Osher Lifelong Learning Institute, Fall 2025

Inequality and Economics

Northwestern University

Host: Geoffrey Woglom, Director
National Economic Education Delegation

Course Schedule

Inequality and Public Policy

- Week 1 (10/14): The New Inequality, Geoffrey Woglom, Amherst College
- Week 2 (10/21): Economics of Immigration, Robert Gitter, Ohio Wesleyan University
- Week 3 (10/28): Trade and Inequality Geoffrey Woglom, Amherst College
- Week 4 (11/04): The Black-White Wealth Gap, Jon Haveman, Exec. Director, NEED
- **Week 5 (11/11): Climate Change Economics Sarah Jacobson, Williams College**
- Week 6 (11/18): AI and Inequality Geoffrey Woglom, Amherst College

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Climate Change Economics

Sarah Jacobson, Ph.D.
Williams College

OLLI Northwestern University

November 11, 2025

Credits and Disclaimer

- **This slide deck was authored by:**
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- **Disclaimer**
  - NEED presentations are designed to be nonpartisan.
  - It is, however, inevitable that the presenter will be asked for and will provide their own views.
  - Such views are those of the presenter and not necessarily those of the National Economic Education Delegation (NEED).

Submitting Questions

- Submit questions in the chat. I will try to address questions as they come up.
- We will do a verbal Q&A once the material has been presented.
- Slides will be available from the NEED website tomorrow: https://needecon.org/delivered_presentations.php

Outline

- Economic Building Blocks
- Climate Change
- Impacts of Climate Change
- Reducing Emissions
- Climate Change Policy
- Policy in Action

Economic Building Blocks

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How Can Economists Help Fight Climate Change?

- By measuring climate change damages and estimating the costs of fighting climate change.
- By assessing behavioral reactions to climate change.
- By designing smart policies that minimize costs to society.

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Econ 101: When Everything Is Simple, No Regulation Is Needed for Efficiency

- **Simple transactions: buyer and seller feel all costs and benefits of sales**
- **They choose based on the costs & benefits they feel**
- **→ Efficient number of transactions! (Maximizes social benefits)**

When Our Decisions Affect Others, We Need Regulation

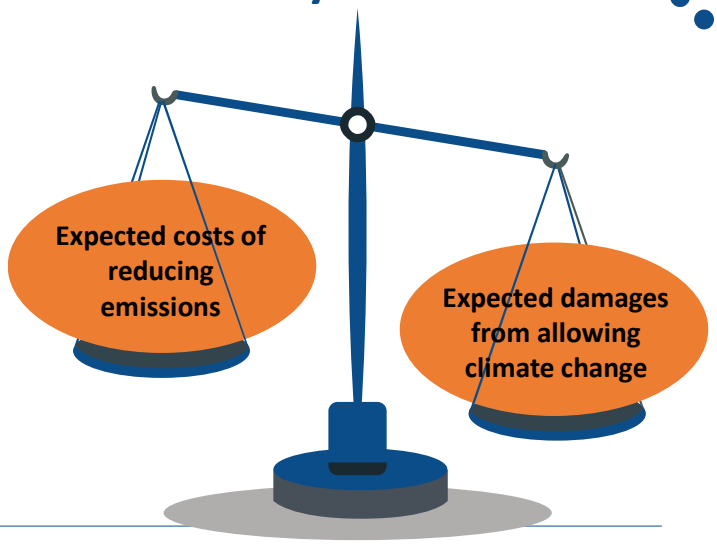
- **Pollution causes an EXTERNALITY: a side effect (here, a cost) that affects someone else**
  - Polluting things have an "unfair cost advantage" because part of cost is offloaded on others
  - → Too much pollution is generated
  - Regulation limiting pollution has net benefits
- ***The "efficient" amount of pollution balances costs & benefits of pollution***

How Economists Decide How Much to Fight Climate Change: Cost Benefit Analysis

Abating greenhouse gas emissions is costly…

… but without action, climate change damages are even more costly.

Goal is not zero emissions, but efficient level that achieves a balance.



