

How We Got Here:

A bit of Climate History and Individual Actions to get us to where we need to go.

Presentation by Green Hudson - 5 November 2023



What is the problem?

Burning fossil fuels in:

- Transportation
- Residential homes
- Commercial buildings
- Manufacturing

What can I do?

- Limit global warming to 2.7 degrees Fahrenheit (1.5 degrees Celsius).
- Achieve zero (or net zero) emissions by 2050 (with any remaining emissions captured or offset).
- We can do this. How?
 - Stop Burning Fossil Fuels
 - Clean the grid
 - Electrify everything we can
- **WE HAVE ALREADY BEGUN!**

What Causes Climate Change?



CO₂ (Carbon Dioxide)

Wood & Fossil Fuel Combustion
Human & Animal Respiration
Plant Decay
Volcanos

CH₄ (Methane -- ie Natural Gas)

More potent than CO₂
Oil Drilling
Natural Gas Drilling
Natural Gas Transportation
Human & Animal Digestion
Anaerobic (without oxygen) Plant Decay
Landfill & Waste Treatment

N₂O (Nitrous Oxide)

Synthetic Fertilizer
Fuel Combustion
Waste Treatment

- 5000 BCE - 1850 - Pre-industrial world (**270 ppm**)
 - 1861 - 1865 Railroads were a major front in the American Civil War
 - 1862 John Tyndall discovered that certain gases, including CO₂, helped to trap heat inside the atmosphere.
 - 1875 Oil discovered in Warren, PA
 - 1885 Karl Benz car invented
 - 1890 Electric vehicle invented
 - 1896 Svante Arrhenius Swedish scientist that was the first to claim that fossil fuel combustion may eventually result in enhanced global warming.
- CO₂ PPM = 282 ppm (estimated)**

Action Corner:

Create an Energy transition plan for town
Stop expansion of Natural Gas infrastructure
Weatherize your home to reduce individual energy consumption
Convert homes to be all electric with heat pumps

Why do GHGs cause Climate Change?

Sun's energy -> full spectrum light

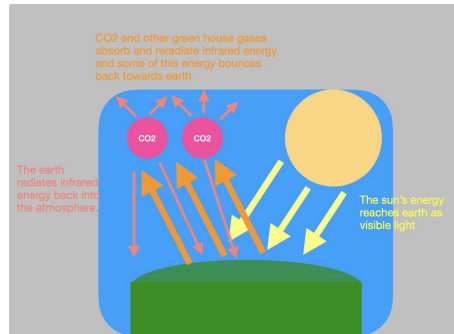
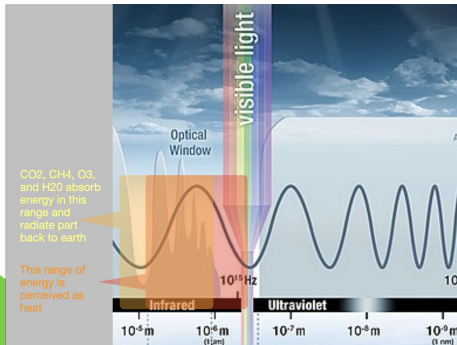
Earth reflects energy -> Infrared (heat)

GHG react with the infrared energy and reflect it back towards earth, instead of exiting the atmosphere

- 1824 Joseph Fourier began to explore the question “Why doesn't the planet keep heating up as it receives sunlight? What is regulating our atmospheric temperature?”
- 1825 Steam Locomotives begin operation in the UK

CO2 PPM = 280 ppm (estimated)

