

The Quest by Daniel Yergin

Part III: The Electric Age
Part IV: Climate and Carbon

TEAM 3:

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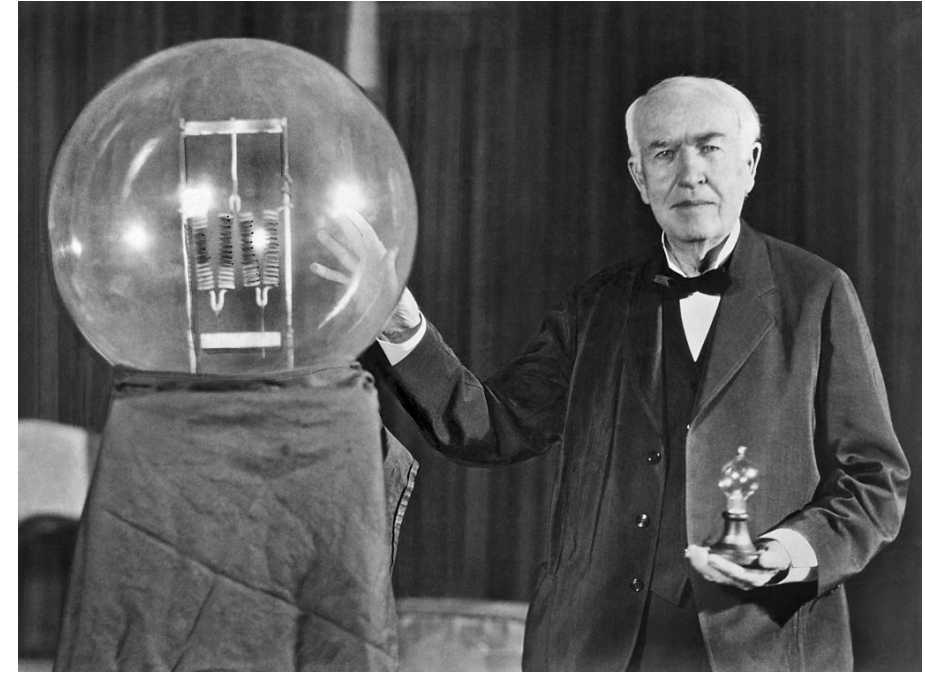
Meddelin Setiawan

PART III: The Electric Age

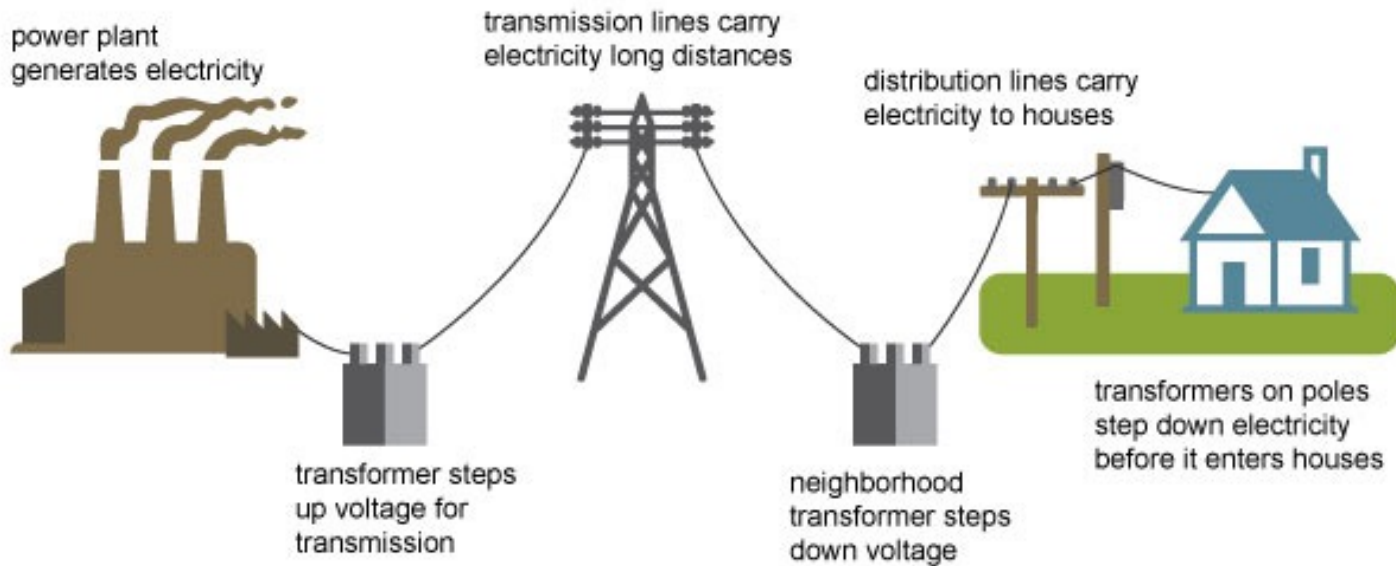
17. Alternating Current

Start of the Electric Age

- Pearl Street Station opens September 4, 1882 in lower Manhattan by Edison Company
- First electricity bill issued January 18, 1883
 - Ansonia Brass and Copper Company- \$50.44
- Subdividing light, replacing gas-fired lamp
 - Carbon filament in light bulb for longer operation



Electricity generation, transmission, and distribution



Source: Adapted from National Energy Education Development Project (public domain)

Distribution of Electricity

- Direct Current vs Alternating Current
- George Westinghouse introduces transformers and AC current transmission
 - True economies of scale, lower costs
- Edison Company merged with Westinghouse rival to form General Electric
- 1890s customers paid for # of bulbs
- Samuel Insull suggests meters

Obligation to Serve

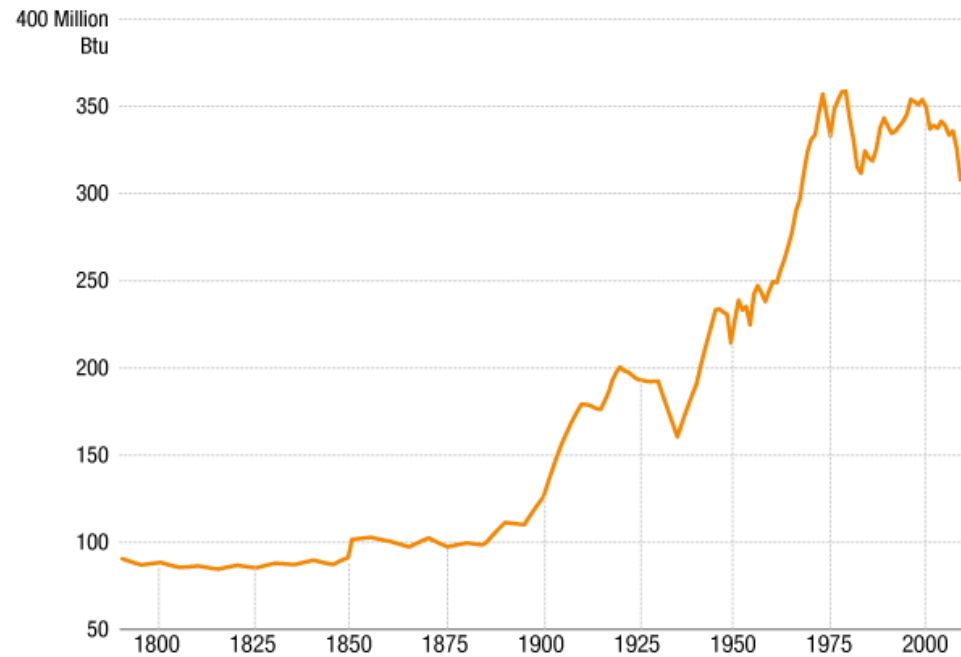
- Holding companies introduced
- Corruption of power franchises
- Natural monopoly suggested- lower costs to customer
 - Regulatory bargain- PUCs established in all states by 1920s
 - Reliable service at reasonable cost

Electricity Advances Around the World

- Creation of German "General Electric Company"
 - By 1912 Berlin most important electrical city
- London lagged due to lack of regulation



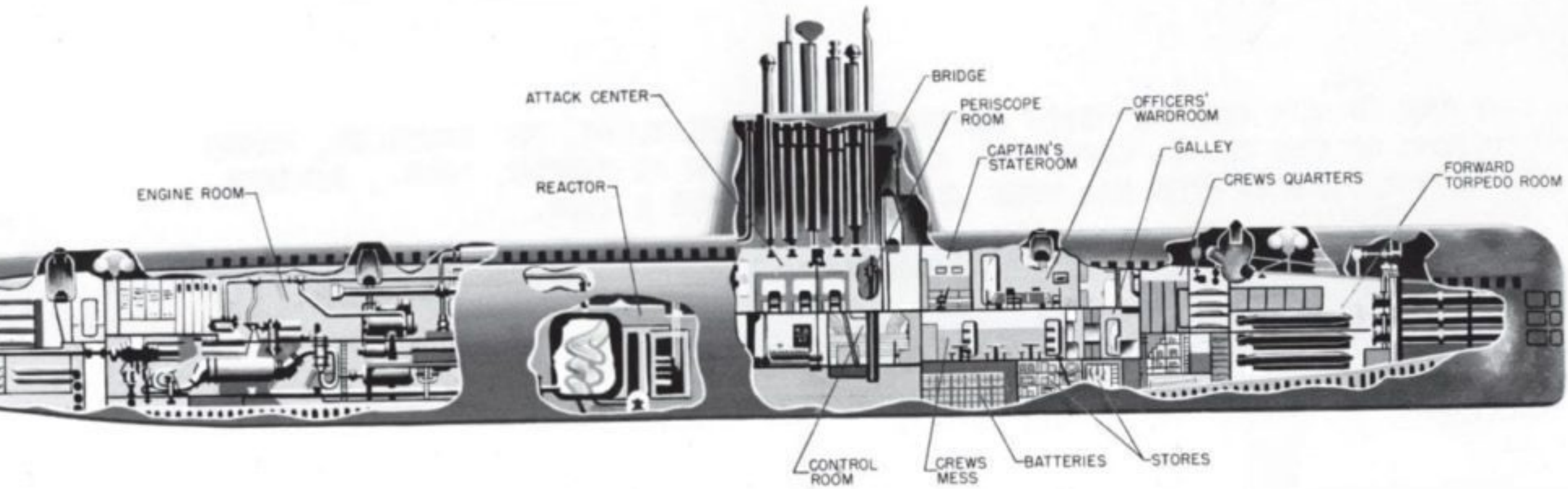
U.S. Energy Consumption, Per Capita (1790-2011)



