

US Energy & Electric Power Policy

The National Security Imperative

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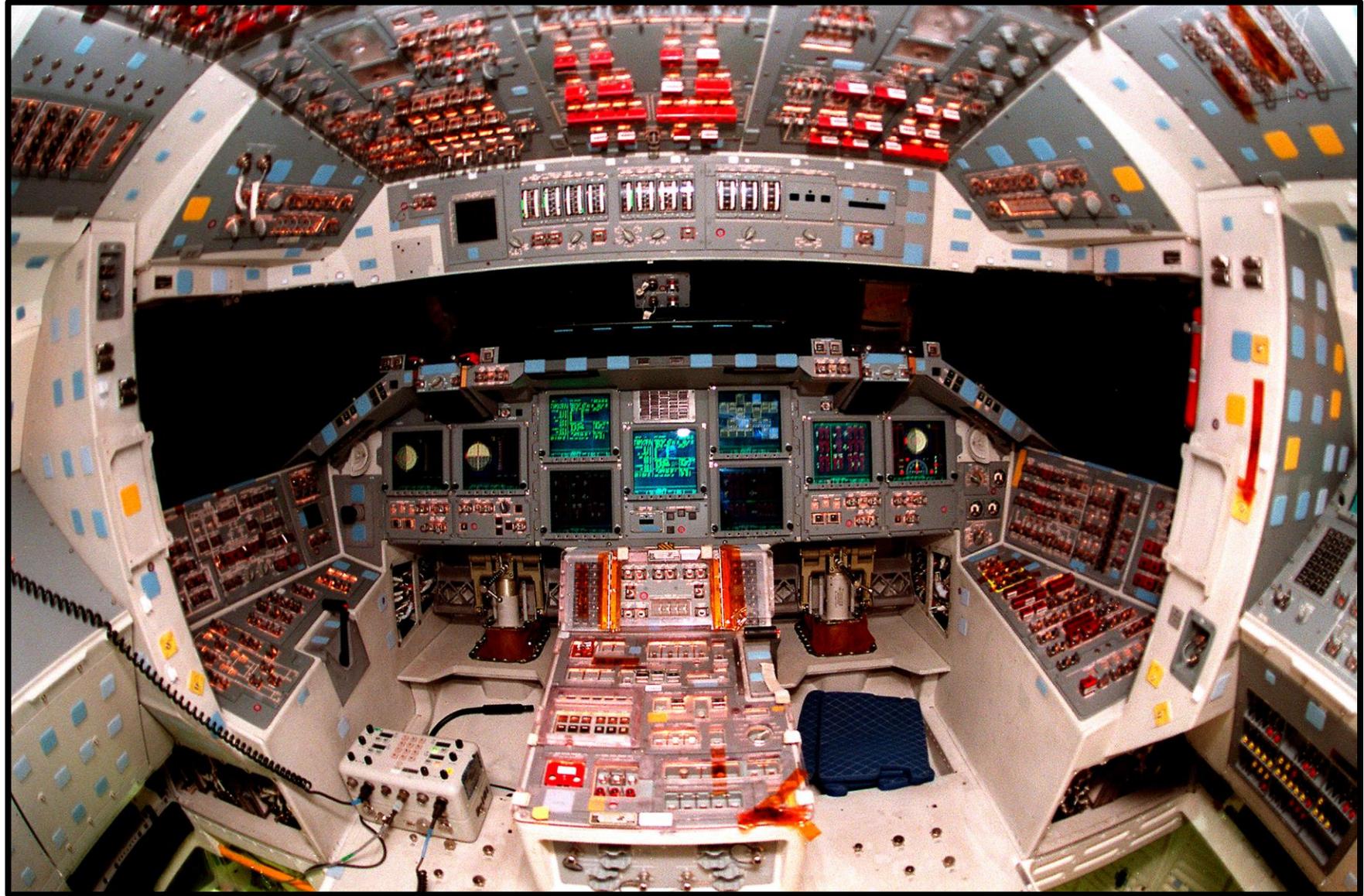
UNIVERSITY OF GEORGIA

COLLEGE OF ENGINEERING AND CENTER FOR INTERNATIONAL TRADE AND SECURITY

NORTH DAKOTA ASSOCIATION OF RURAL ELECTRIC COOPERATIVES ASSOCIATION ANNUAL MEETING

JANUARY 19, 2022

Atlantis Space Shuttle Cockpit



A Battle of Ideas

The US is in the middle of a national and international discussion as to which energy resources will drive the US economy in the 21st century—a debate that, increasingly, is revolving around *global* climate change and *domestic* carbon reduction.

Bottom Line Up Front

AMERICA IS CONSIDERING A GRAND EXPERIMENT
ON TWO OF ITS MOST CRITICAL INFRASTRUCTURE
SECTORS

—ITS ENERGY AND ELECTRIC POWER SECTORS—

AT A TIME WHEN IT'S FACING SOME OF THE MOST
CHALLENGING COMPETITION IN US HISTORY

“The United States has entered an era of long-term competition with revisionist powers. A key aspect of this competition will revolve around a contest for technological superiority waged between the national innovation bases of the respective competitors. The outcome of this competition will determine not just American national security but also how the nations of the world interact—and whether a free and open political and economic system will remain the foundation of those interactions.”

(The Contest for Innovation: Strengthening America’s National Security Innovation Base in An Era of Strategic Competition, *Ronald Reagan Institute*, 2019)



3 Underlying Contentions for this Talk

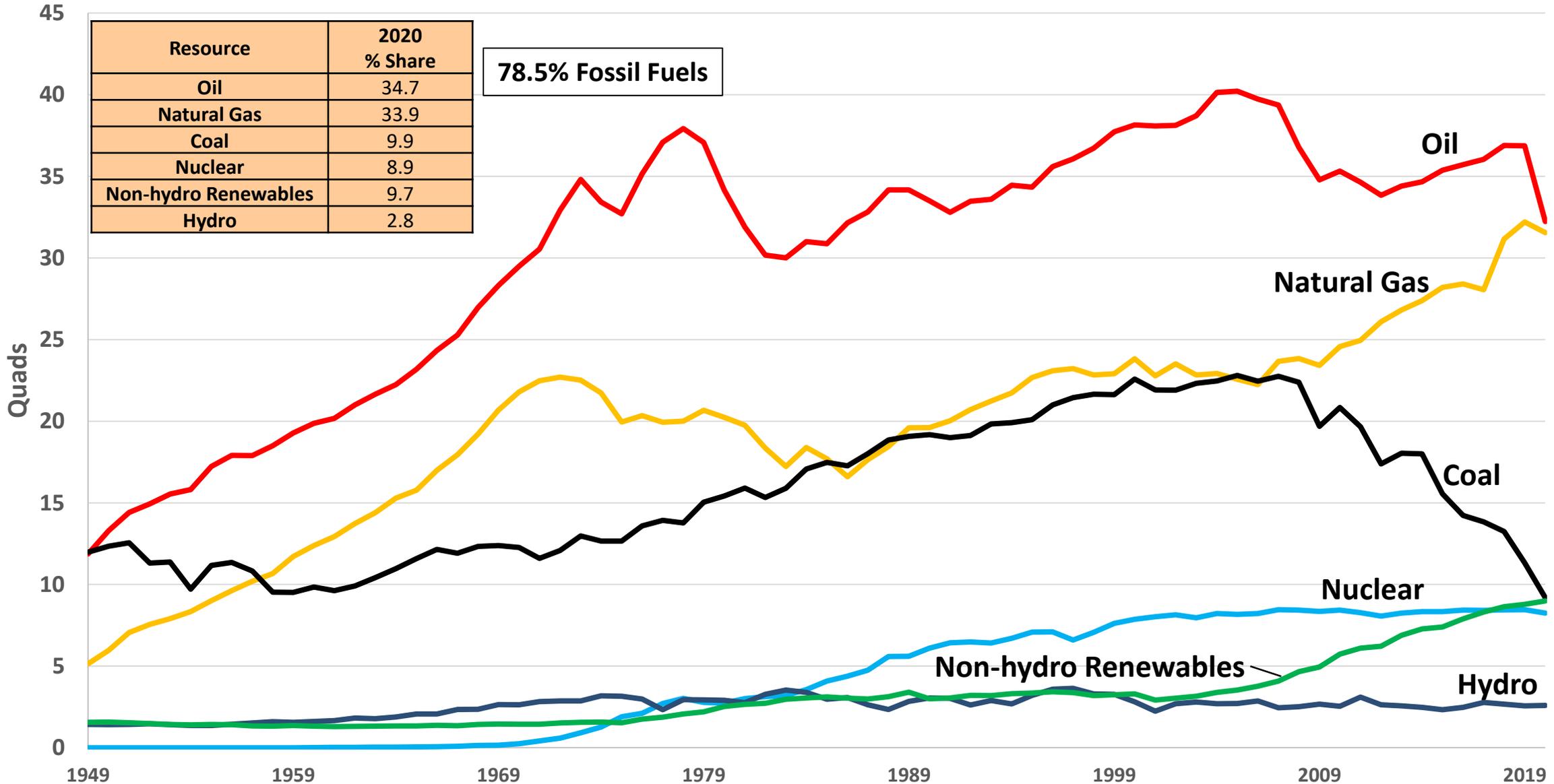
1. Energy is preeminently a resource with *intrinsic national security value*
 - Value that currently is unaccounted for in US policy
2. Energy is not merely a market commodity or diplomatic chattel for global climate change deliberations
 - It's central to the strength and diversity of the *US industrial base*, thus America's capacity to remain a great power
3. What America can do with its energy sector is not necessarily what America should do with its energy sector

Overview

- US energy, CO₂ emissions and electric power trends
- Global realities of energy consumption and CO₂
- Global competition and national security implications of US energy & climate policy
- Security concerns and questions

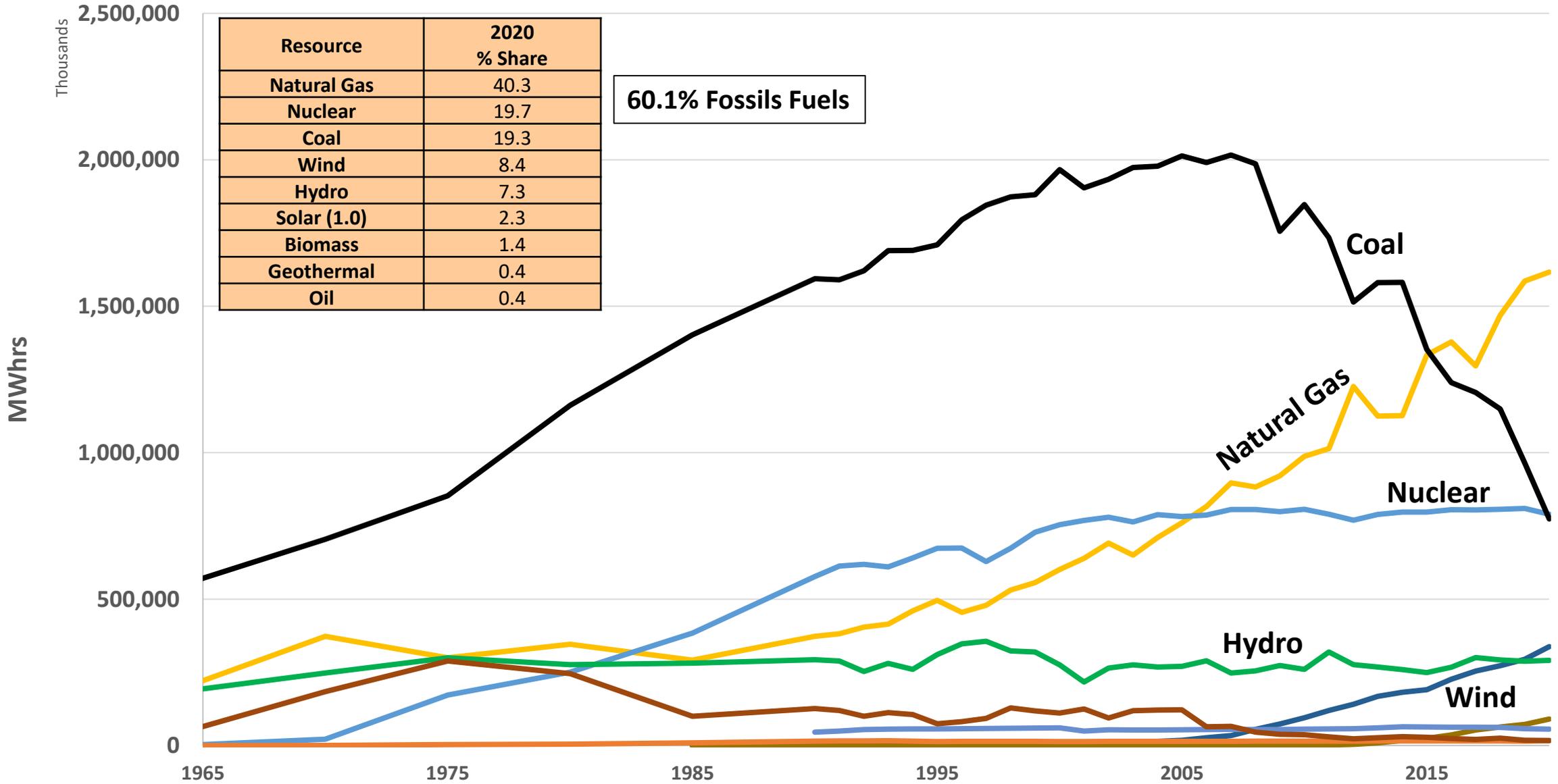
US Total Energy Consumption

Petroleum Natural Gas Coal Nuclear Hydro Non-hydro Renewables



US Electricity Profile: Utility-Scale

— Natural Gas
 — Nuclear
 — Coal
 — Wind
 — Hydro
 — Solar
 — Biomass
 — Geothermal
 — Petroleum



27.15 cents/kWhr

Hawaii & Alaska 2020	
Energy Source	% Share
Petroleum	46.6
Natural Gas	14.6
Coal	12.5
Hydro	12.5
Solar (8.0)	11.5
Wind	4.9
Biomass	2.0

11.88 cents/kWhr

Mountain 2020	
Energy Source	% Share
Natural Gas	34.3
Coal	31.2
Hydro	9.7
Wind	9.0
Nuclear	8.8
Solar (1.5)	6.5
Geothermal	1.3
Biomass	0.3

West North Central 2020	
Energy Source	% Share
Coal	41.7
Wind	29.6
Nuclear	12.4
Natural Gas	9.8
Hydro	5.2
Solar (0.2)	0.8
Biomass	0.5

11.99 cents/kWhr

East North Central 2020	
Energy Source	% Share
Coal	31.9
Natural Gas	29.8
Nuclear	28.8
Wind	6.3
Hydro	1.0
Biomass	0.9
Solar (0.2)	0.4

13.48 cents/kWhr

New England 2020	
Energy Source	% Share
Natural Gas	51.7
Nuclear	26.4
Hydro	8.1
Biomass	5.6
Solar (3.9)	6.2
Wind	4.0
Coal	0.2

21.20 cents/kWhr

Pacific Contiguous 2020	
Energy Source	% Share
Hydro	35.0
Natural Gas	33.3
Solar (4.8)	13.3
Wind	8.2
Nuclear	6.9
Geothermal	3.2
Biomass	2.3
Coal	1.9

16.67 cents/kWhr

West South Central 2020	
Energy Source	% Share
Natural Gas	53.3
Wind	17.2
Coal	14.6
Nuclear	10.3
Hydro	1.6
Solar (0.3)	1.4
Biomass	0.7

11.29 cents/kWhr

East South Central 2020	
Energy Source	% Share
Natural Gas	40.3
Coal	24.6
Nuclear	25.3
Hydro	7.9
Biomass	1.7
Solar (0.1)	0.4

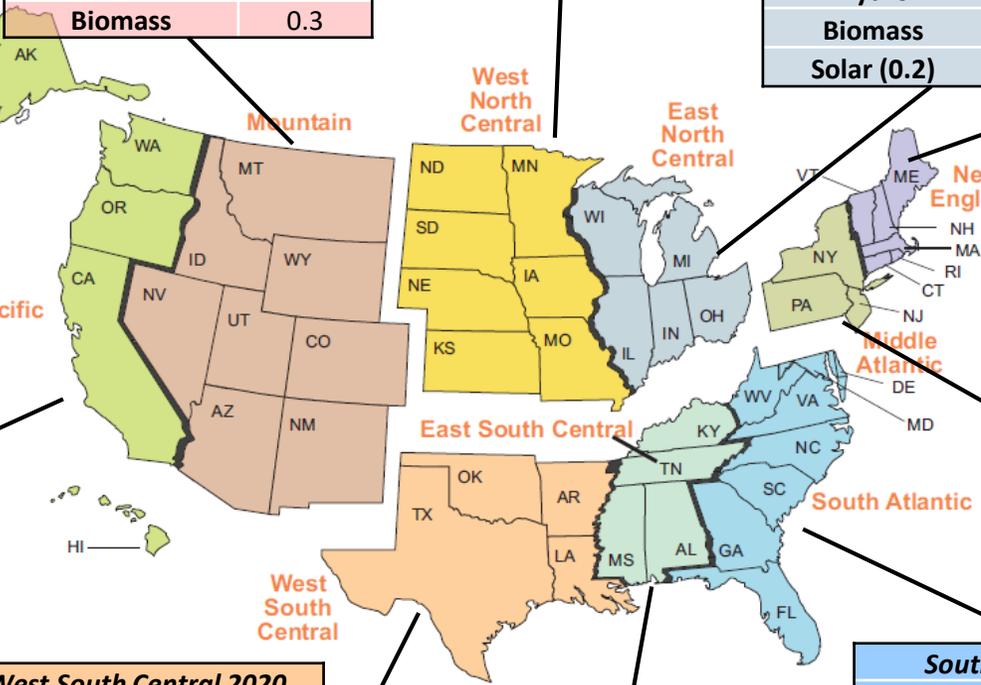
11.36 cents/kWhr

South Atlantic 2020	
Energy Source	% Share
Natural Gas	50.1
Nuclear	25.8
Coal	15.3
Solar (0.5)	3.4
Hydro	2.4
Biomass	2.4
Wind	0.4

11.89 cents/kWhr

15.92 cents/kWhr

Middle Atlantic 2020	
Energy Source	% Share
Natural Gas	48.1
Nuclear	33.4
Hydro	8.2
Coal	5.9
Wind	2.1
Solar (1.3)	2.0
Biomass	1.1



Residential Rates 2020
U.S. Avg: 13.2 cents/kWhr

27.15 cents/kWhr

Hawaii & Alaska 2020	
Energy Source	% Share
Petroleum	46.6
Natural Gas	14.6
Coal	12.5
Hydro	12.5
Solar (8.0)	11.5
Wind	4.9
Biomass	2.0

11.88 cents/kWhr

Mountain 2020	
Energy Source	% Share
Natural Gas	34.3
Coal	31.2
Hydro	9.7
Wind	9.0
Nuclear	8.8
Solar (1.5)	6.5
Geothermal	1.3
Biomass	0.3

West North Central 2020	
Energy Source	% Share
Coal	41.7
Wind	29.6
Nuclear	12.4
Natural Gas	9.8
Hydro	2.2
Solar (0.7)	0.7
Biomass	0.5

11.99 cents/kWhr

East North Central 2020	
Energy Source	% Share
Coal	31.9
Natural Gas	29.8
Nuclear	28.8
Wind	6.3
Hydro	1.0
Biomass	0.9
Solar	0.4

13.48 cents/kWhr

New England 2020	
Energy Source	% Share
Natural Gas	51.7
Nuclear	26.4
Hydro	8.1
Biomass	5.6
Solar (3.9)	6.2
Wind	4.0
Coal	0.2

21.20 cents/kWhr

Pacific Contiguous 2020	
Energy Source	% Share
Hydro	35.0
Natural Gas	33.3
Solar (4.8)	13.3
Wind	8.2
Nuclear	6.9
Geothermal	3.2
Biomass	2.3
Coal	1.9

16.67 cents/kWhr

West South Central 2020	
Energy Source	% Share
Natural Gas	53.3
Wind	17.2
Coal	14.6
Nuclear	10.3
Hydro	1.6
Solar (0.3)	1.4
Biomass	0.7

11.29 cents/kWhr

East South Central 2020	
Energy Source	% Share
Natural Gas	40.3
Nuclear	25.3
Coal	24.6
Hydro	7.9
Biomass	1.7
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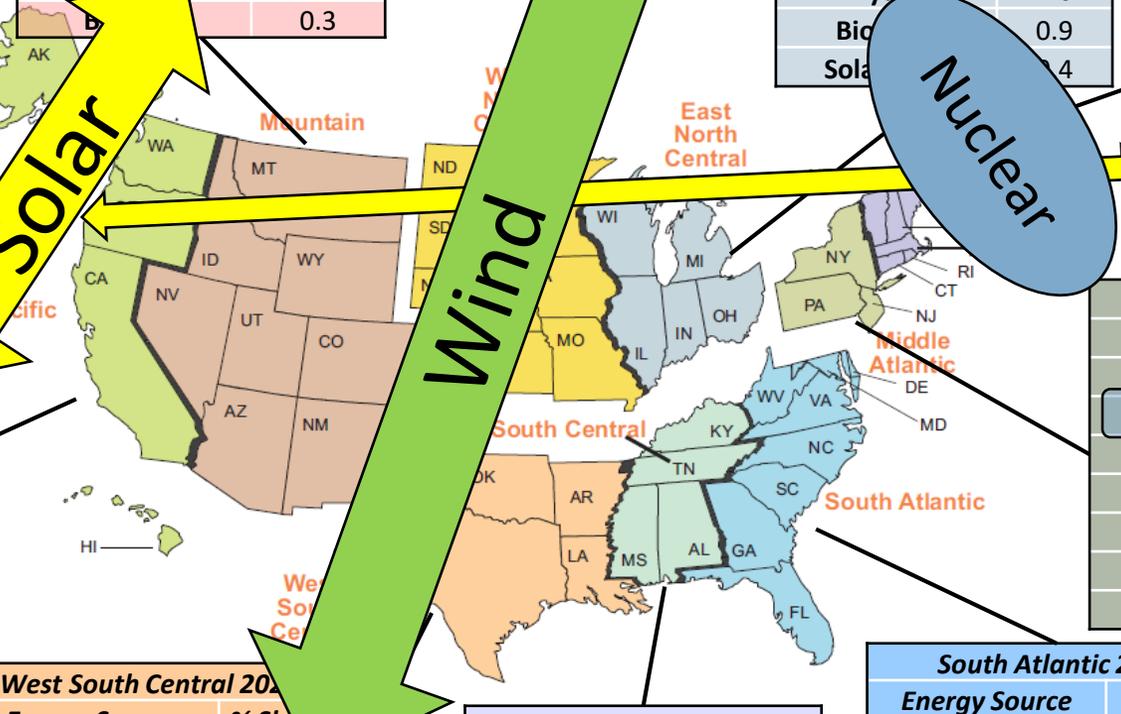
11.36 cents/kWhr

South Atlantic 2020	
Energy Source	% Share
Natural Gas	50.1
Nuclear	25.8
Coal	15.3
Solar (0.5)	3.4
Hydro	2.4
Biomass	2.4
Wind	0.4