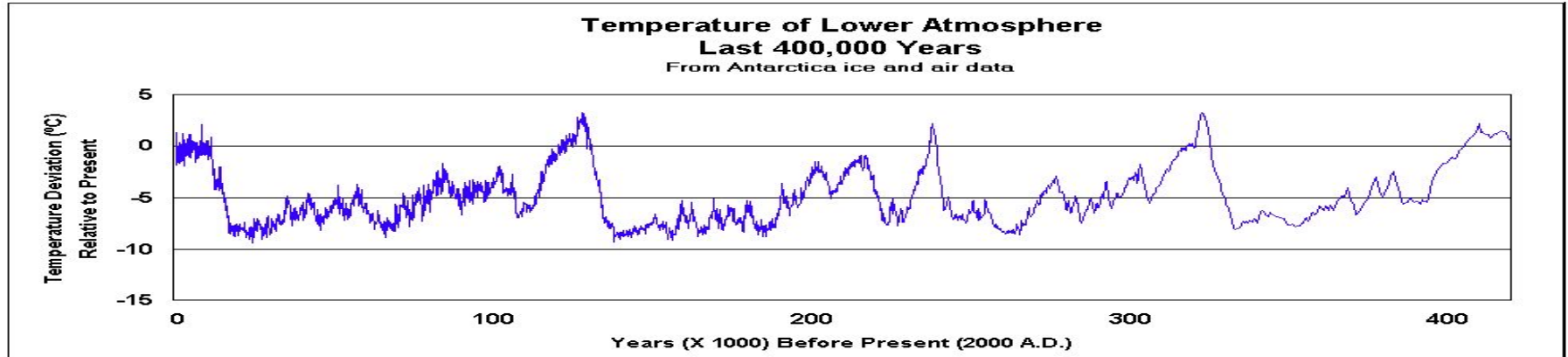
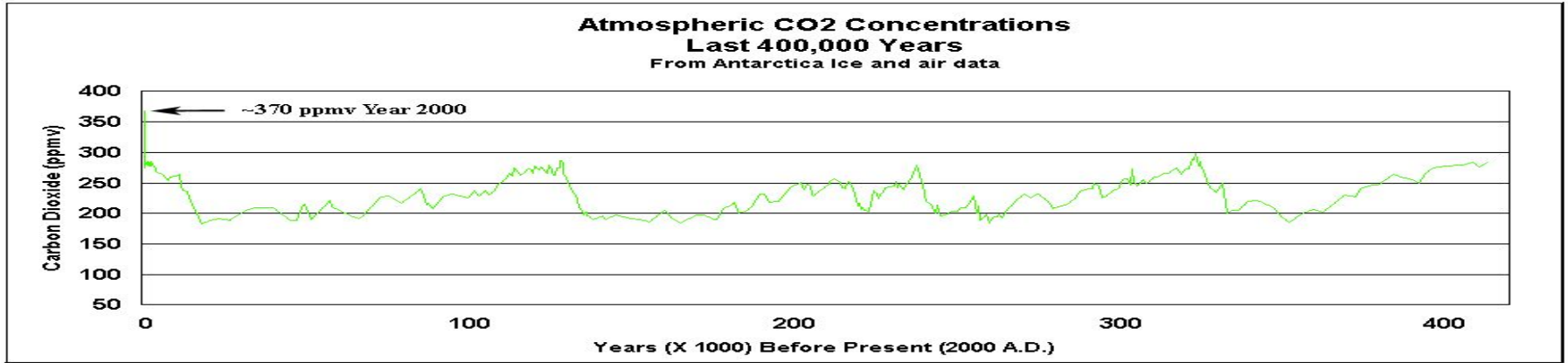
For all of human history, up to the industrial revolution, CO2 levels have been around **270ppm (estimated)**



Action Corner:

Plant Native Trees & Shrubs
Support rewilding of unused areas
Plan to reduce suburban sprawl
Preserve and connect wild places
Avoid palm oil and other products that incentivize deforestation practices.

What is the relationship between CO₂ and temperature?

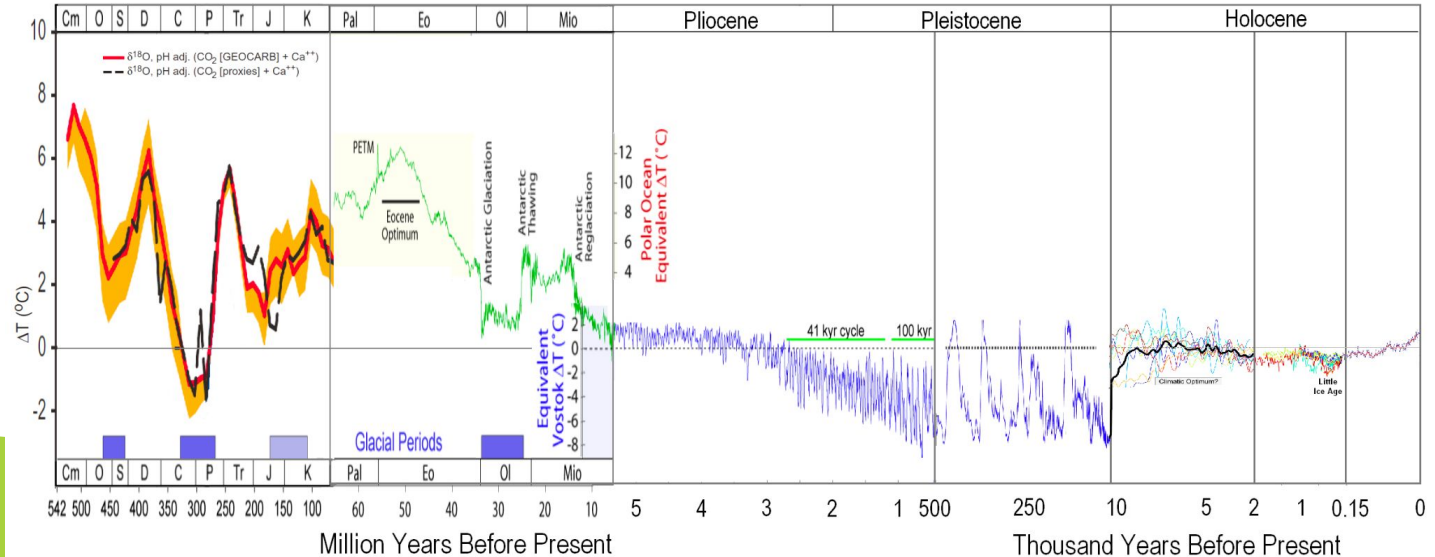


A constant cycle

All of earth's history has been a dance between atmospheric oxygen (O₂) and carbon-dioxide (CO₂)

- The balance between these two gases has been disrupted numerous times by both natural processes and external events.
- With the shift in balance came changes in the climate

Temperature of Planet Earth



Earth's First Climate Change

- Over millions of years, that early bacteria lived, took in CO₂, released O₂, died and sank to the bottom of the ocean
- There was a problem though, O₂ was toxic to this bacteria. It died off and was replaced by bacteria that could live in the new O₂ rich atmosphere.
- Extinct bacteria became our earliest and deepest deposits of oil and natural gas.
- The new O₂ atmosphere didn't retain as much heat and the climate began to cool down.