The New Deal and Restructuring

- 1932 General Electric collapsed in debt
- Public Utility Holding Act of 1935
 - "death sentence" to holding companies except for adjacent utilities
- 1936 Rural Electrification Administration
- 1950s demand grew 10% annually
- "Live Better Electrically" Campaign-Ronald Reagan

18. The Nuclear Cycle



Atoms for Peace

- August 1953- Soviet weapon test
- Light water reactor, Admiral Hyman Rickover
 - Nuclear submarine USS Nautilus 1954
- 1st US nuclear powerplant- Shippingport, PA 1957
- 1963 turning point in power
- Lack of standardization and operating experience
- Rising costs for permits and redesigns

Nuclear Proliferation

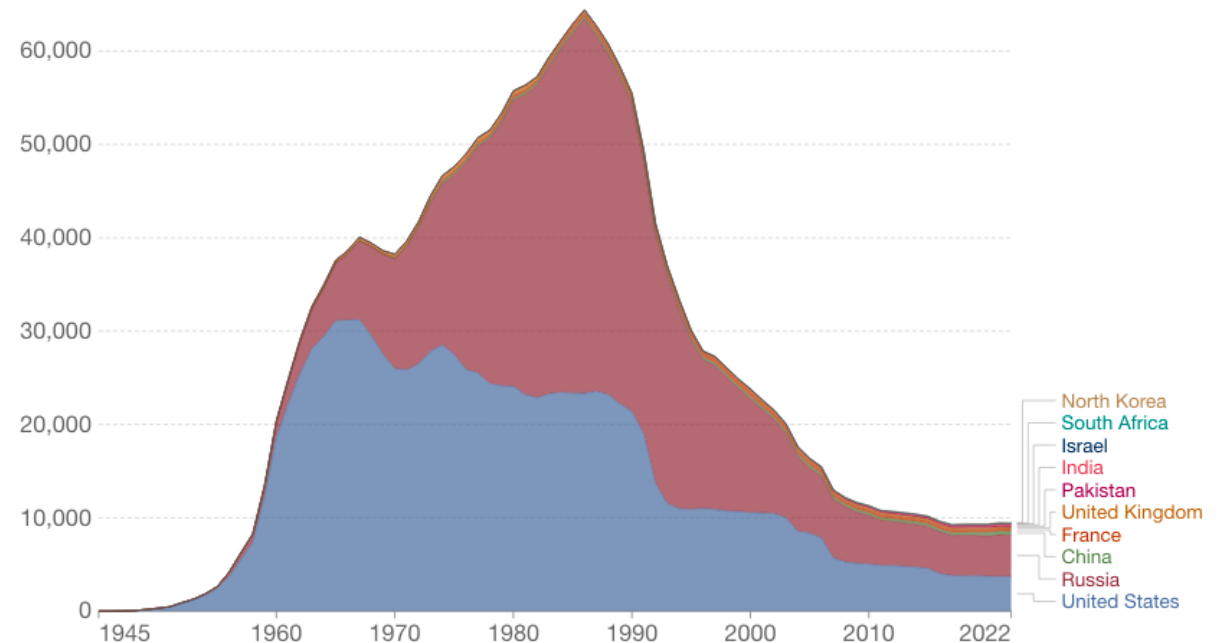
- MAD doctrine
- "The Buddha is smiling" May 1974
- Three Mile Island March 28, 1979
 - Mainly operator errors
 - Creation of Institute of Nuclear Power Operations
 - Projects canceled
- 20% of US electricity within 2 decades
- Soviet Union RBMK reactors- Chernobyl disaster April 26, 1986



Estimated nuclear warhead stockpiles, 1945 to 2022

Stockpiles include warheads assigned to military forces, but exclude retired warheads queued for dismantlement.

Our World
in Data



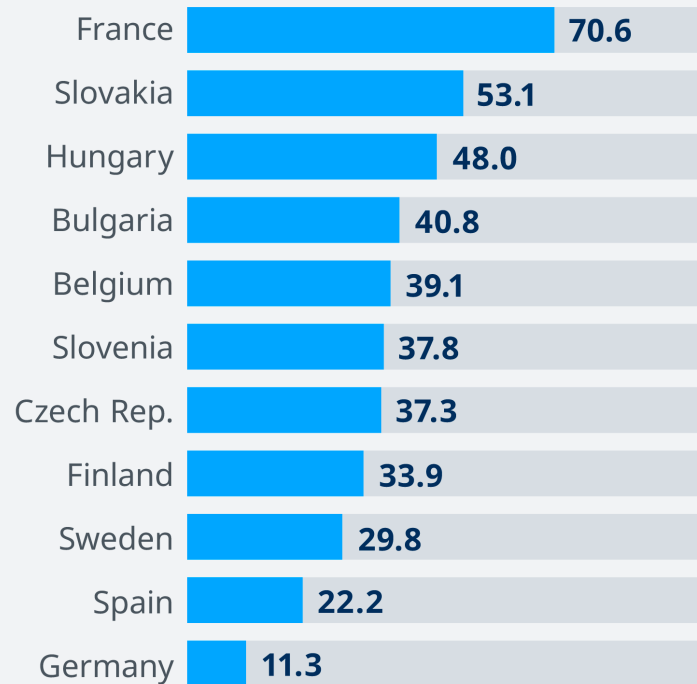
Source: Federation of American Scientists (2022)

OurWorldInData.org/nuclear-weapons/ • CC BY

Note: The exact number of countries' warheads is secret, and the estimates based on publicly available information, historical records, and occasional leaks. Warheads vary substantially in their power.

Share of nuclear energy in electricity generation 2020

In percent



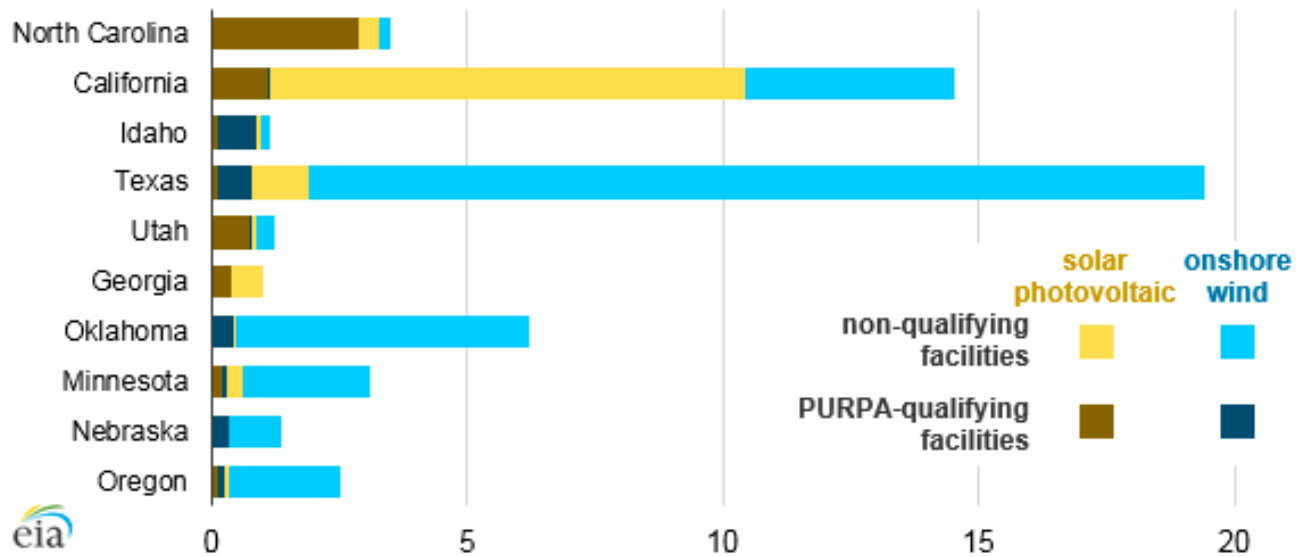
Source: IAEA | July 2021

Chernobyl's Impact

- Italy shut down plants
- Sweden, Germany, and Britain phaseout plans
- France increases capacity to 80%
- Japan seeks energy security