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Cost-Benefit Analysis of Fighting Climate Change

- Most economic models suggest the costs of keeping warming below 2°C are relatively small, amounting to **1-4% of GDP by 2030.**
- Costs of acting to keep warming below 2°C are almost certainly less than future economic damages they would avoid.
  - Damages estimated to be between: **7-20% of worldwide GDP.**

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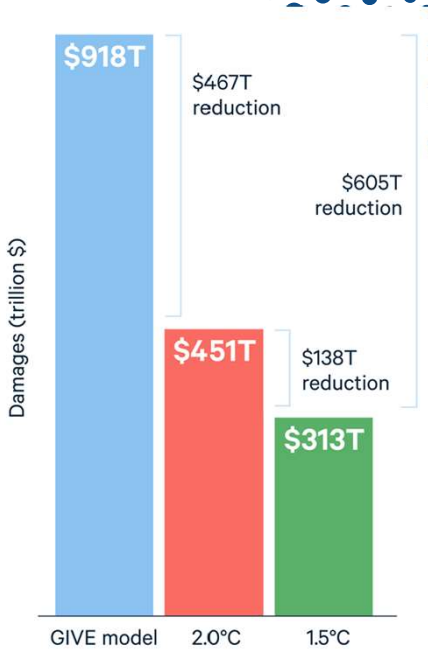
Newer Estimates of Benefits of Fighting Climate Change

- **Policies already declared should limit warming to 2.5°C**
- **Keeping warming even lower would yield additional global benefits of:**
  - 2° → $5.2T annually ($467T total)
  - 1.5° → $6.8 trillion annually (605T total)



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Climate Change

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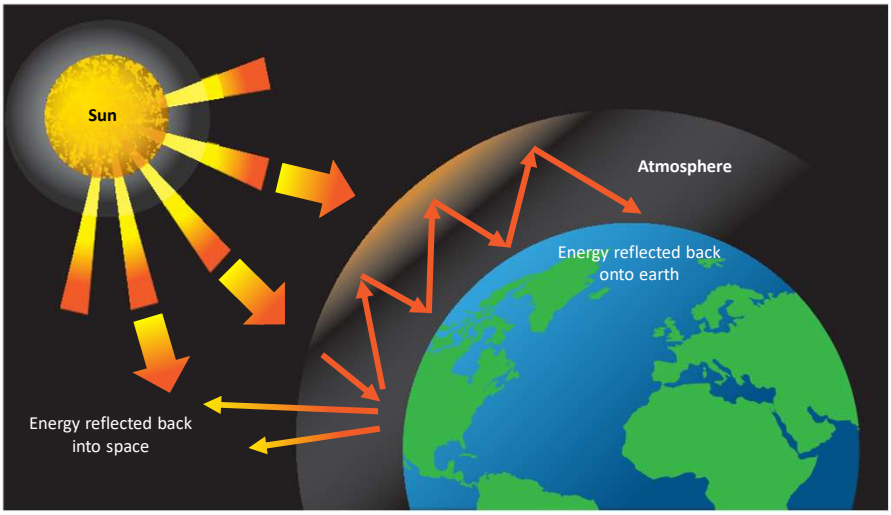
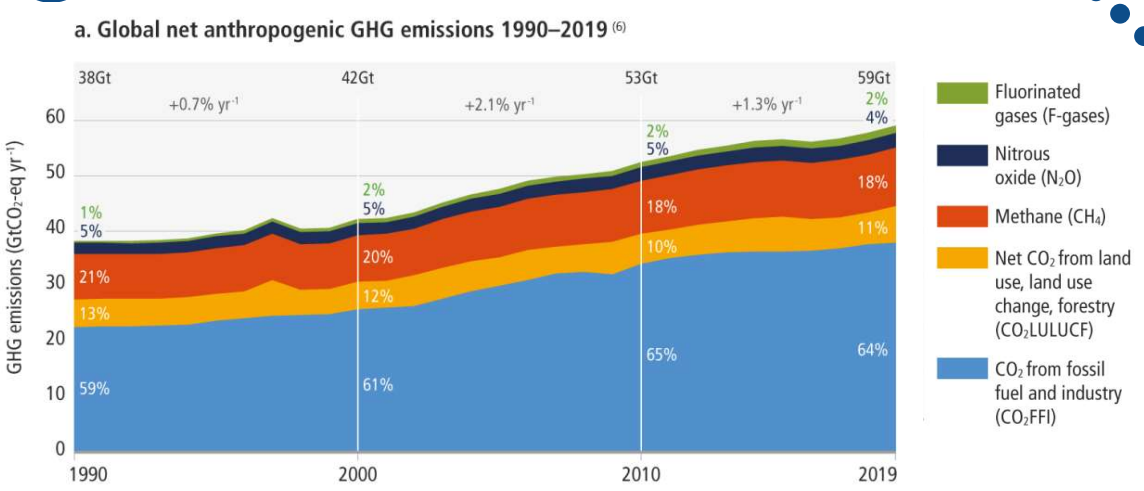
A Climate Change Ladder