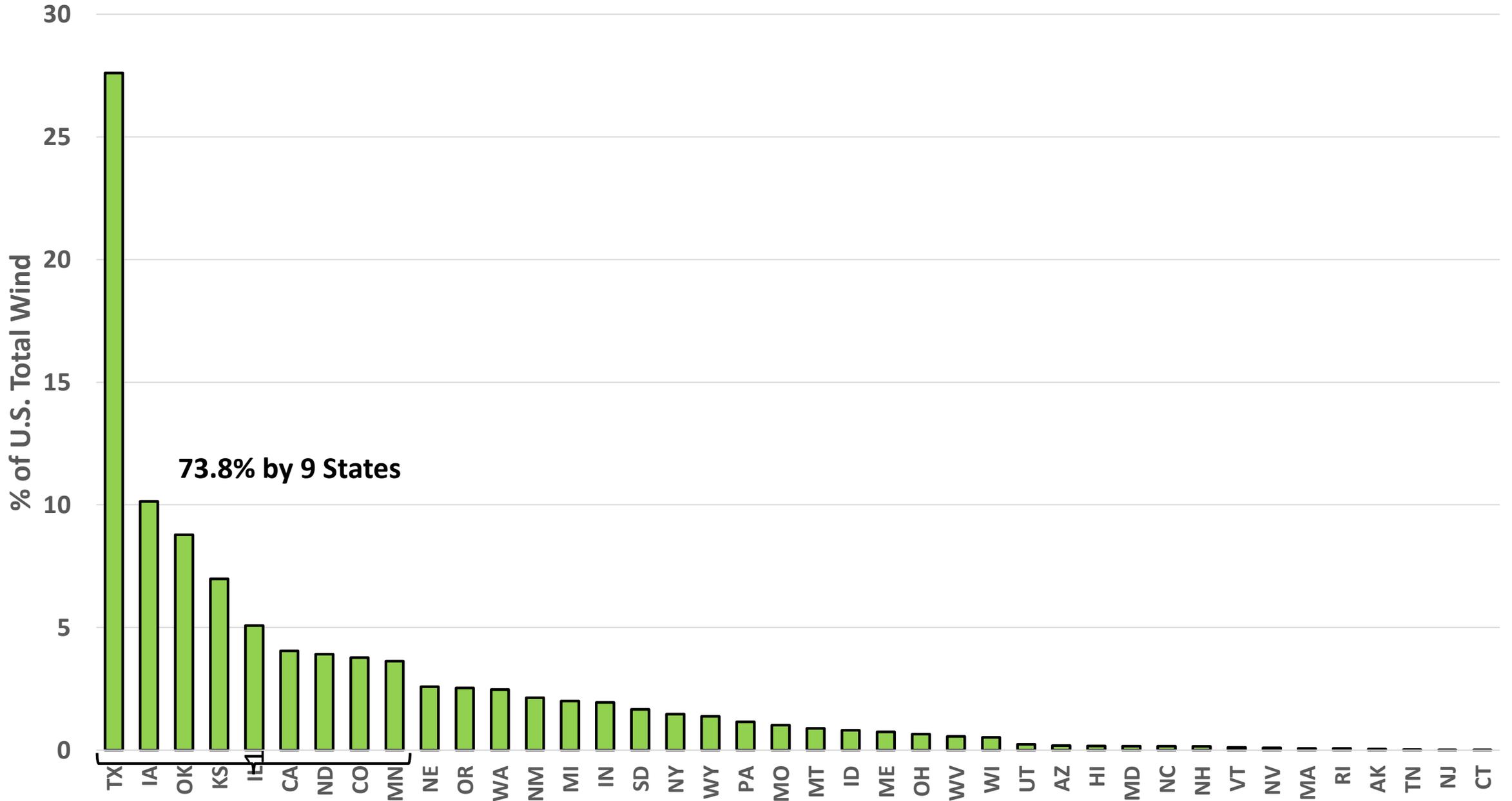
11.89 cents/kWhr

15.92 cents/kWhr

Residential Rates 2020
U.S. Avg: 13.2 cents/kWhr

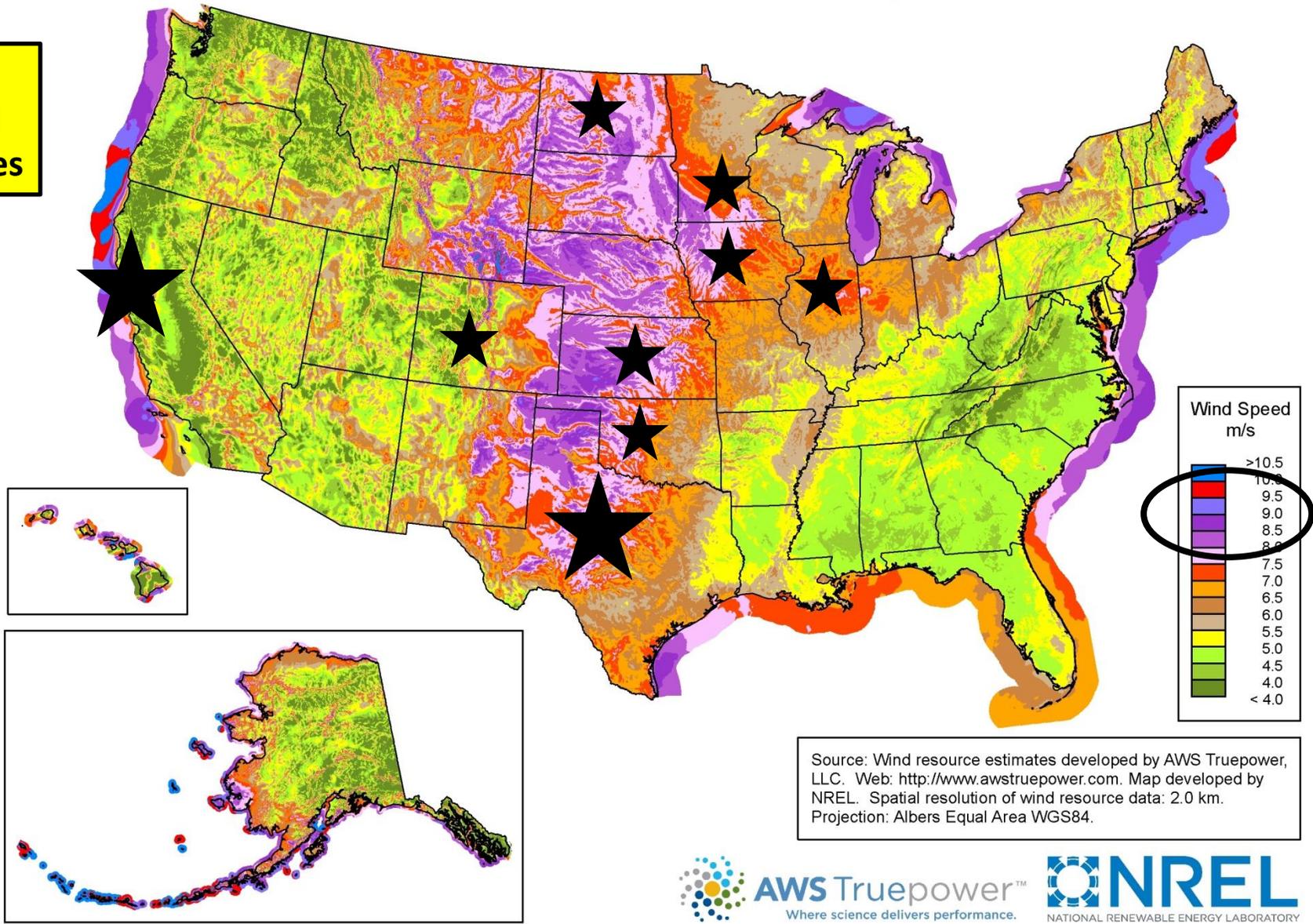


2020 Wind Generation: % Share By State

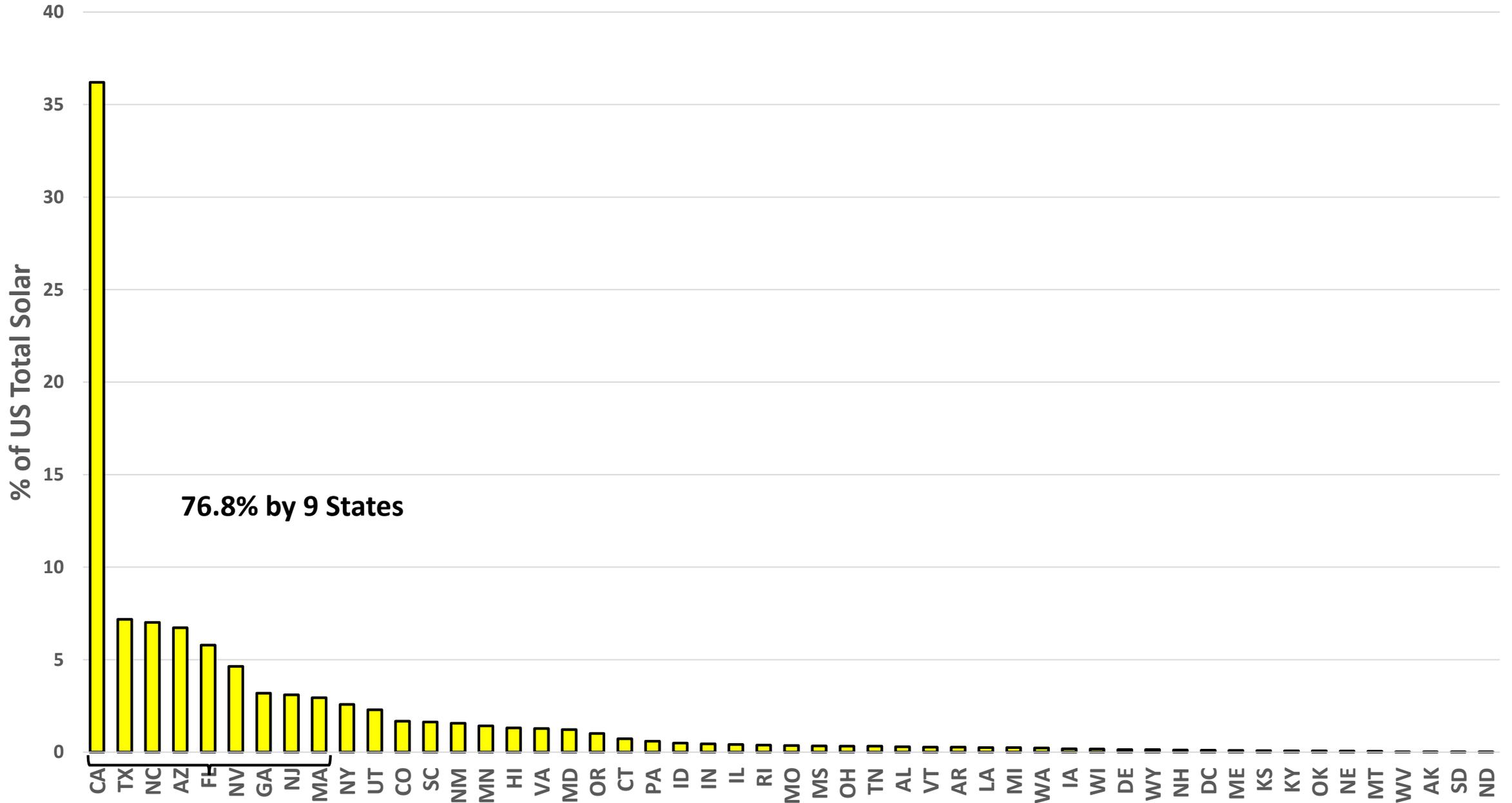


U.S. Wind Resource (80m)

2020 ★
73.8% of U.S. Wind
Generated by 9 States

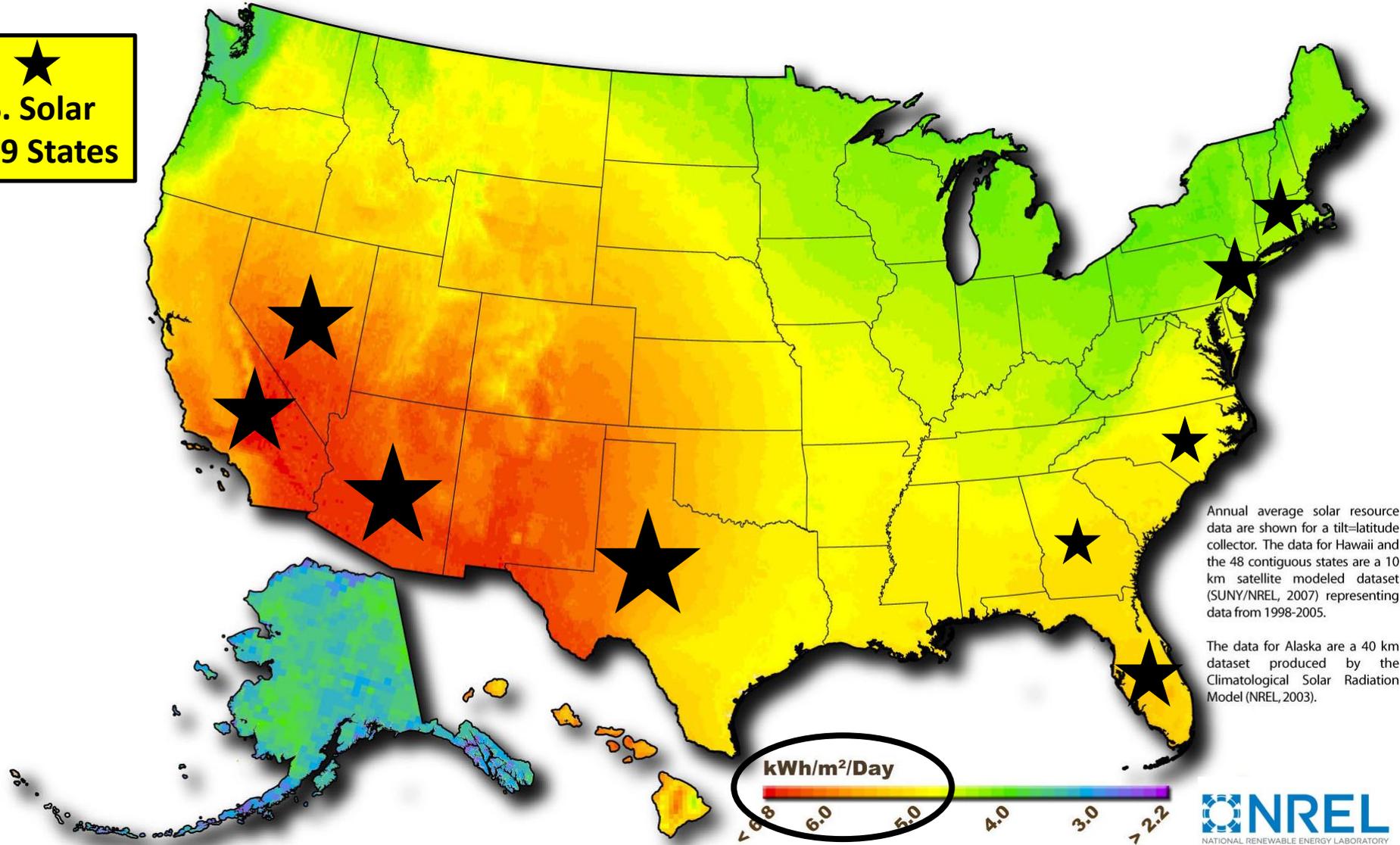


2020 Solar Generation: % Share by State



U.S. Photovoltaic Solar Resource

2020 ★
76.8% of U.S. Solar
Generated by 9 States



Author : Billy Roberts - October 20, 2008

This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

Power Generation Resources: Operational Characteristics

Energy Resource	Operational Characteristics Based on Reliability, Availability			
	Type	Dependency Constraints	Generation	Resource Geography
Coal	<i>Storable</i>	Energy resource is <u>independent of weather conditions</u> and is controlled at the plant through <u>on site storage</u> (1-3 month supply)	Baseload	Transportable, maintains energy density
Natural Gas	<i>Flow Dependent</i>	Energy resource is generally independent of weather conditions, <u>is not stored on site</u> , and can be controlled at the plant but is <u>subject to upstream availability</u> (e.g., severe weather such as winter storms, hurricanes, etc. that impact infrastructure or upstream facilities and create disruptions in flow, <u>import disruptions</u>)	Dispatchable, flexible	Transportable, maintains energy density
Nuclear	<i>Storable</i>	Energy resource is <u>independent of weather conditions</u> and is controlled at the plant through <u>on site storage</u> (up to a 1.5 year supply)	Baseload	Transportable, maintains energy density
Hydro	<i>Flow Dependent & Storable</i>	Energy resource is <u>seasonally weather-dependent</u> but can be controlled at the plant	Dispatchable	Geography dependent
Solar & Wind	<i>Flow Dependent & Intermittent</i>	Energy resource is <u>daily, monthly, and seasonally weather-dependent</u> and cannot be controlled at the plant	Neither baseload nor dispatchable	Not transportable, energy density varies by geography

Performance Comparisons

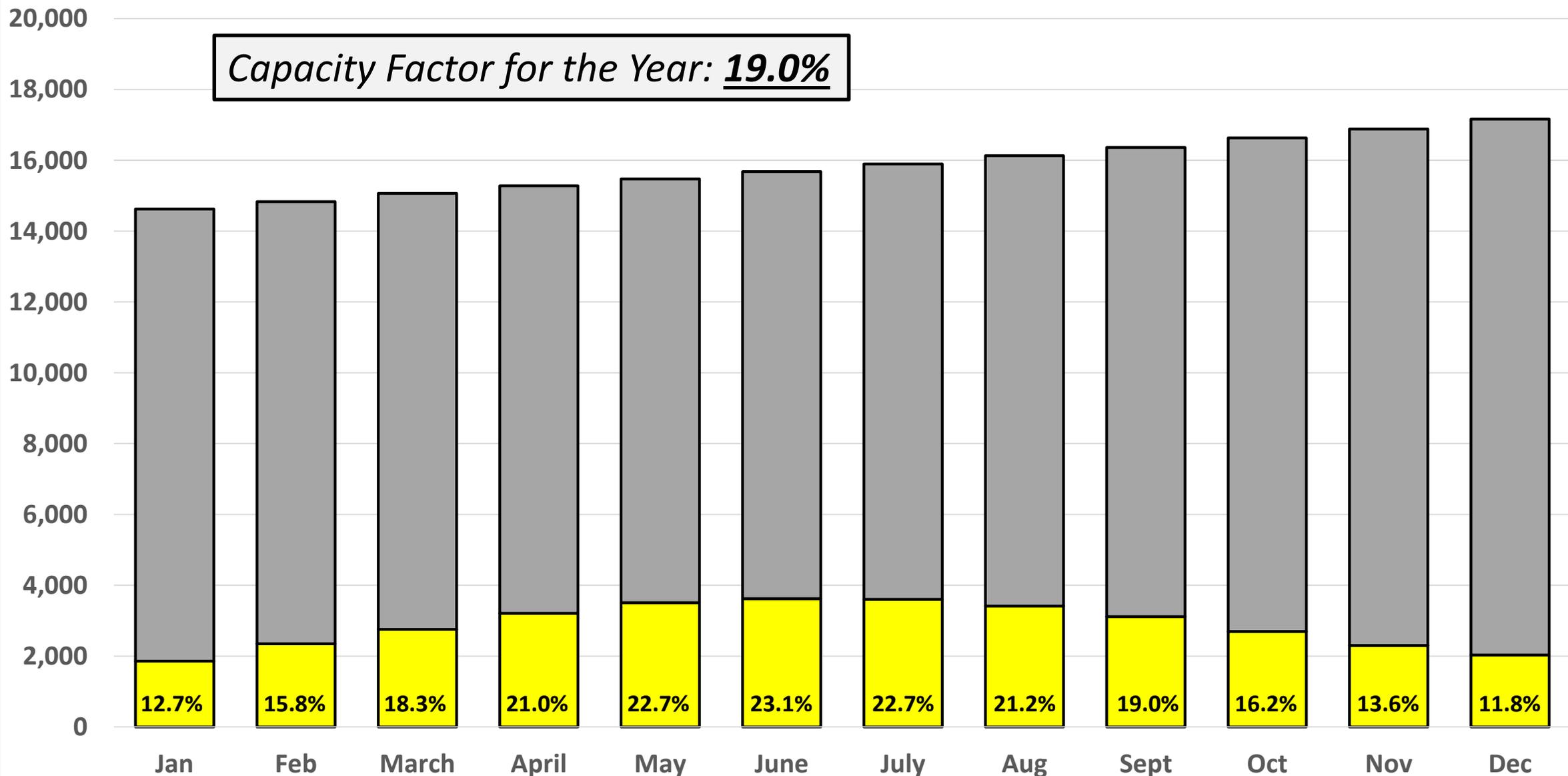
CAPACITY FACTORS:

SOLAR, WIND, HYDRO, COAL, NATURAL GAS, NUCLEAR

2020 U.S. Residential Solar PV (MW)

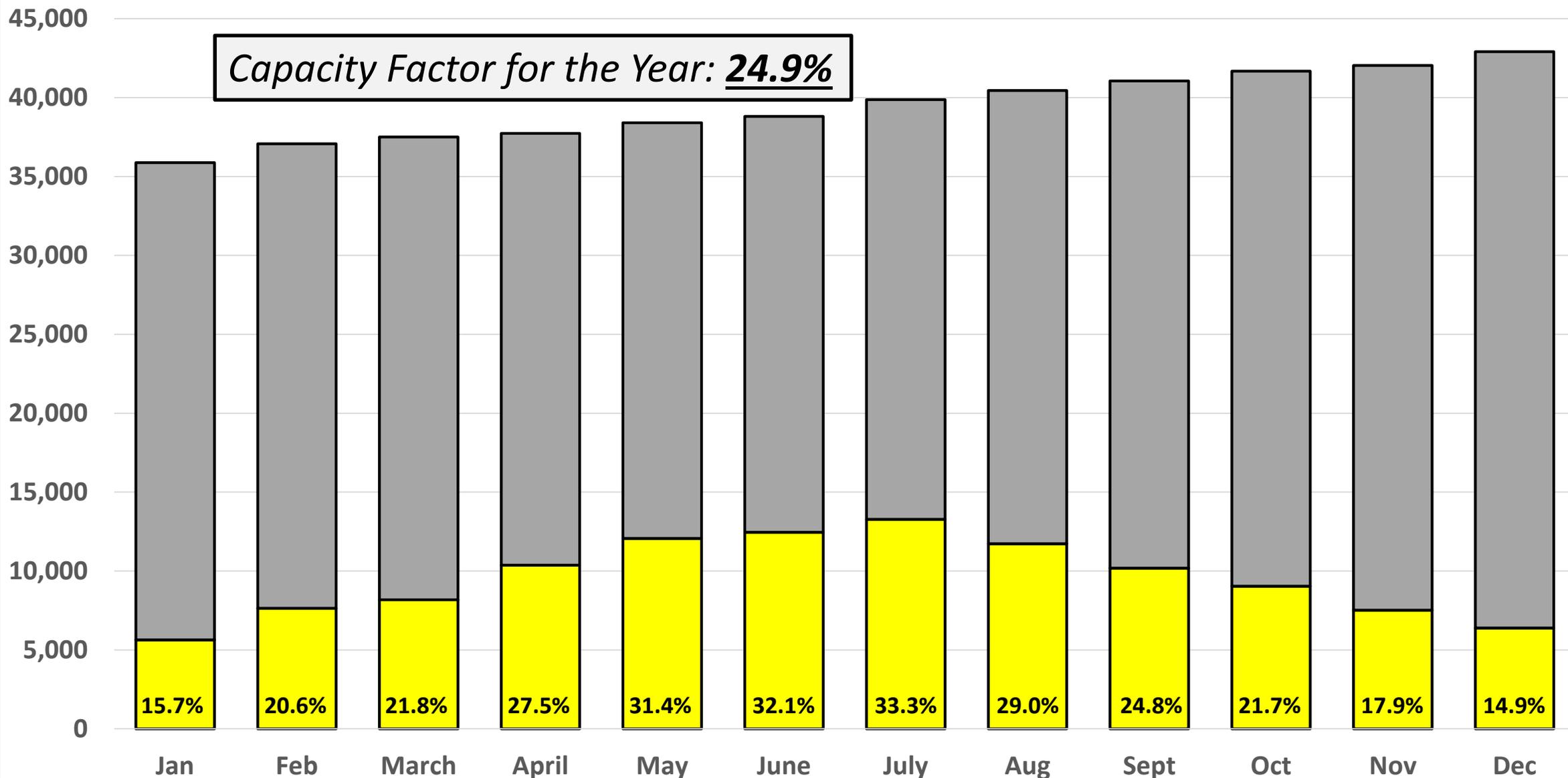
Actual Generation Stranded Generation

*Capacity Factor for the Year: **19.0%***



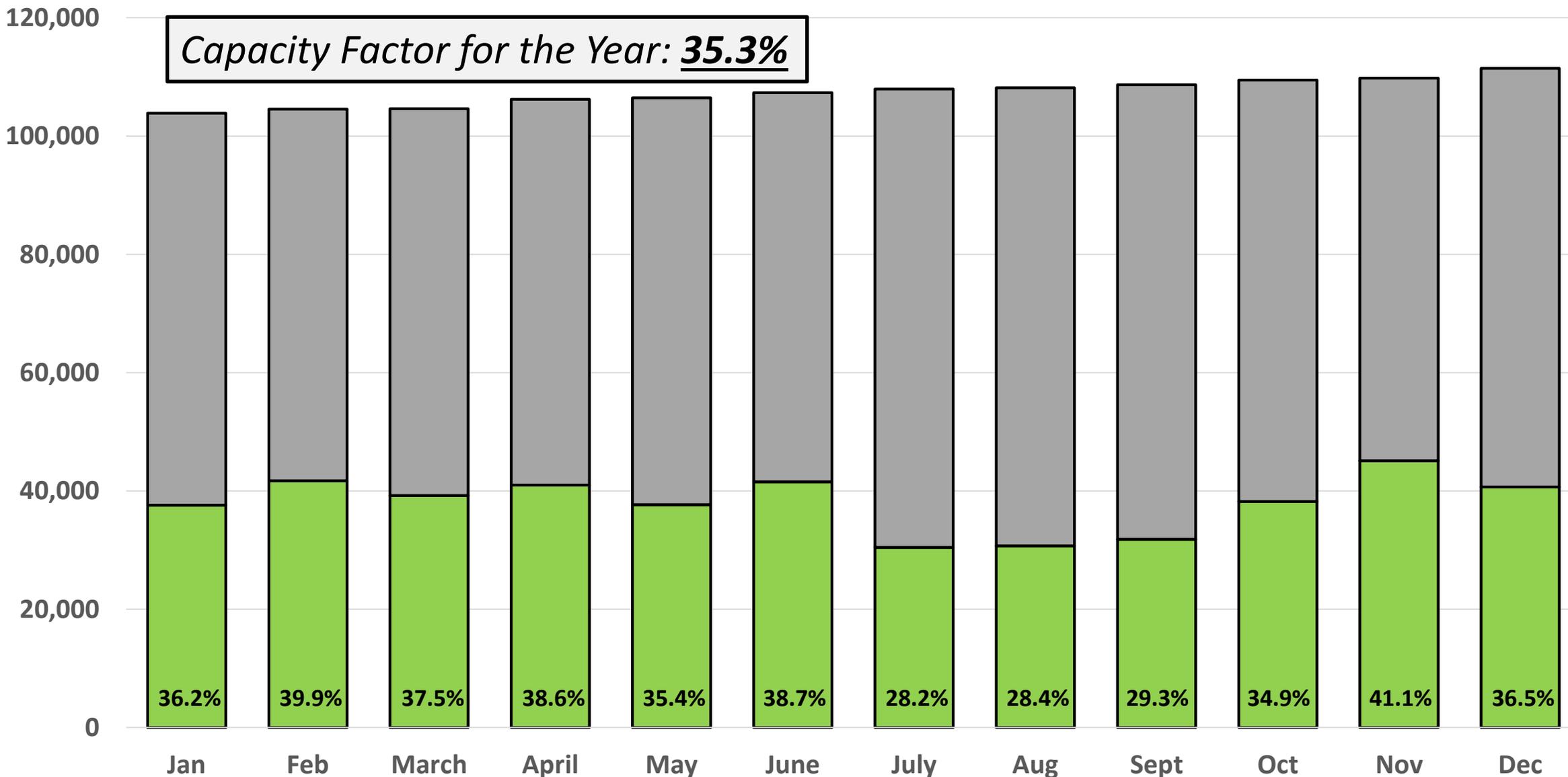
202 U.S. Utility-Scale Solar PV (MW)

