

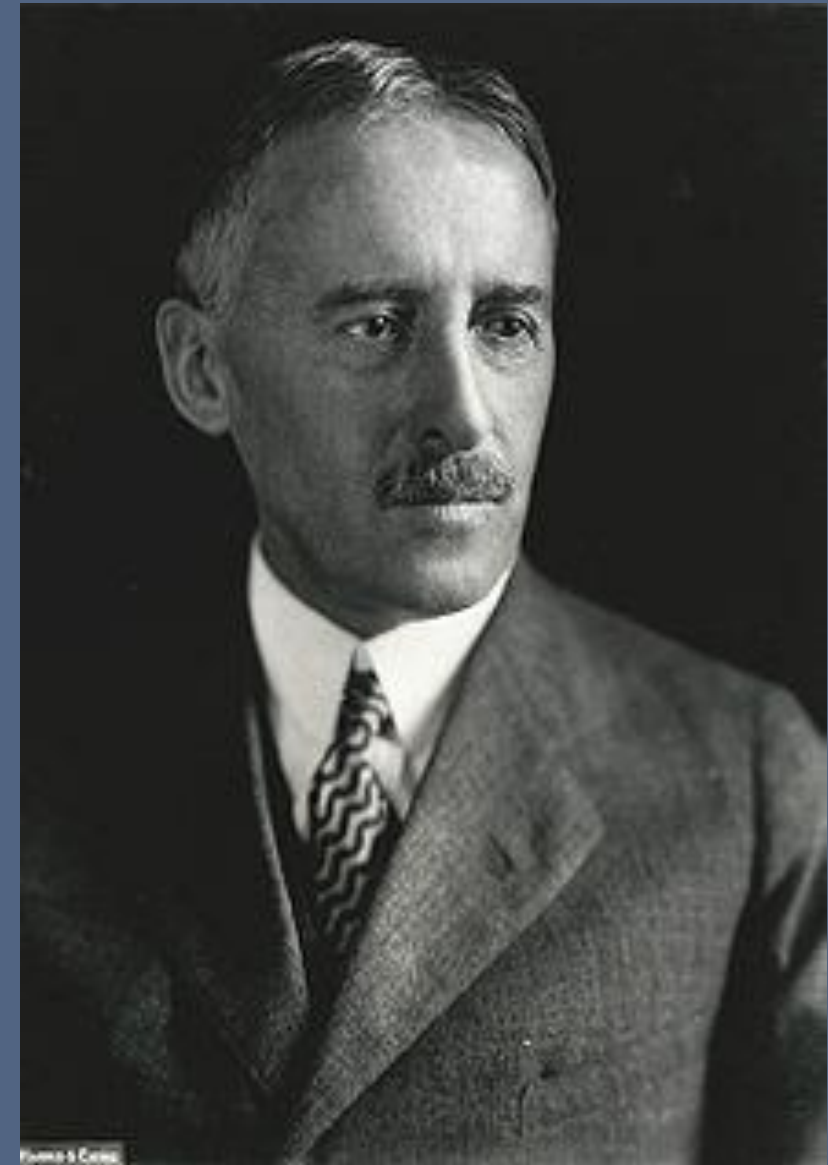
National Security Implications of U.S. Nuclear Power in the 21st Century

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CENTER FOR INTERNATIONAL TRADE AND SECURITY

Overview

- Global energy & CO₂ (numbers and graphs)
 - Focus on electric power generation
- U.S. nuclear disposition in global context
- Early U.S. nuclear power policy principles
- Security concerns of a declining U.S. nuclear enterprise

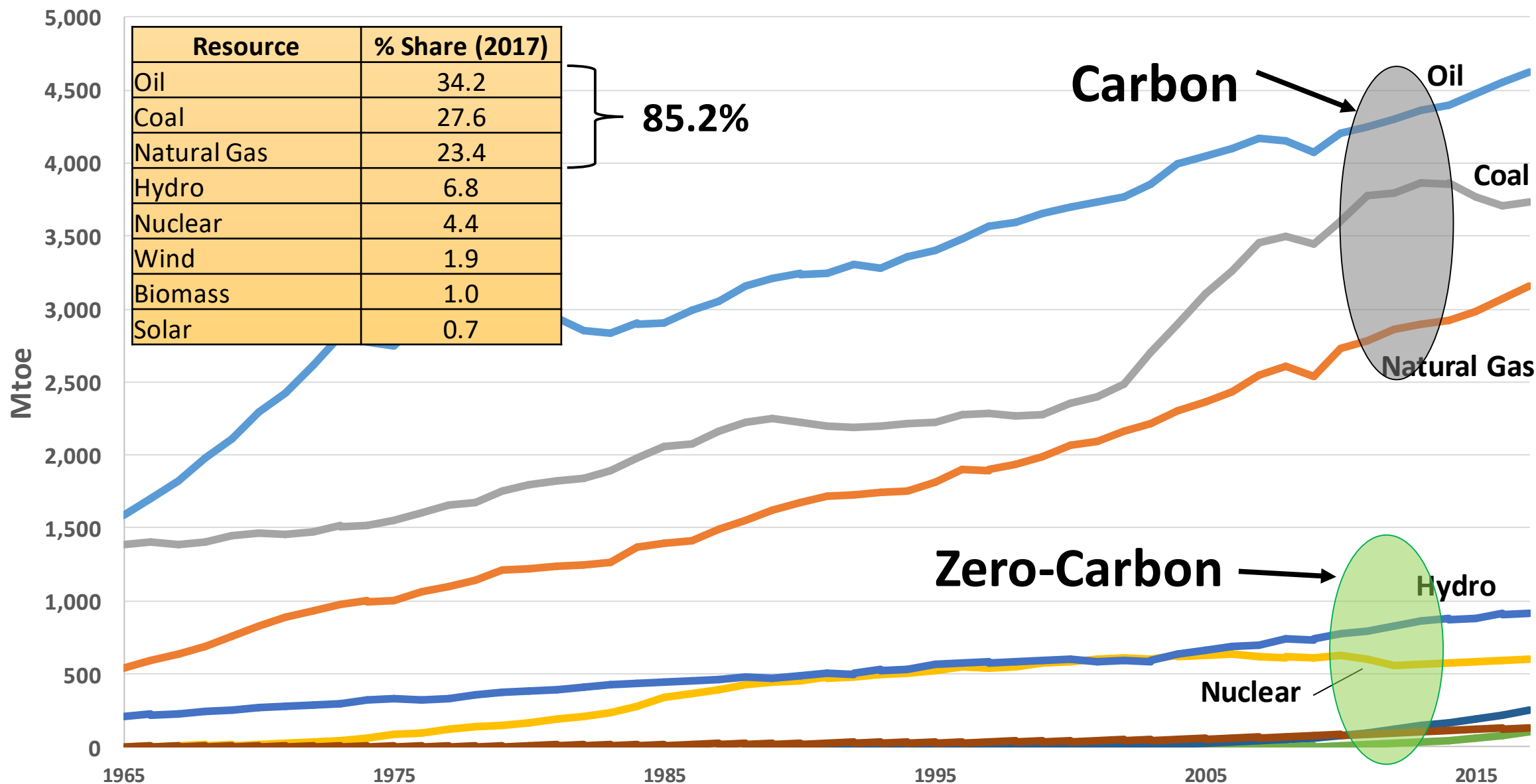
“No public policy, in any sector of our national life, can now escape from the compelling fact that if it is not framed with reference to the world, it is framed with perfect futility. The world is full of warring ideas and we are forced to act in the world as it is, and not in the world as we wish it were, or as we would like it to become”
(Henry Stimson, *The Challenge to Americans*, 1947)