CO₂ PPM = 1000+ ppm (estimated)



Are we the victims of natural processes? – No!



Solar Cycles

- “grand solar minima” - a slight cooling

Changes in Earth's orbit

- Can cause significant climate change
- Ice age projected in the next 1500 years

Volcanos

- Can impact the climate
- Generally short term, <20 years, cooling effect.

Plate Tectonics & Ocean Currents

- New ocean and a new currents
- Exposure of reactive rocks which absorb CO₂.
- Long term cooling trend

Evolutionary Change

- New life forms can significantly alter the climate
- Proto-plants and plant life captured and sequestered CO₂
- Several periods of rapid cooling.

Humans have always relied on carbon fuels

- Wood
- Whale Oil
- Coal
- Oil
- Natural gas



PHOTOGRAPH BY HYWIT
DIMYADI/SHUTTERSTOCK

- Early American automobiles
 - 40 percent steam (coal)
 - 38 percent electricity
 - 22 percent by gasoline
- 1908 Ford Model-T debut
- 1949 Hydraulic fracturing used to increase yield of oil fields

CO2 PPM = **285 ppm** (estimated)

Action Corner:

Minimize Air Travel

Maximize use of public transit

Carpool

Consolidate trips

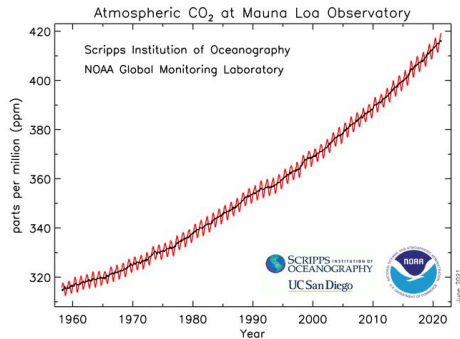
Convert home heating to high-efficiency heat pump

When it is time, purchase an electric vehicle that is right sized for your needs

The late-20th Century



- 1958 Atmospheric CO₂ Measurement began (**316ppm**)
- 1980 Horizontal Hydraulic fracturing used to access vast Natural gas reserves
- 1980's India and China follow the industrial trajectory of the US and Europe
- 1988 James Hansen testifies before the US Congress that 350 ppm is the maximum concentration of CO₂ that can sustain our current ecosystem. (**351ppm**)
- 1992 President Bush authorized the United States to become a founding member of the United Nations Framework Convention on Climate Change (**356 ppm**)
- 2021 99.9% of 88,000 peer-reviewed scientific studies agree that Humans are the primary cause of climate change (**417 ppm**)



Action Corner:

Create the Electrification infrastructure that meets our modern challenges
Reduce & Reuse before Recycle
Buy furniture used or build for sustainable sources
Avoid fast fashion
Reduce Beef, Dairy, and Palm Oil consumption

Climate Change in New England

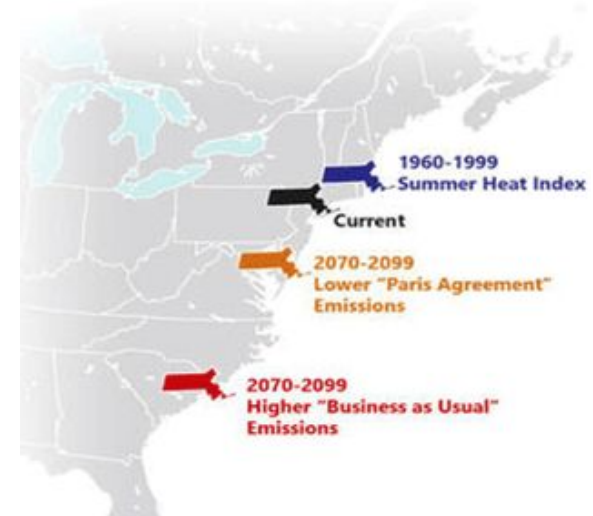
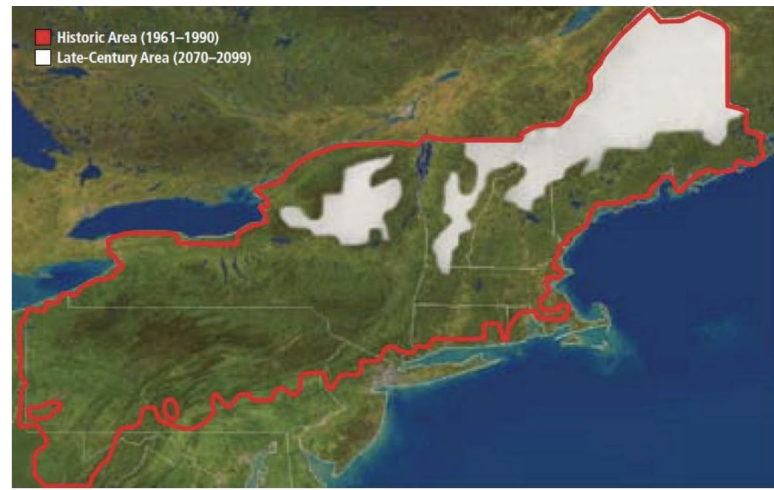
Reduced Snowfall