Actual Generation Stranded Generation



2020 U.S. Wind (MW)

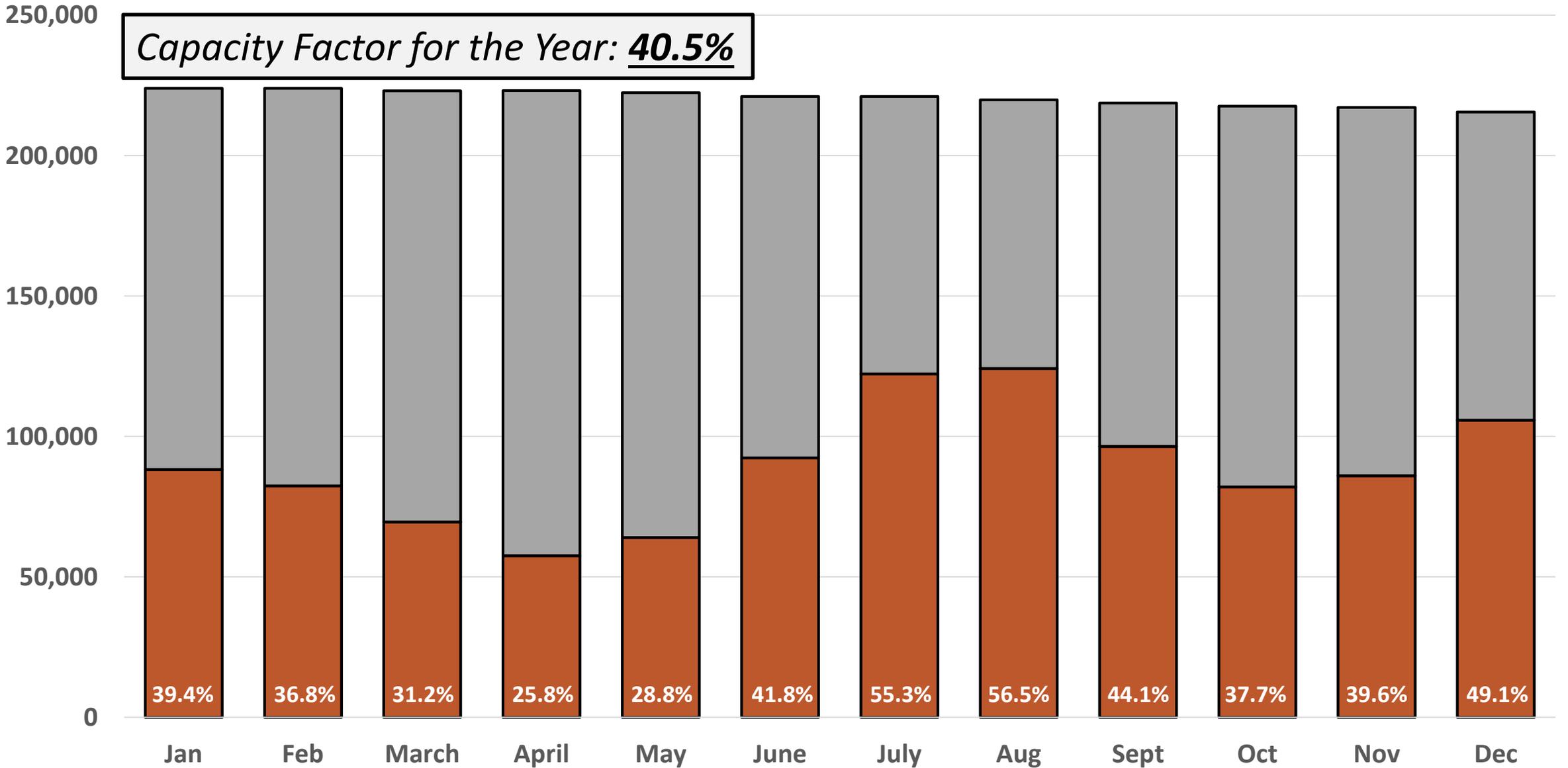
Actual Generation Stranded Generation



2020 U.S. Coal (MW)

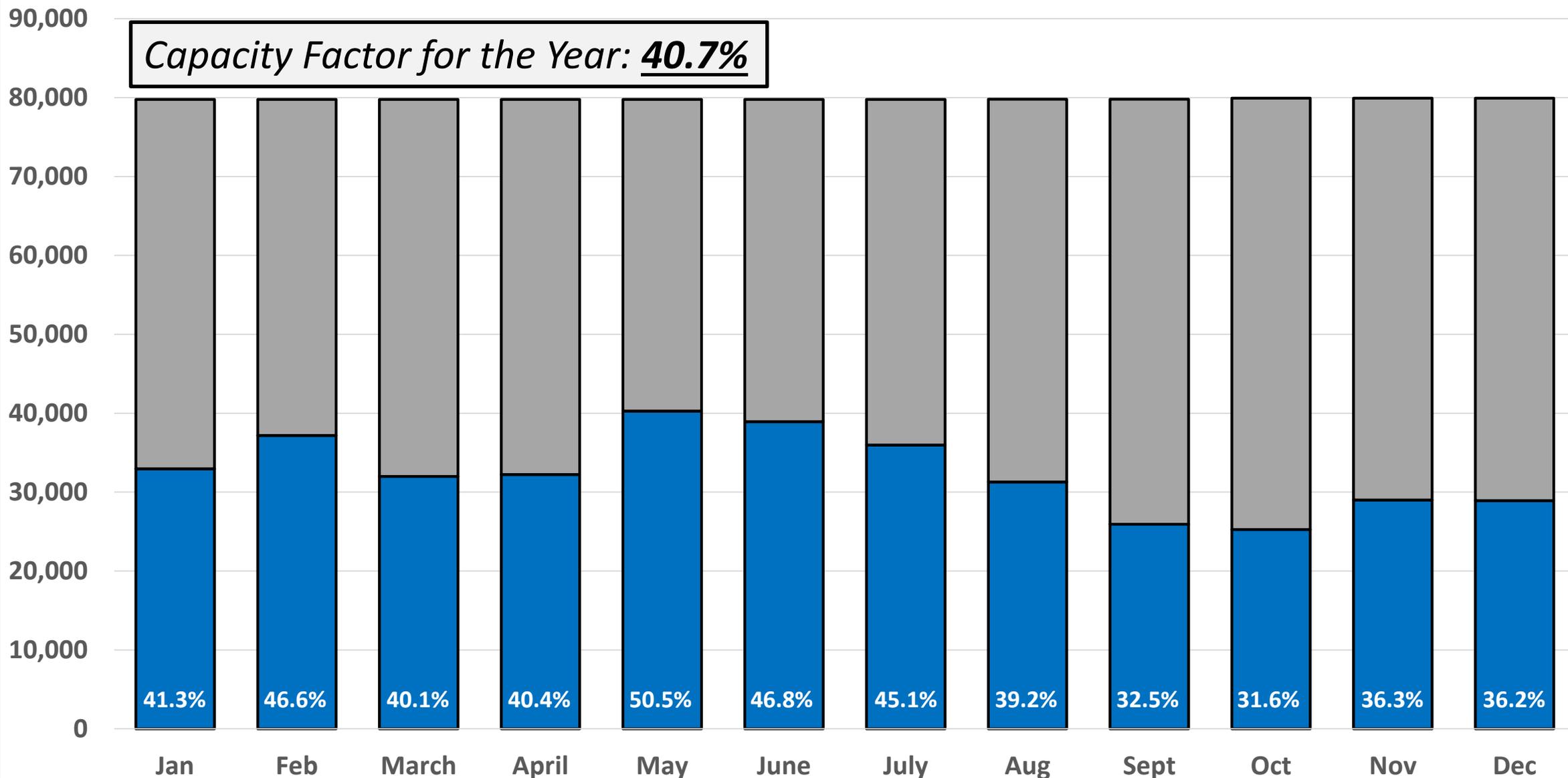
Actual Generation Stranded Generation

*Capacity Factor for the Year: **40.5%***



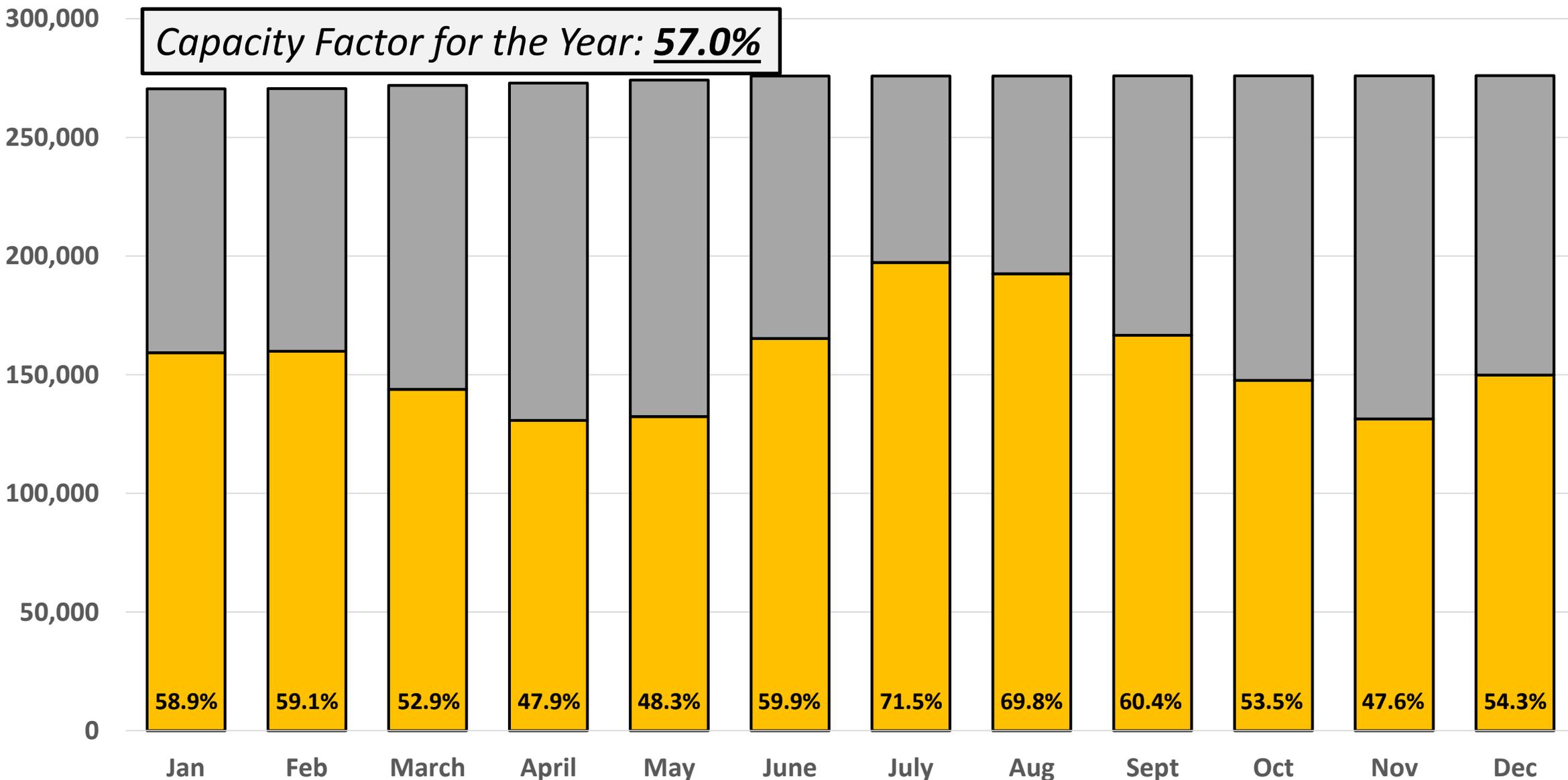
2020 U.S. Hydroelectric (MW)

Actual Generation Stranded Generation



2020 U.S. Natural Gas Combined-Cycle (MW)

Actual Generation Stranded Generation



2020 U.S. Nuclear (MW)

Actual Generation Stranded Generation

120,000

*Capacity Factor for the Year: **92.4%***

100,000

80,000

60,000

40,000

20,000

0

Jan

Feb

March

April

May

June

July

Aug

Sept

Oct

Nov

Dec

100%

96.5%

87.7%

83.9%

89.1%

96.2%

96.1%

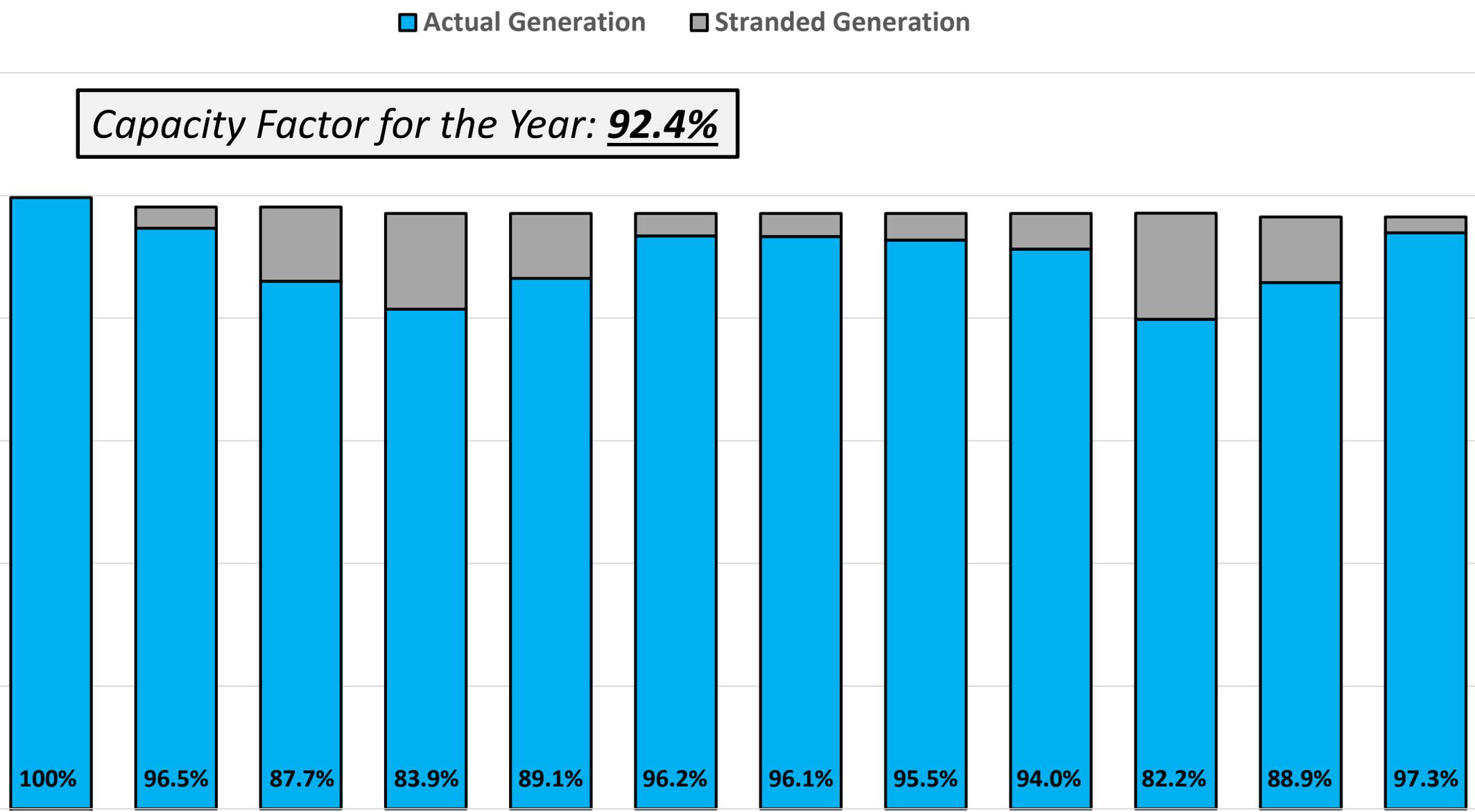
95.5%

94.0%

82.2%

88.9%

97.3%



US Nuclear Reactors: Shutdown & Under Threat

Status	Plant	Nameplate Capacity (MW)	Location	Generation (MWhrs)	Retirement Year (or announced)
Retired (11)	Crystal River	860	Florida	7,000,079	2013
	Kewaunee	566	Wisconsin	4,990,254	2013
	San Onofre 2 & 3	2,150	California	18,097,173	2013
	Vermont Yankee	604	Vermont	5,060,582	2014
	Fort Calhoun	483	Nebraska	3,425,235	2016
	Oyster Creek	608	New Jersey	4,585,091	2018
	Pilgrim	674	Massachusetts	5,414,318	2019
	Three Mile Island 1	803	Pennsylvania	5,214,196	2019
	Duane Arnold	601	Iowa	5,235,716	2020
	Indian Point 2	1,016	New York	8,351,945	2020
	Total	8,365		67,374,589	
Planned (8)	Diablo Canyon 1 & 2	2,240	California	16,258,298	2024, 2025
	Palisades	772	Michigan	5,995,123	2022
	Dresden 2 & 3	1,797	Illinois	15,478,888	2021
	Byron 1&2	2,300	Illinois	15,524,894	2021
	Indian Point 3	1,038	New York	9,108,821	2021
	Total	8,147		62,366,024	
State Action (16)	Davis-Besse	894	Ohio	7,228,063	2020 (Hold)
	Perry	1,240	Ohio	10,990,962	2021 (Hold)
	Beaver Valley 1 & 2	1,808	Pennsylvania	15,393,393	2021 (Hold)
	FitzPatrick	848	New York	6,588,676	2017 (Hold)
	R. E. Ginna	581	New York	4,332,888	2017 (hold)
	Clinton	1,065	Illinois	9,462,481	2017 (Hold)
	Nine Mile Point 1&2	2,054	New York	15,640,608	2017, 2018 (Hold)
	Quad Cities 1 & 2	1,819	Illinois	15,712,445	2018 (Hold)
	Salem 1 & 2	2,295	New Jersey	16,145,436	2020, 2021 (Hold)
	Hope Creek	1,172	New Jersey	10,592,697	2021 (Hold)
	Millstone 2 & 3	2,073	Connecticut	15,714,855	2020 (Hold)
Total	15,849		127,802,504		
Total All	32,361		257,543,117		

8.5% of 2020 US nuclear level

Recently preserved by state action

Shut Down April 30, 2021

7.9% of 2020 US nuclear generation

16.2% of 2020 US nuclear generation

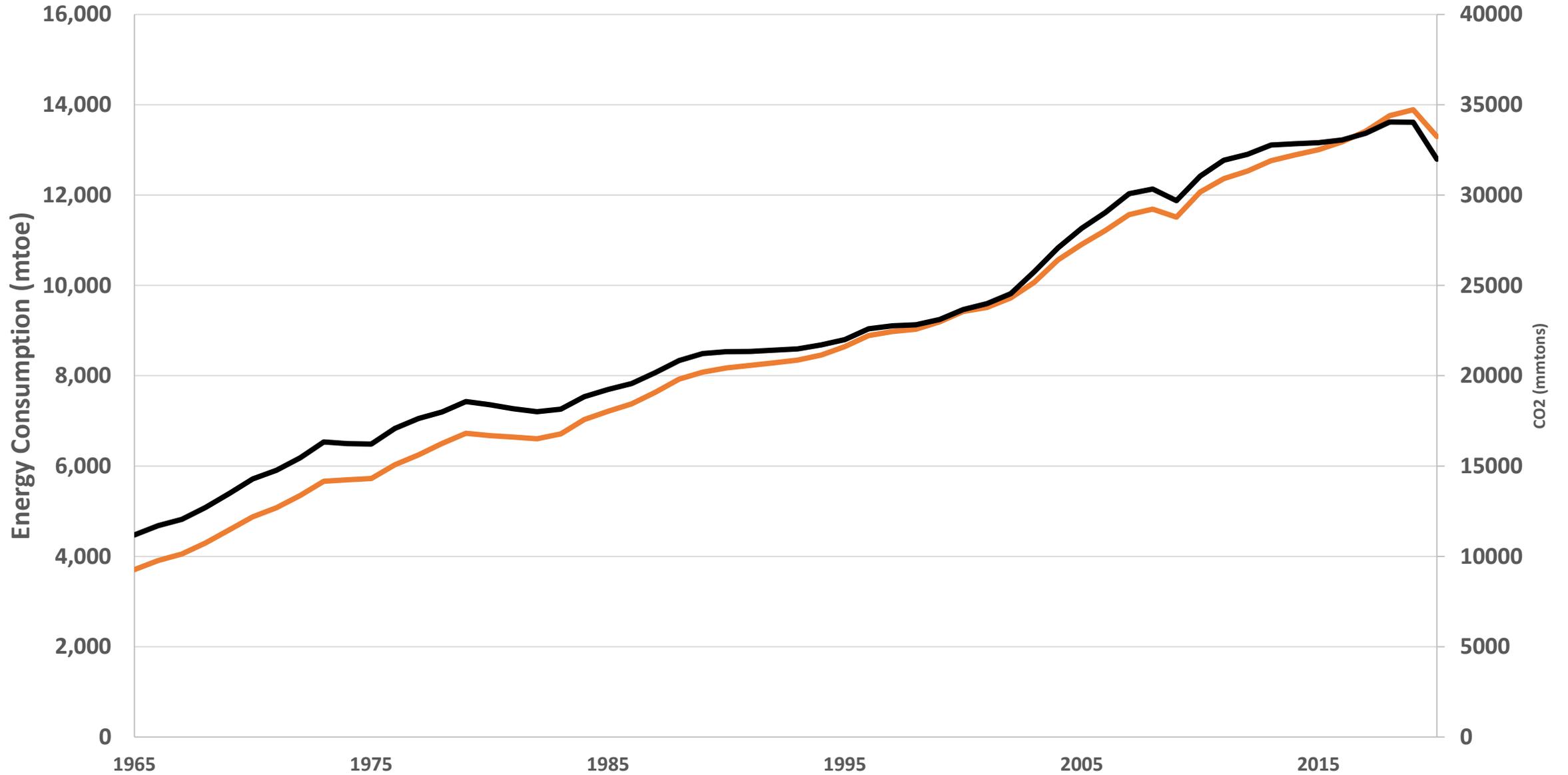
Data Source: US EIA; NEI
Retirement Years: Third Way

Global Energy & CO₂

CONTEXT & GLOBAL REALITIES

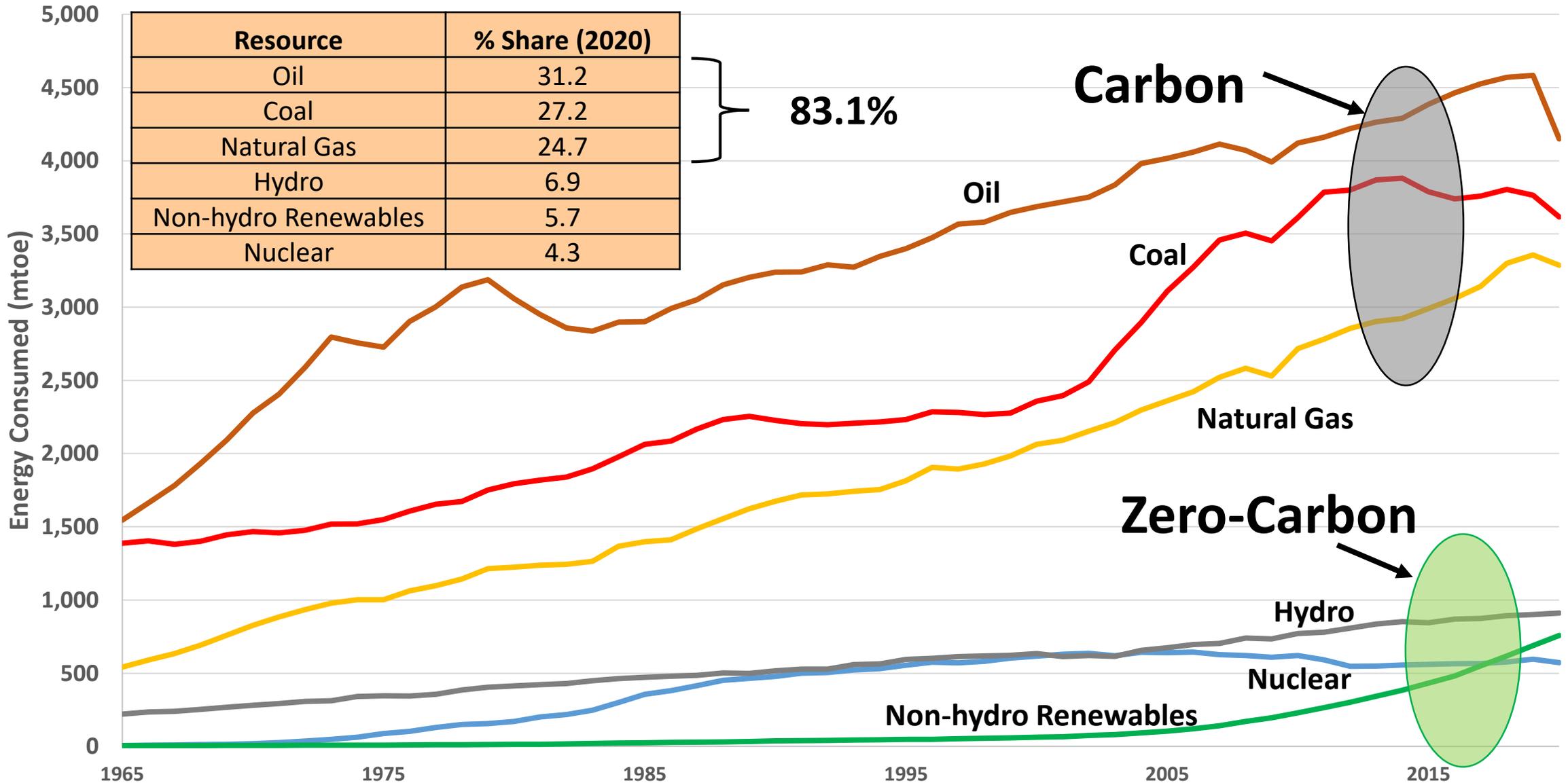
World Energy Consumption & CO₂ Emissions