Secretary of State, 1929-1933
Secretary of War, 1940-1945

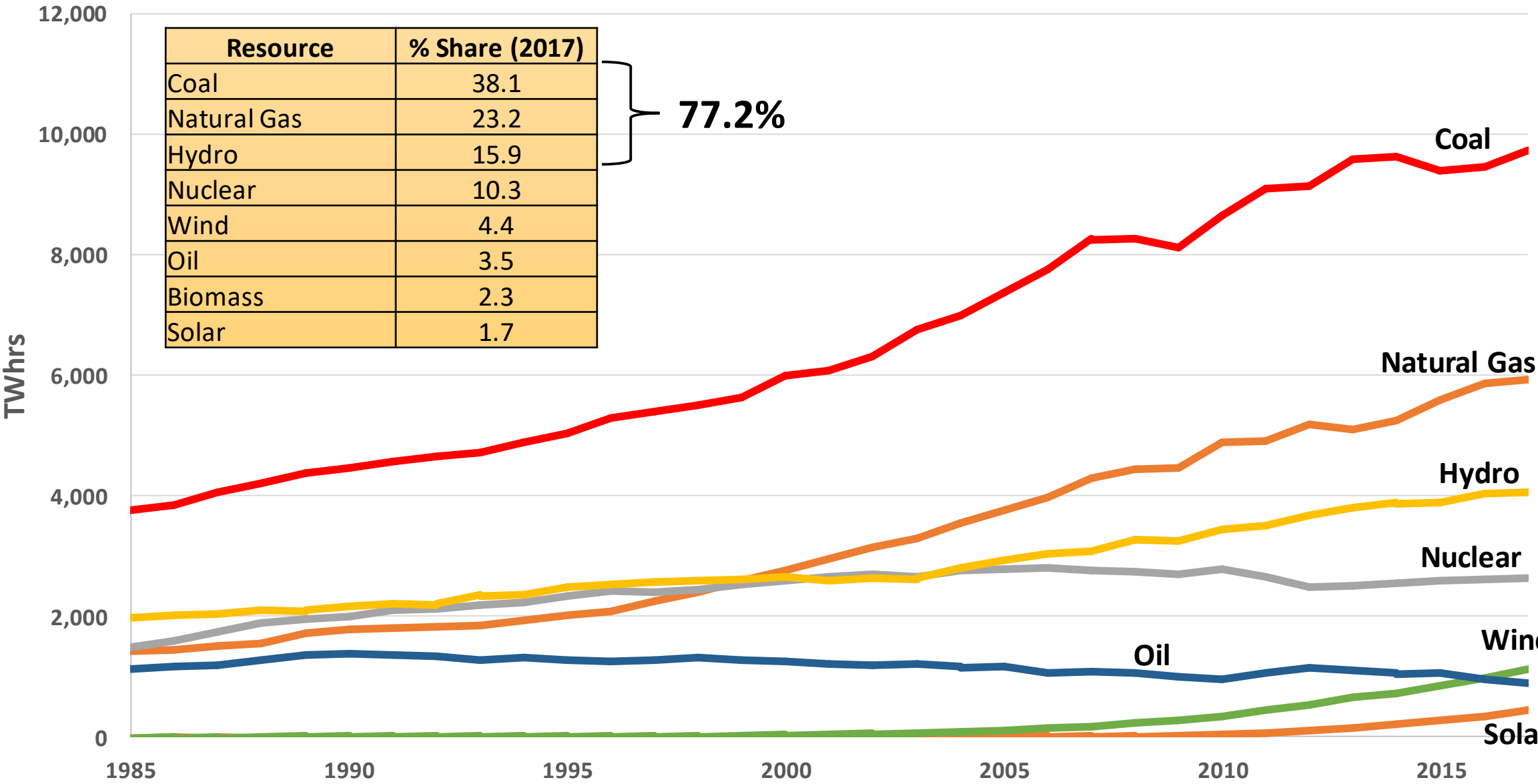
World Energy Consumption by Resource

Oil Natural Gas Coal Nuclear Hydro Solar Wind Biomass

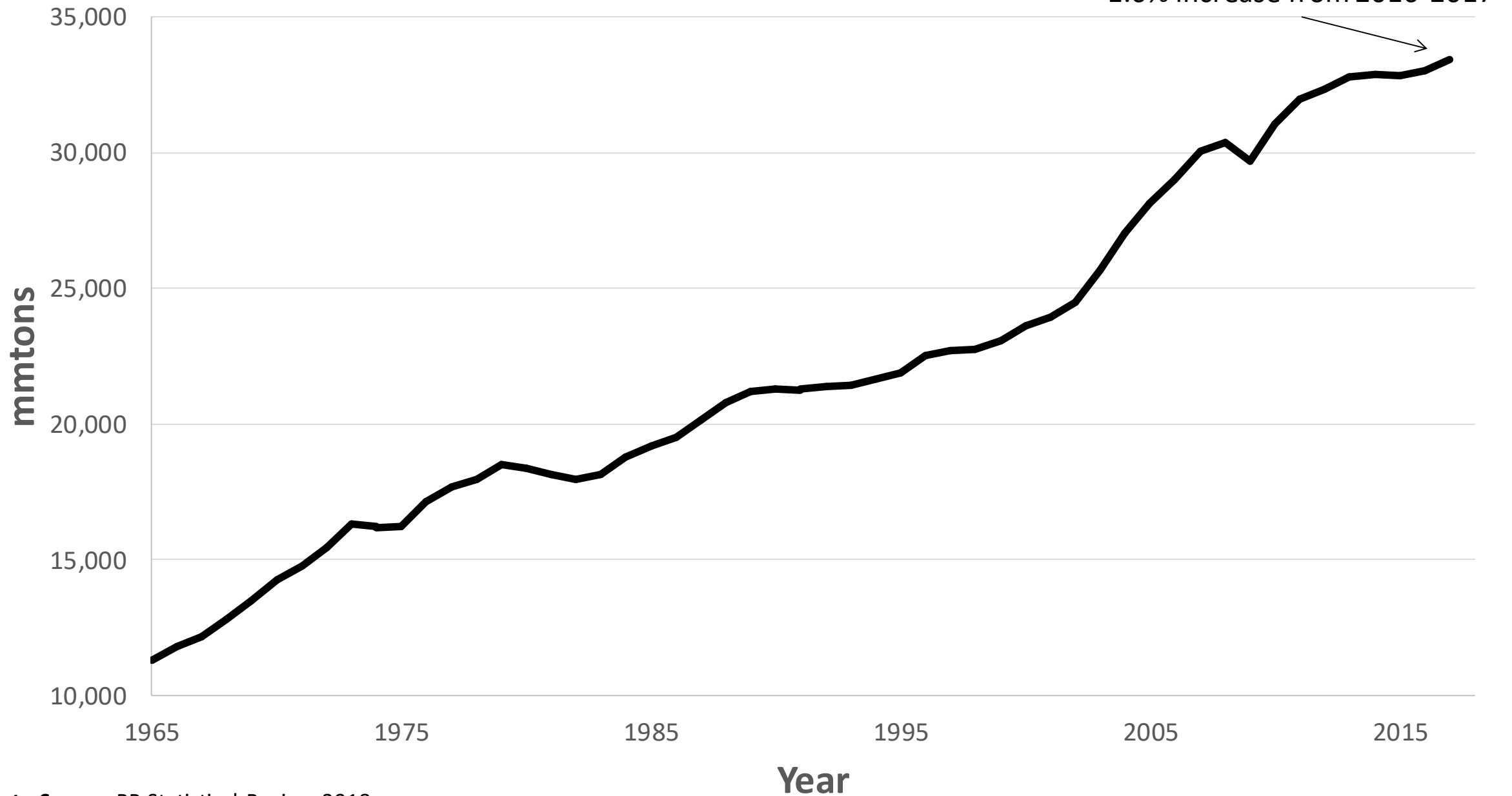


World Electricity Generation by Resource

Coal Natural Gas Nuclear Hydro Solar Wind Oil

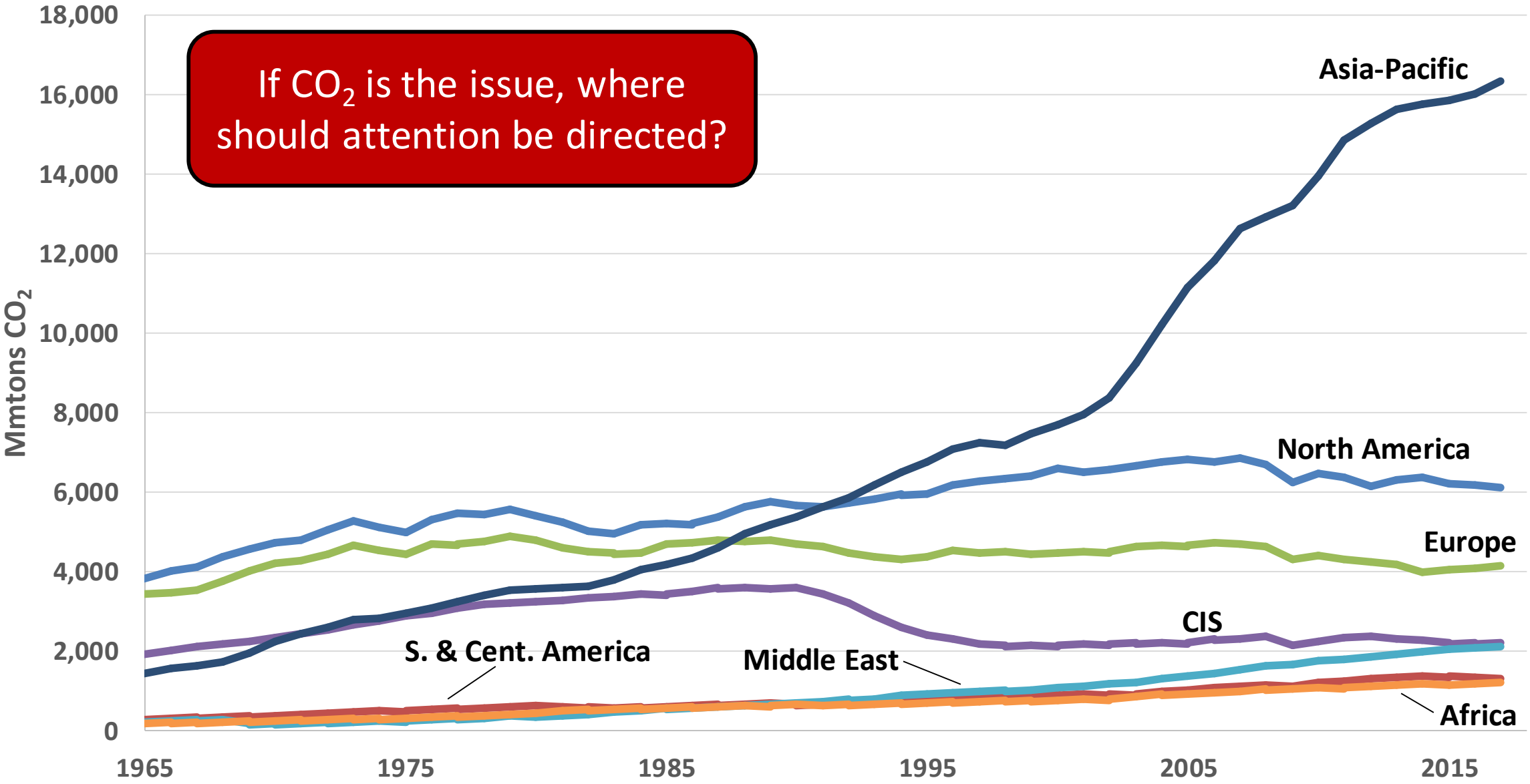


Global CO₂ Emissions

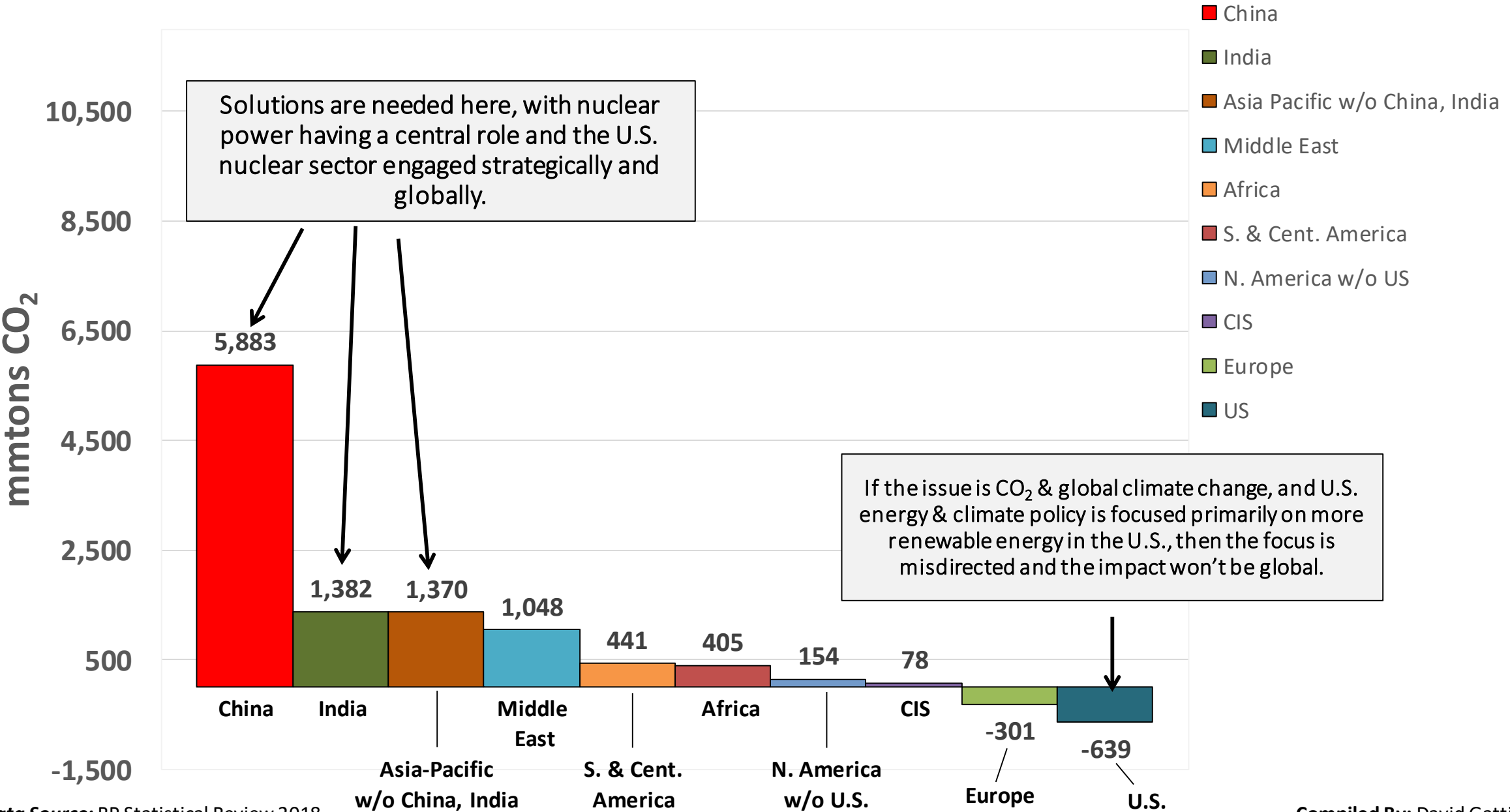


CO₂ Emission Trends by Region

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



Change in CO₂ Emissions [2000-2017]



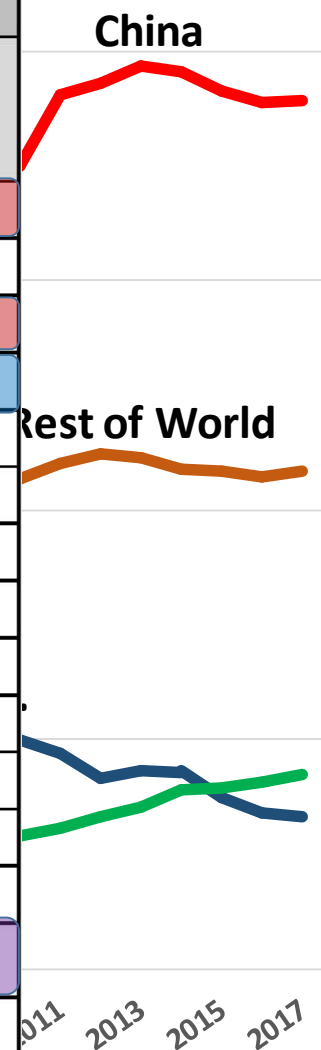
Data Source: BP Statistical Review 2018

Compiled By: David Gattie

Coal Plants by Country

Compiled By: David Gattie

	Operating		Under Construction	Announced + Pre-permit + Permitted	Operating + Construction + Announced + Pre-permit + Permitted	