19. Breaking the Bargain

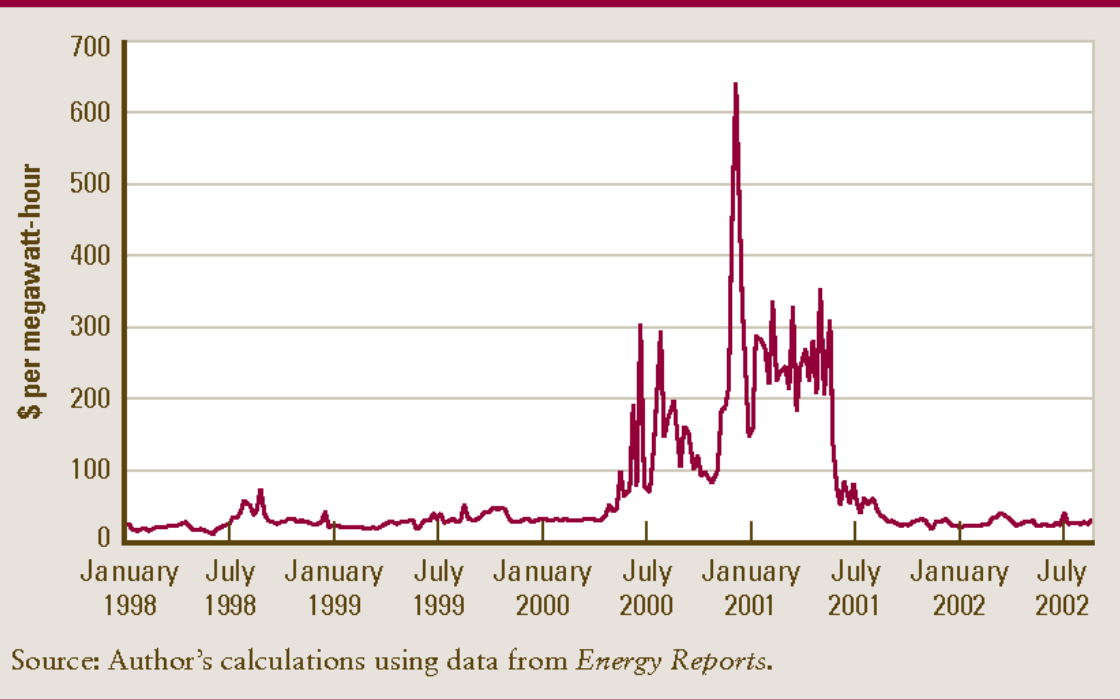
Top ten states with PURPA-qualifying facility generating capacity additions (2008-2017)
gigawatts



The Bargain

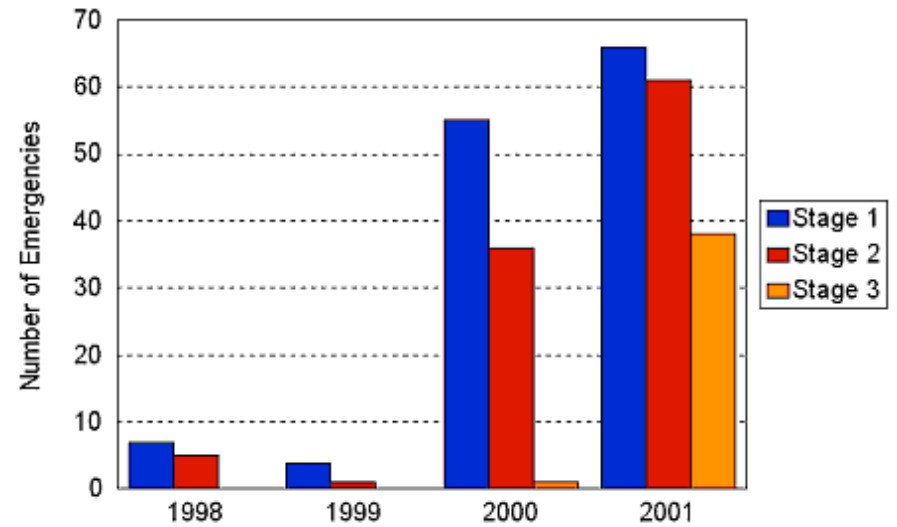
- PURPA 1978- rate shock
- Ban on natural gas in generation lifted- "dash to gas"
- Industry privatized after British model

Figure 1. Weekly Average On-Peak Prices in West Coast Spot Markets, 1998–2002



California's Power Crisis 2000-2001

- Deregulation enacted in 1998
 - Iron Curtain
- Reserve margin ignored
- Ban on utility-generator contracts
- Economic depression turns 1988
 - Consumption increased, capacity decreased
- Dependence on foreign power
 - Drought in 2000
- \$600 MWh -> \$60 MWh



Source: California Independent System Operator

Future of the Utility

- Slowed deregulation
- Hybrid system of generation ownership
 - PJM- transmission and competitive wholesale market
- Fuel choice to meet increasing demand

20. The Urgency of Fuel Choice

Consumption Crisis and Fuel Portfolios

- 1.4% increase per year in US

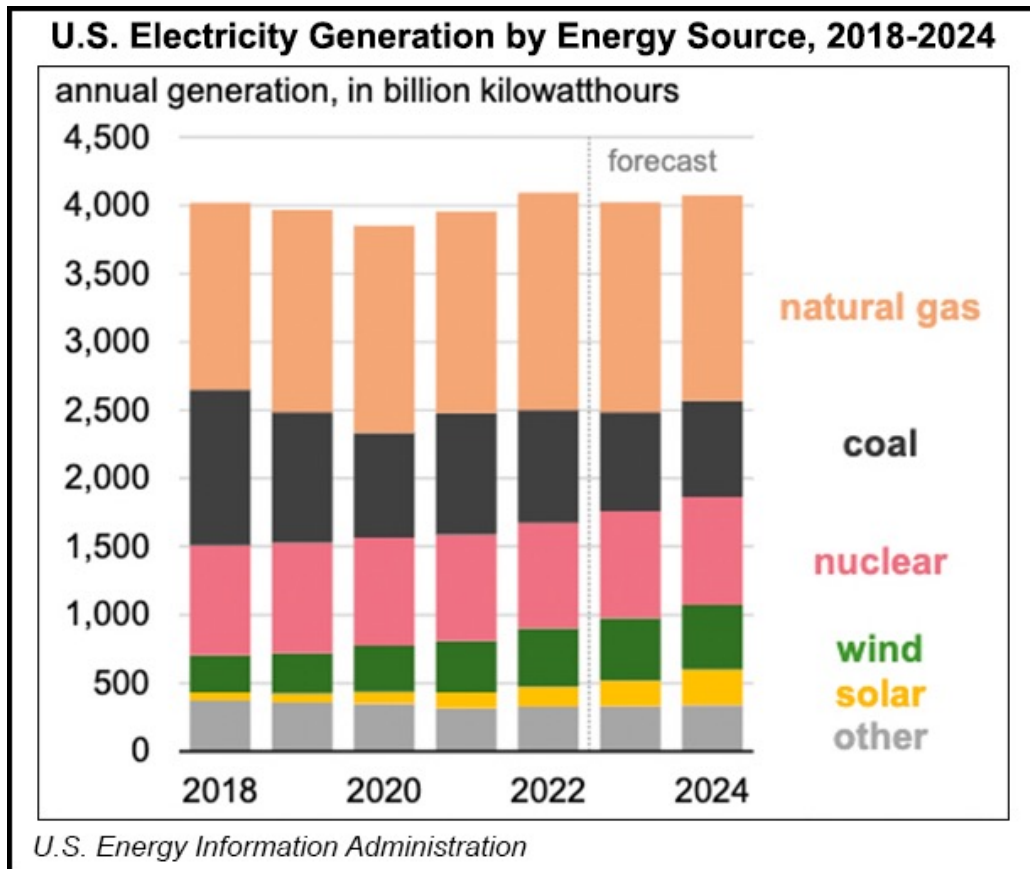
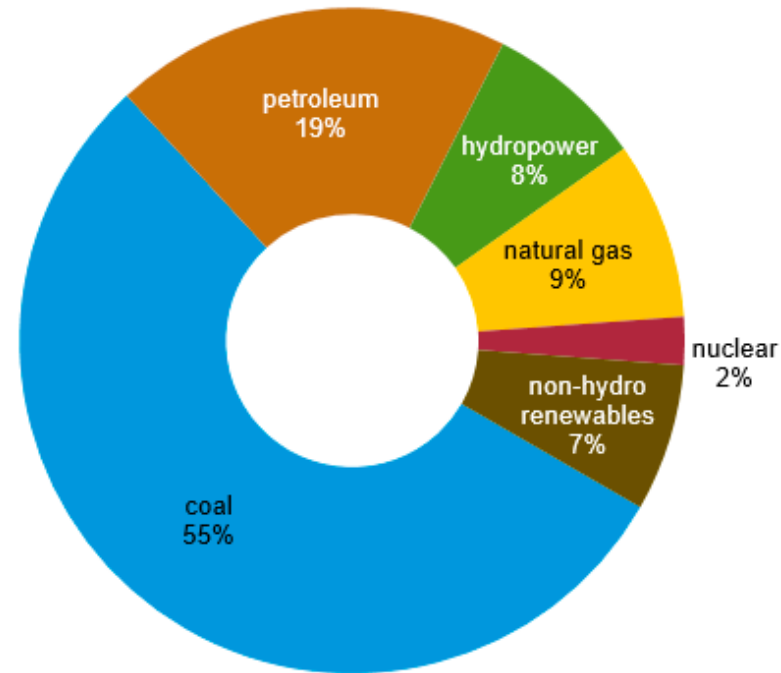
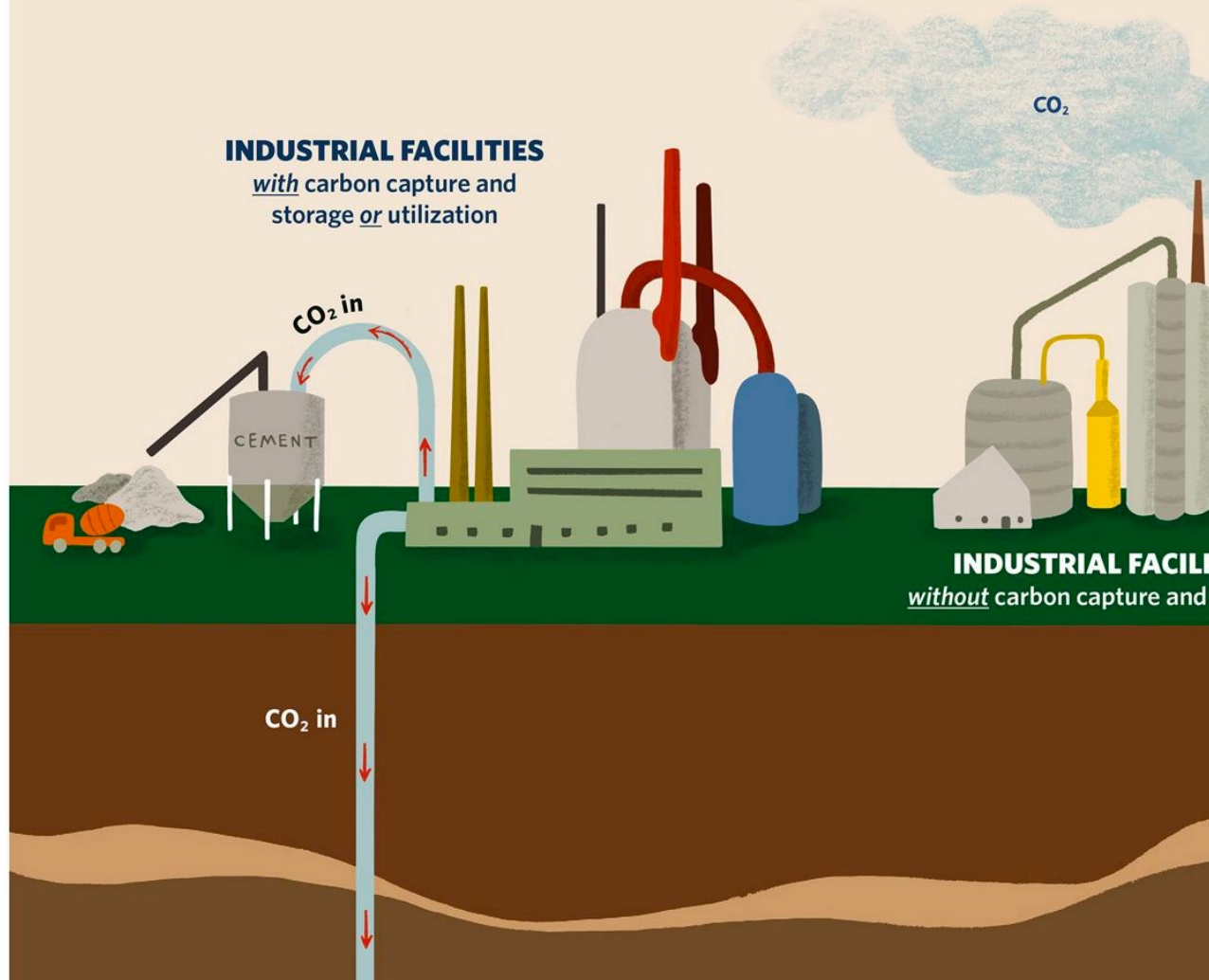