Reduced # cold days

Increased # hot days & high extreme temperatures

Increase in extreme weather events

Ocean Warming & Sea Level Rise



Our mission

1. **Stop putting CO2 into the atmosphere**
2. **Get CO2 out of the atmosphere**

This will take decades to achieve!

Natural Processes

- Photosynthesis – Store carbon in forests
- Photosynthesis – Store carbon underground on farm land
- Carbon Mineralization
- Shell formation

Industrial Processes

- Technology demonstrated, but not at scaled
- Direct Air Capture – Chemical process
- Direct Air Capture – Electromagnetic process
- Flue pipe Capture

3. **Support a health ecosystem to endure climate changes damage**

TOTAL U.S. GREENHOUSE GAS EMISSIONS BY ECONOMIC SECTOR (2020):

- 11% Agriculture
- 13% Commercial & Residential
- 24% Industry
- 25% Electricity
- 27% Transportation



Climate Change Solutions

Civic Engagement

- Remind your elected officials and preferred candidates, schools, religious, and civic organizations of their role
- Solutions are only too expensive because we place financial priorities elsewhere
- Tell your favorite companies how much you like them and that you want them to be greener. Be willing to switch to a greener alternative

Food

- **Support Organic and Sustainable Agriculture that increases natural carbon sequestration**
- Reduce Beef, Dairy, and Palm Oil consumption
- Minimize waste & packaging
- Compost and support native plants

Home

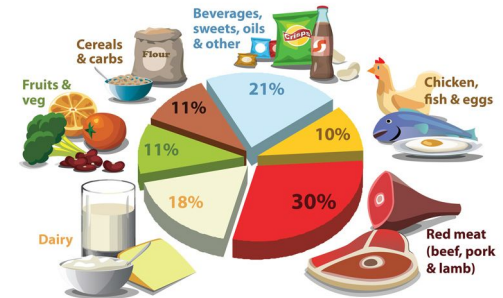
- **Switch home and water heating to energy efficient Heat Pump technology**

Transportation

- **Minimize Air Travel**
- Maximize public transit
- Carpool
- Consolidate trips
- When it is time, purchase an electric vehicle that are right sized for your needs
- **Live local, work local, buy local**

Economic consumption

- Reduce & Reuse before Recycle
- **Buy furniture used or build for sustainable sources**
- Avoid fast fashion
- **Replace gas powered machines with electric versions, at end of service life**
- Reduce energy consumption during peak hours
- Question everything, watch out for Green-washing





Green

Thank you

Hudson



Will our mission succeed?

We have all the tools we need to tackle Climate Change

Recognize that we need to live in balance with the Earth and not work against it

Stop putting carbon into the atmosphere by replacing fossil fuel infrastructure with Clean, Green, & Renewable electricity

Exercise a conservation mindset with smart energy use

Allow and support the Earth in healing itself – **Plant Native Plants!**

Remove Carbon from the atmosphere

Reduce our culture of waste and overconsumption

Reduce single use plastics with sustainable and reusable alternatives

Why 1.5°? Why 350ppm?



Observations

- Progress in slowing climate change in recent years
- Solar and wind power are now cheaper than coal and gas
- Cost of batteries has plummeted
- Governments and businesses are investing in green energy
- Not enough to claim victory but
 - an indication that action improvements are visible
 - a motivation to do more

Annual global greenhouse gas emissions in gigatonnes of carbon dioxide-equivalents

150 Gt

100 Gt

50 Gt

Greenhouse gas emissions up to the present

1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

Data source: Climate Action Tracker (based on national policies and pledges as of December 2019). OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors Hannah Ritchie & Max Roser.

No climate policies
4.1 – 4.8 °C

→ expected emissions in a baseline scenario if countries had not implemented climate reduction policies.

Current policies
2.8 – 3.2 °C

→ emissions with current climate policies in place result in warming of 2.8 to 3.2°C by 2100.

Pledges & targets
2.5 – 2.8 °C

→ emissions if all countries delivered on reduction pledges result in warming of 2.5 to 2.8°C by 2100.