Country	Capacity (MW)	% Global Share	Capacity (MW)	Capacity (MW)	Capacity (MW)	% Global Share
China	936,057	46.9	94,828	116,175	1,147,107	43.3
Rest of World	407,419	20.4	24,113	70,764	502,316	18.9
India	214,910	10.8	43,628	87,731	346,280	13.1
United States	278,823	14.0	0	0	278,837	10.5
Indonesia	28,584	1.4	12,015	25,890	66,490	2.5
Japan	44,578	2.2	4,979	13,596	63,155	2.4
Vietnam	14,971	0.8	10,635	35,890	61,497	2.3
Turkey	18,469	0.9	1,130	41,760	61,360	2.3
South Africa	42,101	2.1	6,352	5,540	53,995	2.0
Bangladesh	250	0.0	4,115	17,883	22,248	0.8
Philippines	7,206	0.4	4,581	7,560	19,347	0.7
Pakistan	2,450	0.1	3,190	9,195	14,835	0.6
Egypt	0	0.0	0	14,640	14,640	0.6
Global Total	1,995,818	100	209,566	446,624	2,652,108	100.0



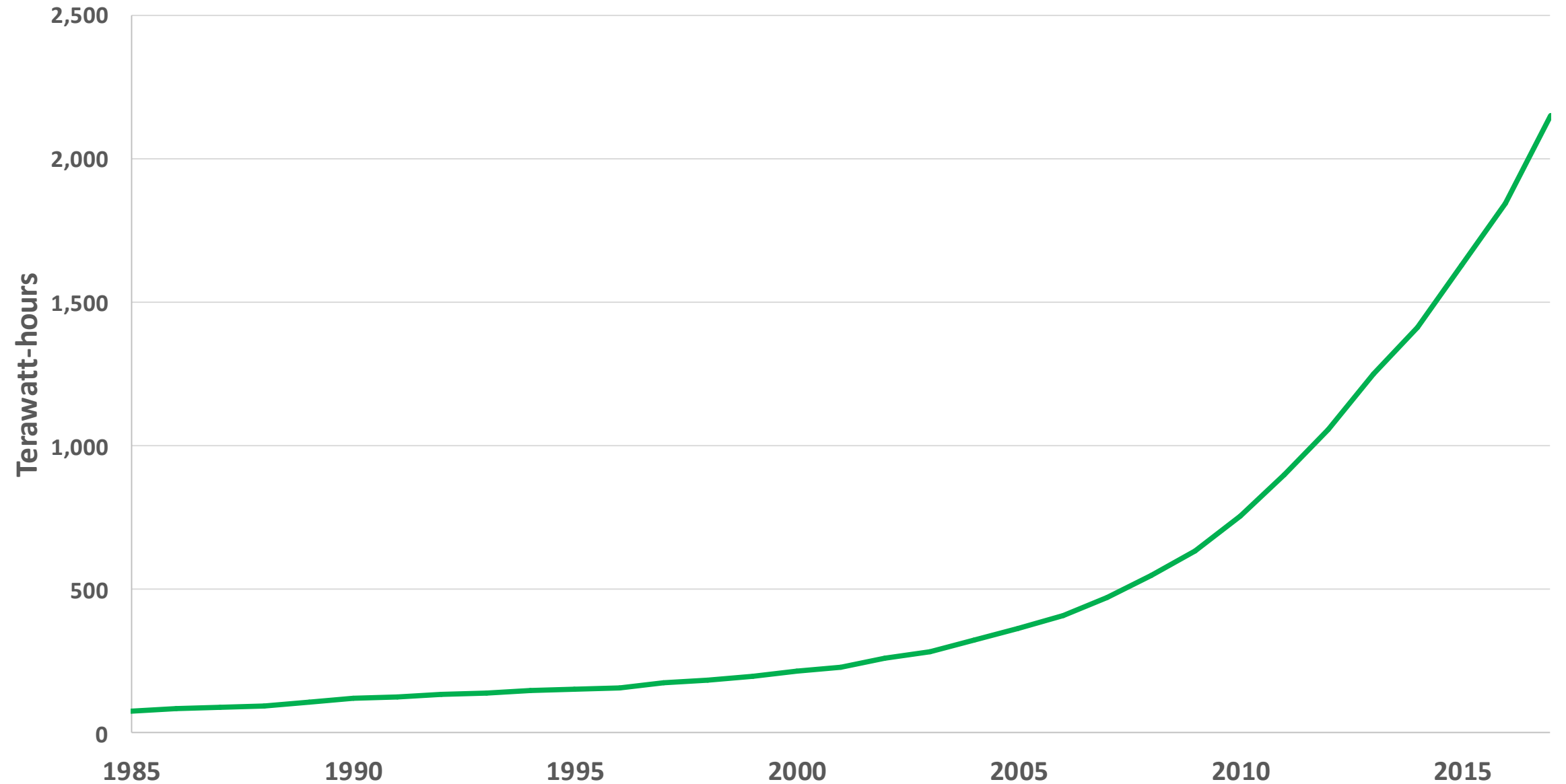
Data Source: CoalTracker

Data Source:

