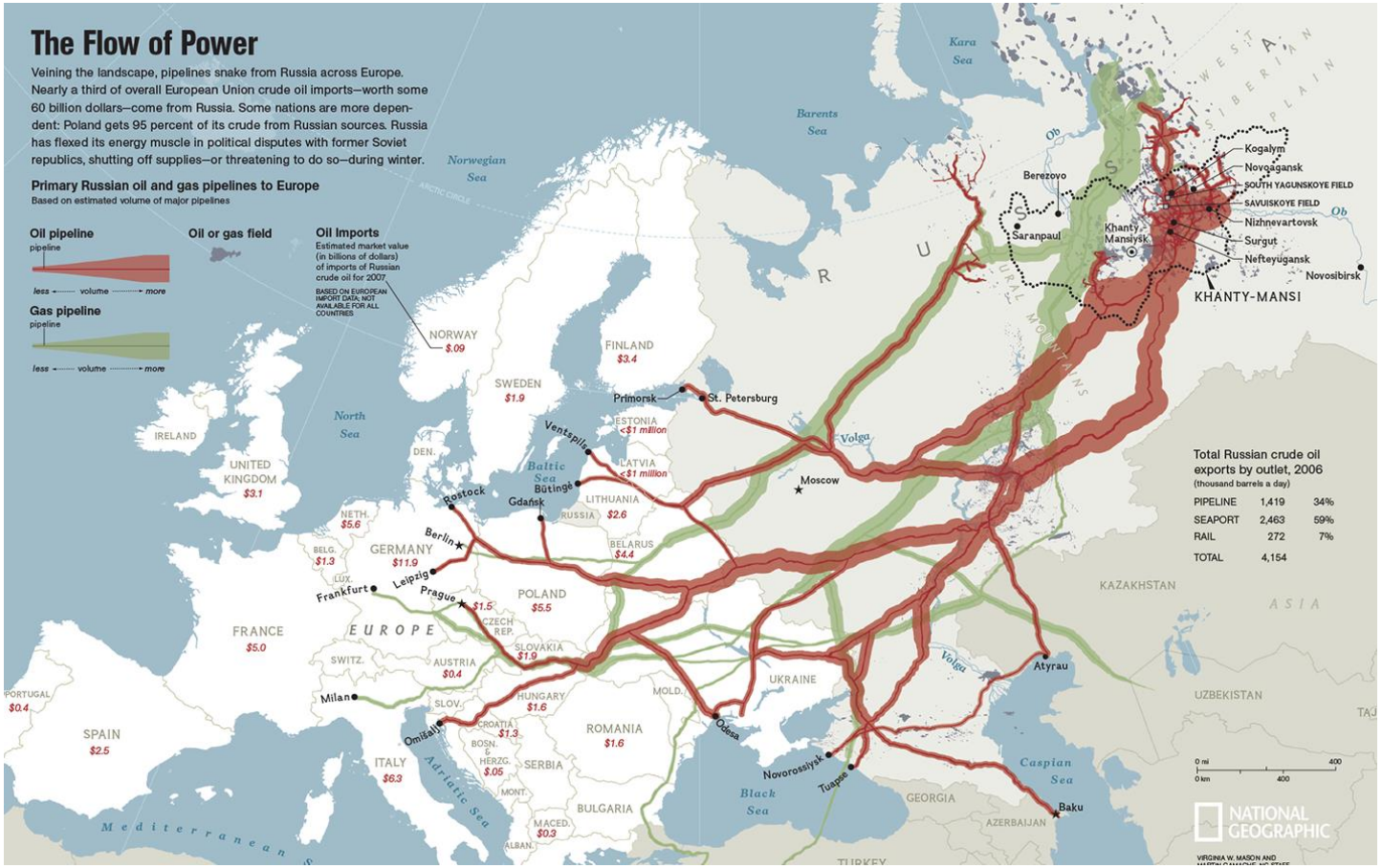
Reality Check: IEA Transition Aspirations

Who supplies the 66%?



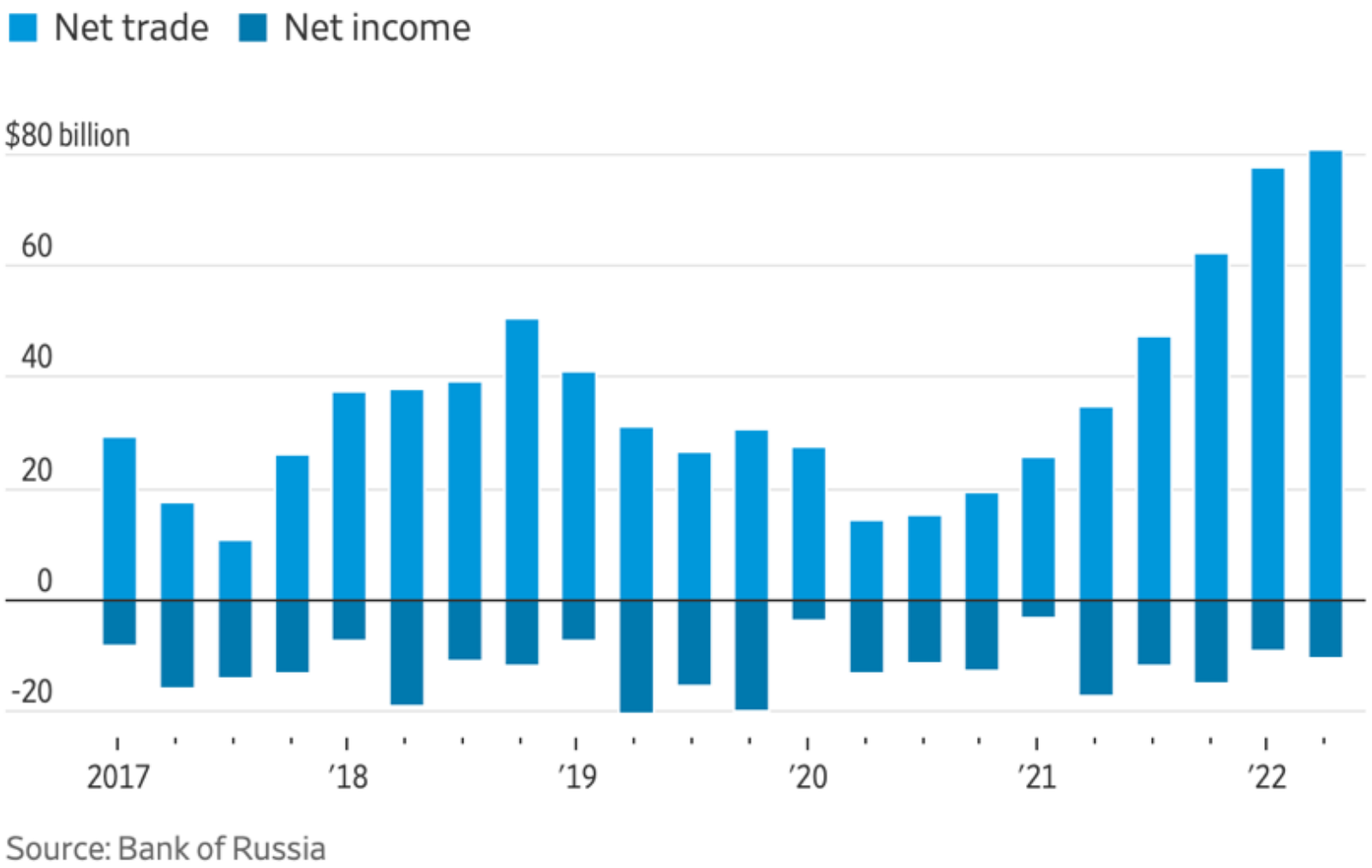
Reality Check: Russia X-Rays Supply Chains

Share of world supply:
Natural gas 17% & oil 12%



Reality Check: Russian Sanctions Didn't Work

Russia Quarterly Current-Account Balances



Source: Bank of Russia

Russia → Energy Policy Reset ?