Energy CO2



World Energy Consumption by Resource

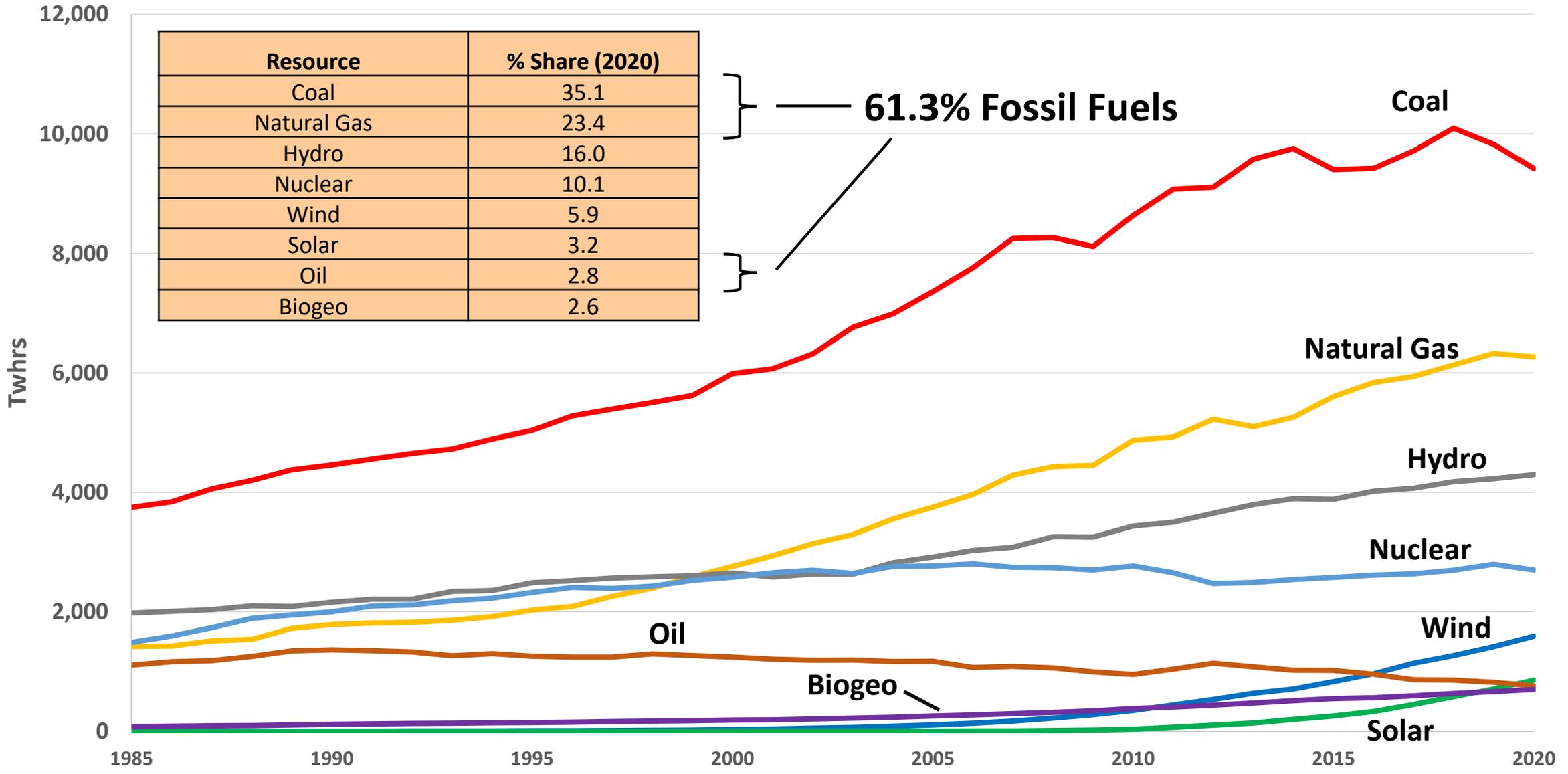
Oil Natural Gas Coal Nuclear Hydro Non-Hydro Renewables



Resource	% Share (2020)
Oil	31.2
Coal	27.2
Natural Gas	24.7
Hydro	6.9
Non-hydro Renewables	5.7
Nuclear	4.3

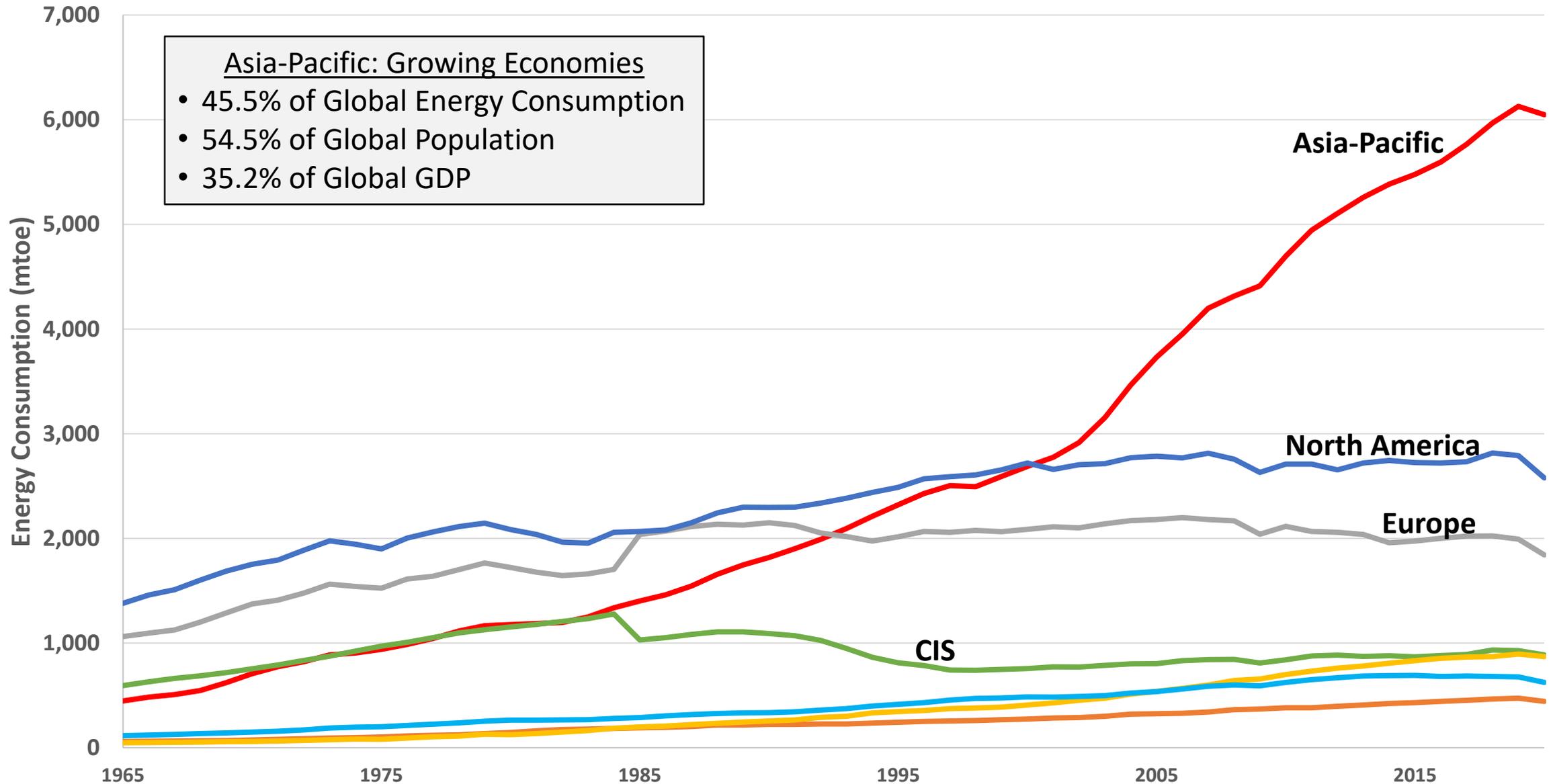
World Electricity by Fuel

Coal Natural Gas Hydro Nuclear Wind Solar Oil Biogeo



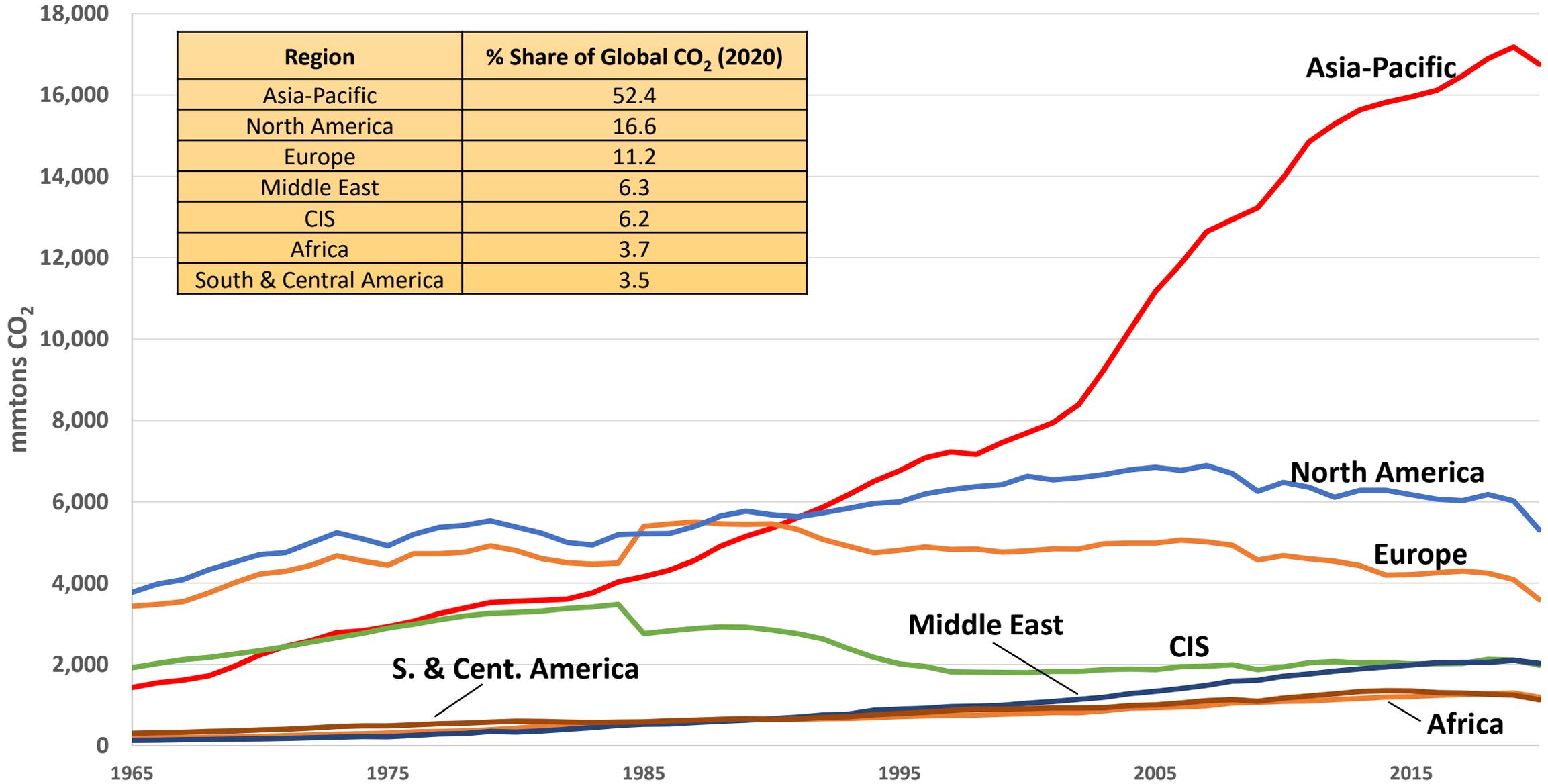
Energy Consumption by Region

Africa Asia Pacific CIS Europe Middle East North America S. & Cent. America



CO₂ Emissions by Region

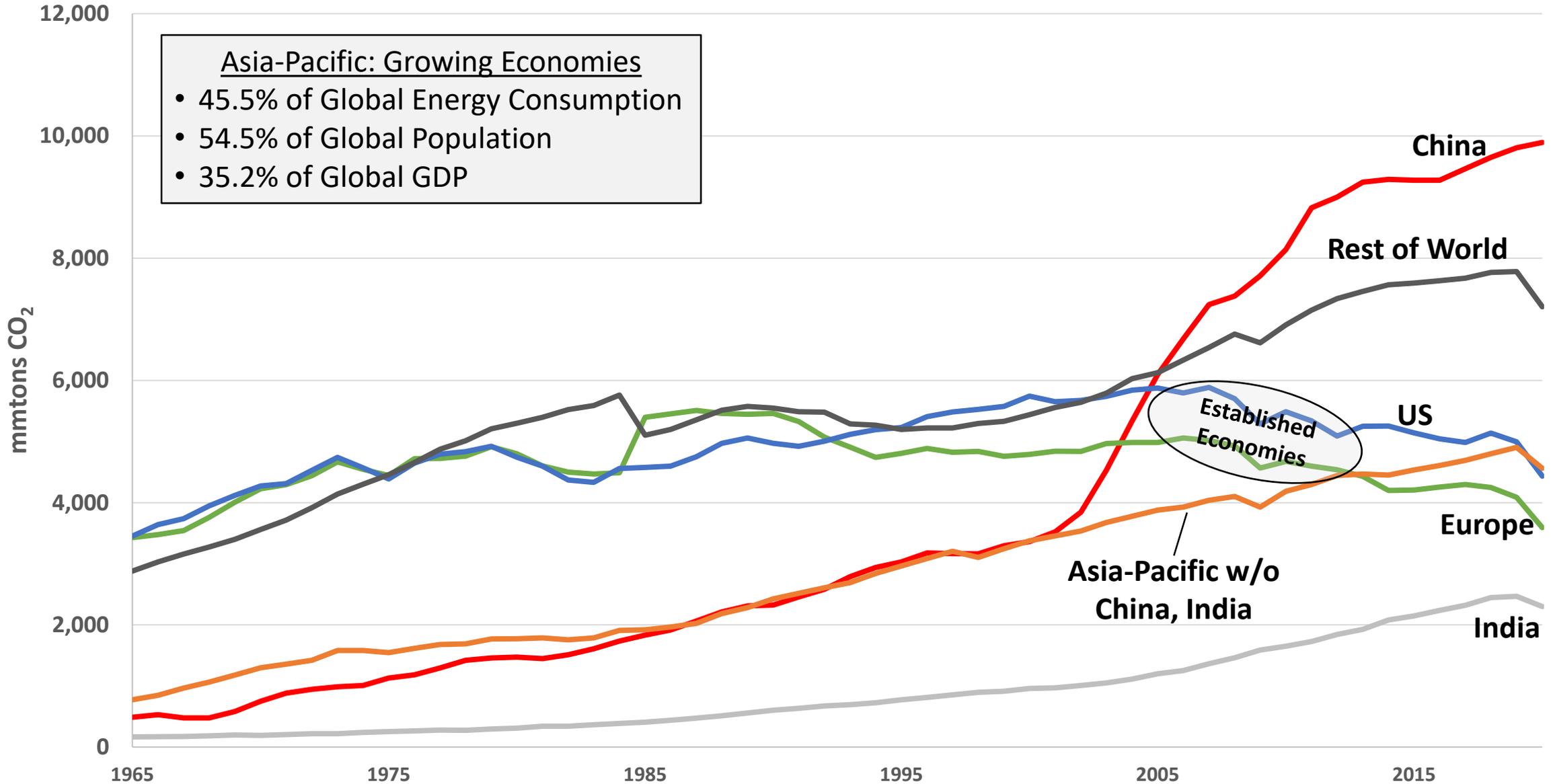
— Africa — Asia Pacific — CIS — Europe — Middle East — North America — S. & Cent. America



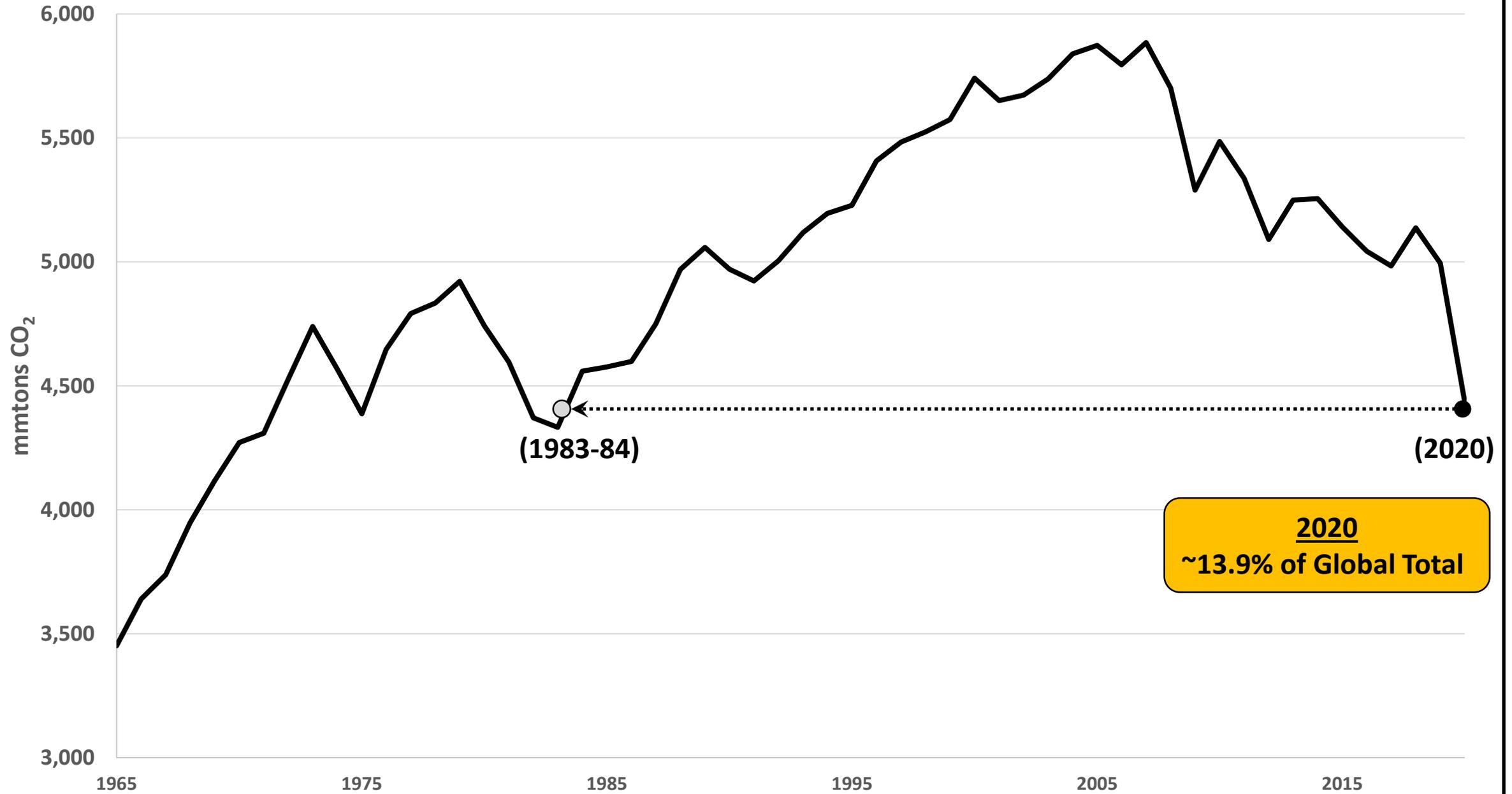
Region	% Share of Global CO ₂ (2020)
Asia-Pacific	52.4
North America	16.6
Europe	11.2
Middle East	6.3
CIS	6.2
Africa	3.7
South & Central America	3.5

CO₂ Emissions: Some Detail

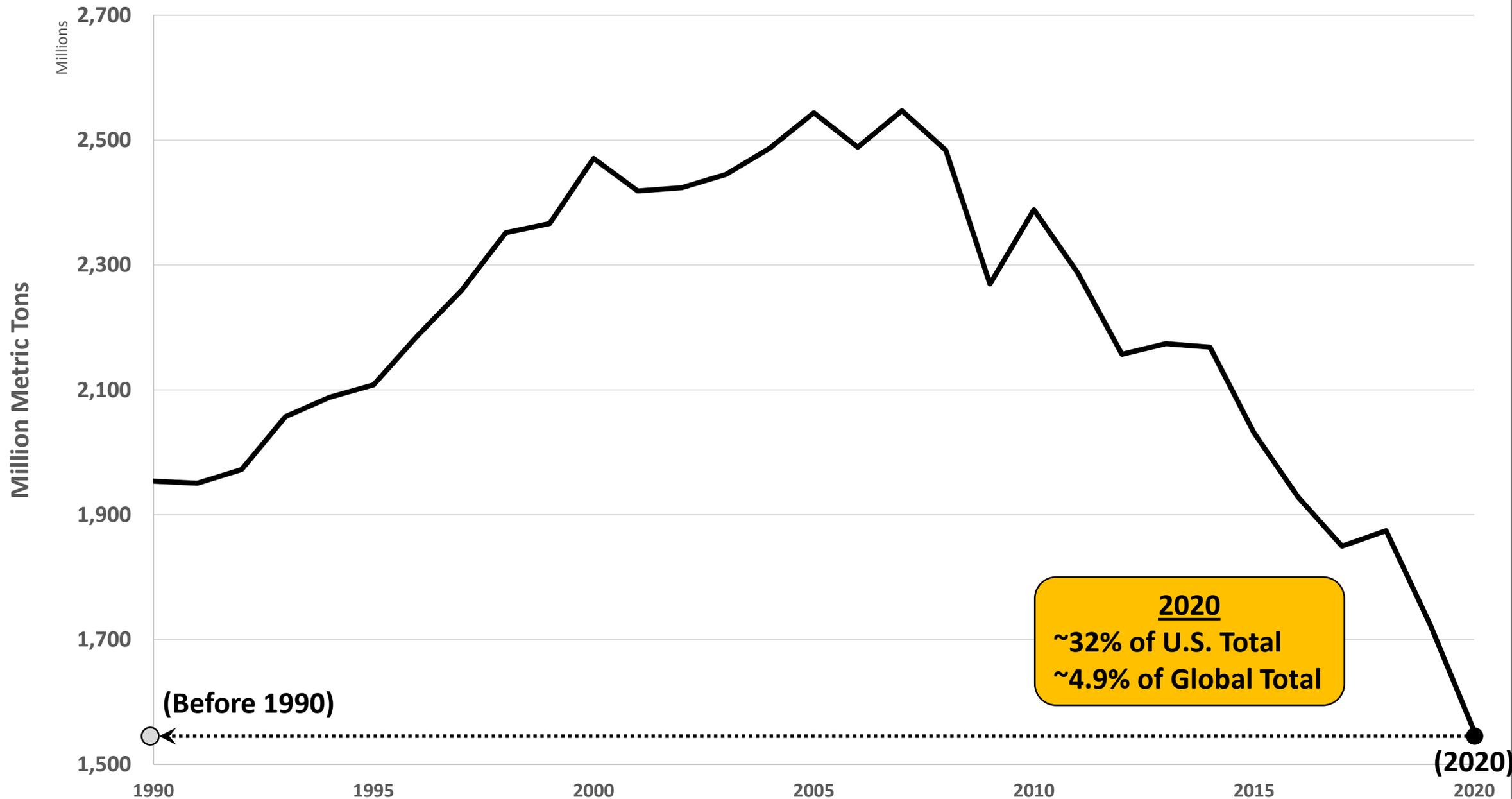
China India Europe U.S. Asia-Pacific w/o China & India Rest of World