Figure 1. Total primary energy consumption in China by fuel type, 2021



Data source: BP Statistical Review of World Energy 2022
Note: Total may not equal 100% because of independent rounding. Includes only commercial fuel sources and does not account for biomass used outside of power generation.

How does Carbon Capture Work?



Future of Coal

- No future in US without CCS
- Questions with liability and public opinion



Future of Nuclear

Increased capacity without new plant construction

"Restarting the nuclear industry"- 2010

SMR-small/medium reactors

Storage of waste- Yucca Mountain

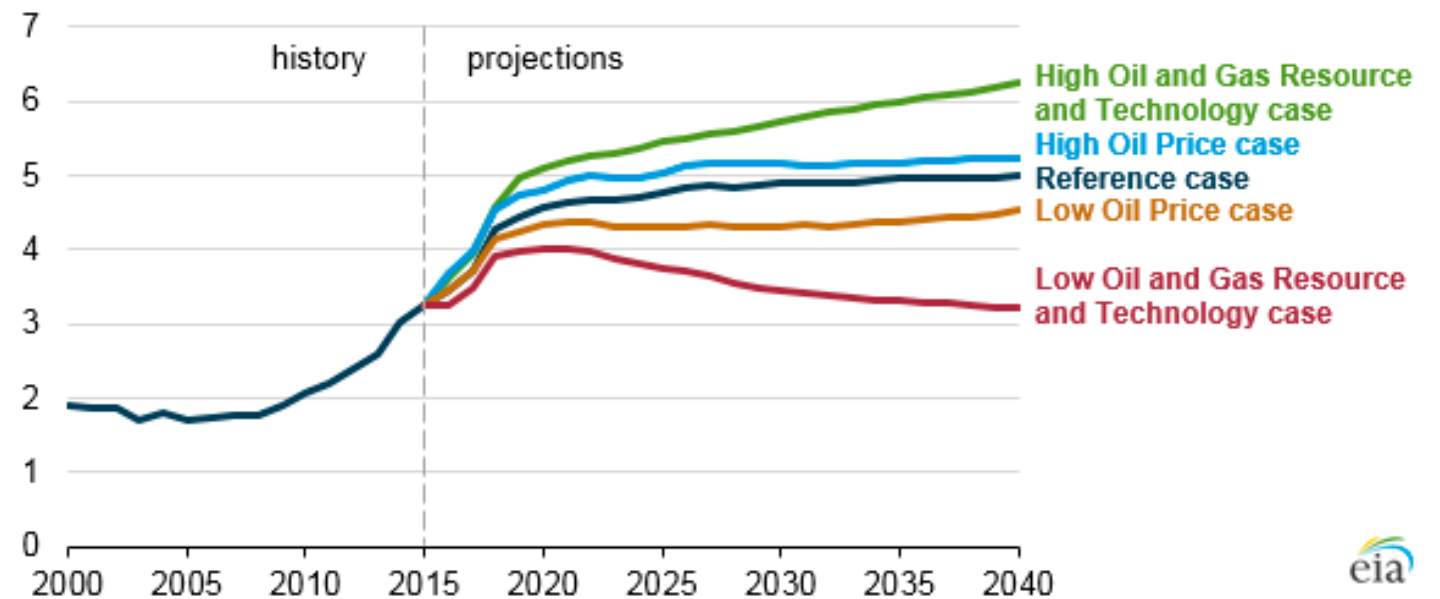
Nuclear Renaissance

Fukushima Daiichi- March 11, 2011

Future of Natural Gas

- Enabler of renewables
- Diversification important

U.S. total natural gas plant liquids production, 2000-2040
million barrels per day





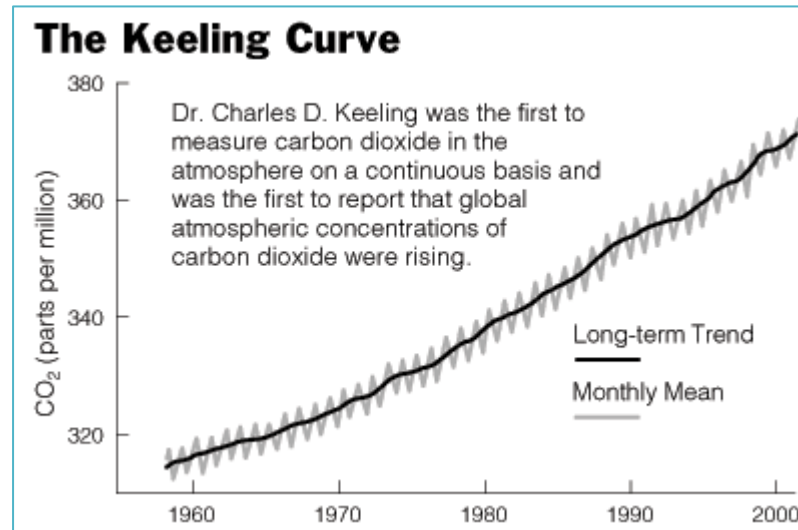
Vex

PART IV: Climate and Carbon

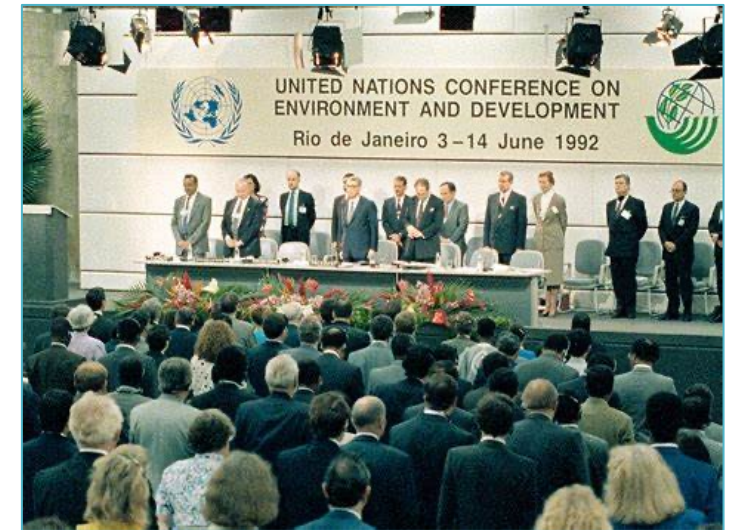
The First Three Sub-parts: What is it about?