"Hate to say it, but we need to increase oil & gas output immediately."
Elon Musk, March 2022

"The quicker we switch to renewables and hydrogen . . .the quicker we will be truly independent "
EU President, March 2022

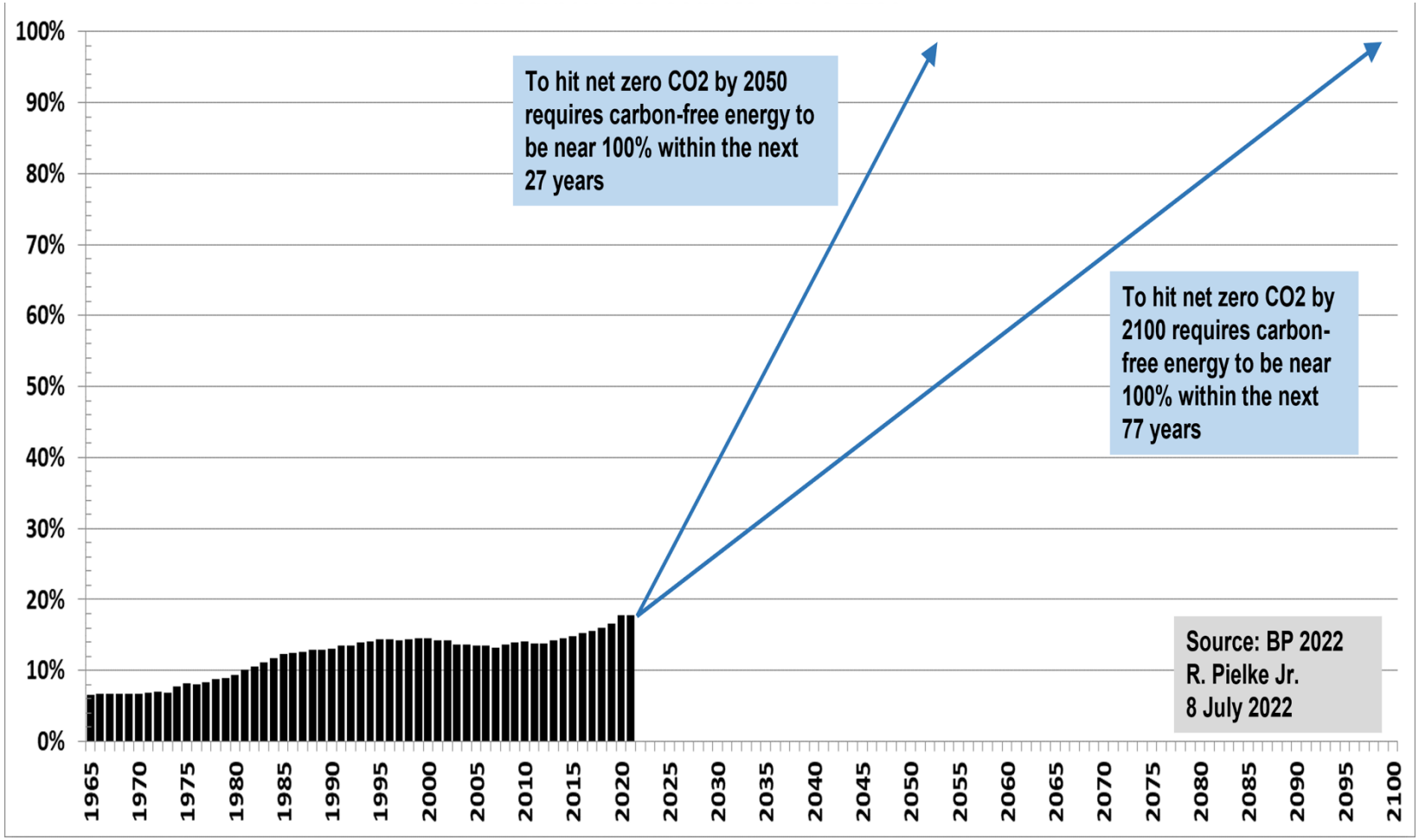
"We need to double-down on our clean energy goals."
President Biden, March 2022

Europe's Solution? Ship-Store LNG

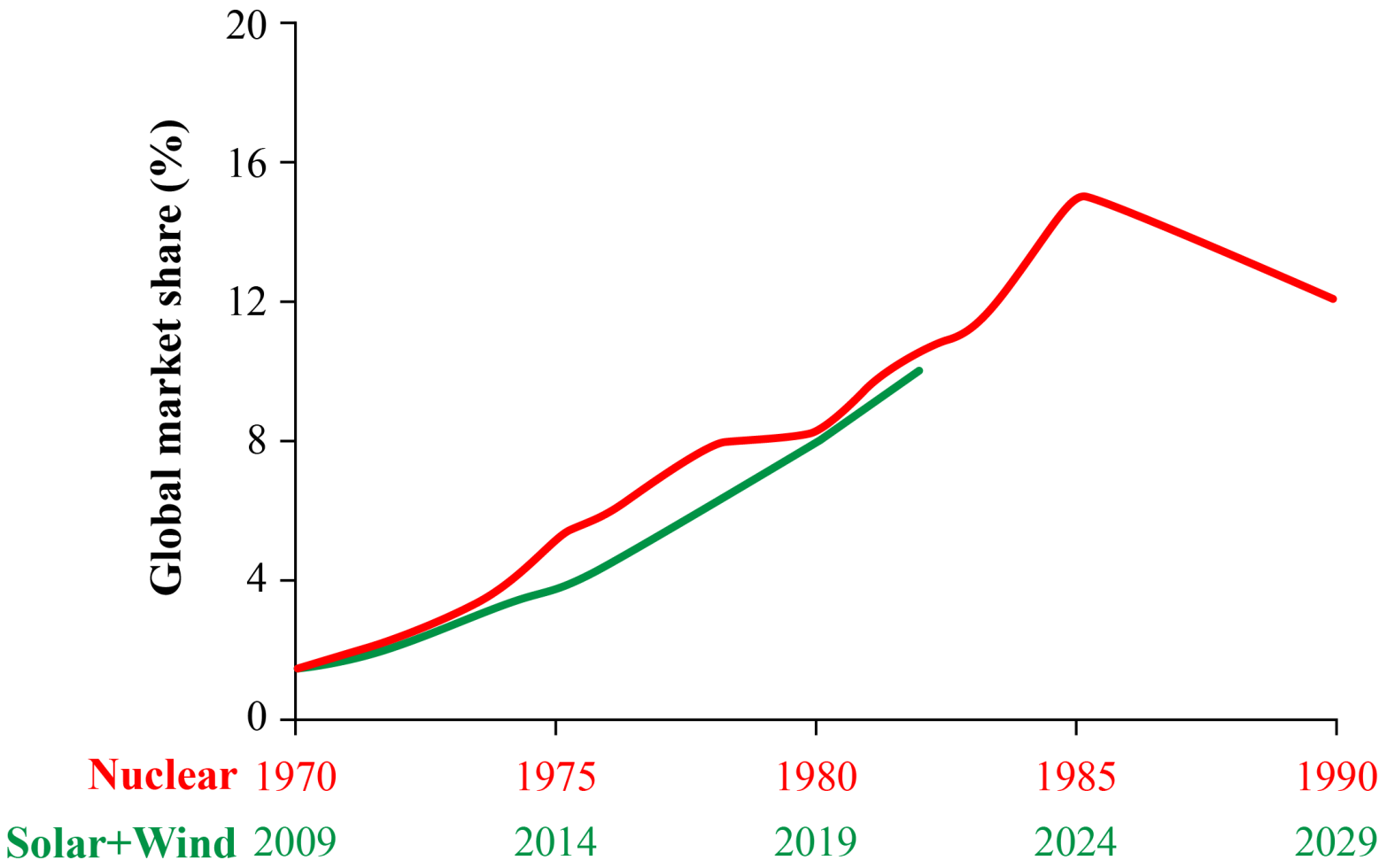
~ 20 FSRUs
1 LNG tanker = 4 million Teslas