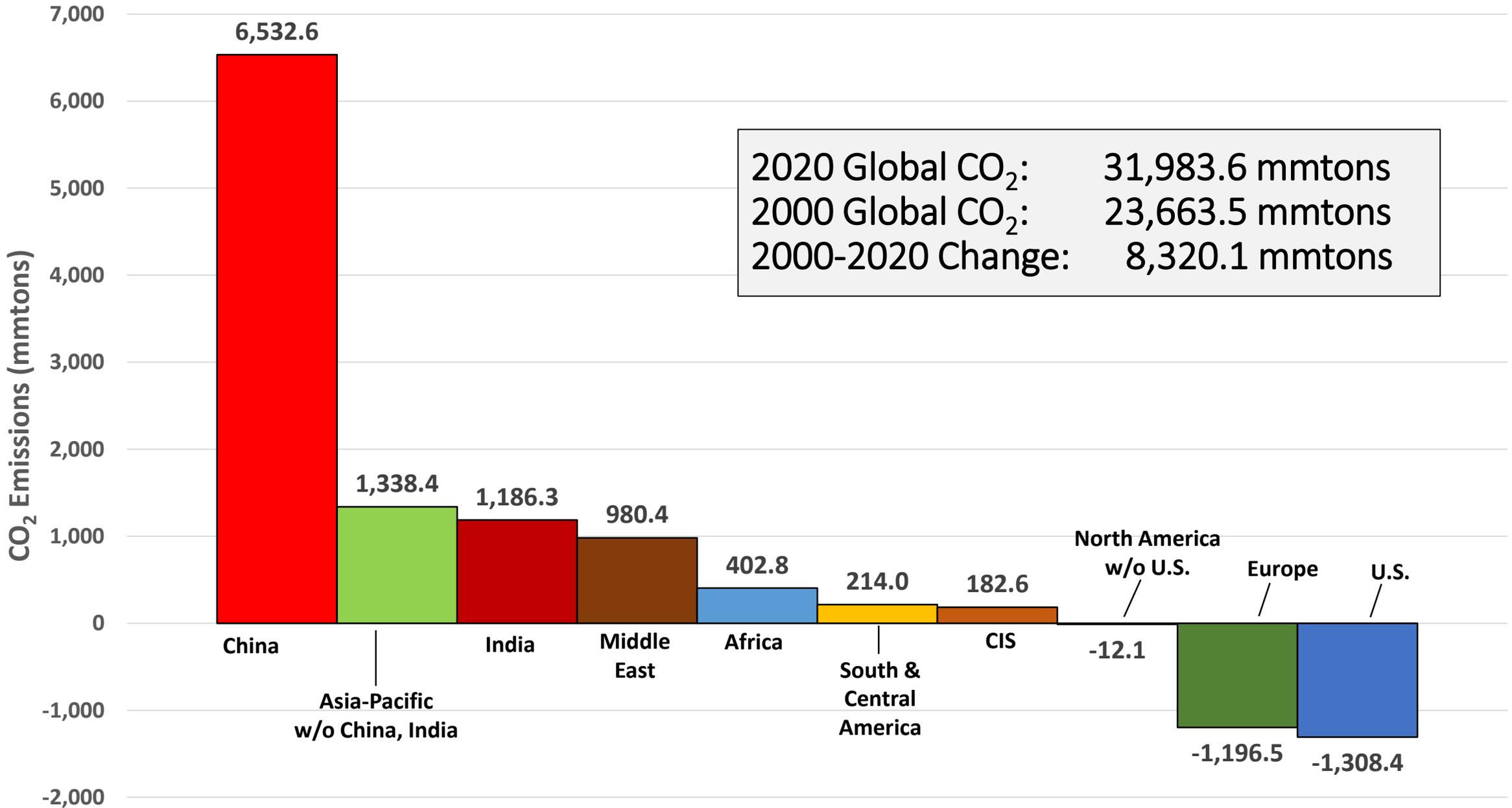
U.S. CO₂ Emissions



U.S. Total Electric Power Industry: CO₂ Emissions

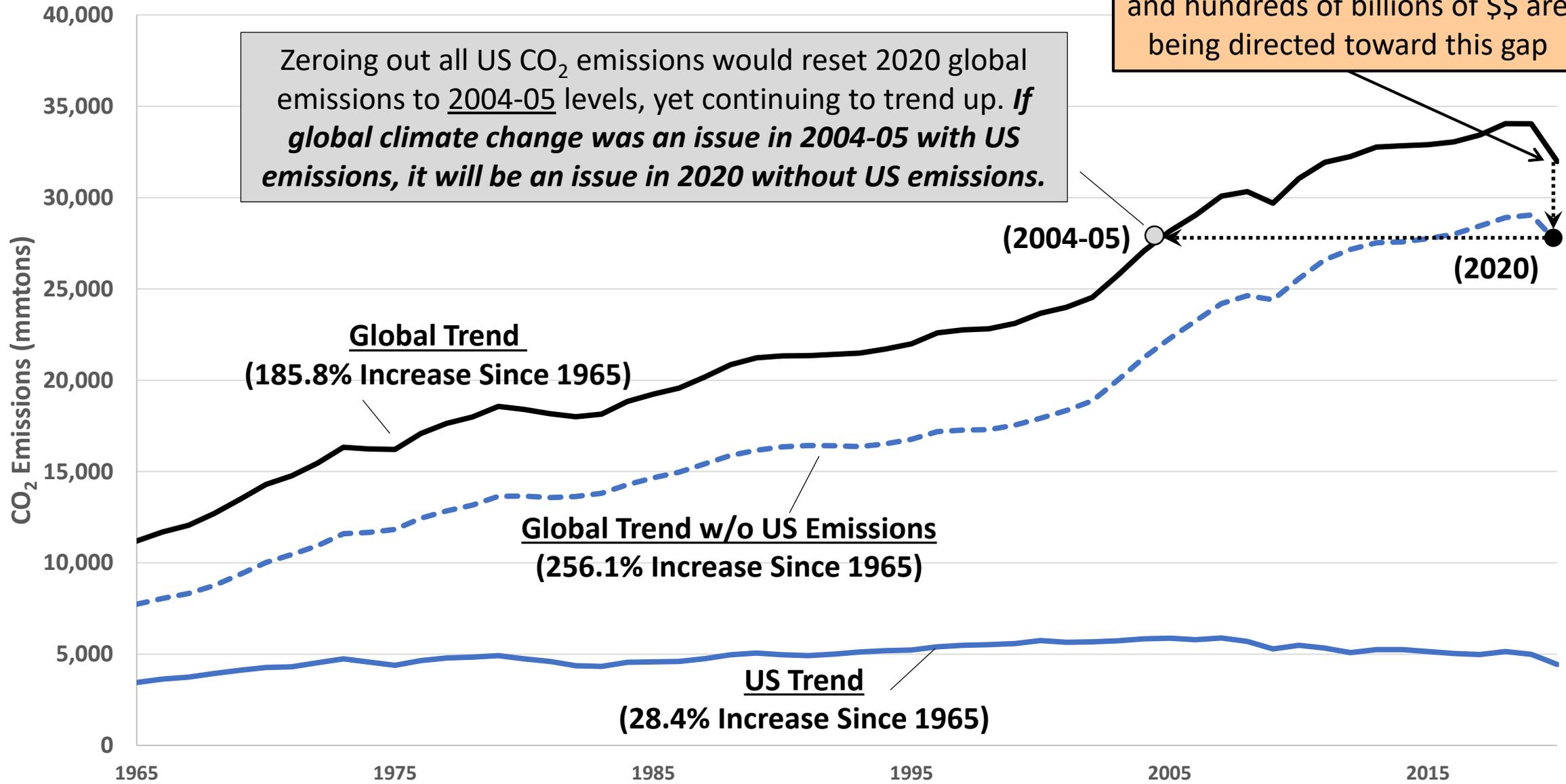


Change in CO₂ Emissions: 2000-2020



CO₂ Emissions: US and World Comparison

— World — US - - - World w/o U.S.



Zeroing out all US CO₂ emissions would reset 2020 global emissions to 2004-05 levels, yet continuing to trend up. *If global climate change was an issue in 2004-05 with US emissions, it will be an issue in 2020 without US emissions.*

Substantial US policy attention and hundreds of billions of \$\$ are being directed toward this gap

Global Trend
(185.8% Increase Since 1965)

Global Trend w/o US Emissions
(256.1% Increase Since 1965)

US Trend
(28.4% Increase Since 1965)

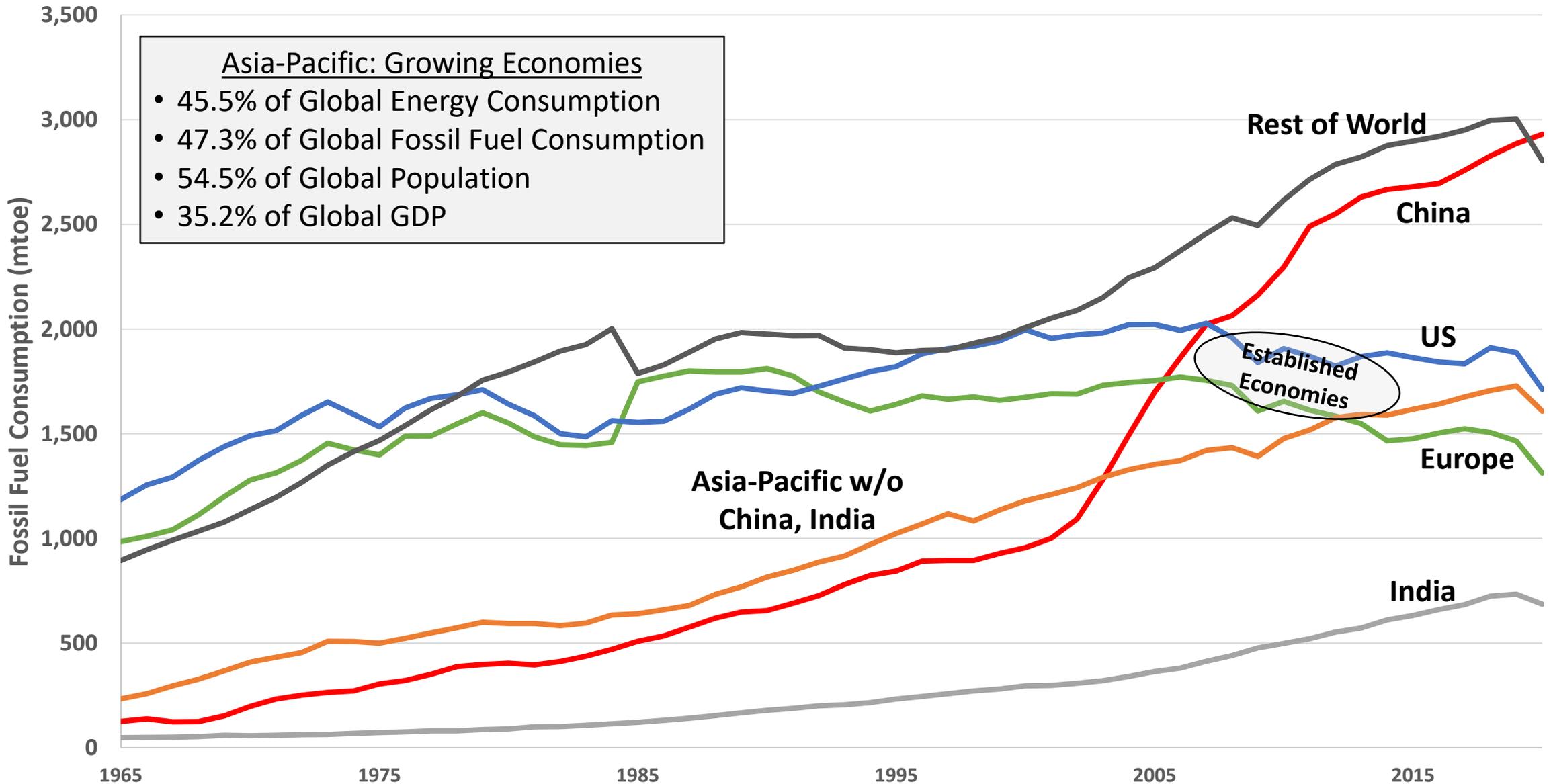
Global Competition & National Security Implications

FOSSIL FUELS, NUCLEAR & RENEWABLES

Fossil Fuels

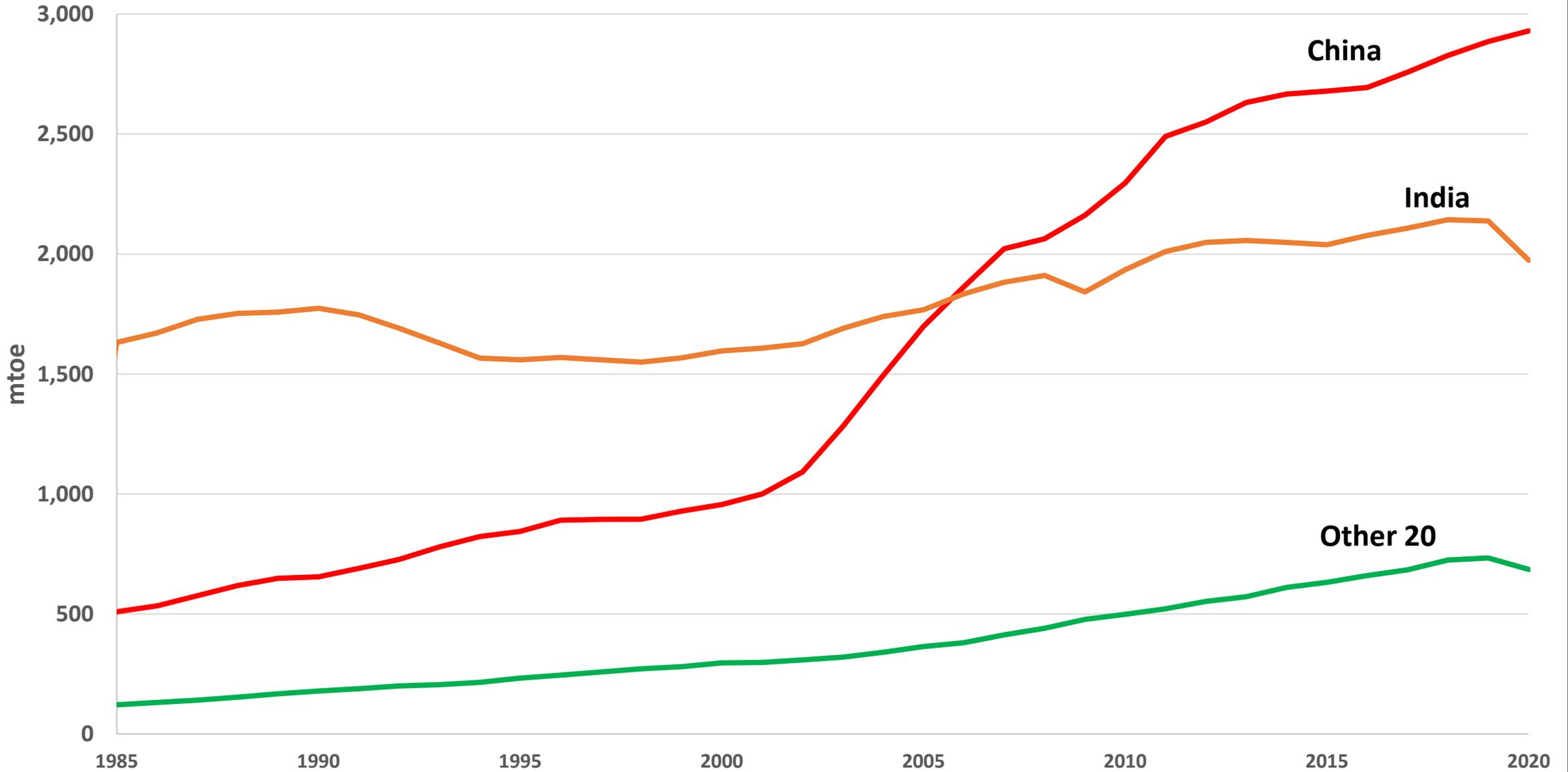
Fossil Fuel Consumption: Some Detail

China India Europe U.S. Asia-Pacific w/o China & India Rest of World



Top 22 Emerging Markets: Fossil Fuel Consumption

China India Other 20



Russia: Energy Producer & Disruptor

- Russia oil and gas
 - 50% of Russia's exports are oil and gas
 - 12.6% of global oil production
 - 16.6% of global gas production; 8.3% of global LNG exports
 - 29% of Europe's crude oil and 32.9% of Europe's gas is from Russia

References:

BP 2021 Energy Review

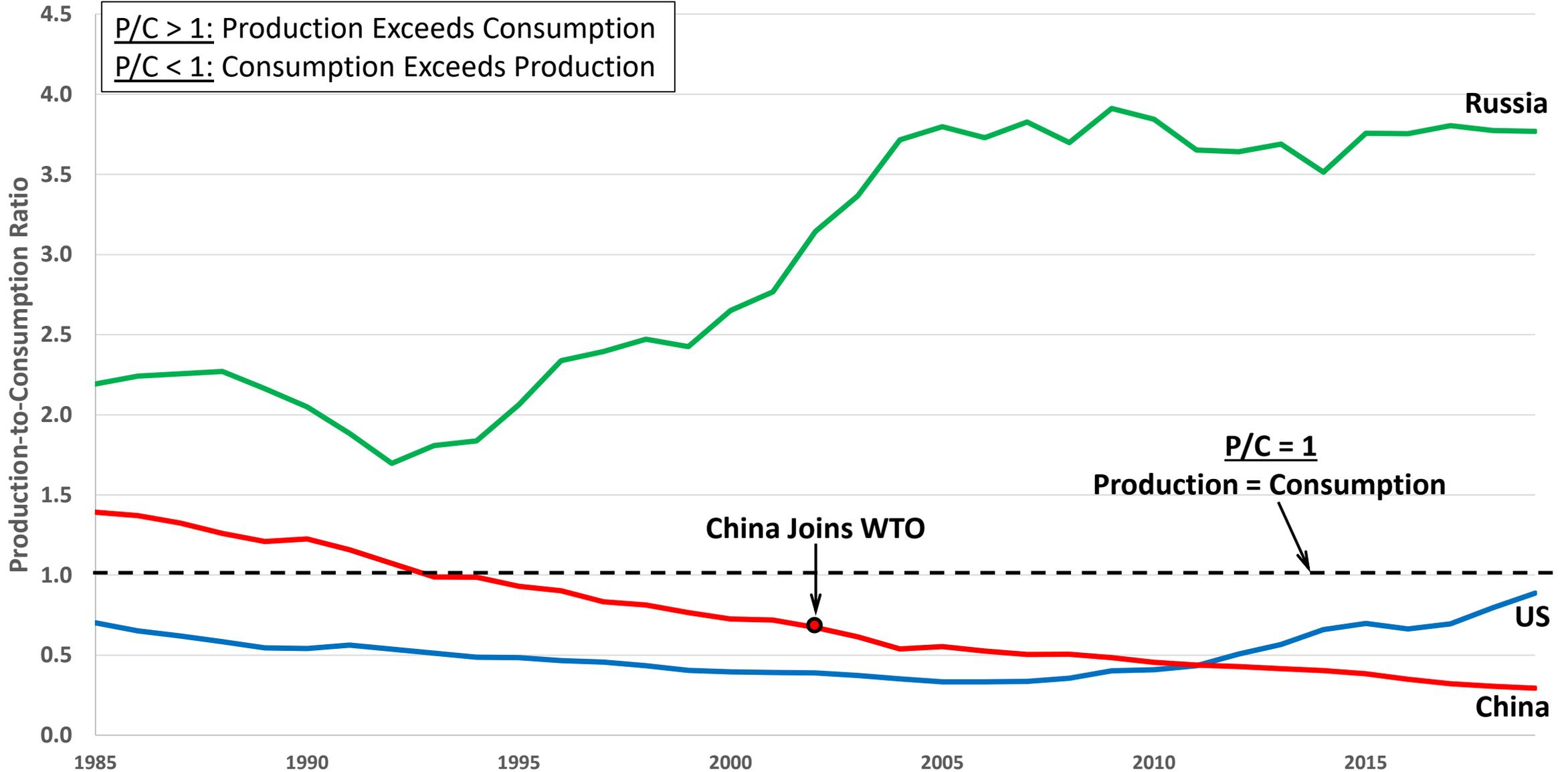
https://www.eia.gov/international/content/analysis/countries_long/Russia/russia.pdf

<https://www.wsj.com/articles/oil-dependent-russia-seeks-to-protect-economy-from-energy-transition-11633099079>

Oil Production-to-Consumption Ratio

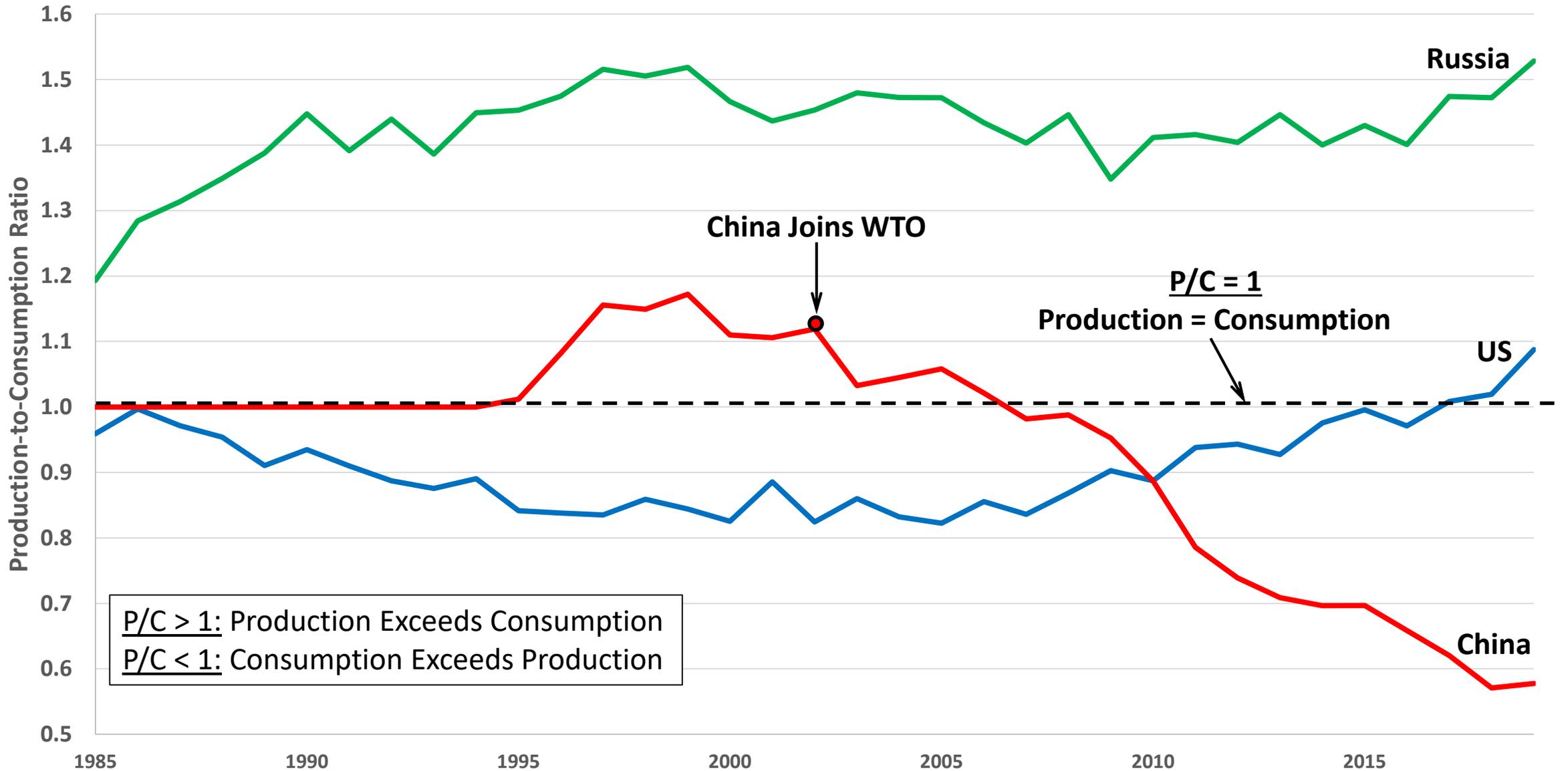
— US — Russia — China

P/C > 1: Production Exceeds Consumption
P/C < 1: Consumption Exceeds Production



Natural Gas Production-to-Consumption Ratio

— US — Russia — China



China: Energy Consumer & Strategic Challenger

- Consumes 26.1% of world's total energy and 26.5% of world's fossil fuels
- 84.3% of its energy use is fossil fuels; 56.6% is coal
- *Made in China 2025* and *14th Five-Year Plan* includes all energy resources and associated technologies—including fossil fuels.
 - China is currently financing 56,135 MW of coal plants globally, but has signaled a willingness to dial back future financing
- China's Arctic Policy "*promotes technology innovation in Arctic oil and gas drilling and exploitation*"