BP Statistical Review 2018

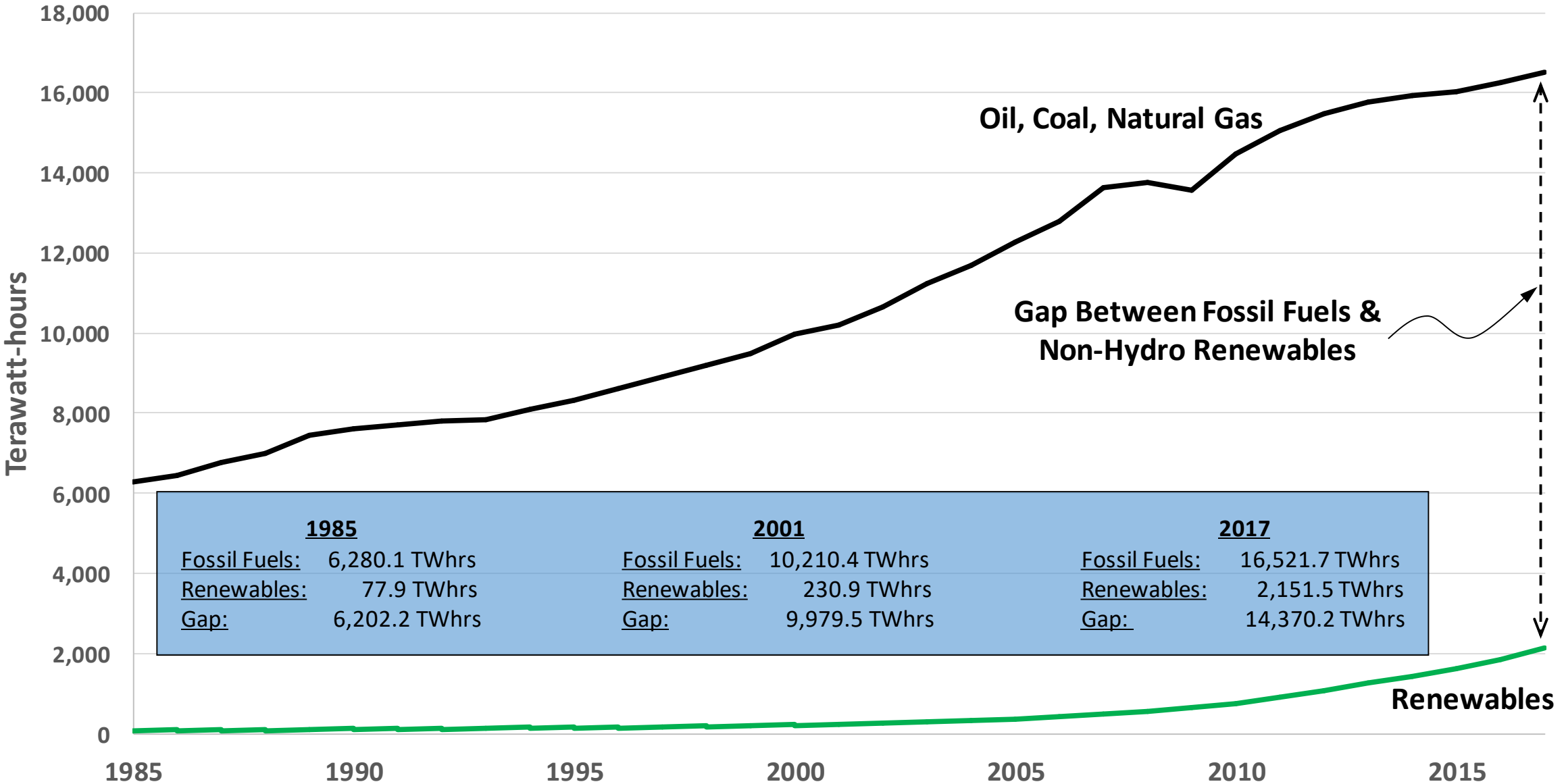
Global Electricity Generation

— Non Hydro Renewables



World Electricity Generation

— Fossil Fuels — Non Hydro Renewables

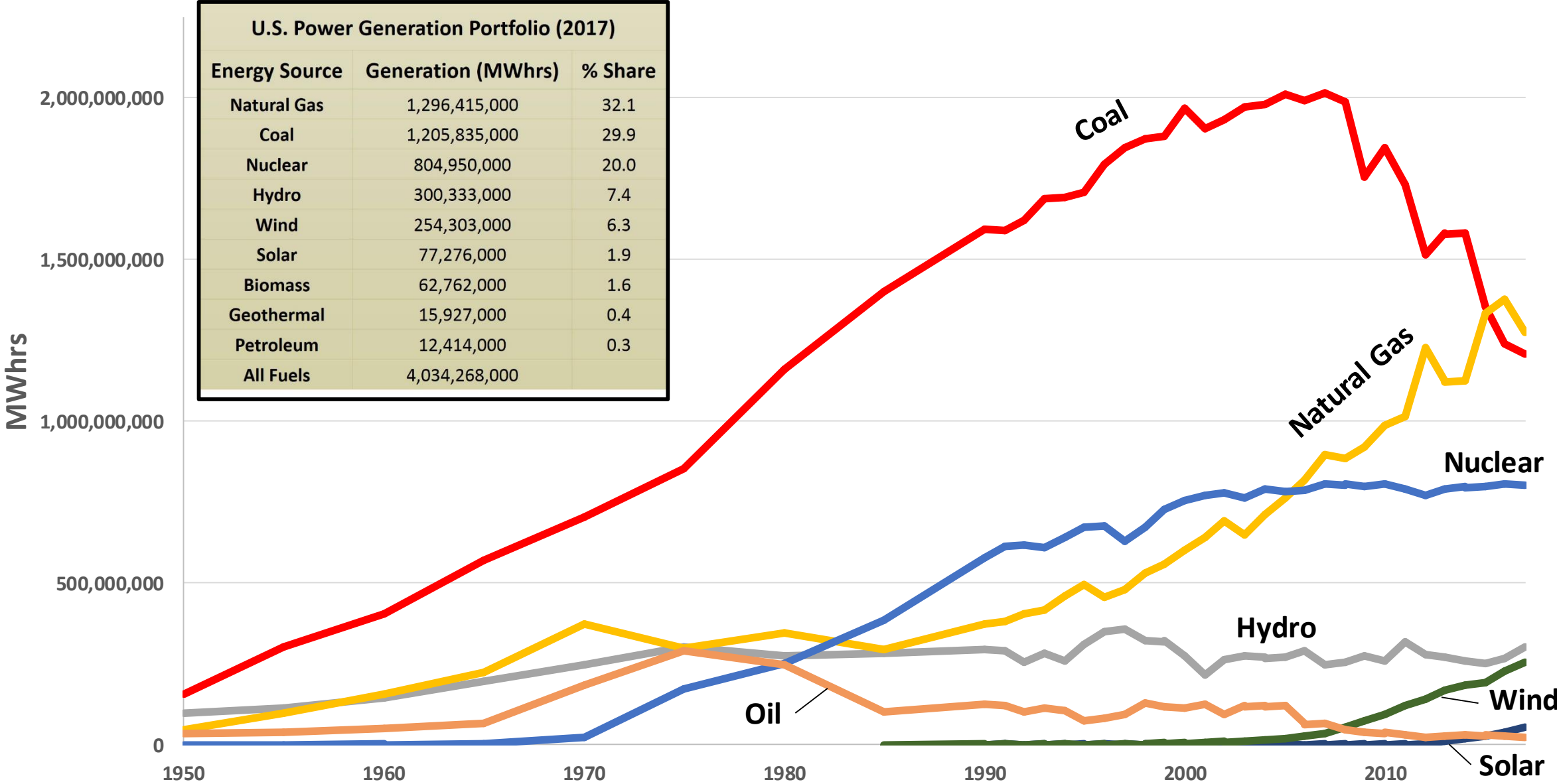


U.S. Nuclear Power

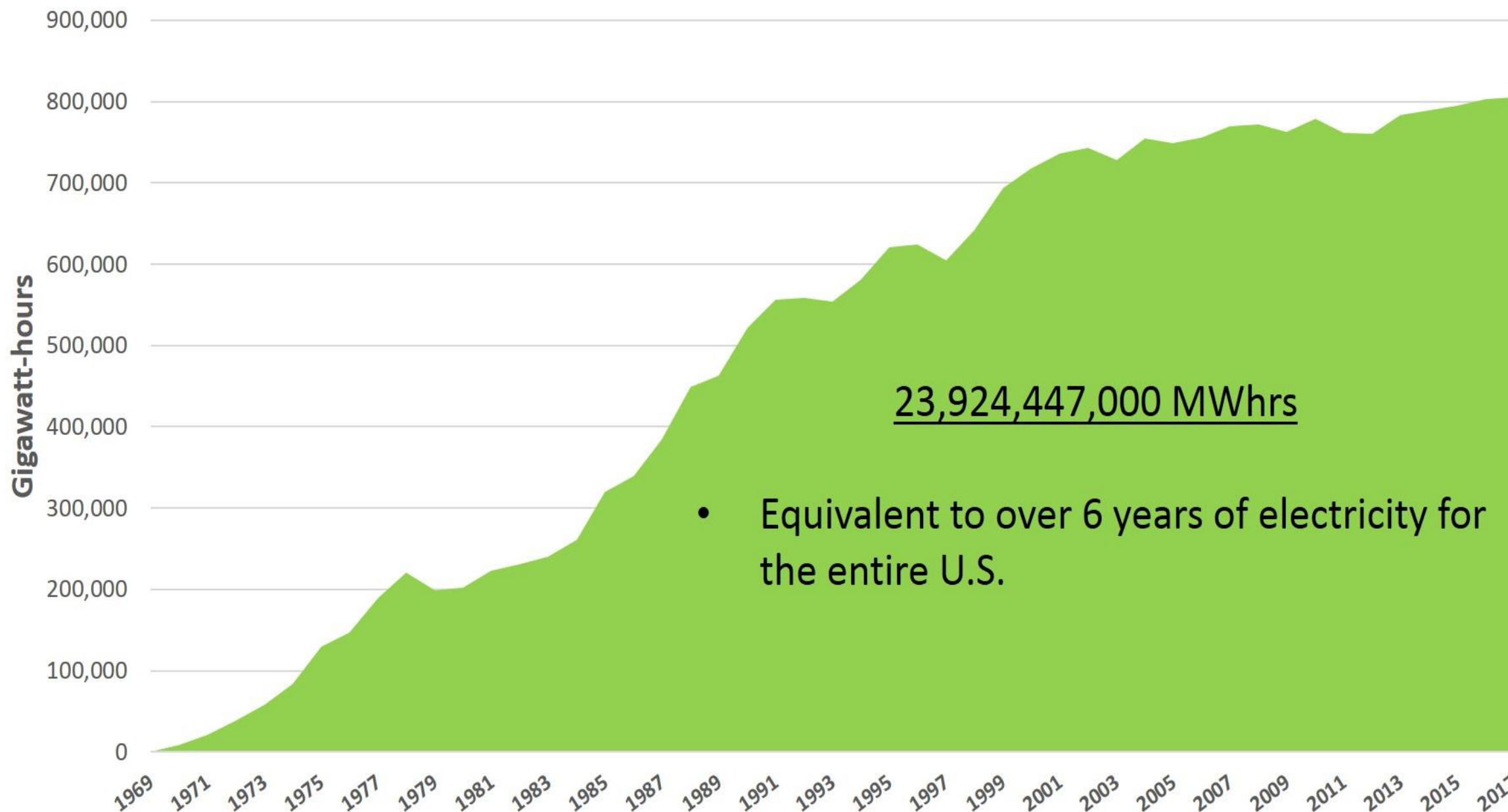
U.S. Electricity Generation by Resource

Coal Hydro Natural Gas Nuclear Solar Wind Petroleum

U.S. Power Generation Portfolio (2017)		
Energy Source	Generation (MWhrs)	% Share
Natural Gas	1,296,415,000	32.1
Coal	1,205,835,000	29.9
Nuclear	804,950,000	20.0
Hydro	300,333,000	7.4
Wind	254,303,000	6.3
Solar	77,276,000	1.9
Biomass	62,762,000	1.6
Geothermal	15,927,000	0.4
Petroleum	12,414,000	0.3
All Fuels	4,034,268,000	



U.S. Nuclear Generation



Plant	Nameplate Capacity (MW)	Location	Generation (MWhrs)	Retirement Year
Crystal River	860	Florida	7,000,079	2013
Kewaunee	556	Wisconsin	4,990,254	2013
San Onofre 2 & 3	2,150	California	18,097,173	2013
Vermont Yankee	620	Vermont	5,060,582	2014
Fort Calhoun	476	Nebraska	3,425,235	2016