2°C pathways
1.5°C pathways

Climate Change Solutions

Local Government

- Make it easier to add solar
- Make it harder to build housing that is space inefficient
- Make multi-family and increased housing density easier
- Tree replacement program
- Discount for all electric homes
- Require high building code standards
- Support pedestrian and bike friendly streets
- All allow purchase of green energy
- Support Land Conservation, Rewilding efforts, & natural restoration
- Support urban consolidation and broad multi-family zoning bylaws

State

- Deny permits for fossil fuel infrastructure. No it isn't illegal, but it does have to stop!
- Implement policies like regional climate goals and standards
- Encourage fee and dividend systems that support low and moderate income families
- Time of use charges for roads that subsidize public transportation
- Support Retrofits of homes and vehicles for efficiency and all electric operation
- Lessen the burden on individuals

Federal

- Federal fee and dividend with trade parity
- Remove subsidies for fossil fuel infrastructure and productions
- Put an economic thumb on the scale in favor of clean energy and transportation
- Lessen the burden on individuals

Numerous other changes

- The intensity of the sun's energy has changed
- The composition of the atmosphere has changed
- Earth has been hit by asteroids
- Earth has seen volcanoes and other seismic activity
- Continents have grown, shifted, and separated
- Plants and animals have lived and died

CO2 PPM = 270+/-50 ppm (estimated) – Earth's current period of stability over the last million years



Will our mission succeed?

Humans have tackled complex global problems in the past

Ozone Layer

Acid Rain

International Conflict & World Wars

International Trade, Finance, and Intellectual Property


Long ago, in this very galaxy...

- The earth was hot and volcanically active.
- Volcanic eruptions created an atmosphere of CO₂ and H₂O, along with several other gases.
- Volcanoes formed landmasses and H₂O precipitated out of the atmosphere to form oceans.
- The earliest bacteria breathed in CO₂. As part of this early chemical/biological process the O₂ emitted into the atmosphere and the Carbon merged with Hydrogen to form organic carbon chains.

CO₂ PPM = 3000+ ppm (estimated)



Goals

- Learn something you didn't know when you walked in
 - Connect the climate past, present, and future
 - Adopt one carbon reducing strategy in your life
 - Inspire you to help make our community an active participant in climate change mitigation and reduction of future harm
- 

Introduction

Brian White

Head of CE Software Advanced Development & Consumer Audio Outloud Software Development, Bose Corp.
Founder & Co-president, Green Hudson
Founder & Director, Hudson Land Trust

I'm a software engineer, not a climate scientist

I'm an introvert

More hobbies than I have time for:

- Hiking
- Biking
- Gardening
- Playing Clarinet
- Wildlife and Landscape Photography
- Playing Basketball
- Playing board games
- Making computer programs



End Fossil Fuels

The background of the slide features a sunset over a body of water. In the foreground, there are several silhouettes of oil pumpjacks (jack-o'-lanterns) against the bright, orange and yellow sky. The sun is low on the horizon, creating a strong glow and long shadows.

Coal, Oil, and Natural Gas have been critical to human progress over the last two centuries, but they are holding us back.

We need to break free from what is easy and do what is right

Embrace Clean Renewable Energy



Work with nature

Generate energy that doesn't contribute to global warming

Begin the process of drawing down atmospheric and oceanic CO₂

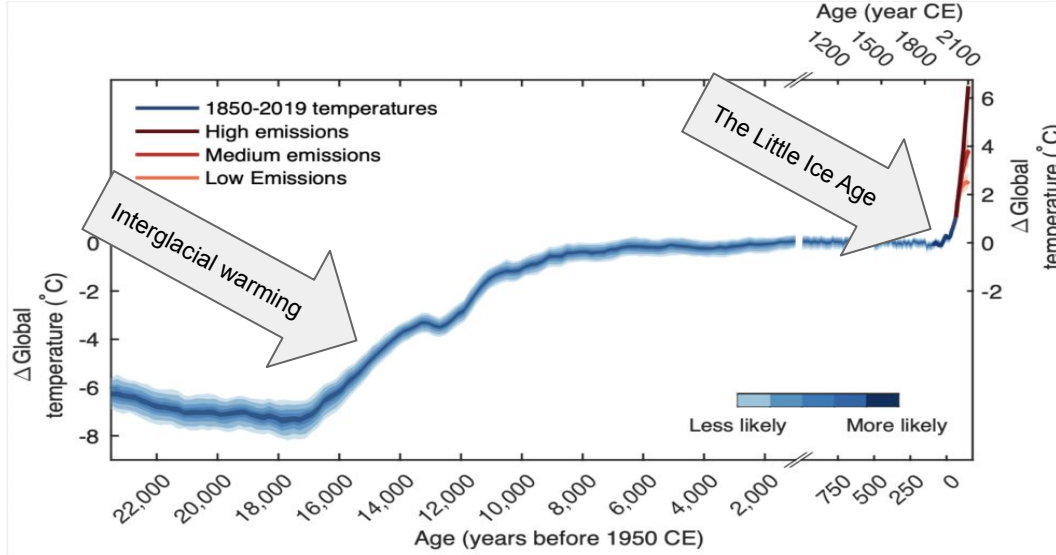


“I’d put my money on sun and solar energy.
What a source of power! I hope we don’t
have to wait until oil and coal run out before
we tackle that.”