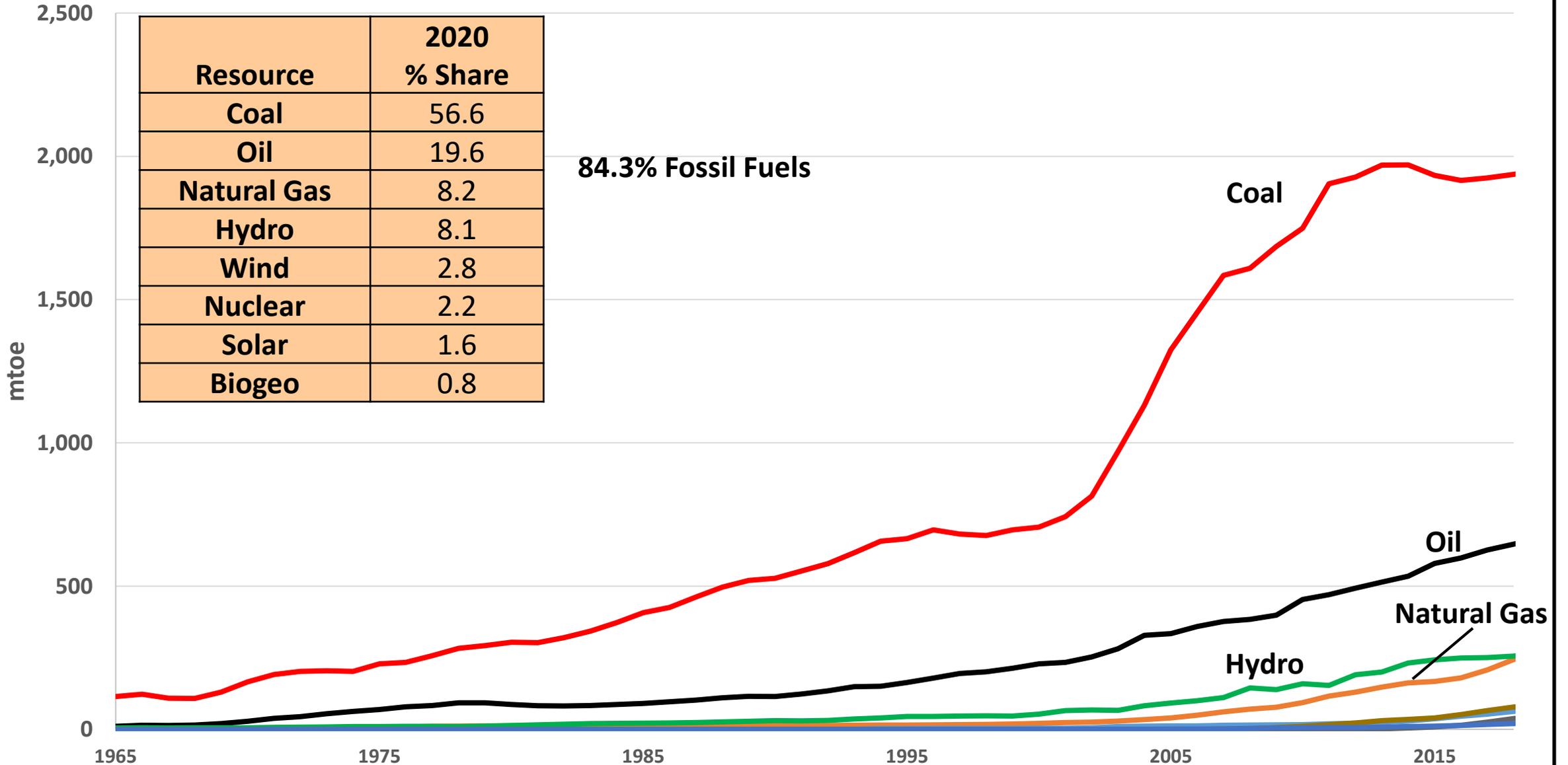
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<https://endcoal.org/finance-tracker/>
http://english.www.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm

BP Statistical Review 2021

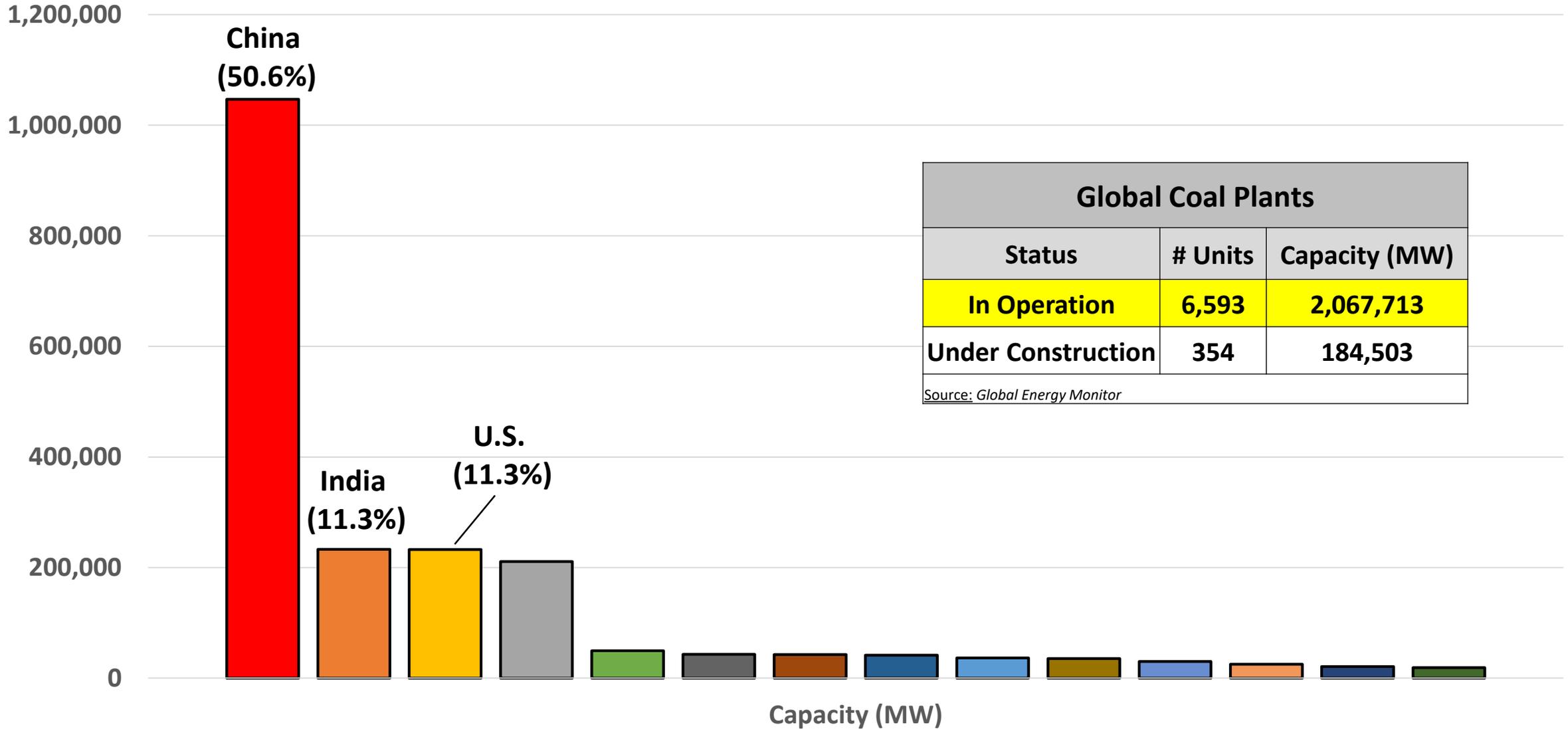
China Total Energy

Coal Oil Natural Gas Hydro Nuclear Solar Wind Biogeo



Existing Coal Plant Capacity (MW)

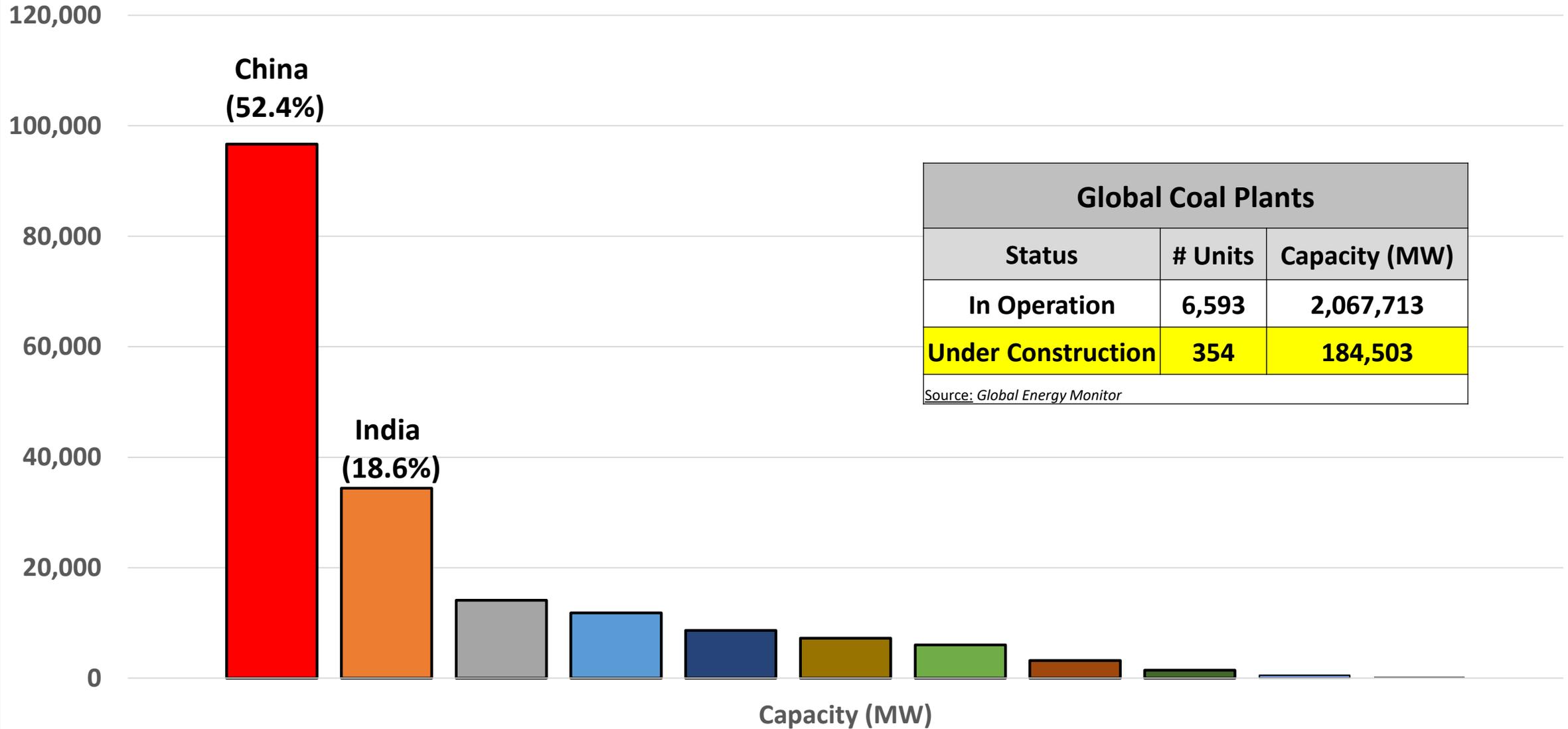
- China
- India
- US
- Rest of World
- Japan
- Russia
- South Africa
- Germany
- Indonesia
- South Korea
- Poland
- Australia
- Vietnam
- Turkey



Global Coal Plants		
Status	# Units	Capacity (MW)
In Operation	6,593	2,067,713
Under Construction	354	184,503

Source: Global Energy Monitor

Coal Plant Capacity Under Construction (MW)

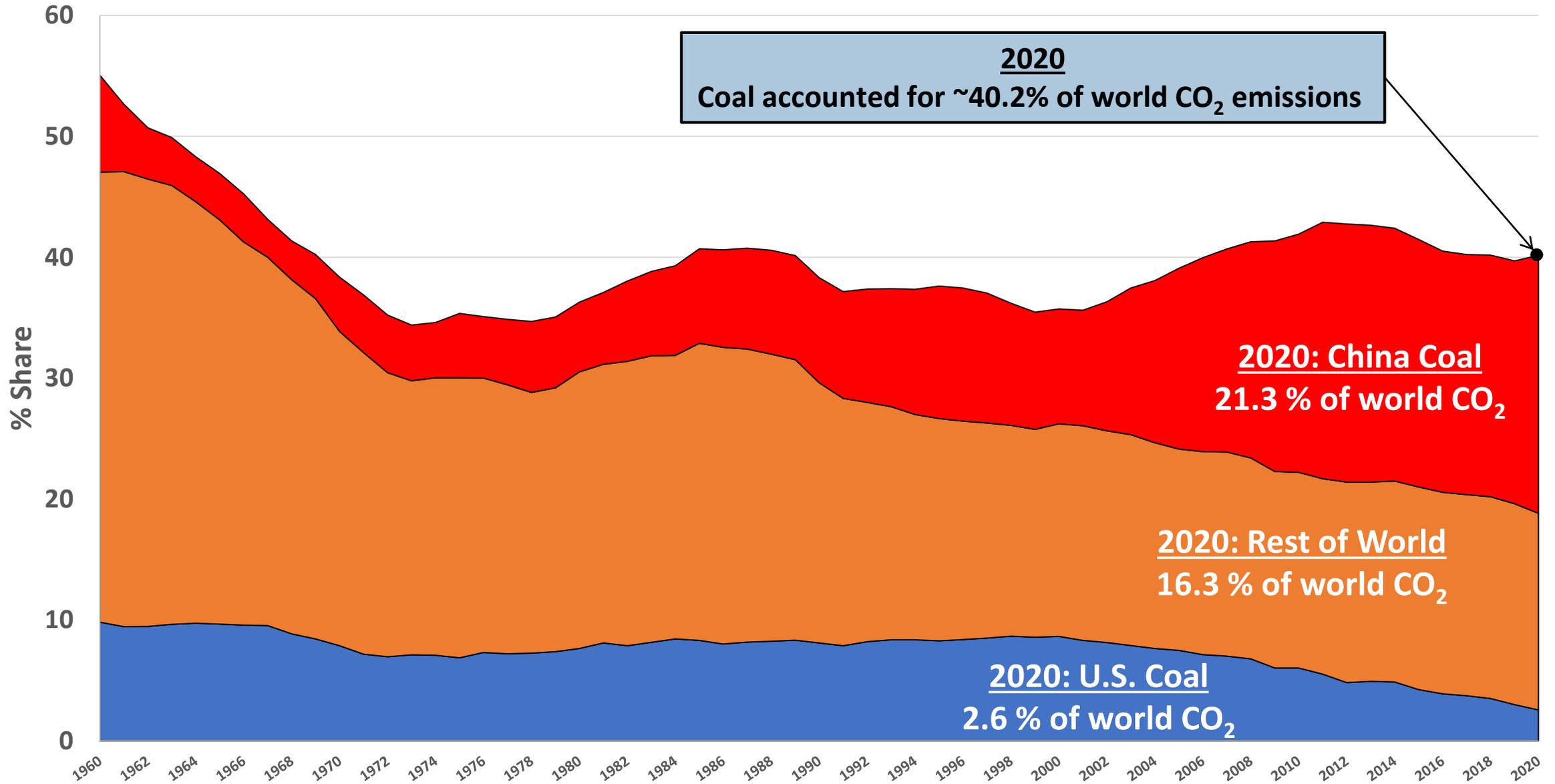


Global Coal Plants		
Status	# Units	Capacity (MW)
In Operation	6,593	2,067,713
Under Construction	354	184,503

Source: Global Energy Monitor

CO₂ Emissions from Coal as a % Share of World Total CO₂ Emissions

■ US ■ Rest of World ■ China



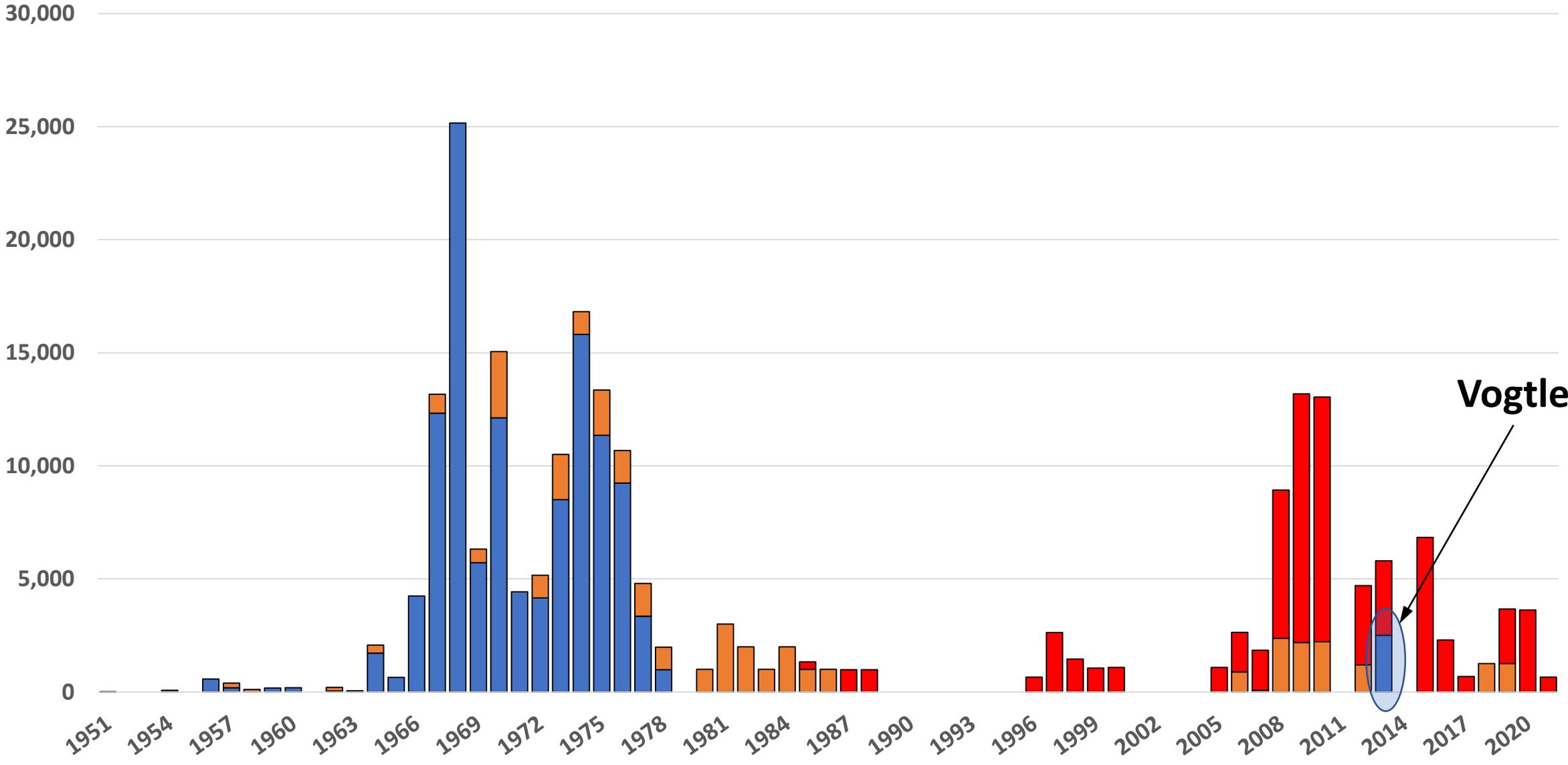
Civilian Nuclear Power

Nuclear Reactor Construction Starts: Historical Total (MW)

Compiled By: David Gattie

Data Source:
IAEA; Power Reactor Information System

■ US ■ Russia ■ China



Nuclear Power in the 21st Century

Of these 155 reactors, 105 are associated with China or Russia—either by location or by reactor technology.

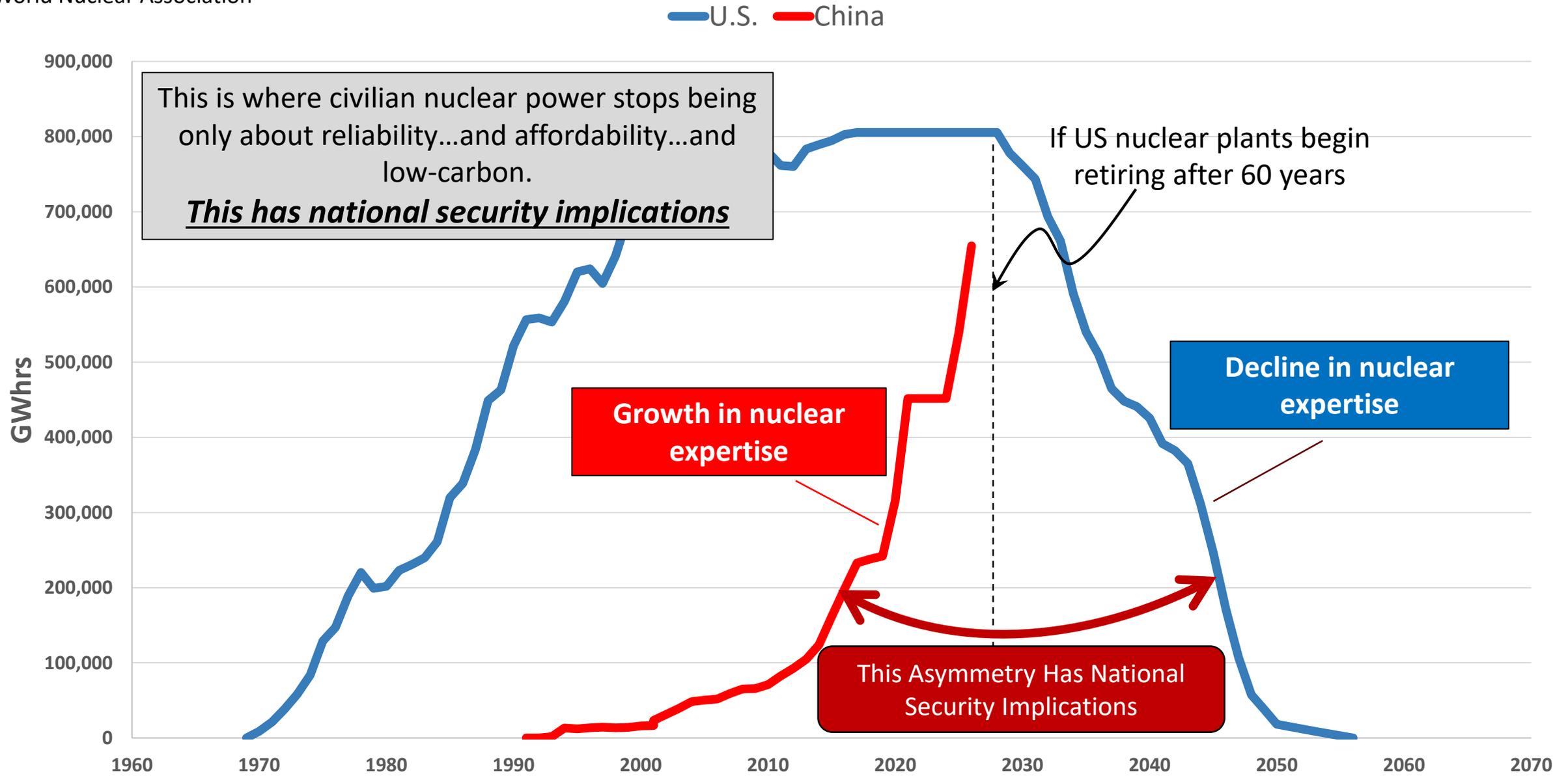
Number of Reactors Since 2000		
Country	Connected to Grid	Under Construction
China	47	14
Russia	13	3
India	12	6
South Korea	10	4
Japan	5	2
Pakistan	5	1
Czech Republic	2	
Ukraine	2	2
Argentina	1	1
Belarus	1	1
Brazil	1	1
Iran	1	1
UAE	1	3
US	1	2
Romania	1	
Bangladesh		2
Finland		1
France		1
Slovakia		2
Taiwan		0
Turkey		3
UK		2
Total	103	52

Source: World Nuclear Association; IAEA (2021)

US and China Nuclear Power Generation: Projected

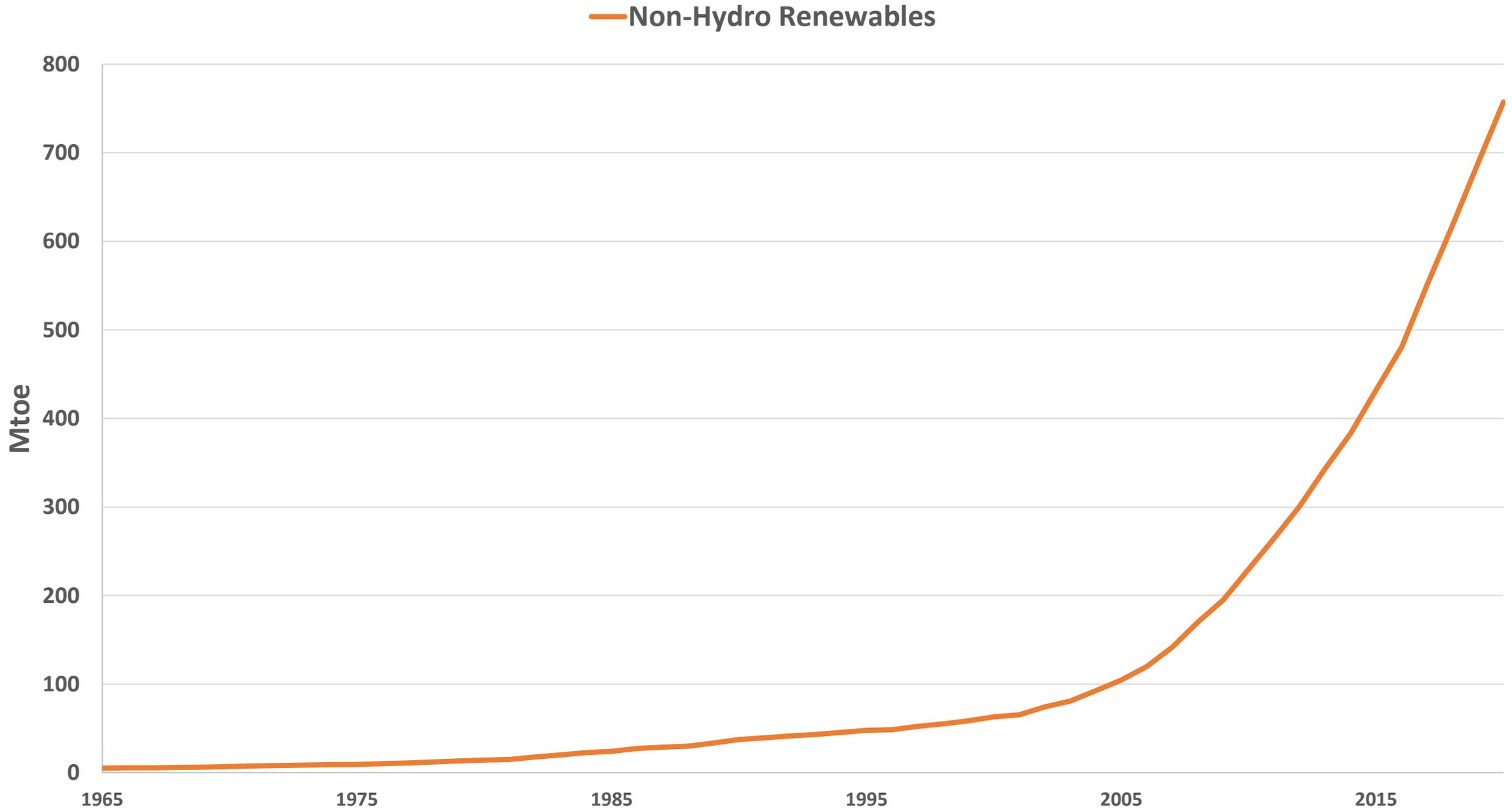
Data Source:

US EIA; IAEA; &
World Nuclear Association



Renewables

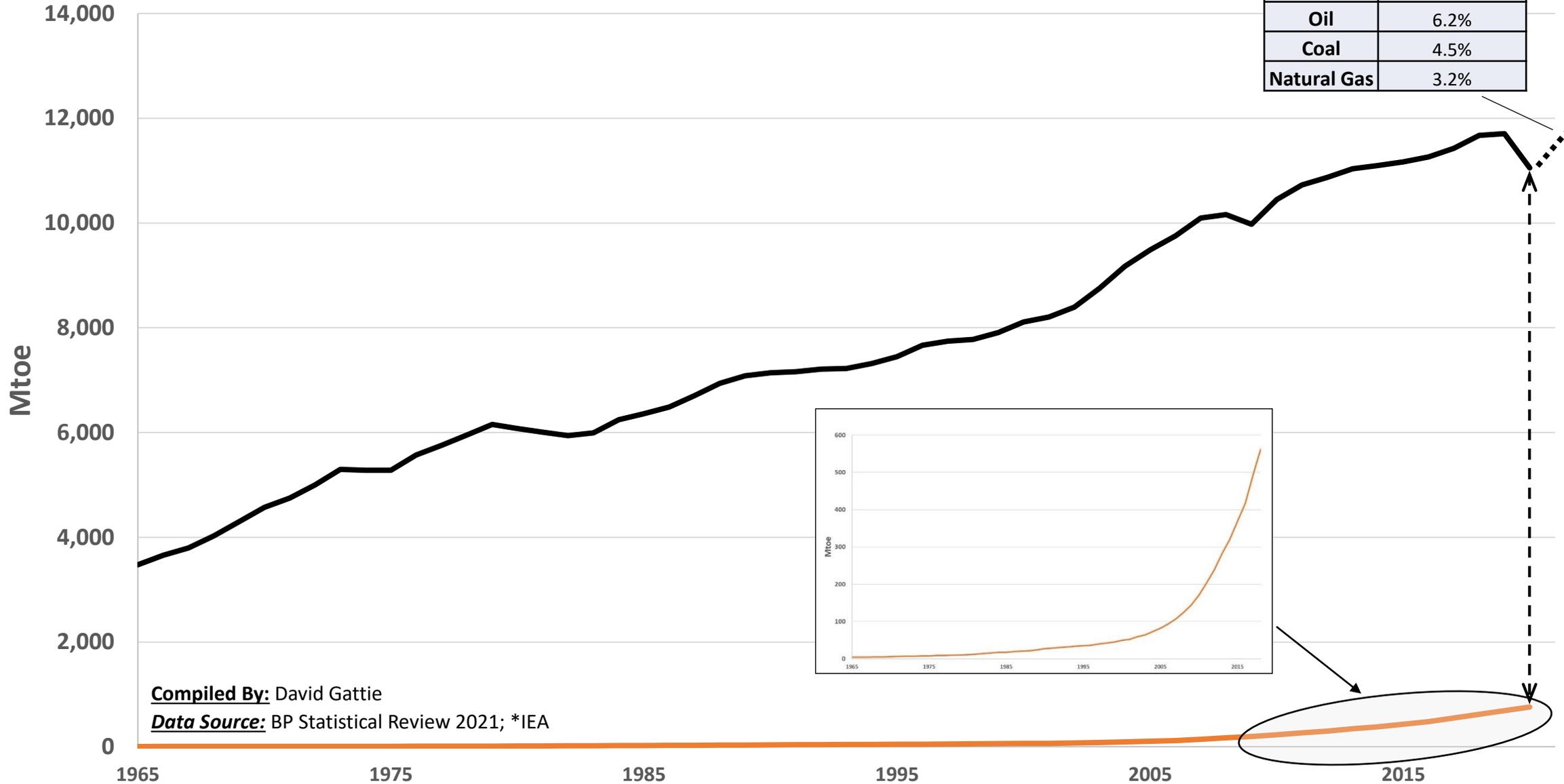
World Energy Consumption: Non-hydro Renewables



World Primary Energy Consumption: Fossil Fuels & Non-hydro Renewables

— Fossil Fuels — Non-Hydro Renewables

Resource	2021 Projected Change*
Oil	6.2%
Coal	4.5%
Natural Gas	3.2%

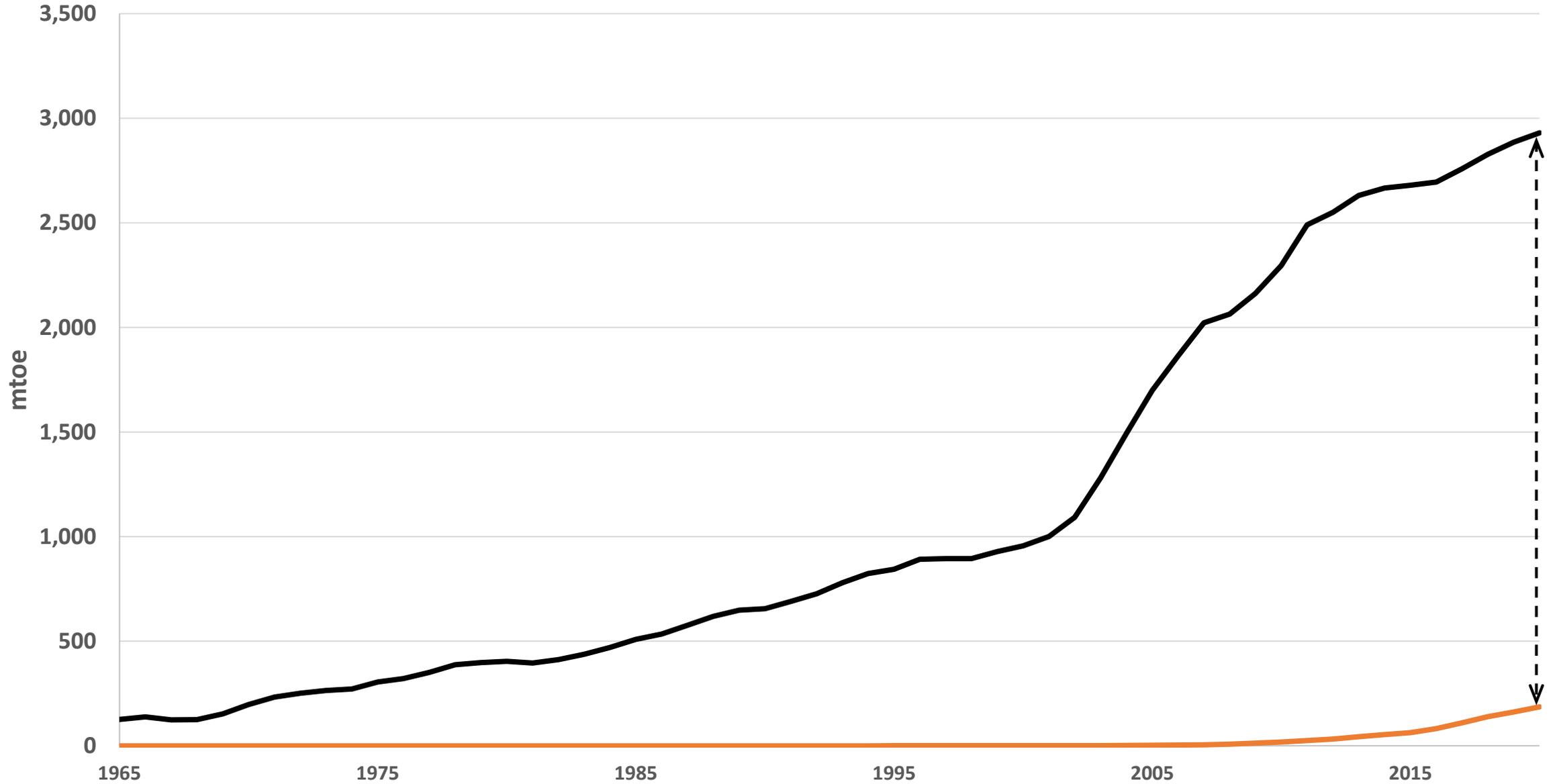


Compiled By: David Gattie

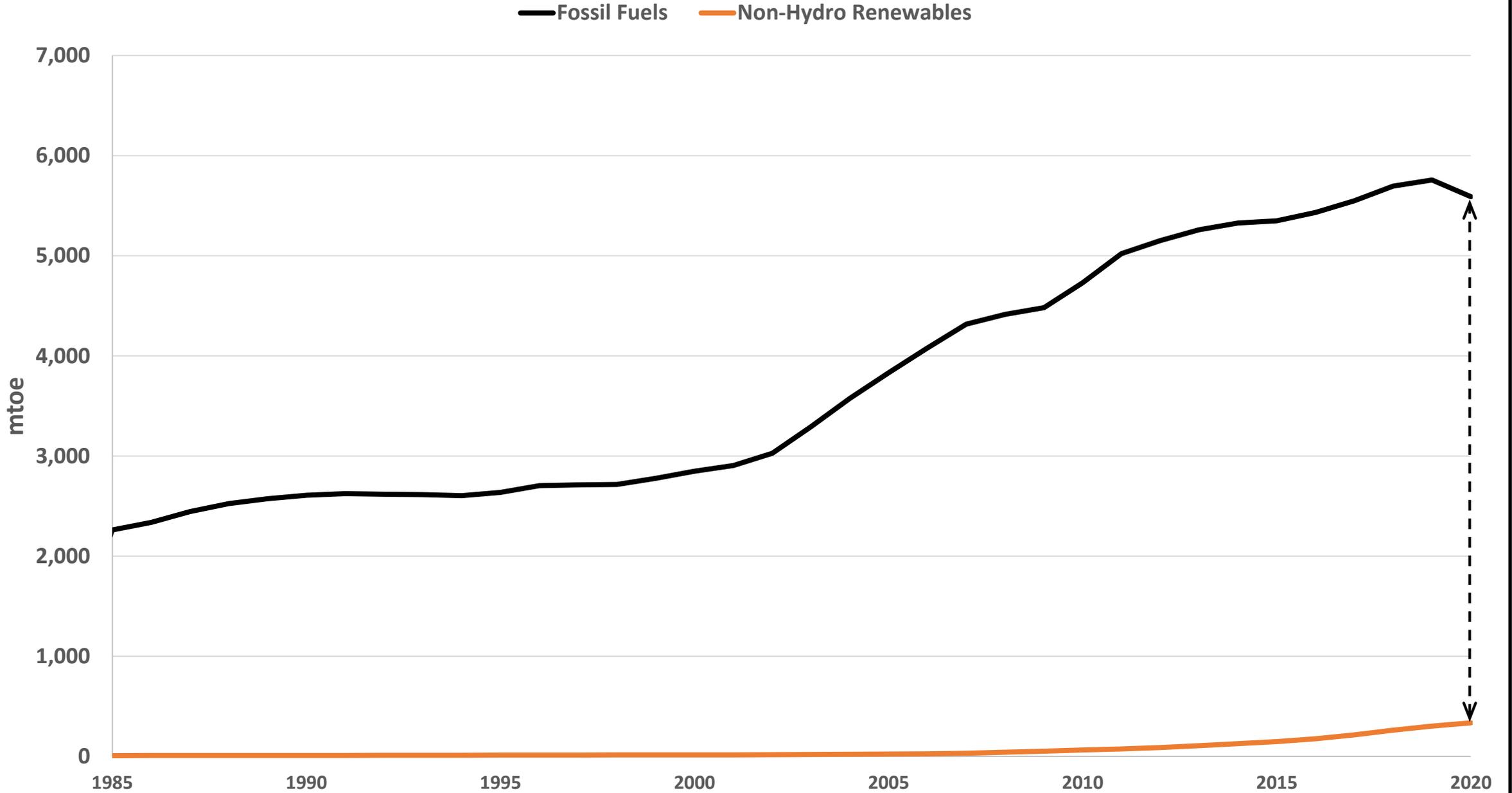
Data Source: BP Statistical Review 2021; *IEA

China: Fossil Fuels & Non-Hydro Renewables

Fossil Fuels Non-Hydro Renewables



Emerging Markets: Fossil Fuels and Non-Hydro Renewables



Global Solar Generation

Country	Solar Generation	Total Generation (2020)		GDP (2020)	
	2020 Share of World Total (%)	Fossil Fuels & Nuclear (%)	Fossil Fuels, Nuclear & Hydro (%)	Constant 2015 US\$ (millions)	Share of World Total (%)
China	30.5	71.2	88.2	14,625,052	17.9
US	15.7	80.1	86.8	19,278,194	23.6
Japan	9.7	73.3	81.1	4,324,541	5.3
India	6.9	79.8	90.3	2,480,916	3.0
Germany	5.9	51.7	54.9	3,434,436	4.2
Italy	3.0	57.5	74.0	1,744,164	2.1
Australia	2.8	75.6	81.1	1,490,374	1.8
Spain	2.4	56.0	66.7	1,180,730	1.4
France	1.5	67.4	79.1	2,410,286	3.0
UK	1.5	54.6	56.7	2,810,363	3.4
Subtotal	79.9			53,779,055	65.9
<i>World</i>				<i>81,562,560</i>	<i>100</i>

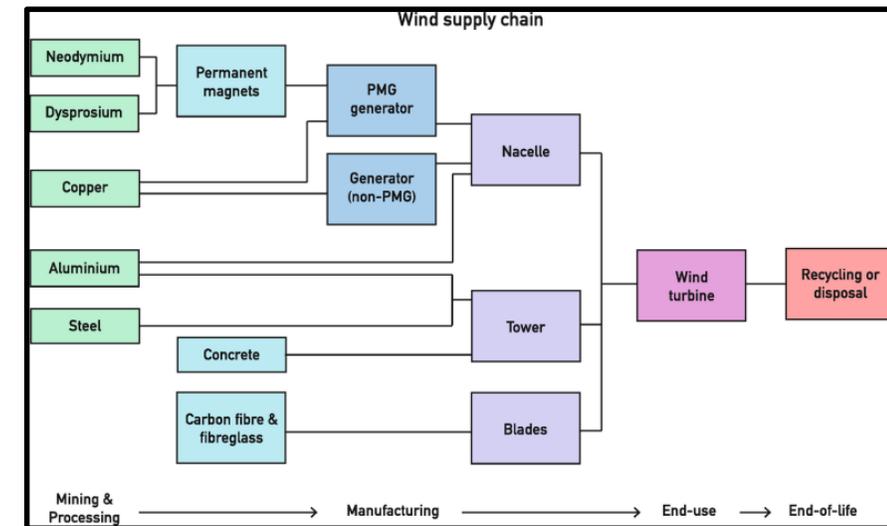
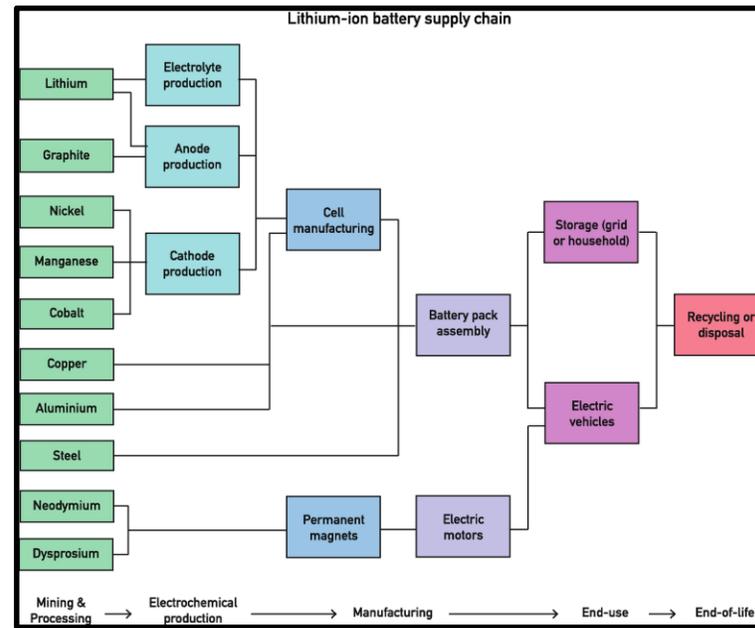
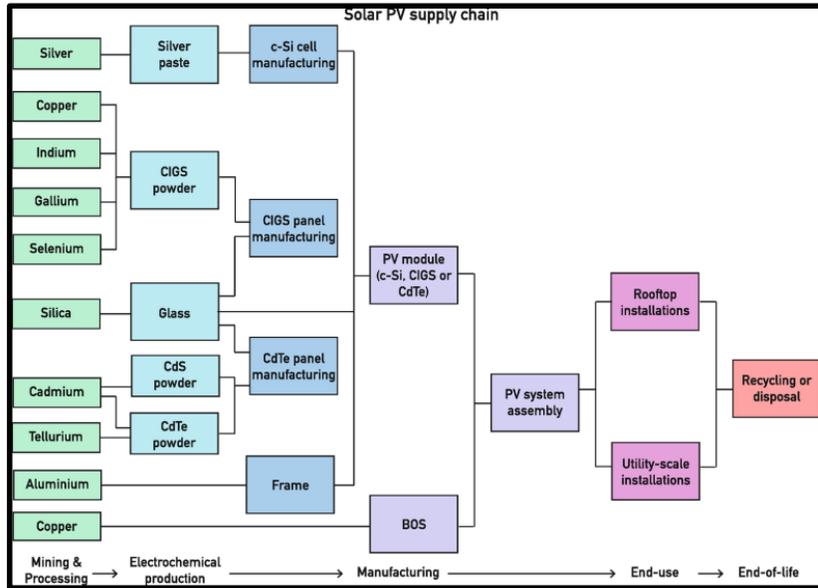
GDP Data Source: World Bank

Energy Data Source: BP Statistical Review of World Energy 2021

Global Wind Generation

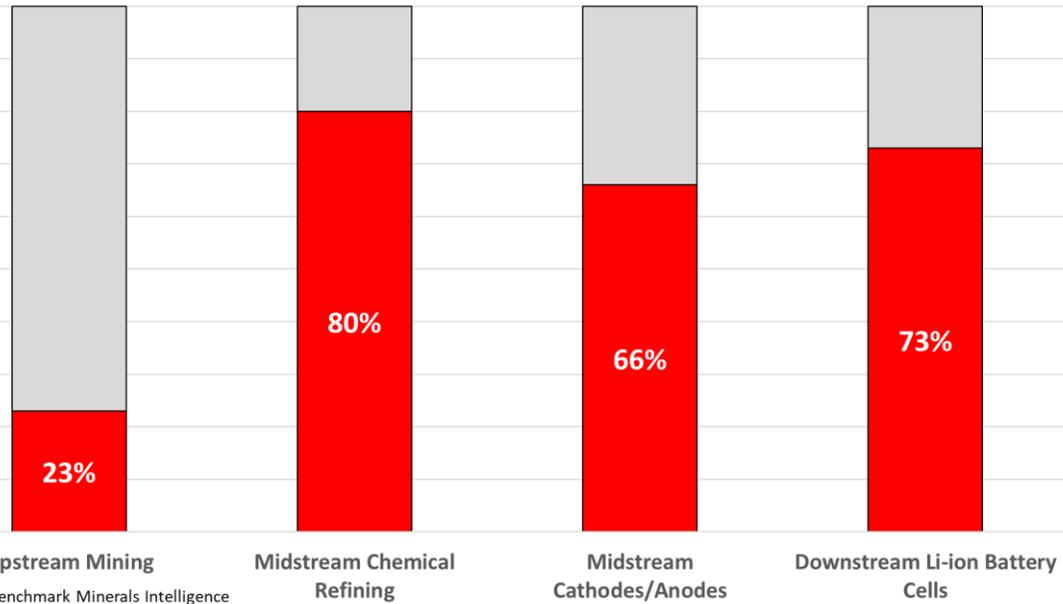
Country	Wind Generation	Total Generation (2020)		GDP (2020)	
	2020 Share of World Total (%)	Fossil Fuels & Nuclear (%)	Fossil Fuels, Nuclear & Hydro (%)	Constant 2015 US\$ (millions)	Share of World Total (%)
China	29.3	71.2	88.2	14,625,052	17.9
US	21.4	80.1	86.8	19,278,194	23.6
Germany	8.2	51.7	54.9	3,434,436	4.2
UK	4.8	54.6	56.7	2,810,363	3.4
India	3.8	79.8	90.3	2,480,916	3.0
Brazil	3.6	16.4	80.4	1,749,107	2.1
Spain	3.3	56.0	66.7	1,180,730	1.4
France	2.6	67.4	79.1	2,410,286	3.0
Canada	2.3	32.2	91.9	1,600,331	2.0
Australia	1.4	75.6	81.1	1,490,374	1.8
Subtotal	80.7			51,059,789	62.6
<i>World</i>				<i>81,562,560</i>	<i>100</i>

Solar PV, Wind Turbine & Li-ion Supply Chain



Source: Giurco D., Dominish E., Florin N., Watari T., McLellan B. (2019) Requirements for Minerals and Metals for 100% Renewable Scenarios. In: Teske S. (eds) Achieving the Paris Climate Agreement Goals. Springer, Cham. https://doi.org/10.1007/978-3-030-05843-2_11

China's % Share of Li-ion Battery Production (2019)



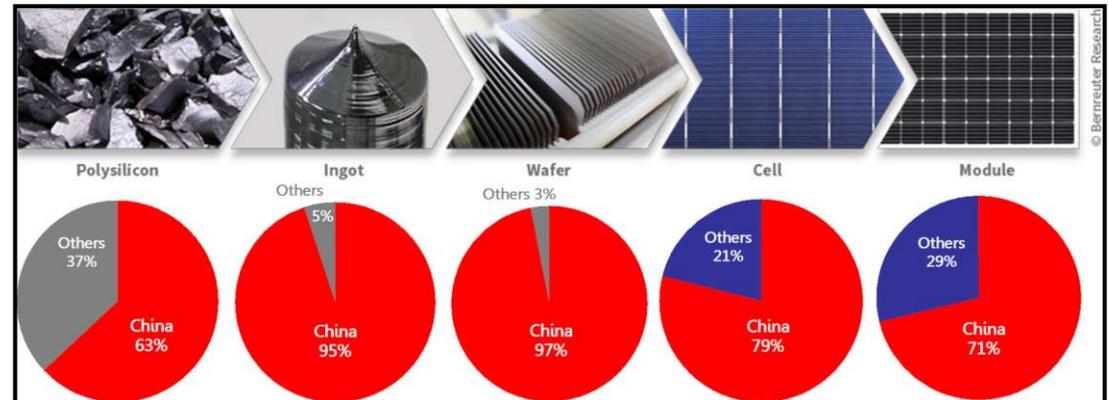
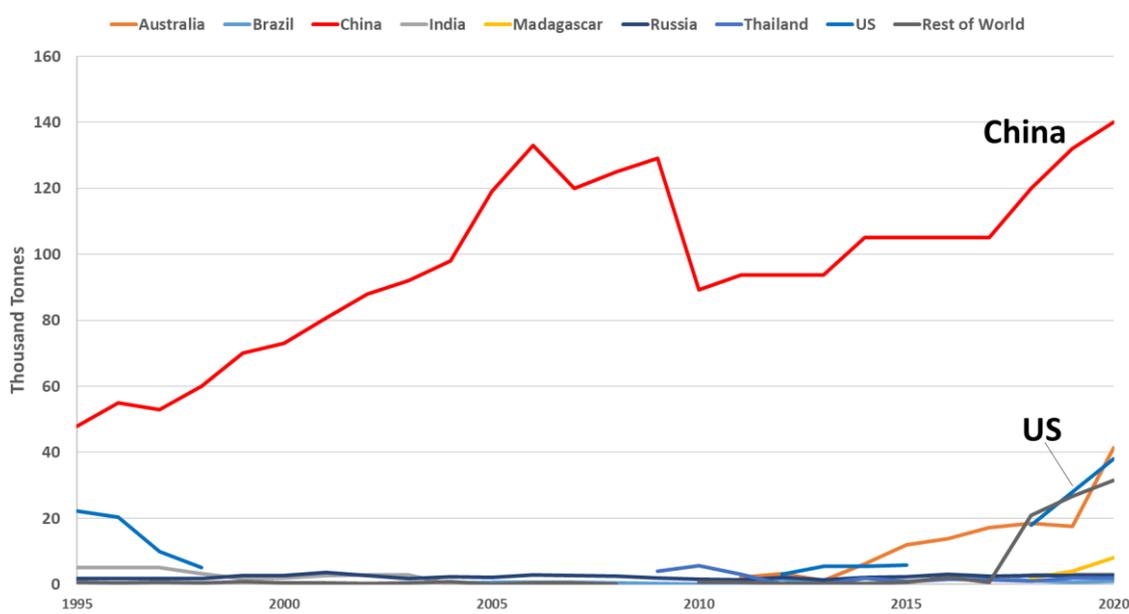
Source: Benchmark Minerals Intelligence