FitzPatrick	838	New York	7,382,237	2017 (hold)
R. E. Ginna	614	New York	4,697,675	2017 (hold)
Clinton	1,069	Illinois	8,914,453	2017 (hold)
Nine Mile Point	641	New York	5,144,656	2017 (hold)
Quad Cities 1 & 2	1,868	Illinois	15,386,504	2018 (hold)
Pilgrim	688	Massachusetts	5,414,318	2019 (planned)
Oyster Creek	625	New Jersey	4,585,091	2019 (planned)
Three Mile Island 1	981	Pennsylvania	7,082,652	2019 (planned)
Indian Point 2 & 3	2,041	New York	17,308,255	2019 (planned)
Davis-Besse	925	Ohio	5,829,169	2020 (planned)
Perry	1,311	Ohio	10,455,271	2021 (planned)
Beaver Valley 1 & 2	1,846	Pennsylvania	14,757,306	2021 (planned)
Palisades	811	Michigan	5,822,926	2022 (planned)
Diablo Canyon 1 & 2	2,323	California	8,091,303	2024, 2025 (?)
Salem 1 & 2	2,340	New Jersey	16,282,398	On Hold
Hope Creek	1,291	New Jersey	4,177,235	On Hold
Millstone 2 & 3	2,162	Connecticut	6,843,359	On Hold
Total	27,036		186,748,131	

Data Source: U.S. EIA; U.S. EPA eGRID 2014
Retirement Years: Third Way

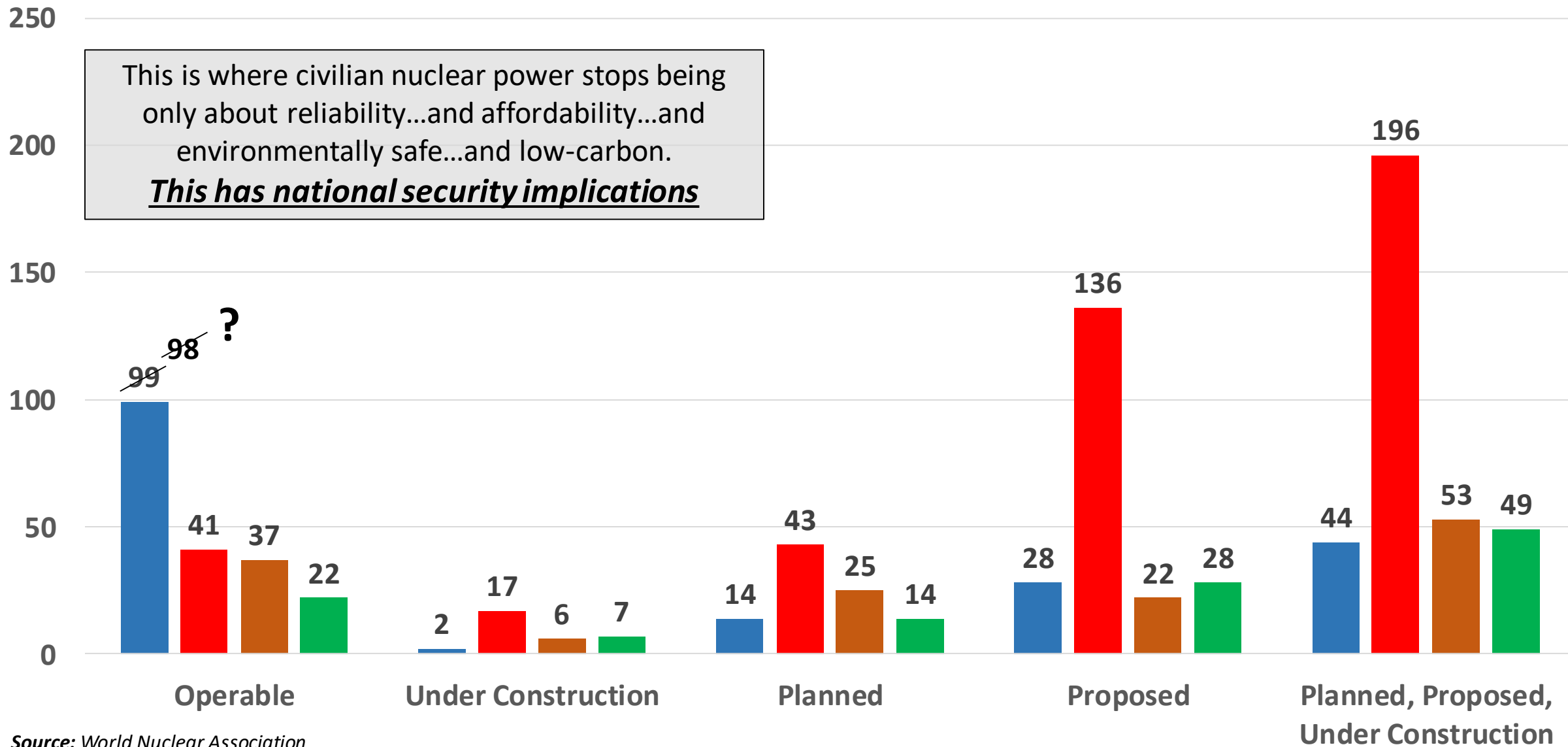
U.S. Nuclear Plant
Premature Closings
(29 reactors)