21. Glacial Change



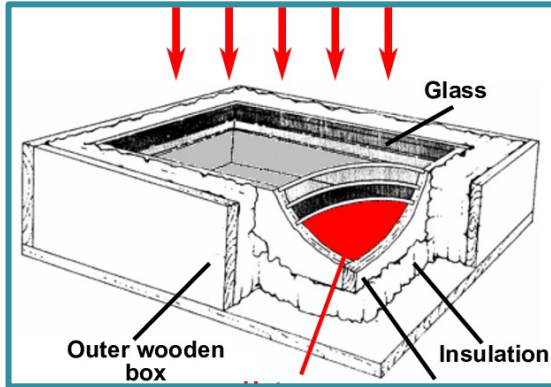
22. The Age of Discovery



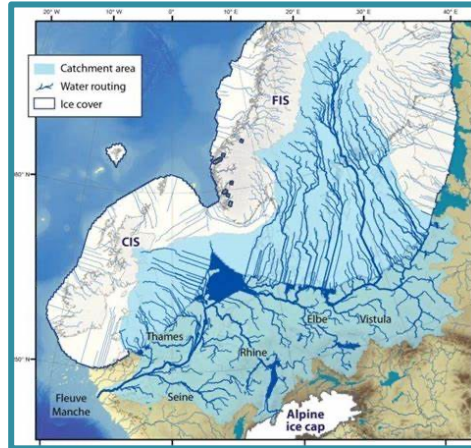
23. The Road to Rio

Narrative story that spans from 1770s to 1992 about the road leading to global action to save the climate.

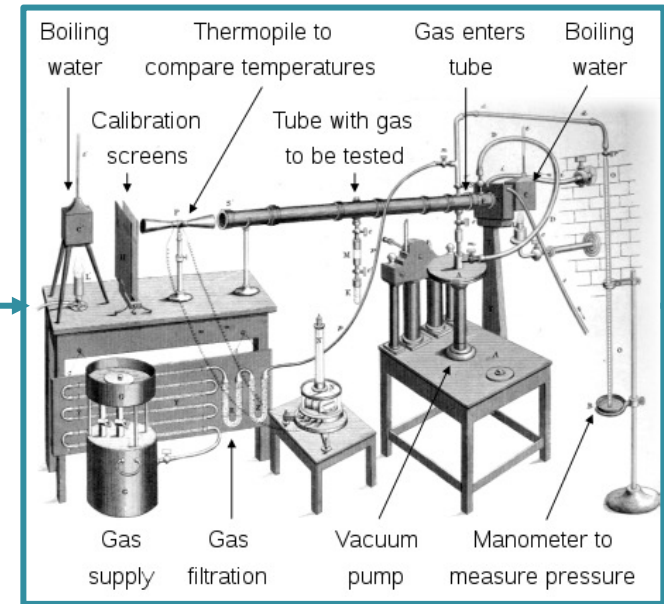
I. Glacial Change



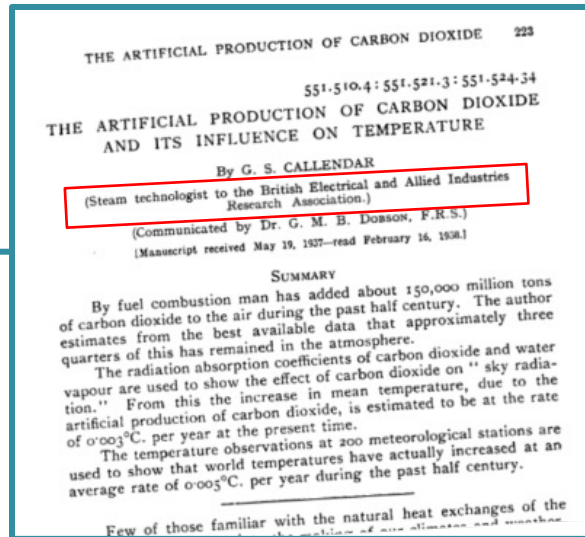
1770s: "Hot Box" by Saussure
"GREENHOUSE EFFECT"



1837: Pre-ice age glaciers
"CLIMATE"



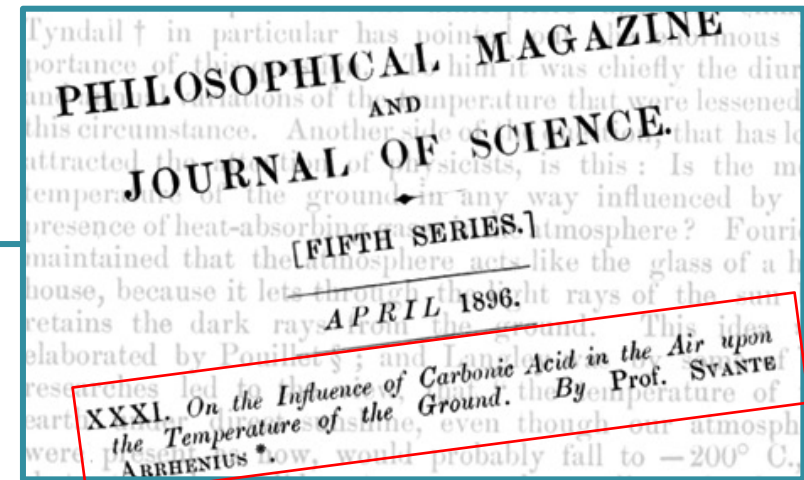
1859: Tyndall experiment
First experimental approach



1894: "CALLENDAR EFFECT"

1950s:
TOPIC STILL
DISMISSED
BY PEOPLE

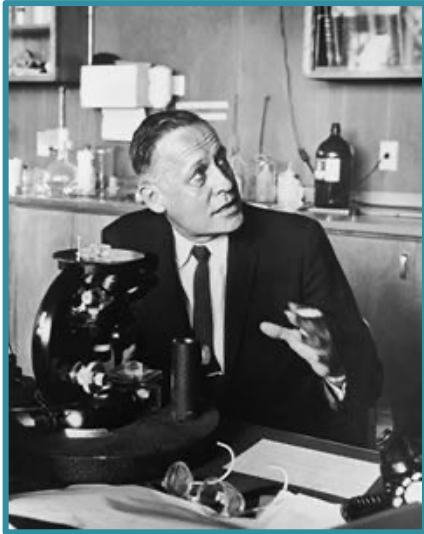
1900-1930: Climate
was not topic of
interest.



1894: Significant effect of carbon to temperature
Temperature rise was a positive consequence.

II. The Age of Discovery

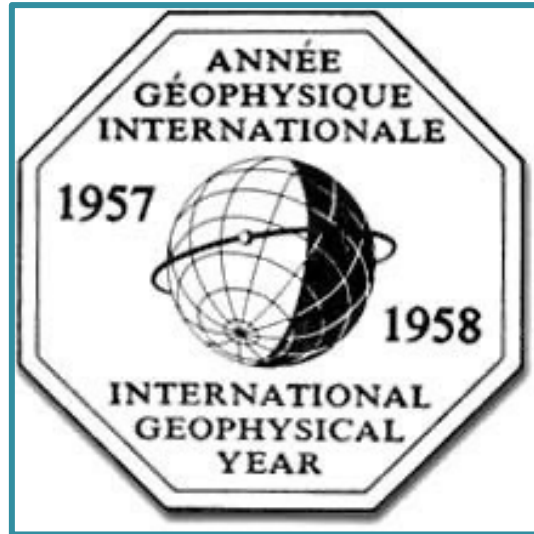
CATALYST 1



1950s: Roger Revelle

Ambiguous response to Callendar

- Buildup of atmospheric carbon will warm the Earth
- Industrial based carbon may or may not affect temperature.
- Less of a warning, more of a reflection

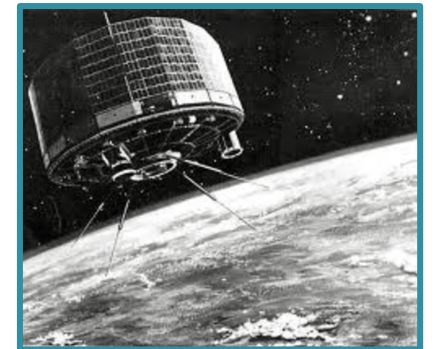


July 1957- December 1958

"The IGY"

- Global scale experiment to understand climate and weather
- Contacted Charles Keeling