Velocity Problem

Share global energy carbon free

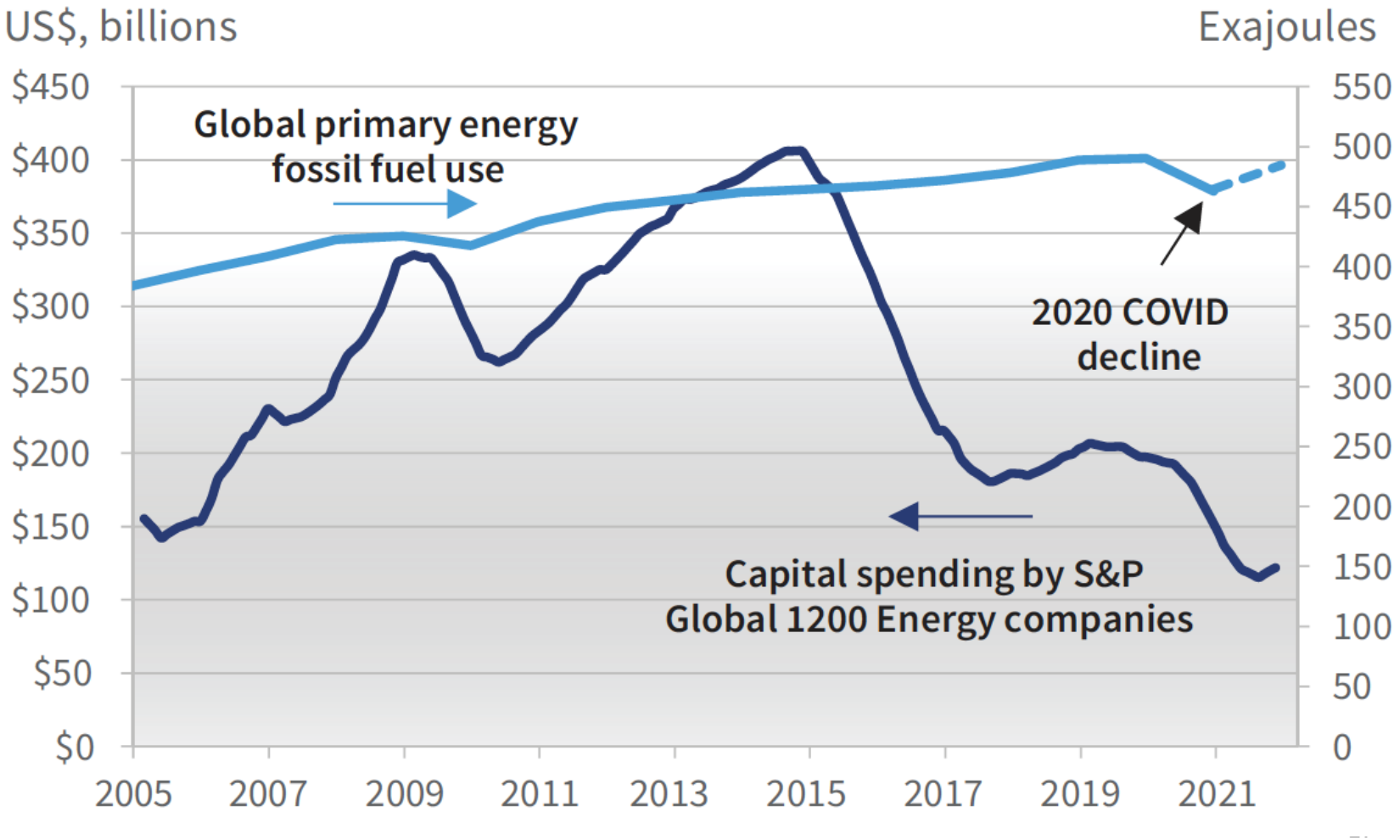


A Tale of Two Velocities: Nuclear vs. Solar+Wind



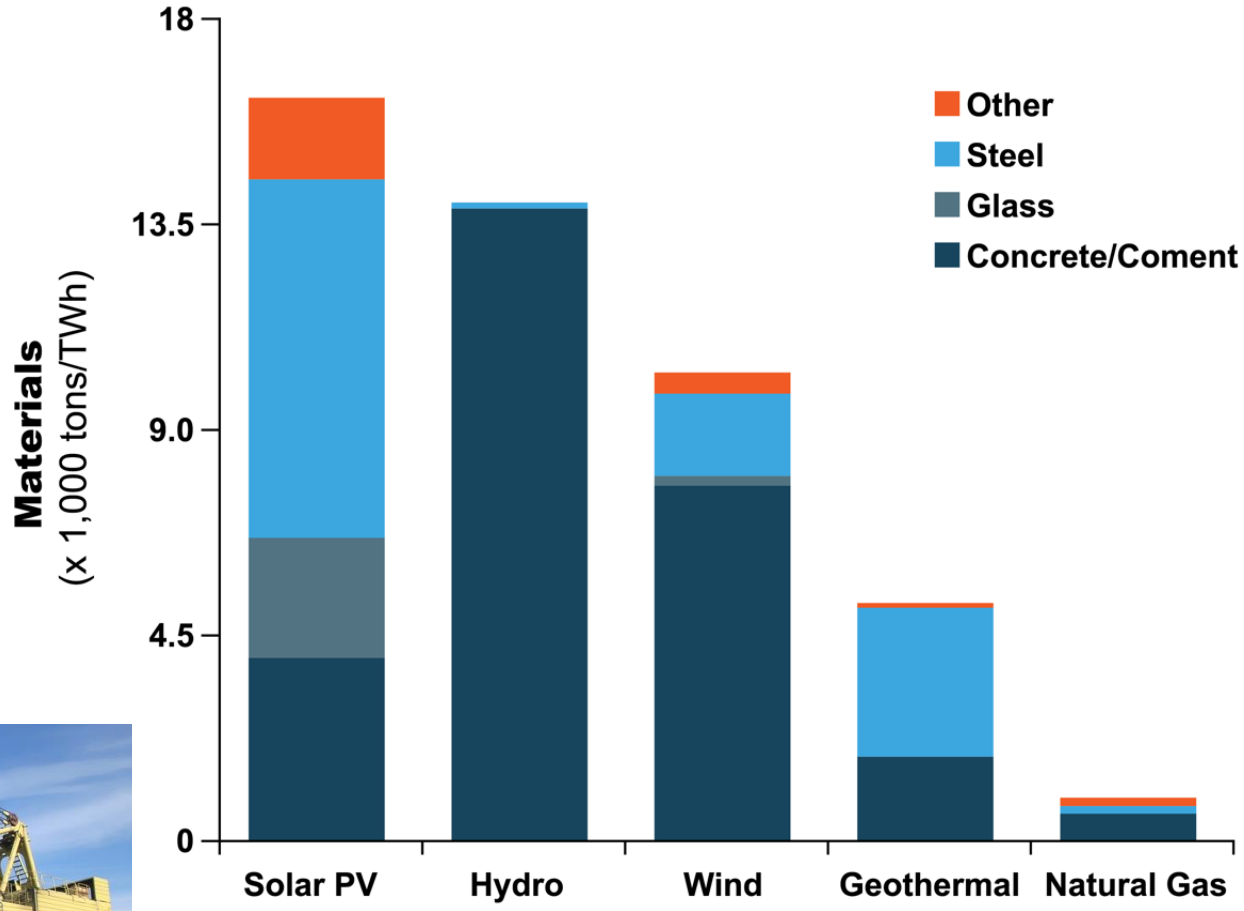
Lost Velocity: Oil & Gas Capital Spending