Figure 3.—Major Import Sources of Nonfuel Mineral Commodities for which the United States was greater than 50% Net Import Reliant in 2020



Source: U.S. Geological Survey

Rare Earth Metals: Production and Reserves



Sources: Bernreuter Research (polysilicon), <https://www.bernreuter.com/solar-industry/value-chain/> Bloomberg New Energy Finance (ingot), China Photovoltaic Industry Association (wafer/cell/module); Graphic: Bernreuter Research

A General Contrast in Perspectives



US:
Energy is generally a
market commodity
or a climate issue

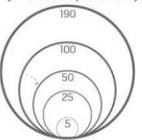
China and Russia:
Energy and energy technologies
are instruments of national power
to achieve geopolitical
objectives—national security and
national power are at the center of
their energy policy

A Global Network of Energy & Energy Technology Interdependencies

LIQUIFIED NATURAL GAS TRADE FLOW, 2018

LNG

Regional trade volumes (million tons per annum)

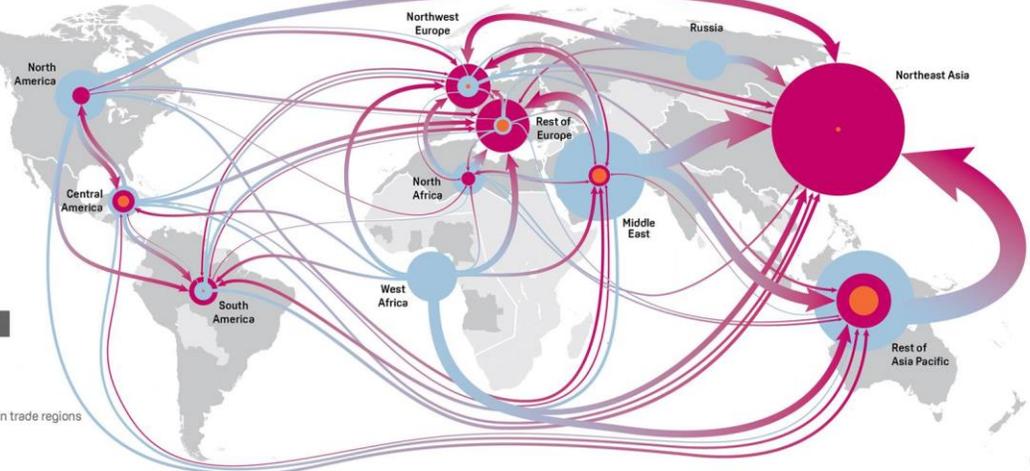


Trade flows (million tons per annum)



- Inter-regional trade
- Exports
- Imports
- Countries not included in trade regions

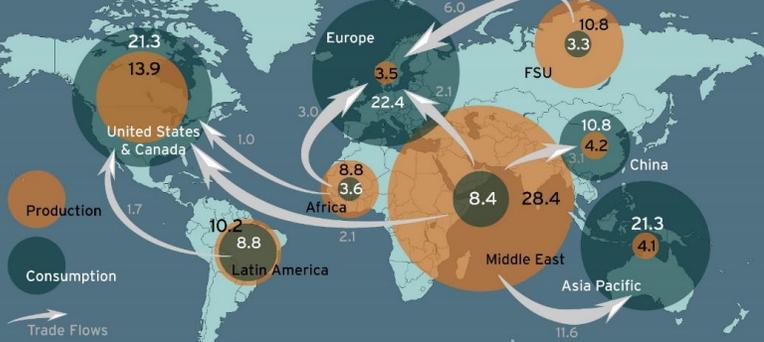
S&P Global Platts



0 500 mi

Source: S&P Global Platts

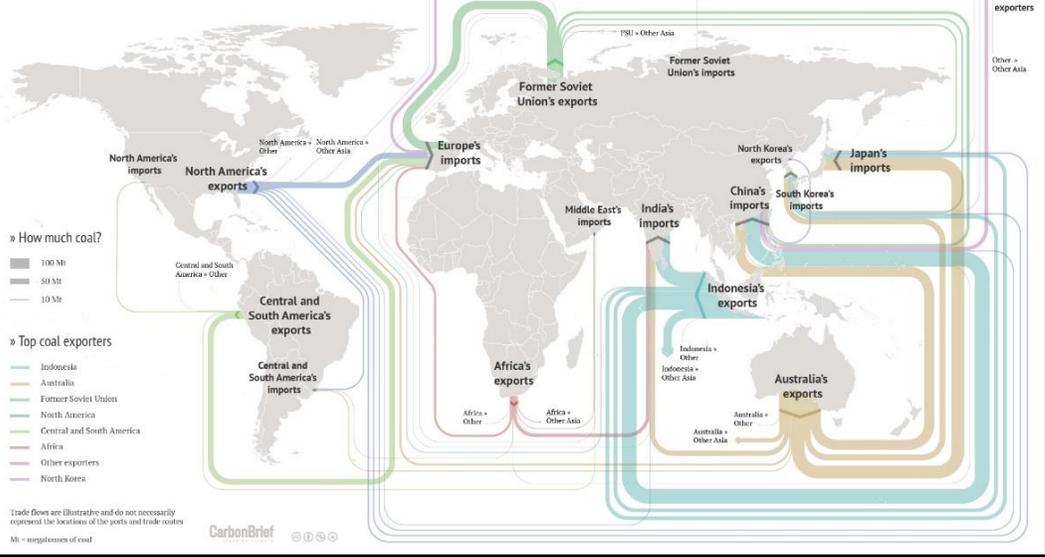
Oil: Global Balance of Trade



Source: SAFE analysis based on data from BP Statistical Review, all values in million barrels per day. Production and consumption values represented at scale. Only trade flows above 1 mb/d represented.

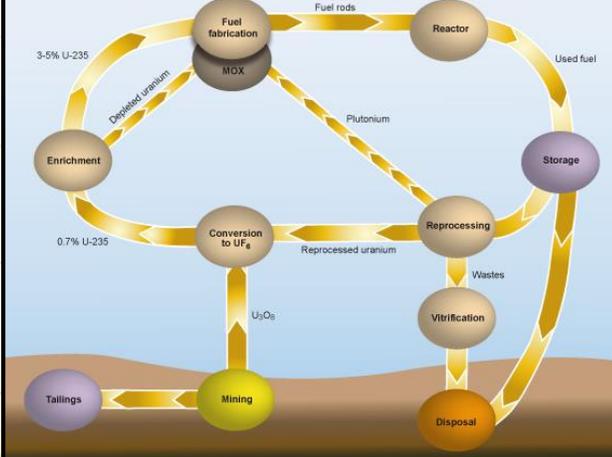
Securing America's Future Energy

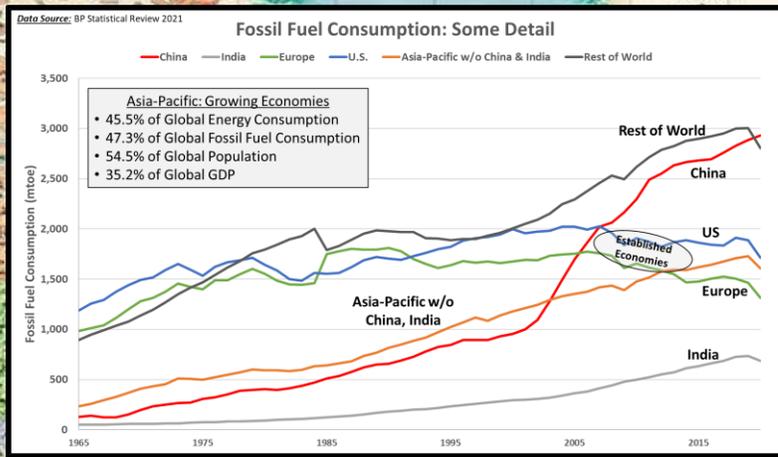
» Coal trade around the world »



CarbonBrief

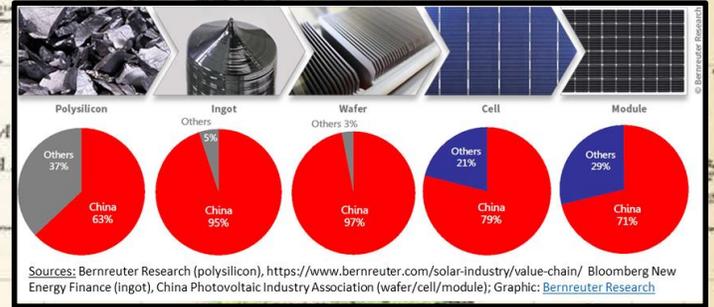
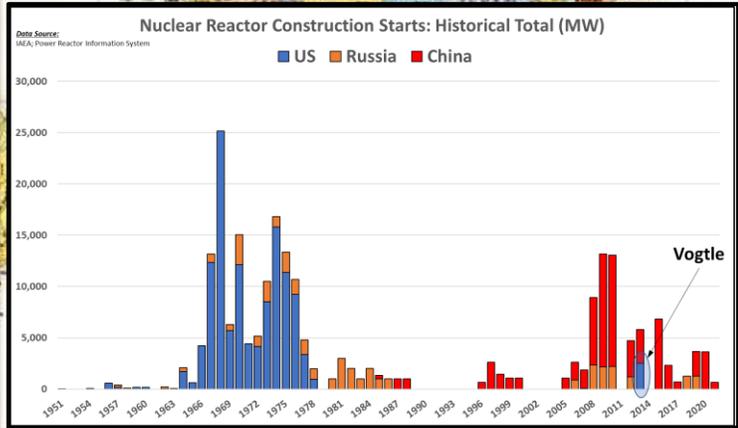
The Nuclear Fuel Cycle





Russia
Oil, Gas,
Nuclear

China BRI
Coal, Nuclear, Solar
& Battery Supply
Chain, Financing



SECURITY CONCERNS

1. China and Russia are strategically exploiting fossil fuel resources and technologies as the U.S. debates moving away from fossil fuels and developing economies move in the same direction as Russia and China
2. This will reduce the diversity of energy resources and technologies in America's industrial base while great power competitors China and Russia expand and diversify theirs

SECURITY CONCERNS

3. Russia and China dominate civilian nuclear exports as the U.S. works to revive its nuclear industry and keep existing plants in operation
4. China currently is a dominant market force in global solar PV, batteries and the rare earth/metals supply chain
5. America's great power competitors are engaged in an all-the-above energy and energy technology strategy, leveraging state-owned enterprises to meet their respective geopolitical objectives

SECURITY QUESTIONS

1. Will policymakers in China and Russia subject their respective energy technology industrial bases and state-owned enterprises to an all-in effort to reduce carbon emissions and solve the climate crisis?
 - Or will they weaponize climate diplomacy?
2. If the U.S. disengages from fossil fuels and doesn't aggressively promote nuclear power, will this shift the geopolitical advantage in global energy and energy technology partnerships to China and Russia?
 - Will emerging economies be vulnerable to provider nations?

SECURITY QUESTIONS

3. As the U.S. shifts toward renewables and a greater dependency on a global supply chain of rare earths & metals, what impact will this have on U.S. energy security?
4. What will be the impact on US national security if the energy resources and energy technologies that operationalize America's industrial base shift asymmetrically relative to great power competitors?

21st Century America

US Military, US Industry

Critical Infrastructure

Trade & Commerce

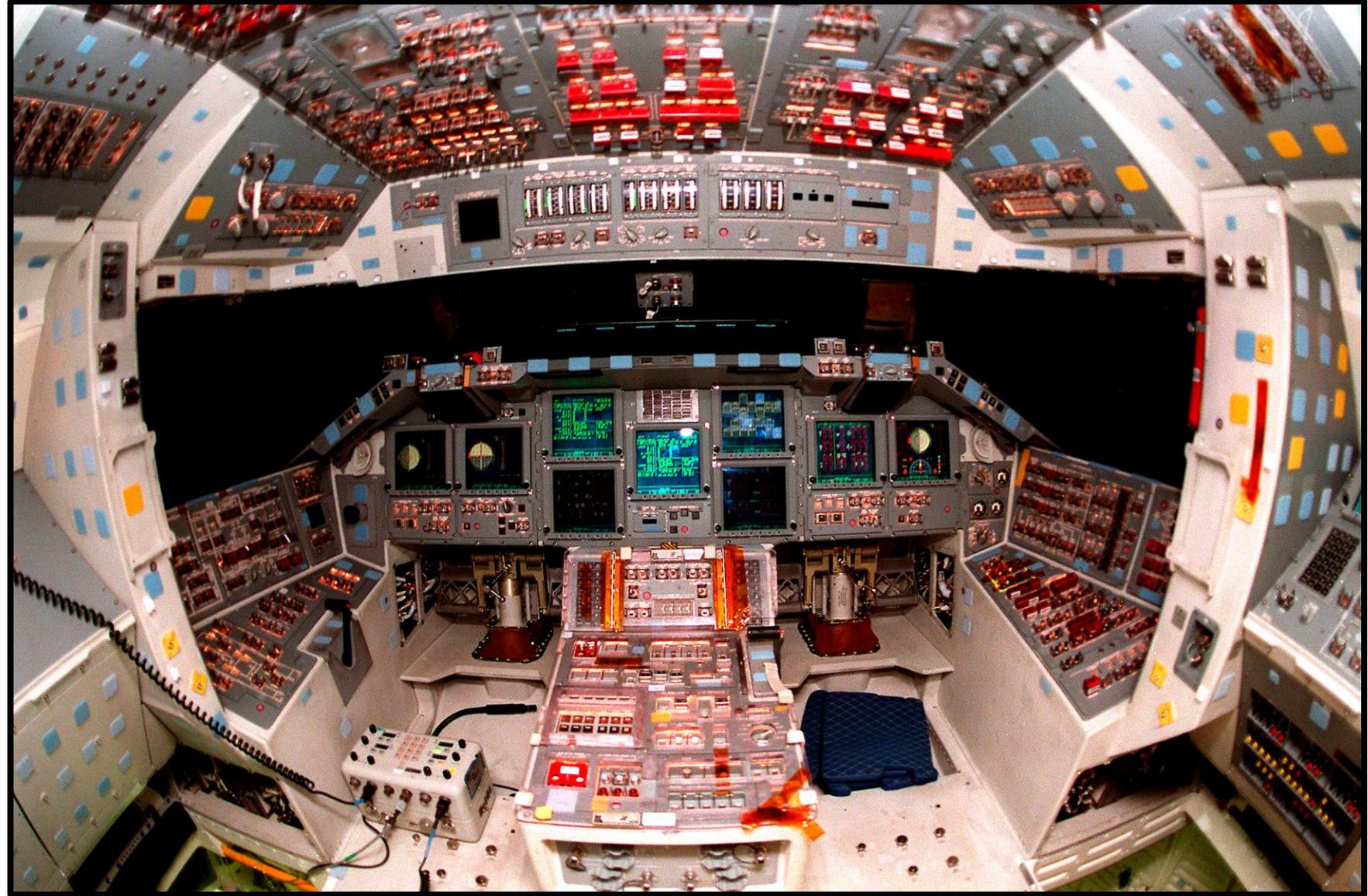
Cybersecurity & The Grid

Economic Growth

Great Power Competitors

Security for Allies

Post-WWII World Order



21st Century America

US Military, US Industry

Critical Infrastructure

Trade & Commerce

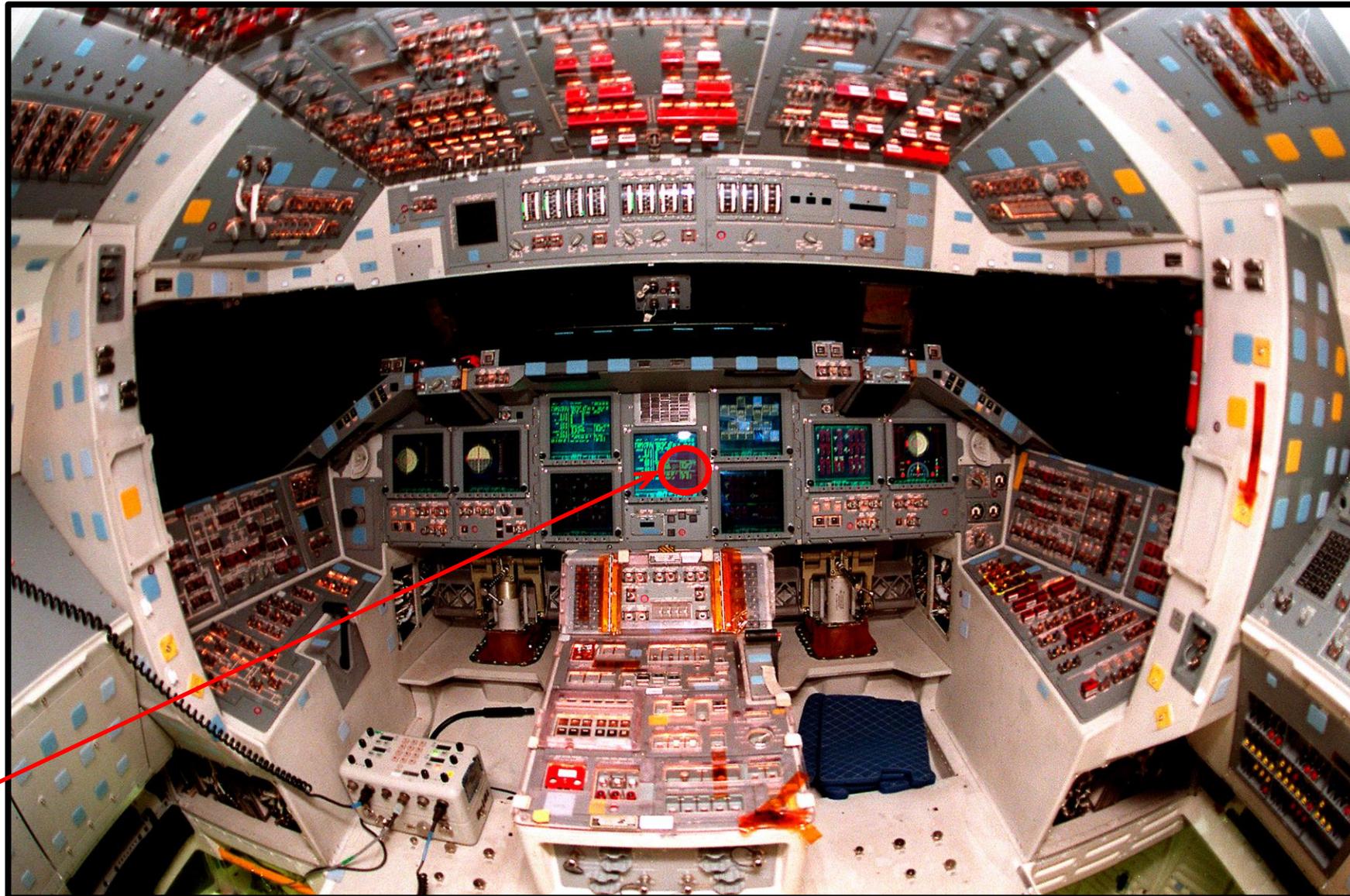
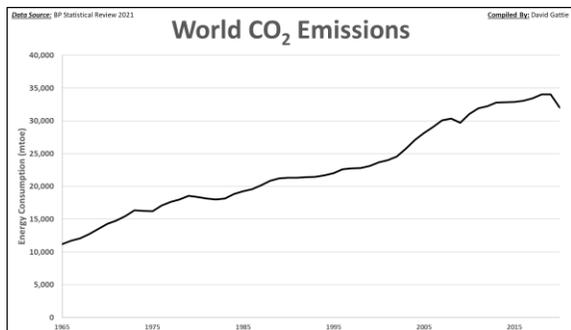
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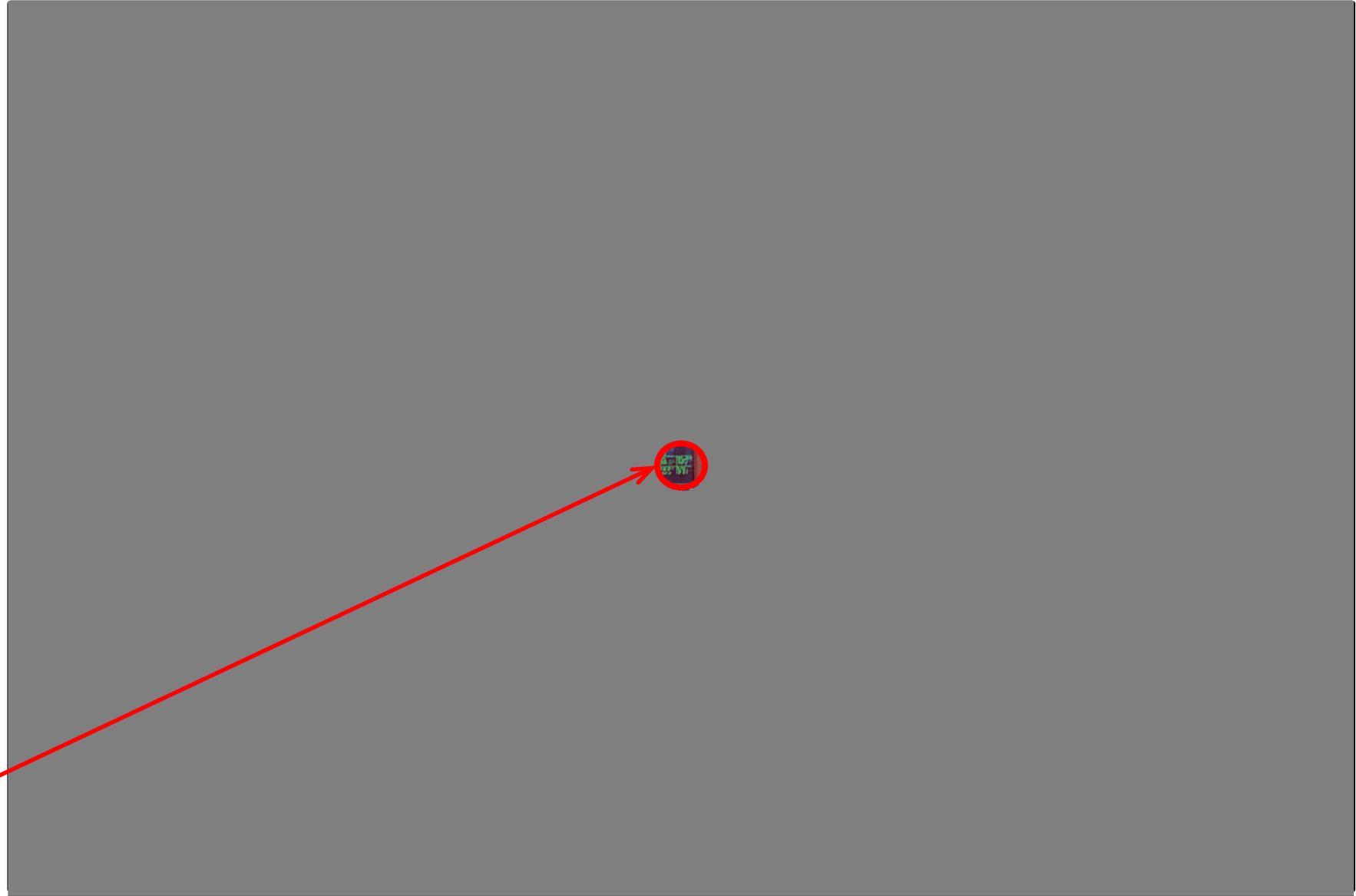
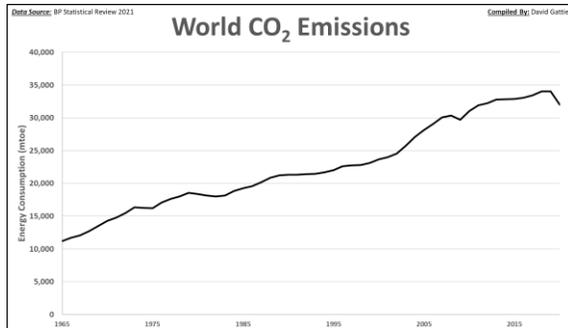
Cybersecurity of the Grid

Economic Growth

Great Power Competitors

Security for Allies

Post-WWII World Order



AMERICA IS FACING UNPRECEDENTED SECURITY CHALLENGES
IN THE 21ST CENTURY

*-PARTICULARLY WITH GREAT POWER COMPETITORS AND
ENERGY RESOURCES & TECHNOLOGIES-*

HAS THE U.S. EVALUATED THE RISK OF
REORGANIZING ITS ECONOMY AND
RESTRUCTURING ITS INDUSTRIAL BASE WITH THE
PRIMARY FOCUS BEING TO REDUCE DOMESTIC
CO₂ EMISSIONS?

*UGA Engineering and
The †Center for International Trade & Security (CITS)

*†David Gattie—†Justin Conrad—†Josh Massey

Applied Energy Studies

Informing US policy to better align with national security realities and geopolitical dimensions of the global energy sector



Energy Systems



National Security

Thank You

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