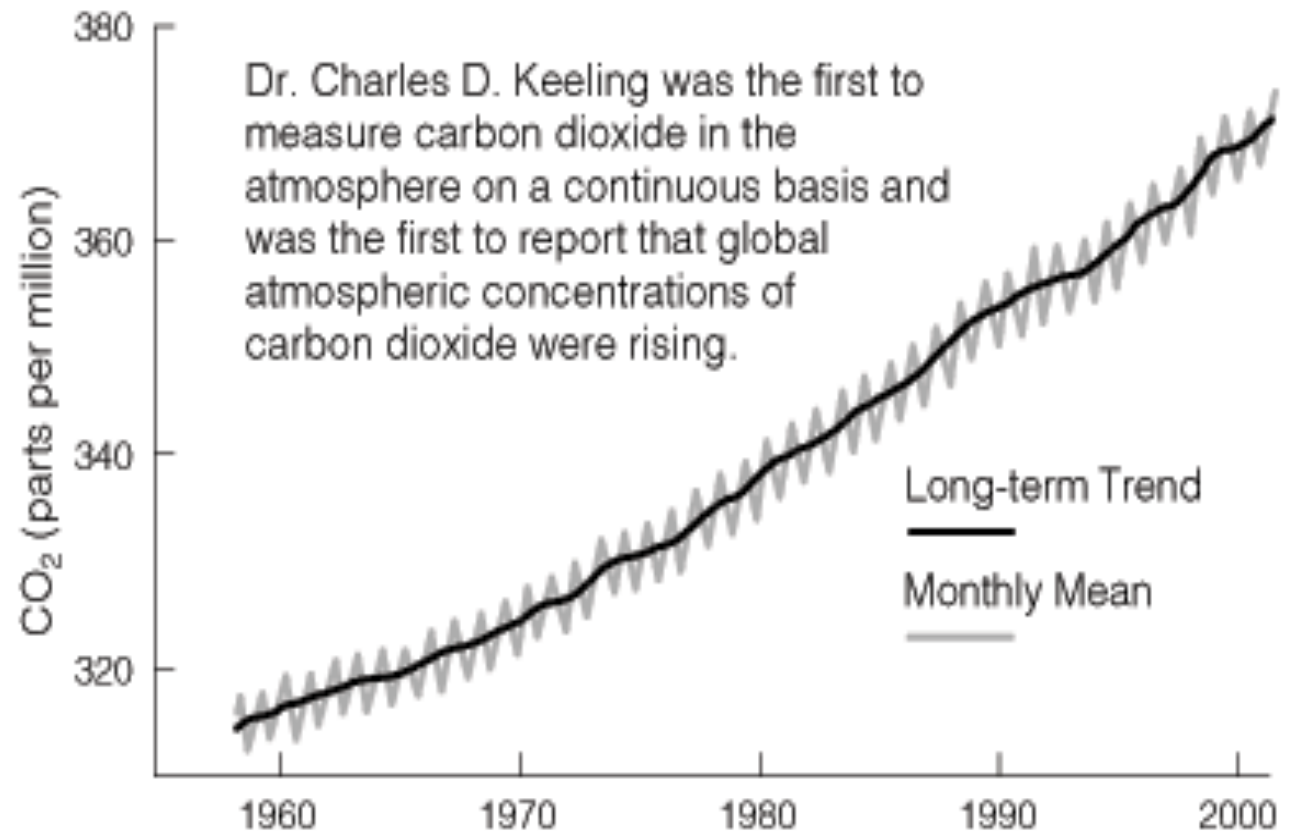
CATALYST 2



1950-1960

Computer Modelling for Climatology

1969: KEELING CURVE



III. The Road to Rio

THE RISE OF CLIMATE ACTIVISM

WITHIN U.S.

1980: First highly attended Senate hearings to witness Keeling Curve.

1986: Congress finally wanted action for climate change, not just research.

1988: Most influential Senate hearing about the global warming.



GLOBAL

1987: 24 countries signed on to the Montreal Protocol to restrict

1988: Inauguration of IPCC (Intergovernmental Panel on Climate Change) in Geneva.

1990: IPCC delivered its first assessment report to the UN.



III. The Road to Rio

IN RESPONSE TO IPCC'S REPORT



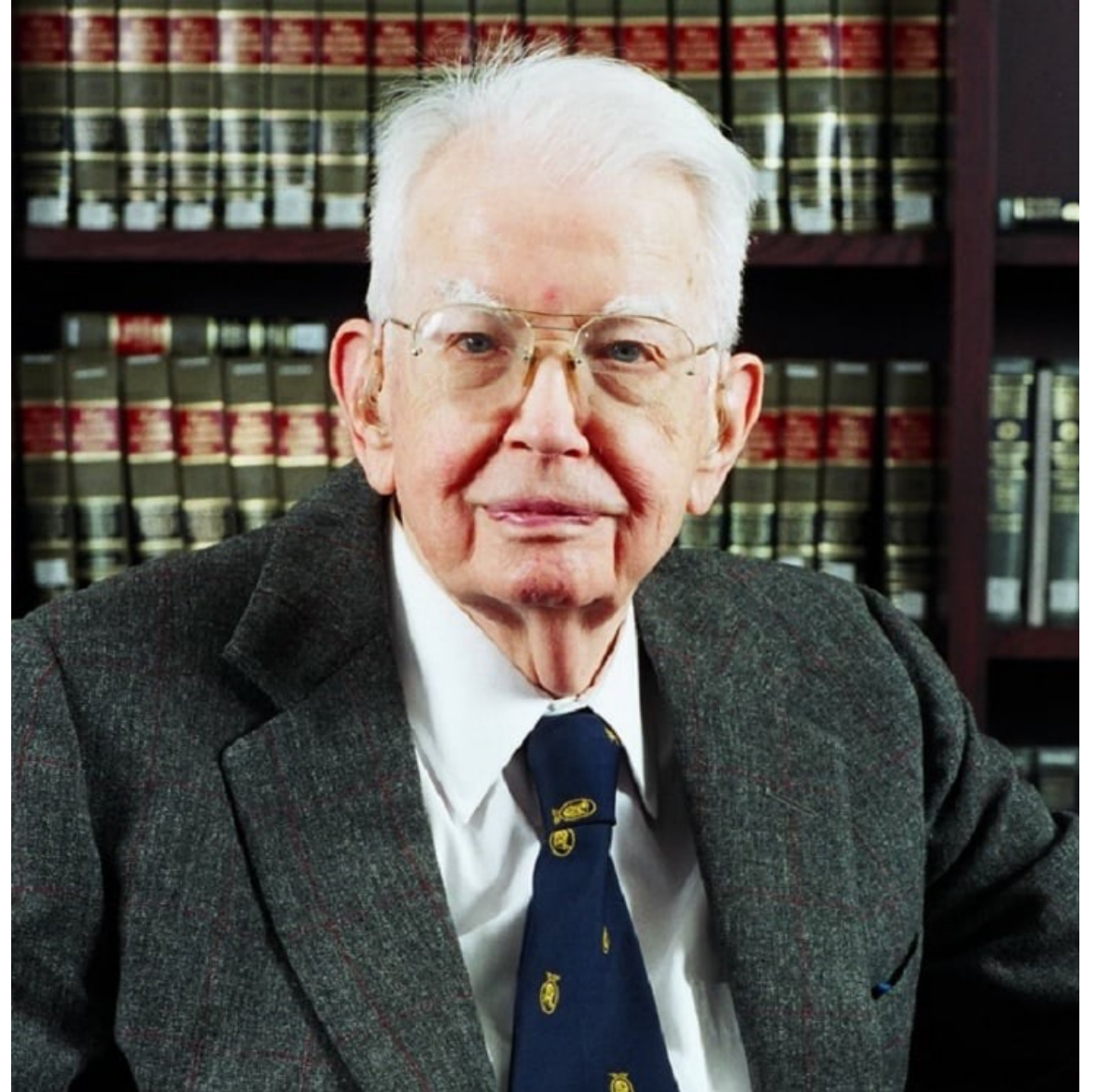
- “fractious 12 days of diplomatic free-for-all”
- 160 heads of state and governments and international org, 10000 other government officials, 25000 activists, NGOs, business leaders, and journalists
- Attended by George W. Bush

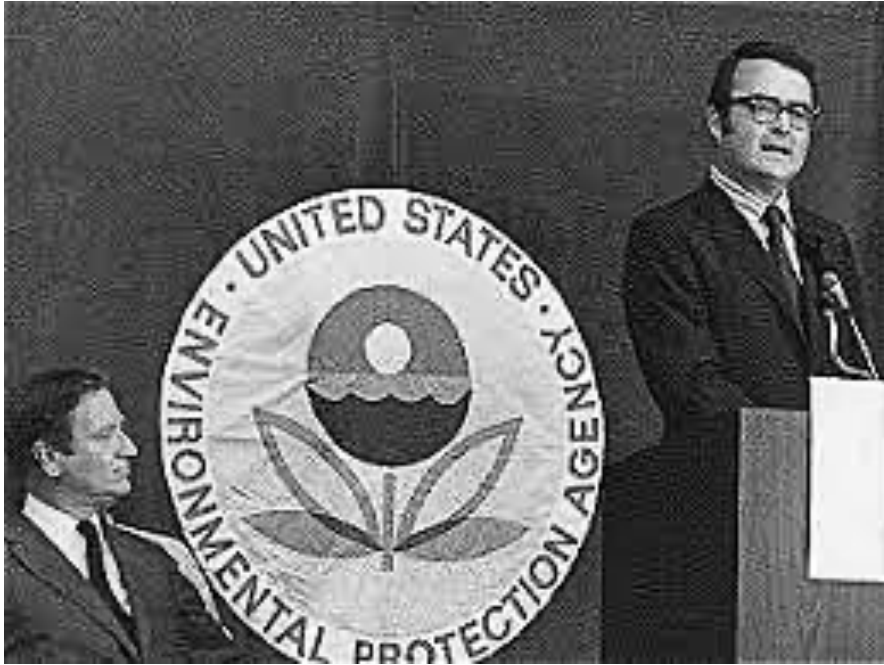
United Nations Framework Convention on Climate Change

the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

24. Making a Market

Ronald Coase: Won a
Noble Prize in
economics that
revolutionized pollution
by creating a
marketplace






In 1970, President Richard Nixon started "The War on Pollution" and created the EPA

A market-based solution to phasing out lead, lead to the quick removal of lead within 5 years of the program's introduction



A photograph of a forest landscape. The foreground and middle ground are dominated by numerous tall, thin, dead trees with bare, skeletal branches, standing against a bright blue sky with scattered white clouds. Some living trees with green needles are visible on the right side of the frame. A dark, semi-transparent rectangular box is overlaid on the right side of the image, containing white text.