➤ 23% of total U.S. nuclear generation

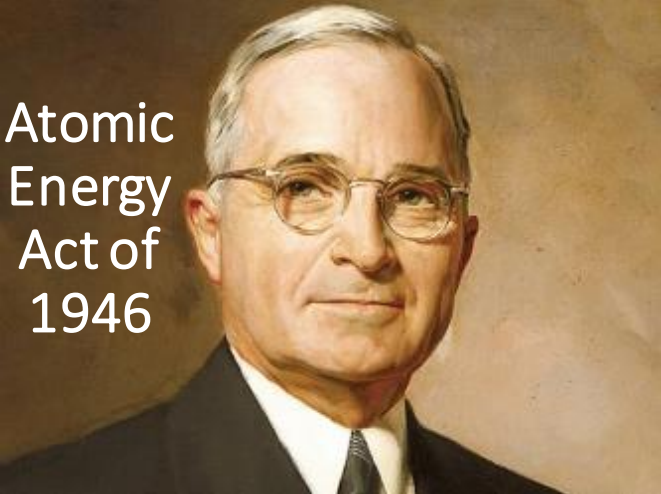
← September 30, 2019

Nuclear Reactors: World's Leading Industrial, Economic, Military Powers

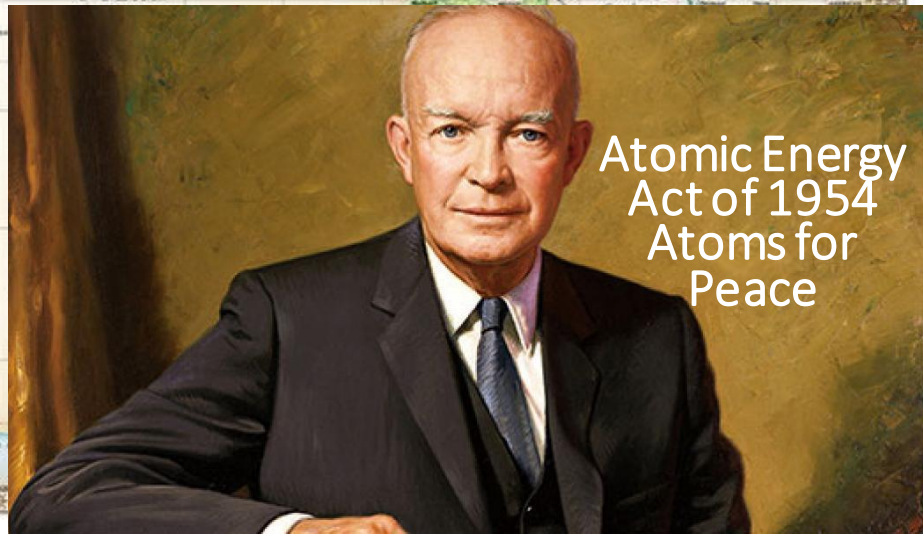
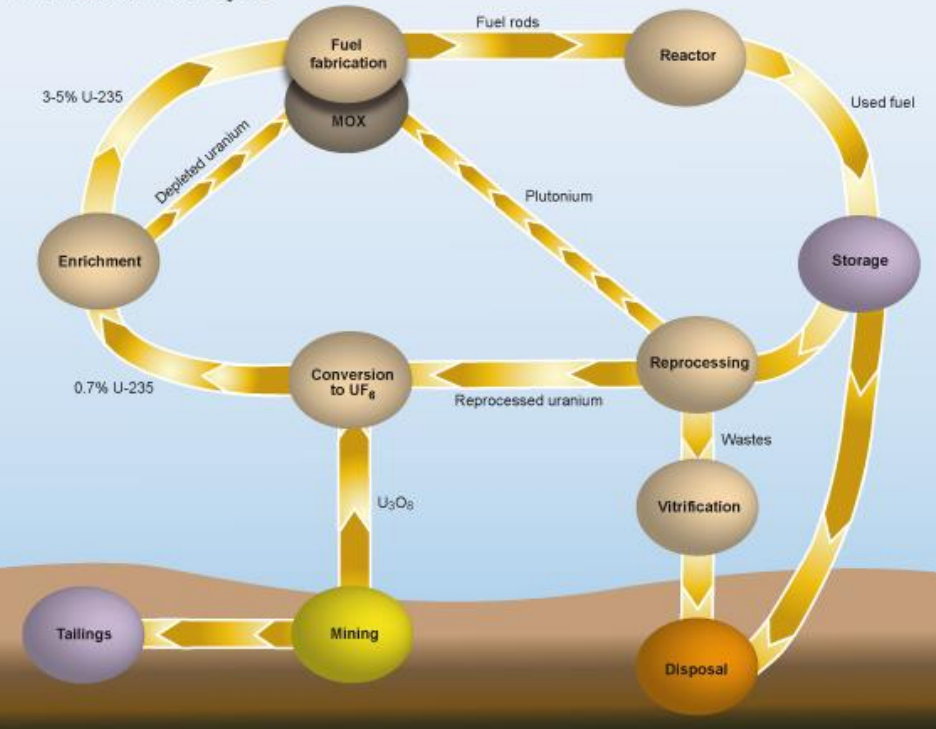
■ USA ■ China ■ Russia ■ India



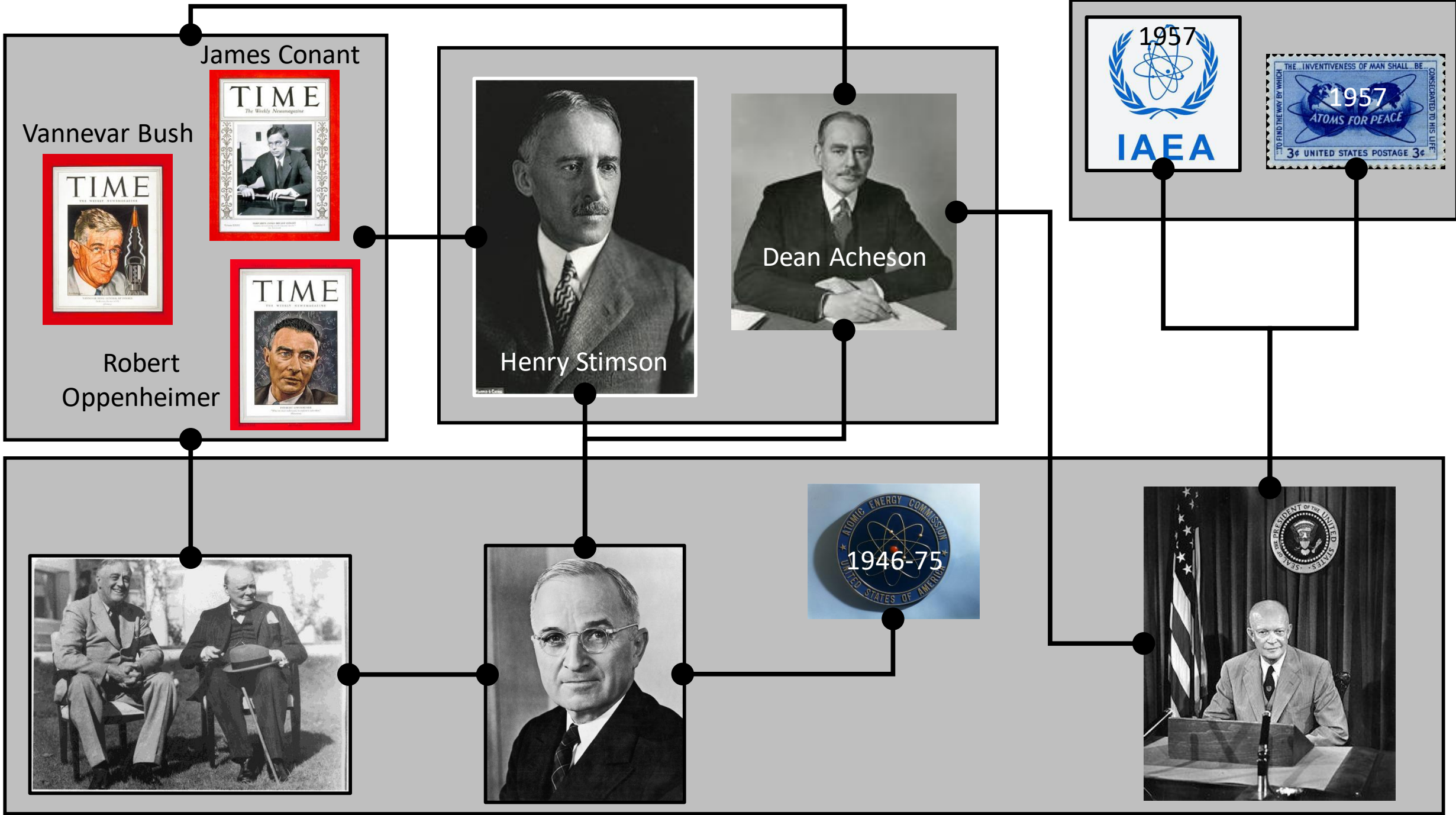
Atomic Energy Act of 1946



The Nuclear Fuel Cycle



Atomic Energy Act of 1954 Atoms for Peace



“There is need for a very extensive and technically highly qualified and varied staff if the job [of atomic energy control] is to be done at all...the controlling agency must itself be active in research and development... In a field as new and as subject to technical variation and change as this, the controlling agency must be at least as inventive and at least as well informed as any agency which may attempt to evade control.”