Hydrocarbons Still 84% global energy



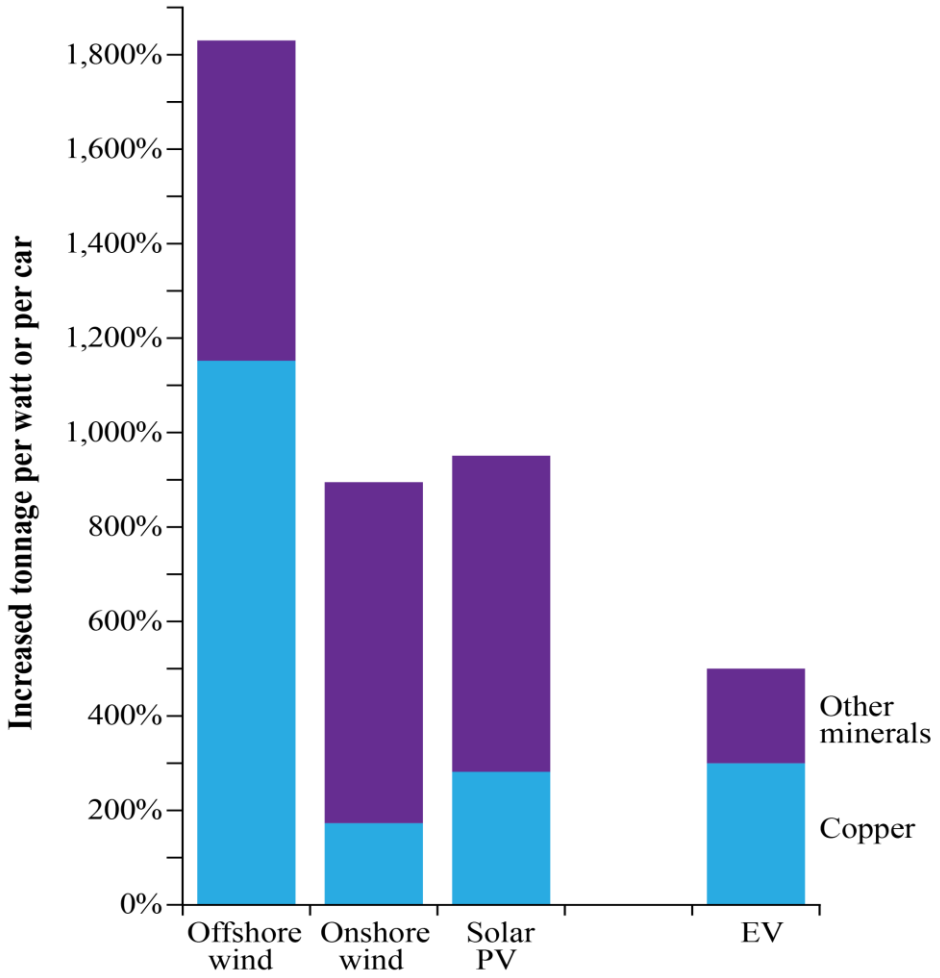
Materials Used To Build Energy Machines

> 1,000% more concrete, steel, glass for green machines

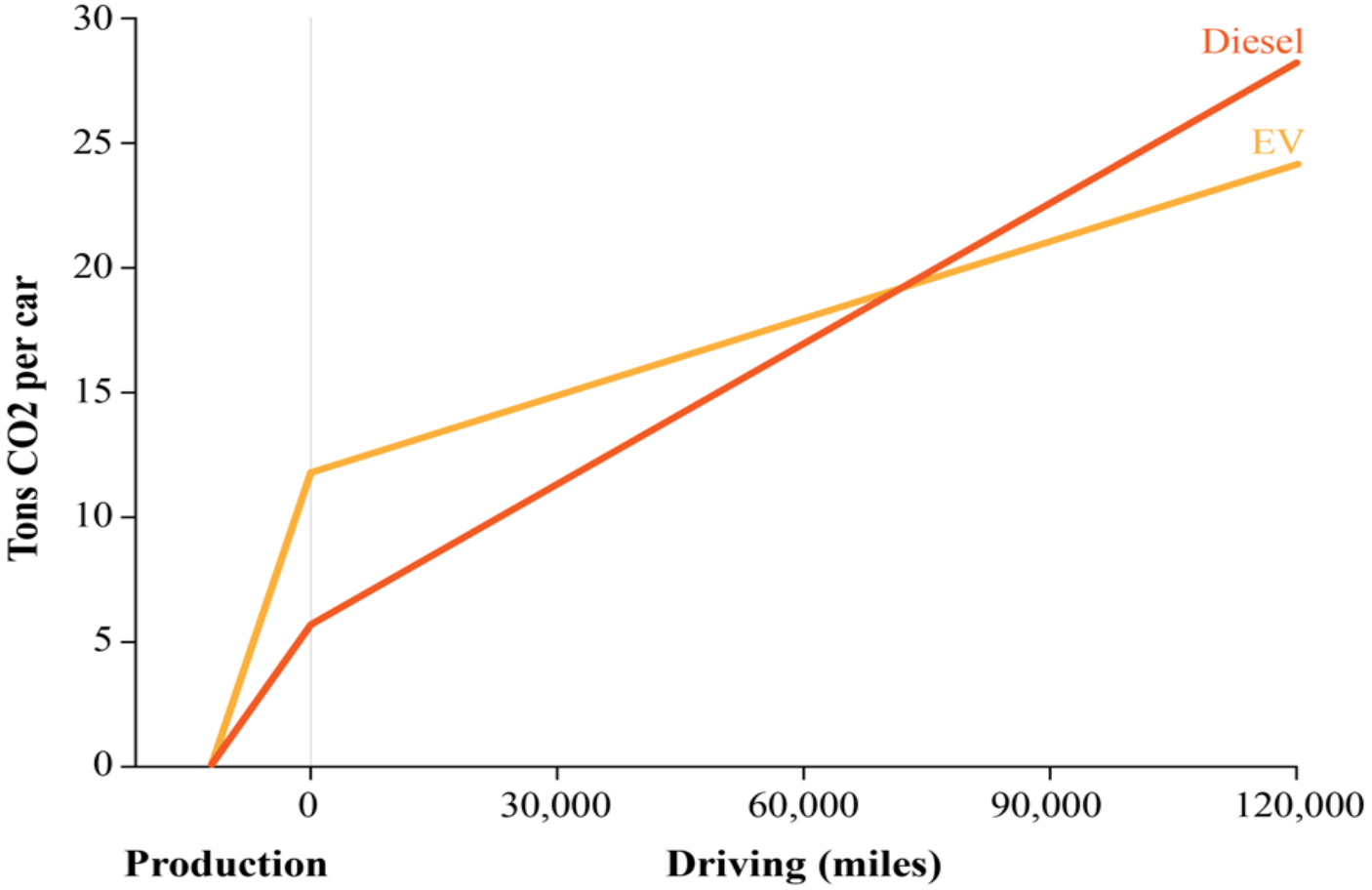


Minerals: *Unprecedented Shift to Mining*