Project 88 introduced the idea of "acid rain" being a nationwide issue during the presidential campaign of 1988



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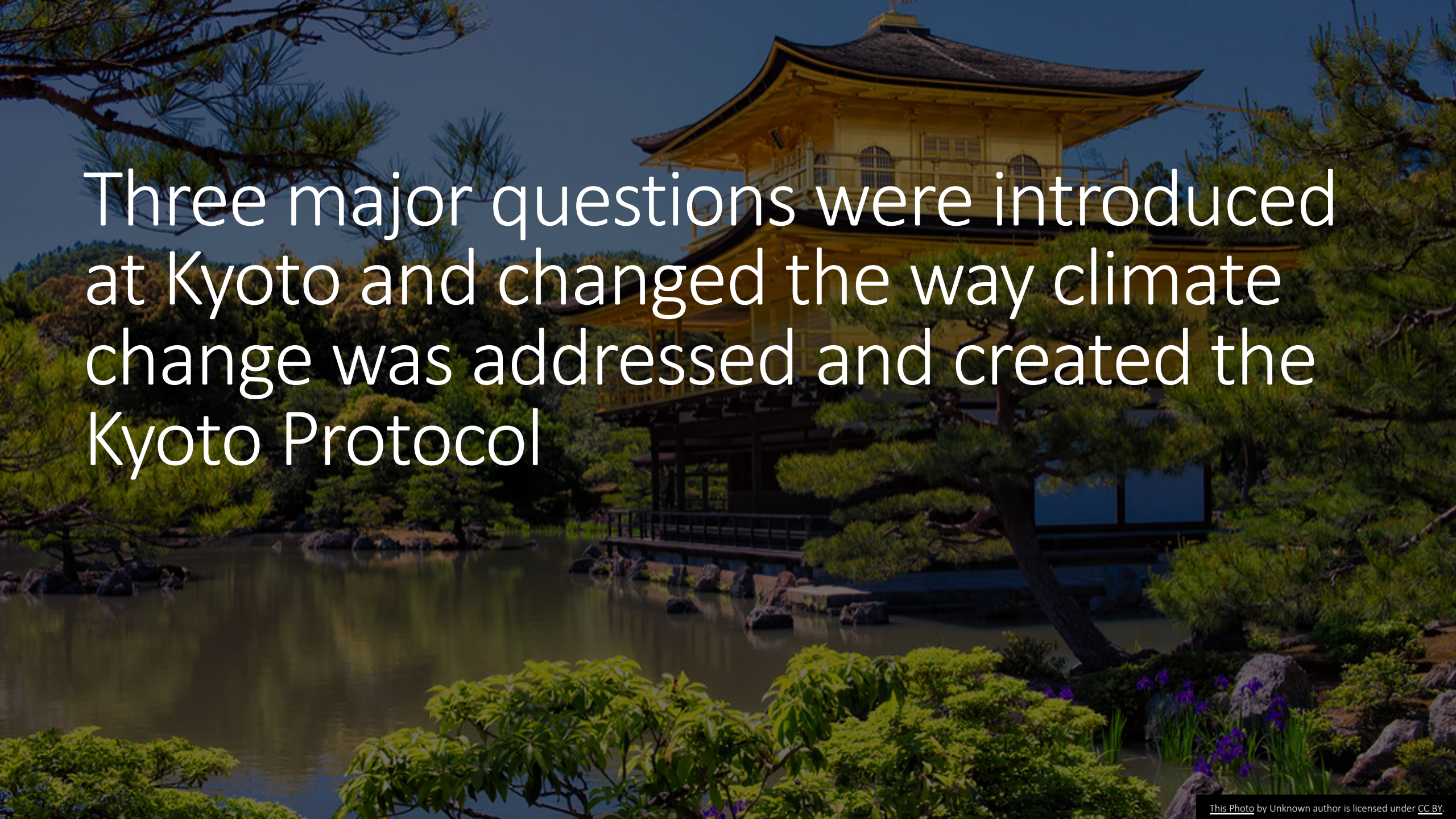
Acid rain, politics, and economics became intertwined, and more policies were put in place to deal with acid rain including cap and trade



Climate Change became controversial issue introducing conflict between developing and developed nations



Kyoto's International Convention Center becomes a battle site for the United Nations Framework Convention on Climate Change in 1992 when there weren't enough blankets during the climate change demonstrations

A traditional Japanese garden scene featuring a pond, a wooden pavilion, and a golden pagoda in the background. The text is overlaid on the image.

Three major questions were introduced at Kyoto and changed the way climate change was addressed and created the Kyoto Protocol

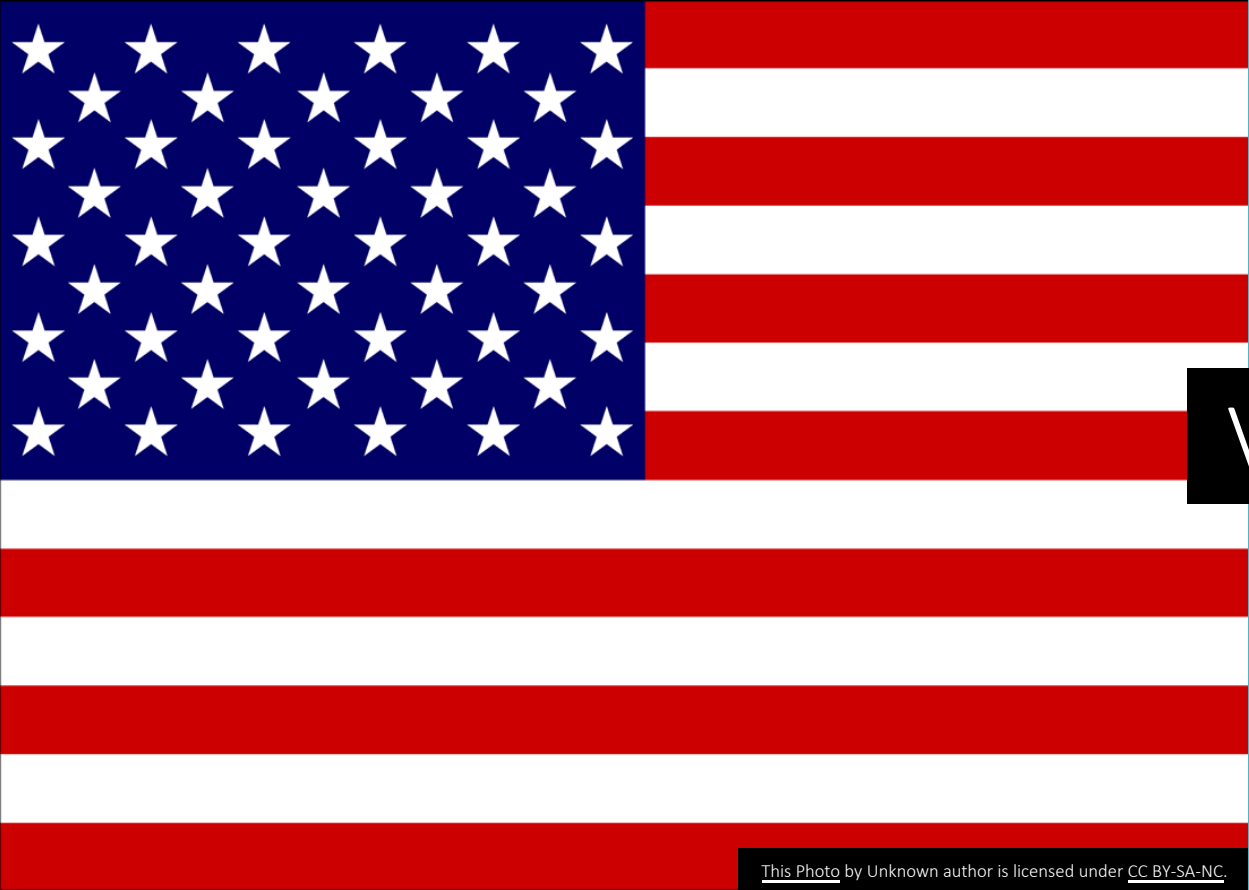
25. On the Global Agenda



Climate change climbed to the top of the global agenda and became a selling point for the 200 US presidential election



After the 2000 election, climate change faded into the background when the 2001 recession occurred