Acheson-Lilienthal Report: The International
Control of Atomic Energy (1946)

“Only a unit that was organic and alive could keep abreast of the changing technology and attract an able, imaginative staff.”

Without such, there would be insufficient intellectual capacity for the U.S. to engage competently and authoritatively in the global nuclear network.

Robert Oppenheimer, Manhattan Project

I have recalled this history to emphasize the fact that decisions about the peacetime development of nuclear energy have not, cannot and probably should not be made on the basis of strict economic realism

Henry DeWolf Smyth (1956)

Manhattan Project, Atomic Energy Commission,

IAEA U.S. Ambassador

Author of *Atomic Energy for Military Purposes*, 1945

Two Core U.S. Policy Principles for Shaping the International Order of Nuclear Power

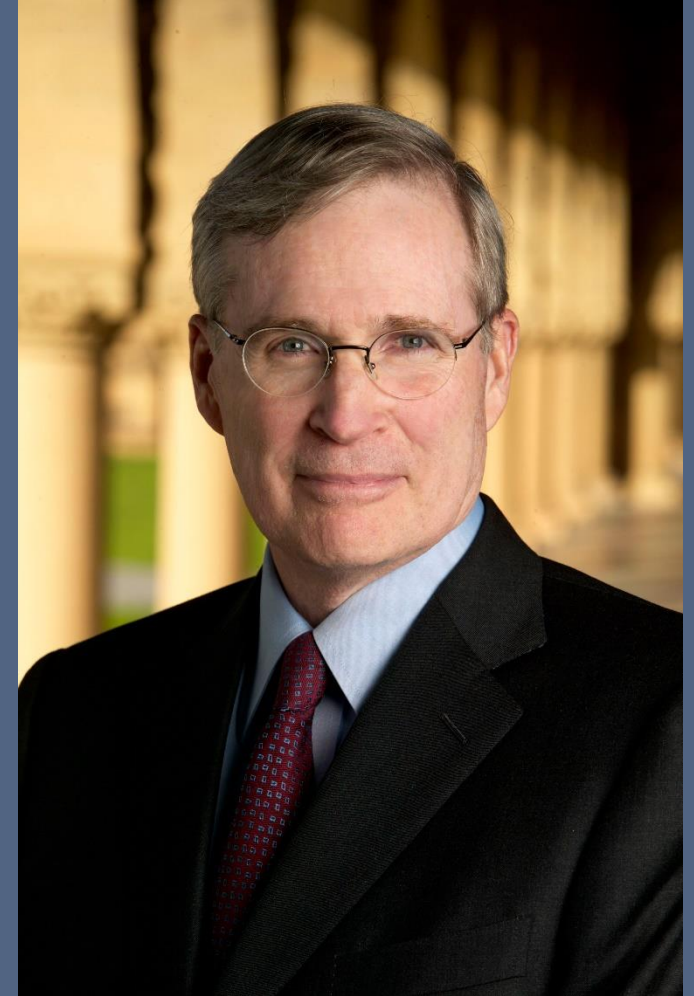
1. Establish International Control

- U.S. will lead the development of an international system to control atomic energy and integrate itself as a nation of experts (not merely inspectors) in the global nuclear network and supply chain

2. Maintain U.S. Leadership (Primacy)

- Develop a vigorous nuclear R&D enterprise that will establish the U.S. as the global leader in the nuclear field

“At the geopolitical level, the world has seen the return of great-power rivalry and ideological competition. The 2017 National Security Strategy said it well: “The competitions and rivalries facing the United States are not passing trends or momentary problems. They are intertwined, long-term challenges that demand our sustained national attention and commitment.” (Stephen Hadley, to the Senate Foreign Relations Comm., 2019)



U.S. National Security Advisor, 2005-2009

To Which Nation Belongs the 21st Century

Country	# Reactors	Capacity (MW)
CHINA	13	13,168
INDIA	7	4,824
RUSSIA	6	4,573
UAE	4	5,380
KOREA, SOUTH	4	5,360
JAPAN	2	2,653
BELARUS	2	2,220
BANGLADESH	2	2,160
PAKISTAN	2	2,028
USA	2	2,234
UKRAINE	2	2,070
SLOVAKIA	2	880
FRANCE	1	1,630
FINLAND	1	1,600
BRAZIL	1	1,340
TURKEY	1	1,114
ARGENTINA	1	25
Total	55	55,859

Reactors Under Construction

Source: IAEA

Russia

- 37 reactors
 - 28,961 MW
 - 187.5 TWhr (17.8%)
- Aggressively expanding role of nuclear power
- Export of nuclear technology and services are strategic objective
 - Build, Own, Operate (BOO); 20 reactors currently confirmed/planned for export
- Policy is to close the fuel cycle by 2030

Nuclear Power Plants in Russia



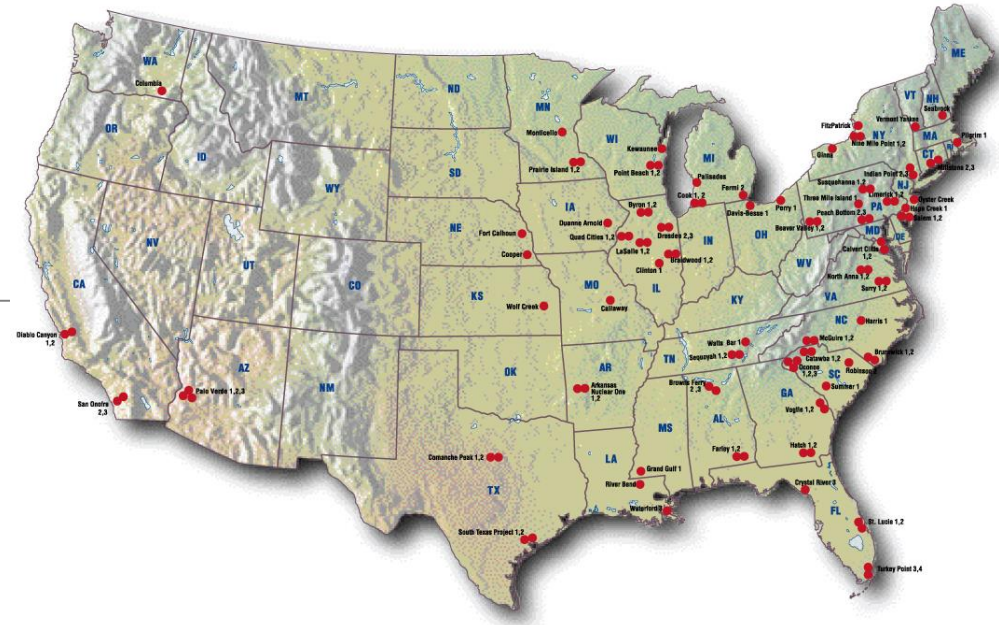
China

- 39 reactors
 - 36,667 MW
 - 247.5 TWhr (3.9%)
- Goals:
 - Become the center of Asian nuclear fuel preparation and manufacturing
 - Close the fuel cycle
 - 3-step strategy (PWRs, FBRs, Fusion)



United States

- ~~99~~ ^{98?} reactors
 - 99,647 MW
 - 805 TWhr (20.0%)
- 2 reactors under construction; no others planned
- No reprocessing
- Yucca Mountain has been set as the long-term geological repository, however, no political resolve



The Other Side of “*The World As It Is*”

Geopolitics and China’s Belt & Road Initiative (BRI)