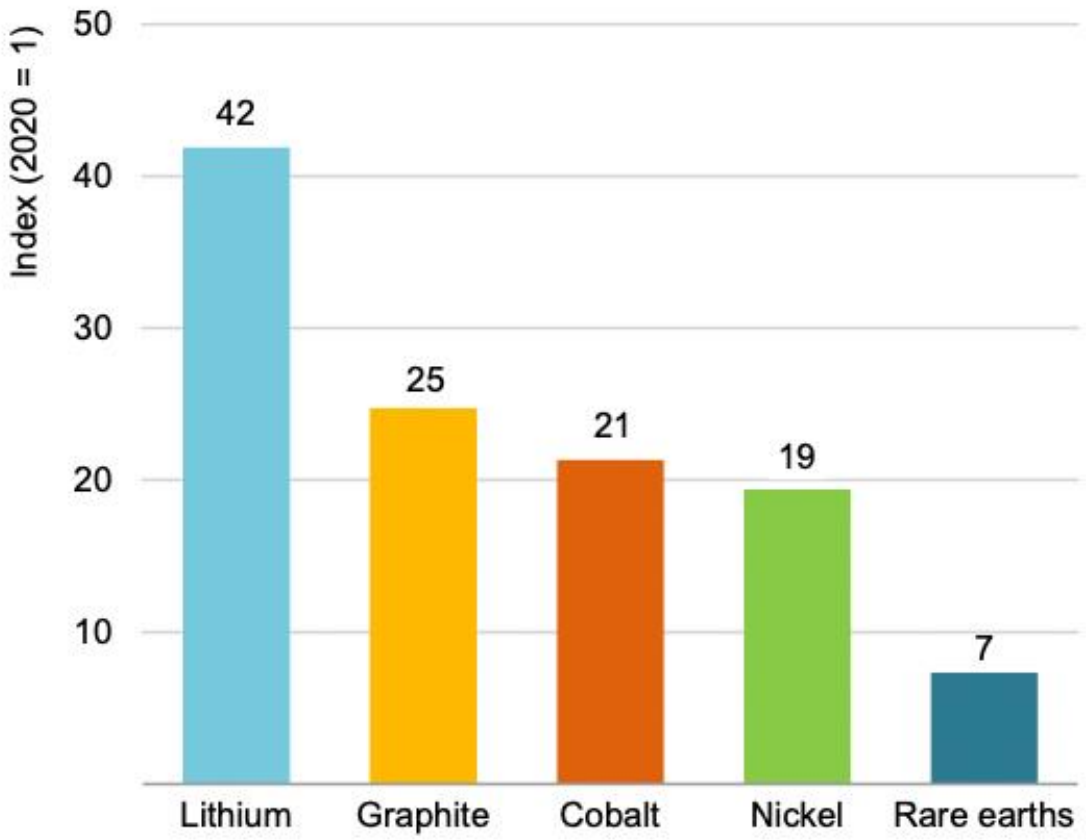
- **1,000% more minerals & metals**
- **1 car battery @ 1000 lbs → 500,000 lbs materials mined**



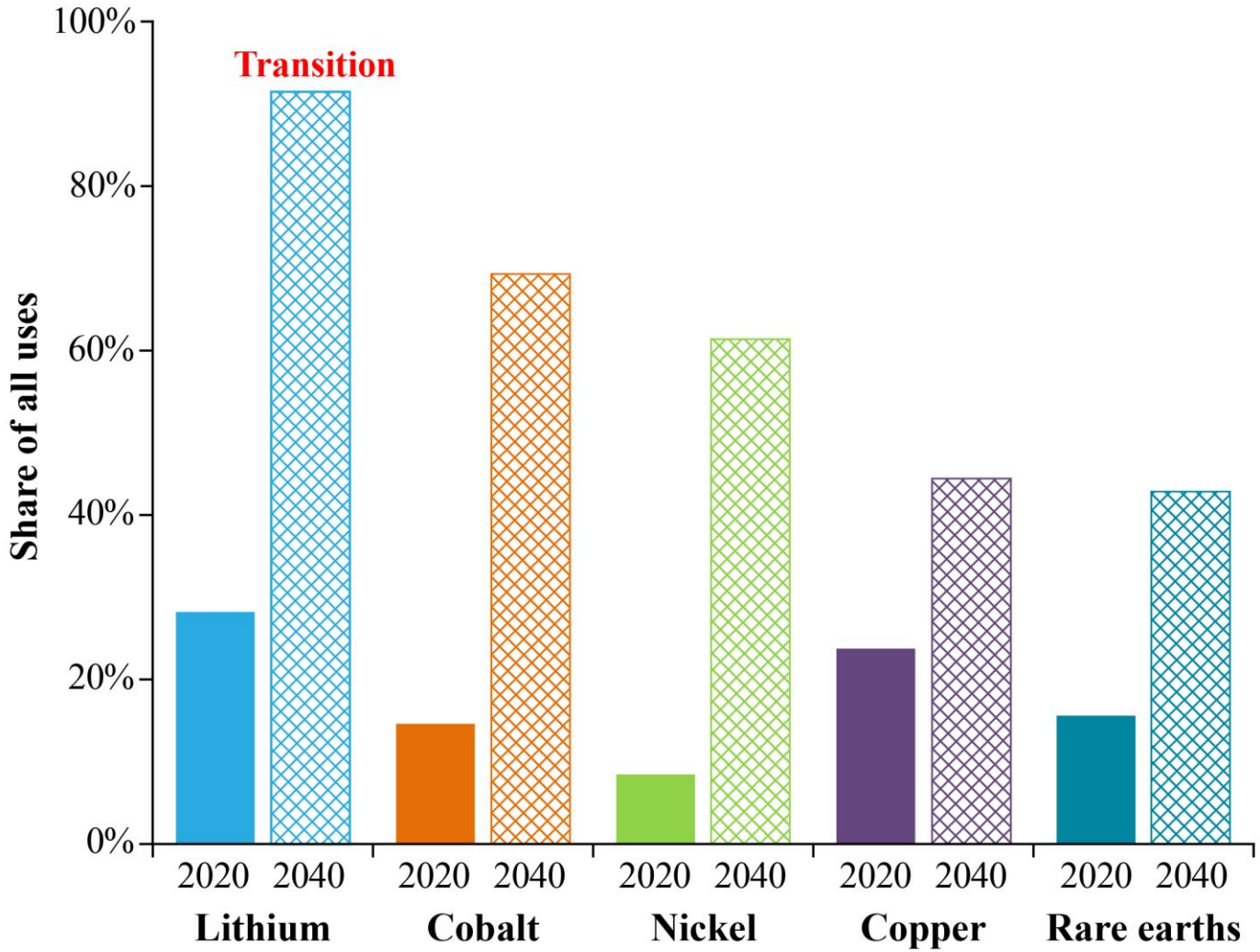
Reality Check: *Carbon Intensive Batteries*



Demand Increases by 2040 For "Energy Minerals"