VS

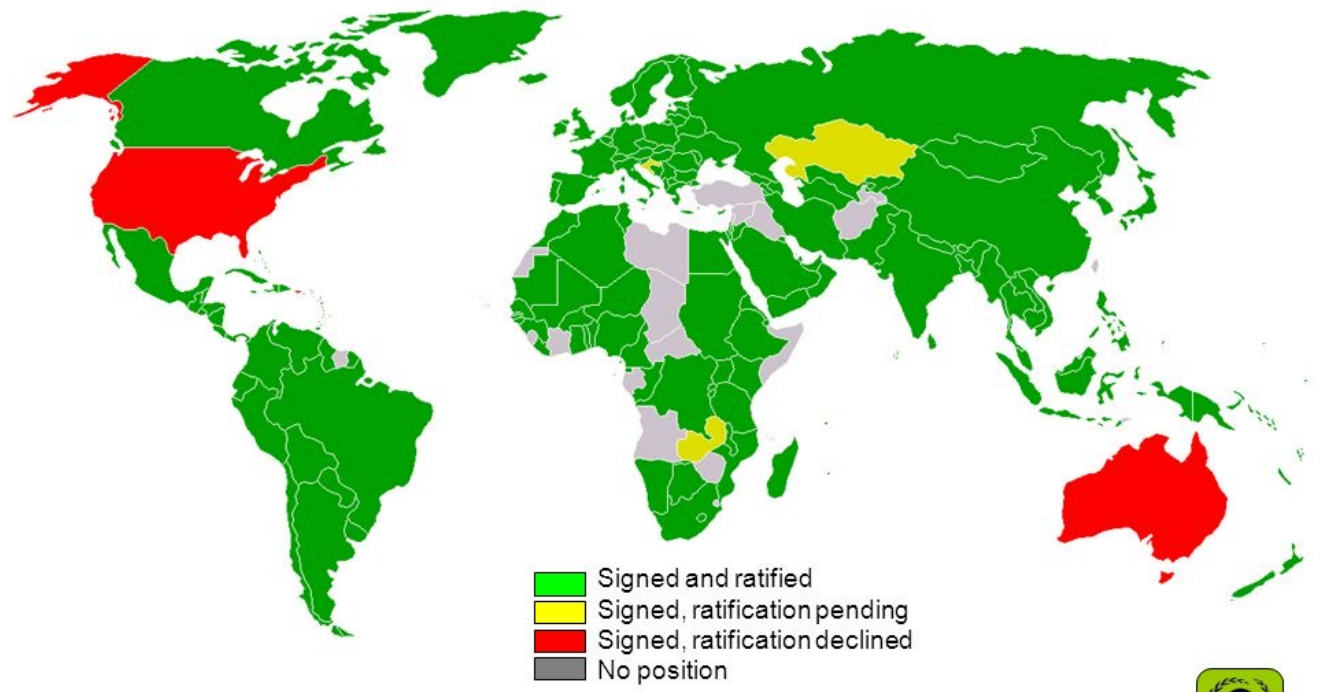


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Climate change was fighting to be the top issue with other more pressing issues for both The European Union and the USA

The US would not join the 55 other countries in ratifying the Kyoto Protocol even with a successful Climate Exchange while Europe fully embraced both

 **UNFCCC**
Ratification of the Kyoto protocol





An Inconvenient Truth

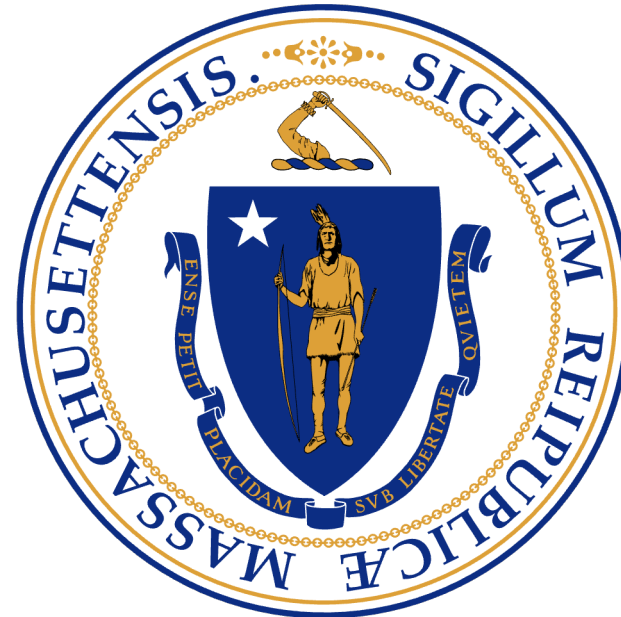


With the IPCC report gaining traction, BP decided that "BP is going green" while all other major energy countries challenged the IPCC's report



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VS



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Massachusetts sues the EPA for not regulating greenhouse gases

26. In Search of Consensus

Arguments ensued over the idea of “cap and trade” and its effectiveness with the energy market

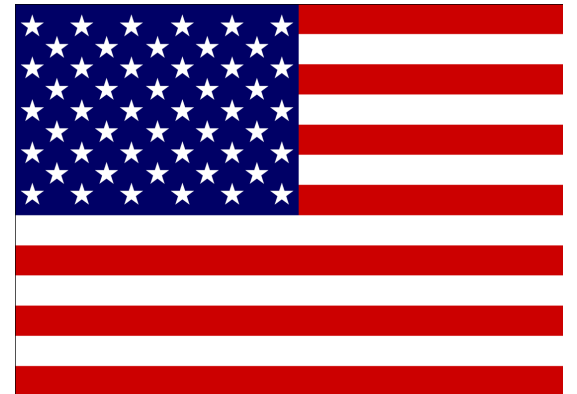




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China's CO₂ emissions became the target of international debate and a source of political tension

India entered the climate change debates and became one of the Big Four nations for climate change negotiations



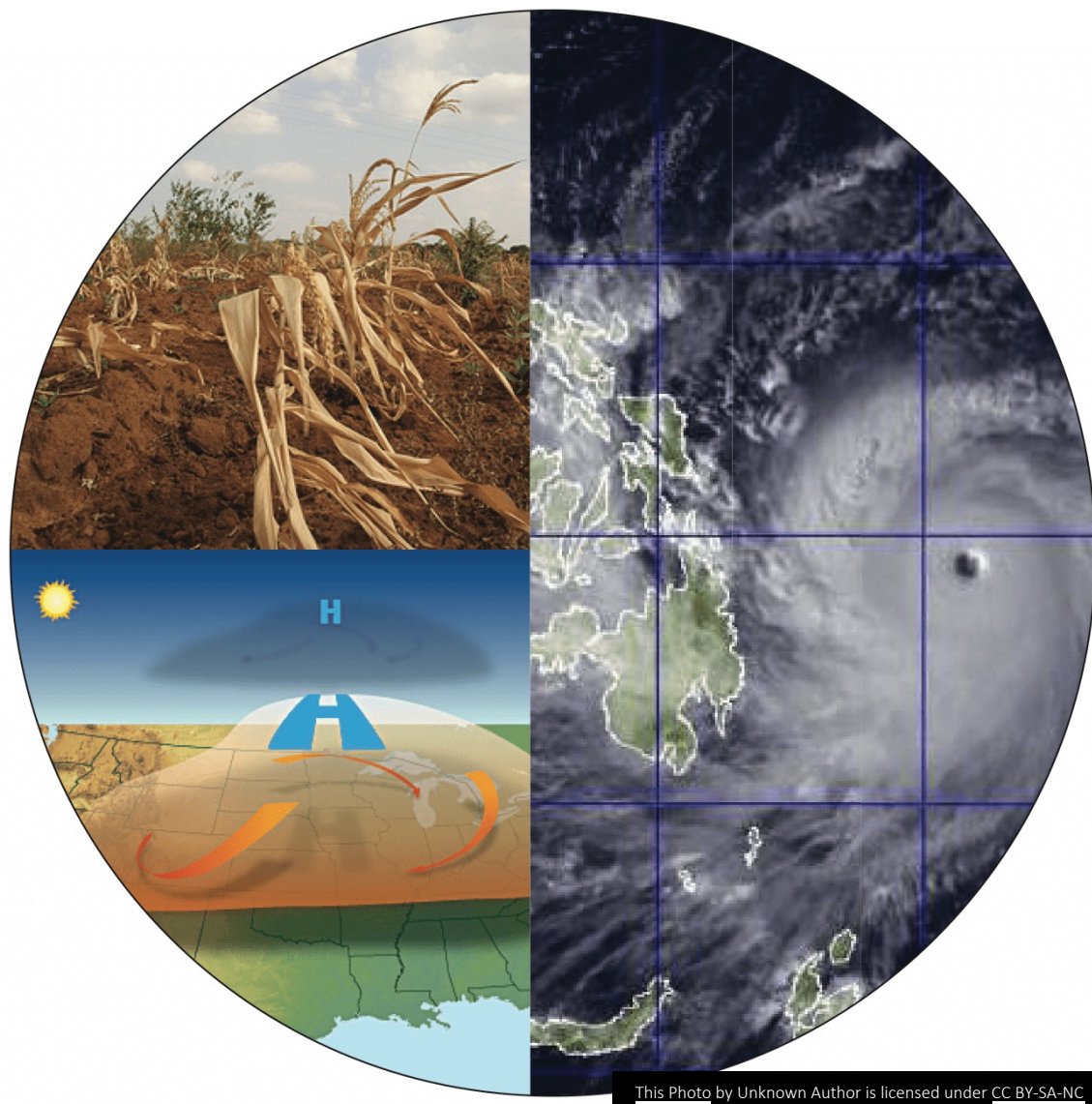


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With lots of progress being made, the COP 15 was supposed to be a conference for new global agreements- instead, it was filled with drama



The IPCC report of 2007 became a point of controversy over sources of information



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In 2010, “global warming” shifted to “climate change” as more places experienced extreme or atypical weather events while Putin remained unconvinced of human involvement

Cancún became what Copenhagen could not be but brought up questions about The Kyoto Protocol





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The US Government was unable to institute any major changes in legislation regarding climate change, so the EPA was left attempting to pick up the slack but was met with backlash



Glaciers became a symbol for climate change with the general goal to be to keep CO₂ concentrations from exceeding 450 parts per million

Questions?

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