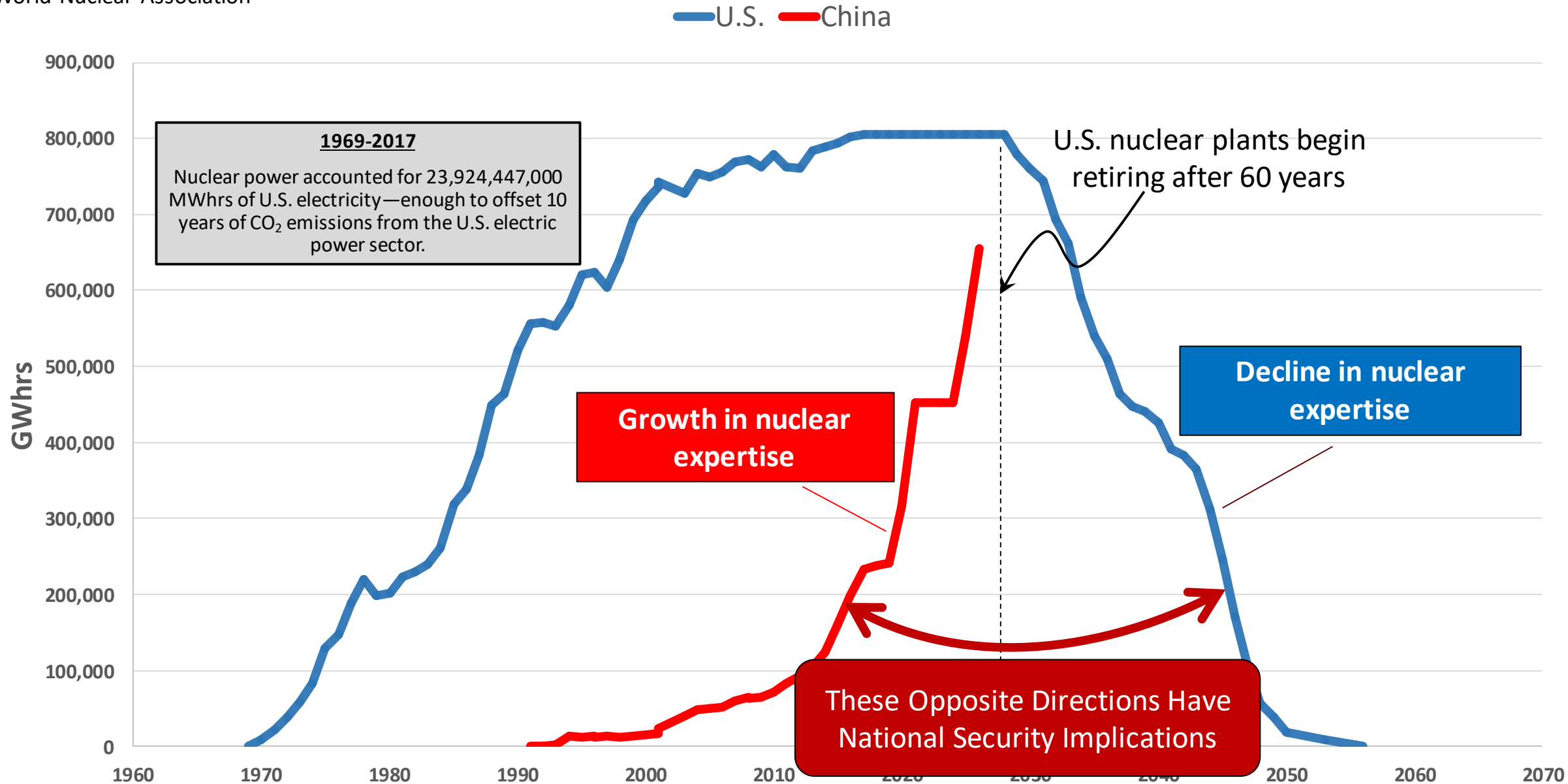


Data Source:

U.S. EIA; IAEA; &
World Nuclear Association

Compiled By: David Gattie

U.S. and China Nuclear Power Generation: Projected



"China is the fastest-expanding nuclear power generator in the world, underscoring the huge potential of the country's nuclear sector at a time when traditional giants like the US are retreating. China has an incomparable advantage in developing nuclear power — the sheer size of State-owned nuclear enterprises, which have long-term stability and rich financing sources to support research and development spending. They are also not as vulnerable to market risks as their private counterparts. The huge injection of capital at the initial stage could be balanced by quantity production in later phases, providing economic efficiency."

LIN BOQIANG, DIRECTOR OF THE CHINA CENTER FOR ENERGY
ECONOMICS RESEARCH AT XIAMEN UNIVERSITY

...the banner of socialism with Chinese characteristics is now flying high and proud for all to see...the culture of socialism with Chinese characteristics have kept developing, blazing a new trail for other developing countries to achieve modernization. It offers a new option for other countries and nations who want to speed up their development while preserving their independence...”

PRESIDENT XI JINPING, OCTOBER 2017

19TH NATIONAL CONGRESS OF THE COMMUNIST PARTY OF CHINA

Headwinds to U.S. Nuclear Development

1. Fear over waste and proliferation issues
2. Capital costs are high for large reactors
 - Reviving a U.S. nuclear sector that has been dormant for over 30 years is challenging
3. Misplaced belief in 100% renewable energy and U.S. as a climate island
4. Overconfidence in markets alone
 - Nuclear as transactional (U.S.) vs. nuclear as strategic (China & Russia)
5. State-owned enterprises in other countries
6. Lack of political resolve
7. A general disconnect from the “*the world as it is*” in the 21st century with Great Power Competition constituting a priority national security

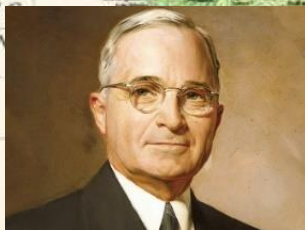
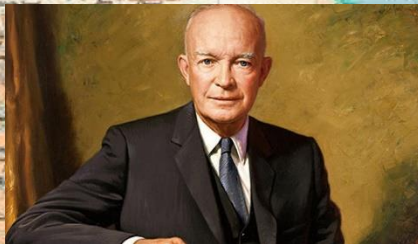
National Security Concerns

- Can the U.S. maintain a reliable grid and meet its future electricity needs and CO₂ reduction objectives without nuclear?
- A U.S. exit from nuclear power would be a unilateral exit among great powers
 - *An exodus of expertise and a loss of global influence/leadership*
 - *The world will not stop developing advanced nuclear technology*
- If the U.S. retreats from civilian nuclear, regardless of cause, it will signal America's abandonment of its foundational principles of nuclear policy & international engagement
 - *Would a world without America's leadership be safer & more secure?*

National Security Concerns

- As China invests, the U.S. has little to show or point to for future development. This could project to developing economies, and the world, that China is bold while the U.S. is cautious & indecisive, or that Xi's "socialism with Chinese characteristics" is succeeding where capitalism with U.S. characteristics is failing.
 - *We're still engaged in a battle of ideas*
- China & Russia are competing for global leadership in civilian nuclear technology, and nuclear cooperation translates to 80-year relationships
 - *U.S. thinking on this must be strategic, not merely transactional*

20th Century Legacy



21st Century Competitors



Which Nation Will Lead the 21st Century *World As It Is*?

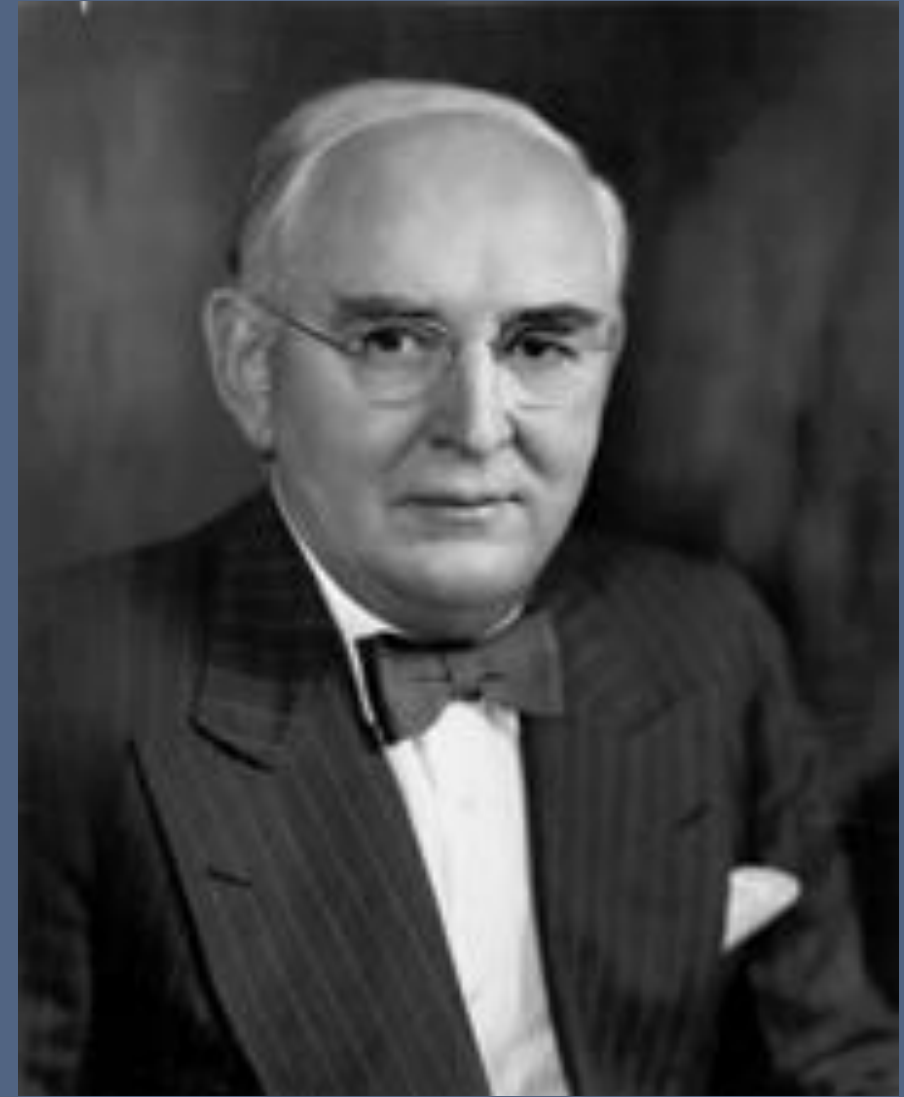
America's legacy in nuclear power and the international control of atomic energy will not carry over to the 21st century by birthright—it must be earned to be retained.

America Must Compete

“There are critical moments in the life of every nation which call for the straightest, the plainest, and the most courageous thinking of which we are capable. We confront such a moment now.”

“...our oceans have ceased to be moats.”

(Arthur Vandenberg, 1947, *American Foreign Policy*;
U.S. Congressional Record, 79th Cong. 1st sess., pp. 164-167)



U.S. Senator, Michigan; 1928-1951

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

*†David Gattie—†Joshua Darnell—†Joshua Massey

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



Energy Systems



National Security

Thank You