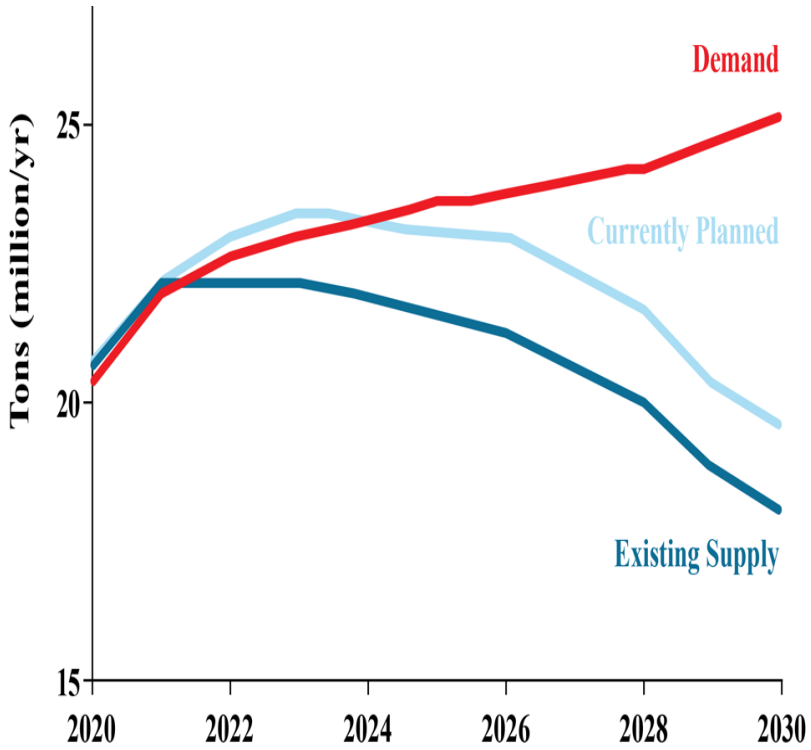


Energy Minerals Will Dominate All Future Uses



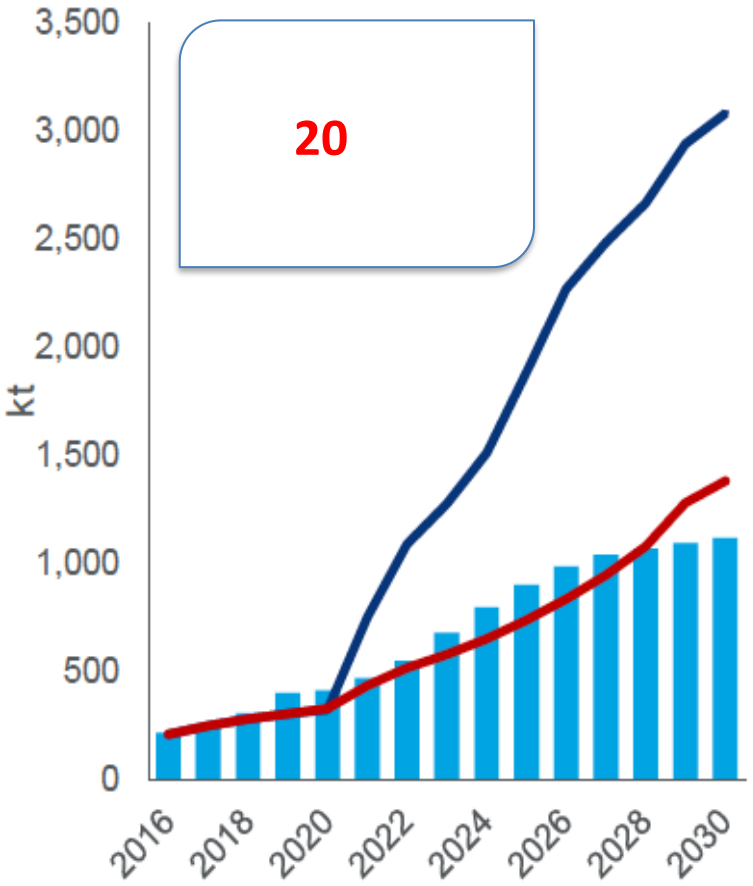
IEA: 100s of New Mines Needed

16 years avg. to open new mine
Coal mining capex >> all minerals combined



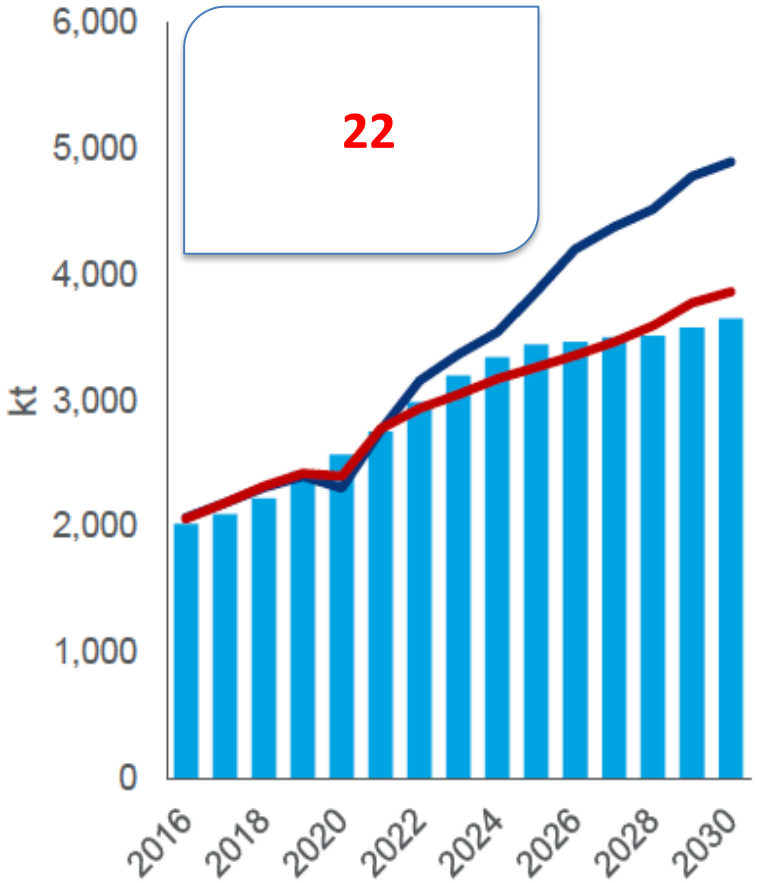
World's biggest copper mine
Escondida, Chile