—Thomas Edison (1931)

Hockey Stick

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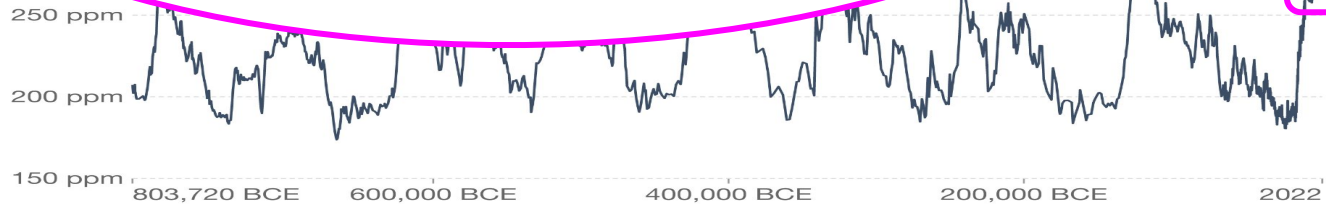


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Our World
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World

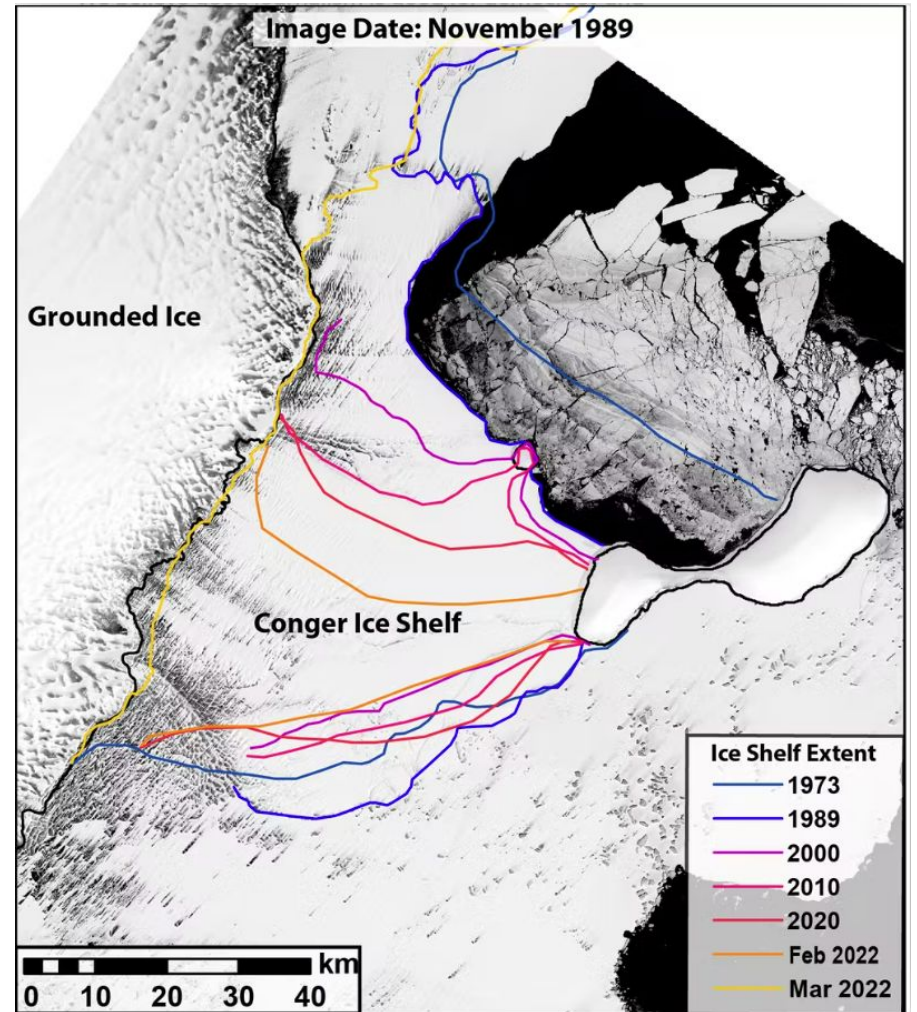