Lithium at OPEC Scale



World's biggest mine
Greenbushes, Busselton, West Australia

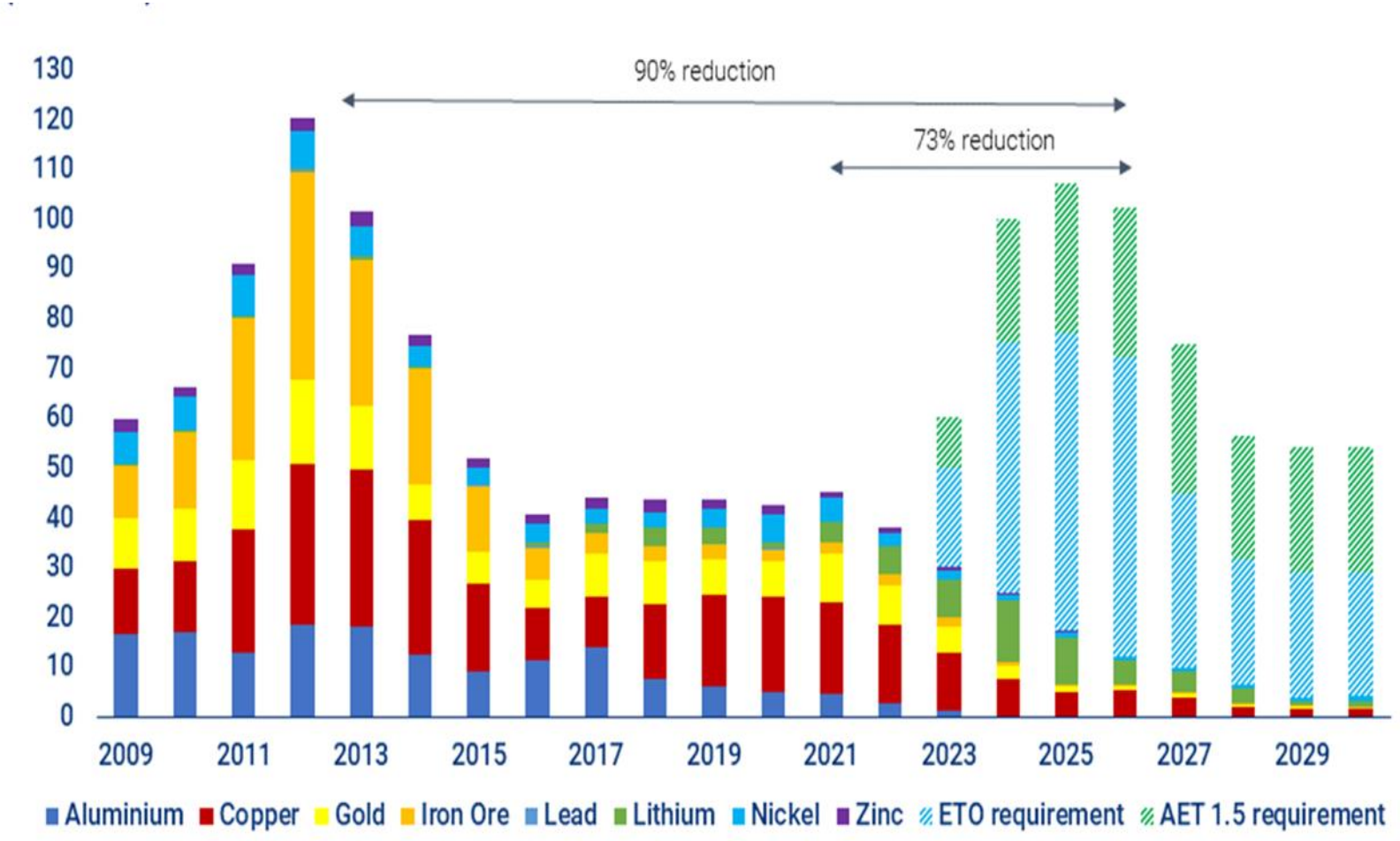
Nickel at OPEC Scale



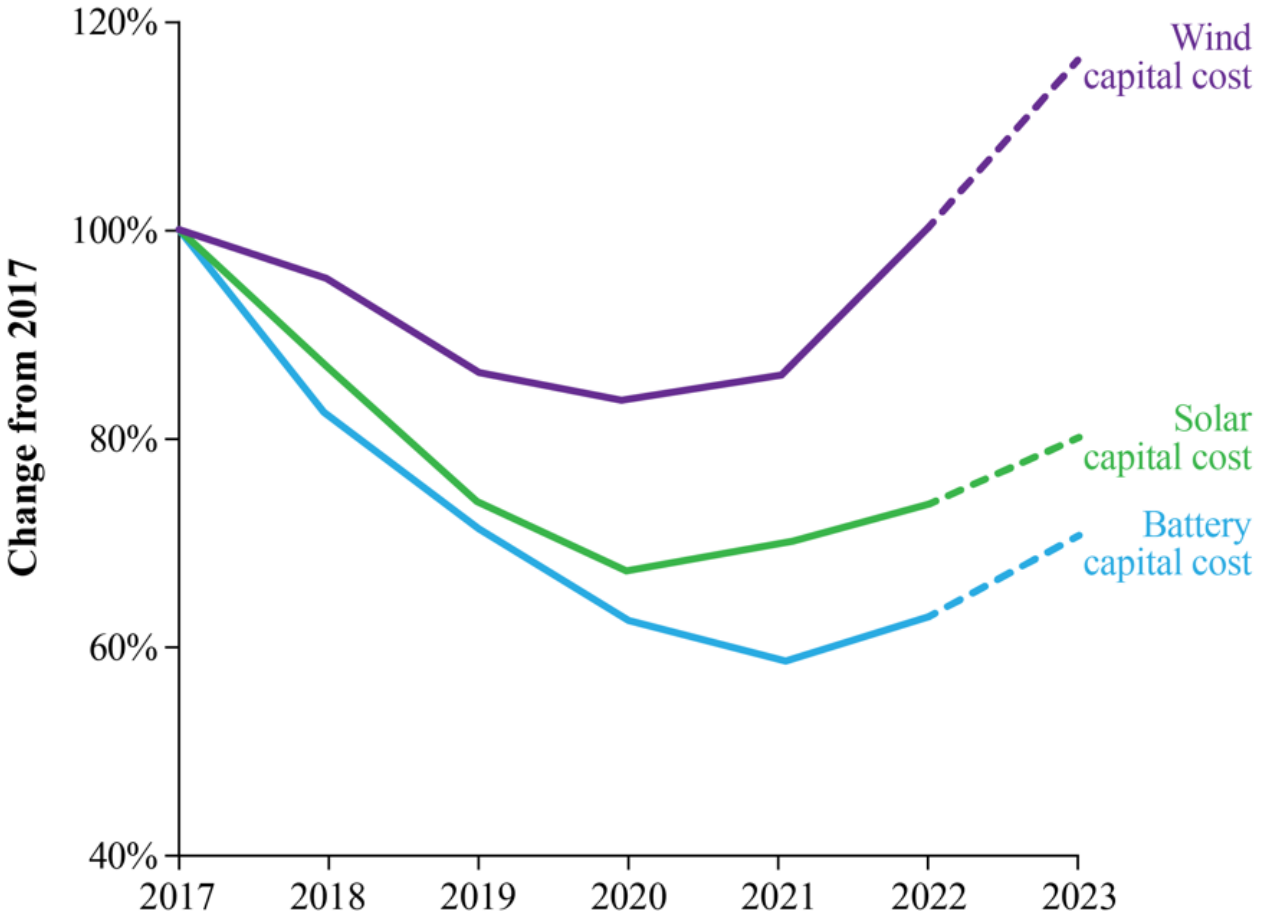
World's biggest mine
Sorowako, South Sulawesi, Indonesia

Massive Gap Between Planned & Needed Mines

Global Mining CapEx ($billion) Planned & Needed

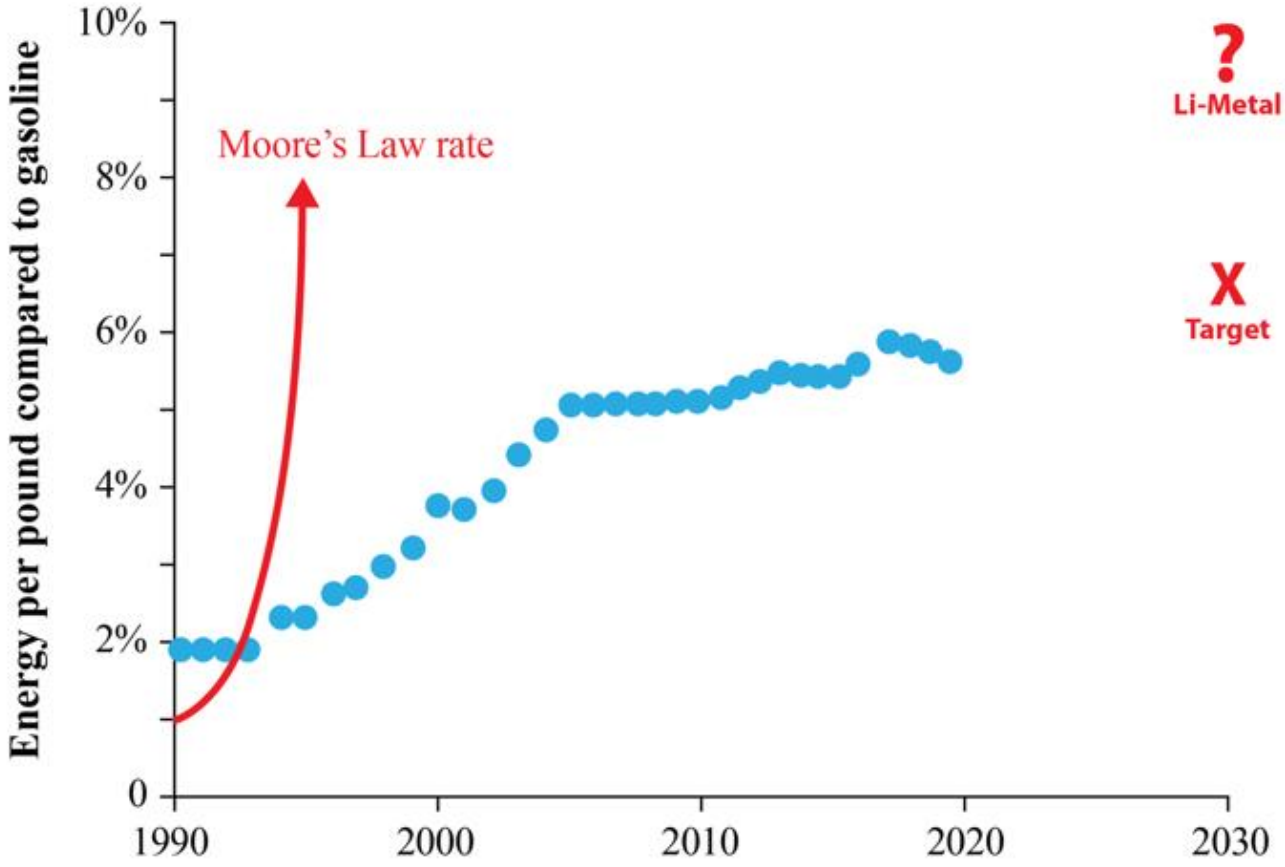


Green Machines Costs Rising

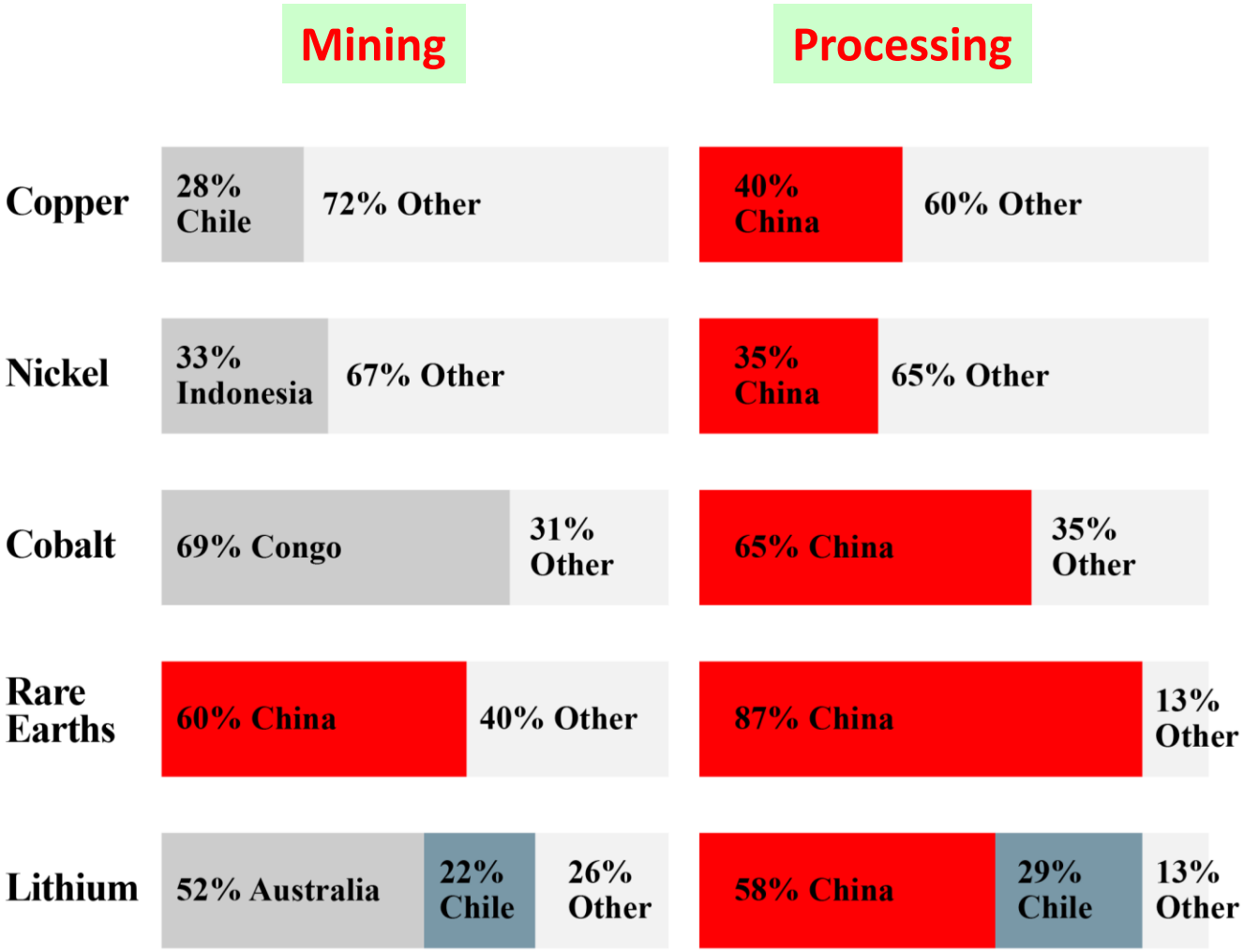


Future Battery Tech: Aspirations vs Physics

There's no "Moore's Law" for green energy



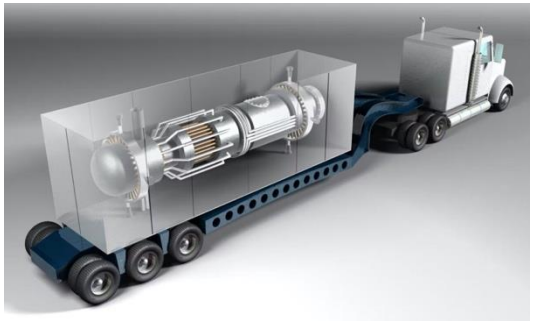
Green Supply Chain: China, OPEC of Energy Minerals



Where Are The Revolutions?

Silicon Carbide & Ultra-Hybrids

Digital Oilfields & Nukes



Robo-mining