Impact on Arctic

Sea Ice

Land Ice

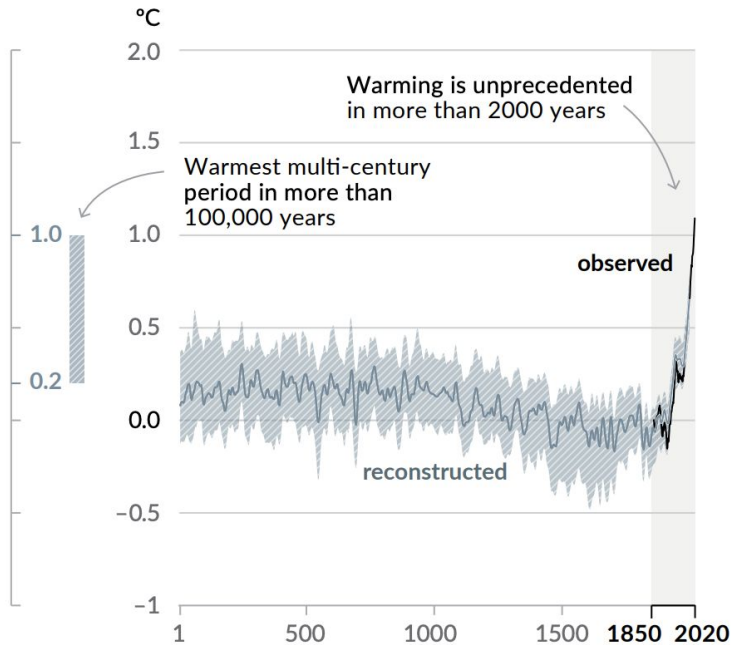
Ocean Warming & Sea Level Rise



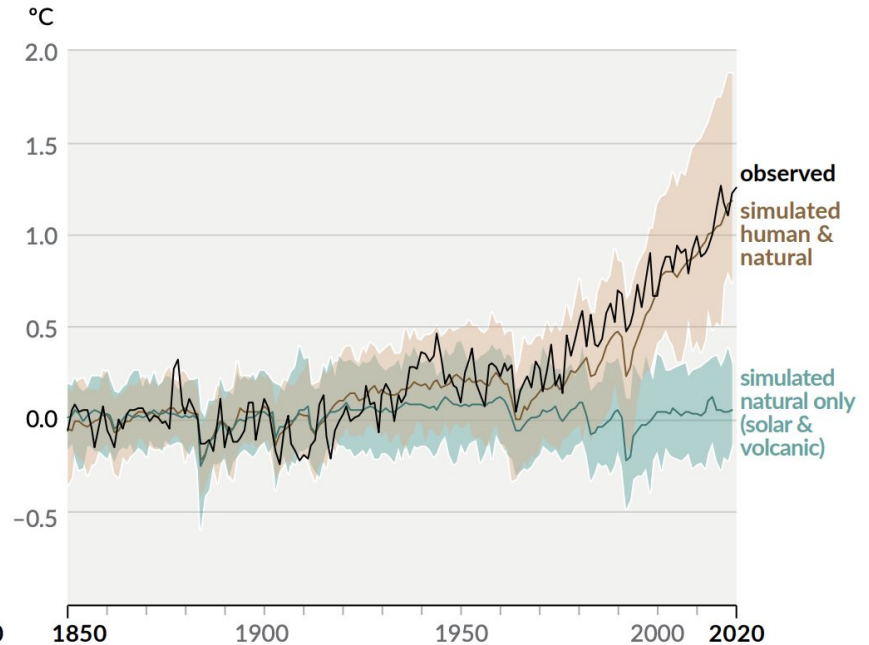
Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

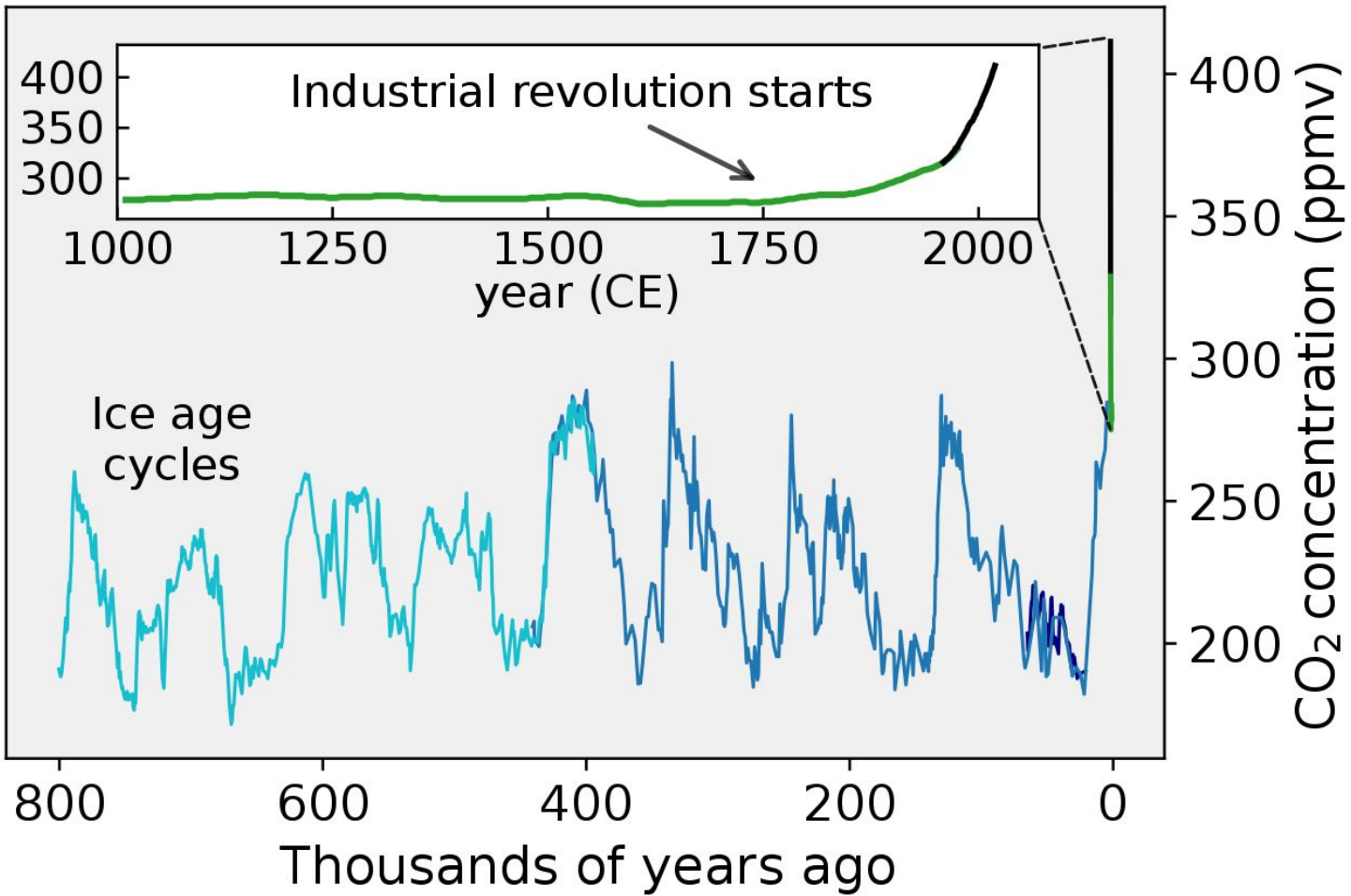
Changes in global surface temperature relative to 1850–1900

(a) Change in global surface temperature (decadal average) as reconstructed (1–2000) and observed (1850–2020)



(b) Change in global surface temperature (annual average) as observed and simulated using human & natural and only natural factors (both 1850–2020)





Massachusetts Legislation & Plans

Legislation:

A Next-Generation Roadmap for Massachusetts

Climate Policy (S.9) – enacted in 2022

- “net zero” greenhouse gas emissions by 2050
- 50% reduction in greenhouse gas emissions by 2030

Executive Action:

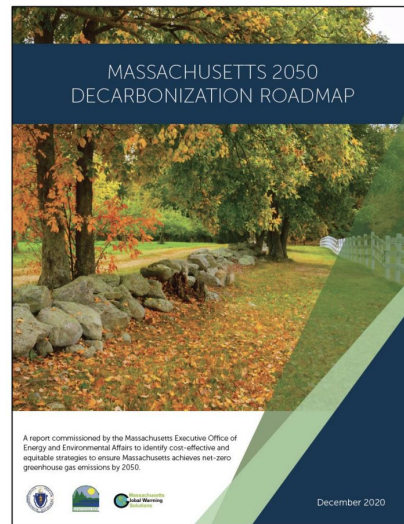
Massachusetts Clean Energy & Climate Plan for 2030

- 2050 Decarbonization Roadmap
 - Examined 8 economy-wide decarbonization pathways to 2050
- 45% gross emissions reduction below 1990 level
- Significantly less residential and commercial gas usage than today and incentivization of heat pumps
- Over **750,000** new zero emission cars & trucks on the road
- Convert **100,000** per year to heat pumps
- Incentives for light-duty and heavy-duty vehicles, including public fleets, transit buses, and school buses

Pending Legislation:

H.2167 - Allow communities to enact restrictions of fossil infrastructure

H.3292 - Supply local Aid to Cities and Towns to make green infrastructure improvements. Creates a fund similar to the Community Preservation Act to distribute support to towns.



Efficient energy use (WIP)

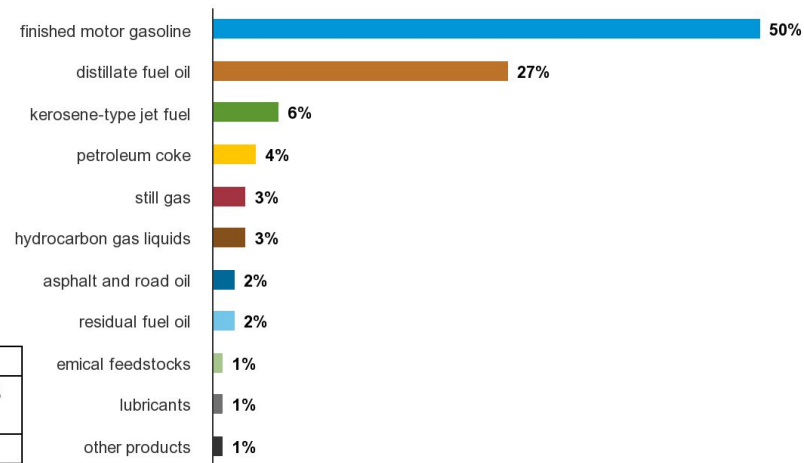


Table 5. Refining Energy Efficiencies for Individual Petroleum Products

	Overall Petroleum Refinery Efficiency	
	90.1% (with all products included)	86.4% (with less desirable products excluded)
Gasoline	87.7%	83.3%
Diesel	90.3%	86.7%
LPG	94.3%	92.1%
Residual oil	94.3%	92.1%
Naphtha	94.3%	92.1%

U.S. refiner and blender net production of petroleum products, 2020

total = 6.40 billion barrels



source: U.S. Energy Information Administration, *Petroleum Supply Annual*, August 2021

Palm Oil Deforestation



© Ulet Ifansasti / Greenpeace

542 Million Years of Earth's climate

Temperature of Planet Earth