- Emissions
- Mitigation (a.k.a. Abatement)
- Adaptation
- Damages

The Atmospheric Greenhouse Effect



Greenhouse Gas Emissions 1990-2019



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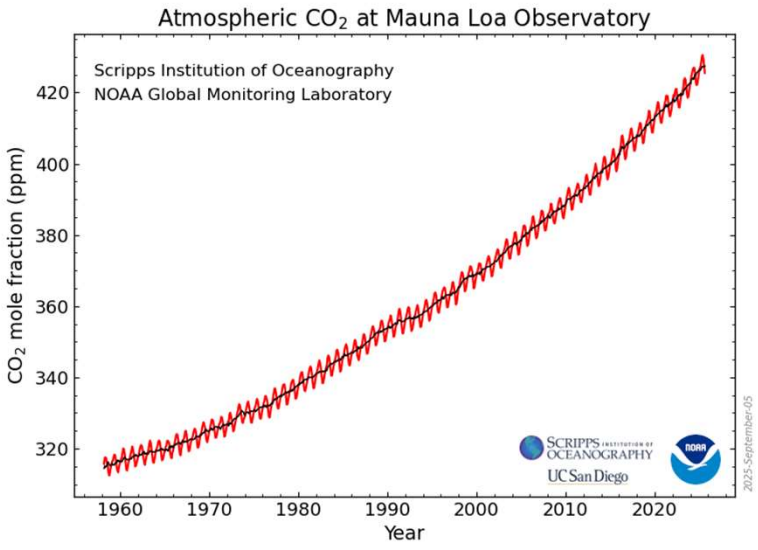
Source: IPCC

Atmospheric CO_2 Concentrations Up To Now



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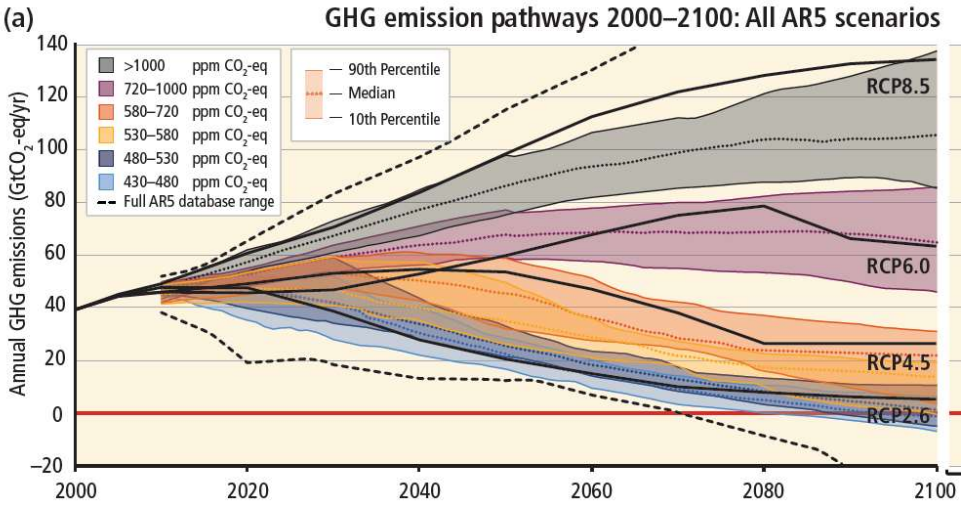
Emissions Trajectories into the Future



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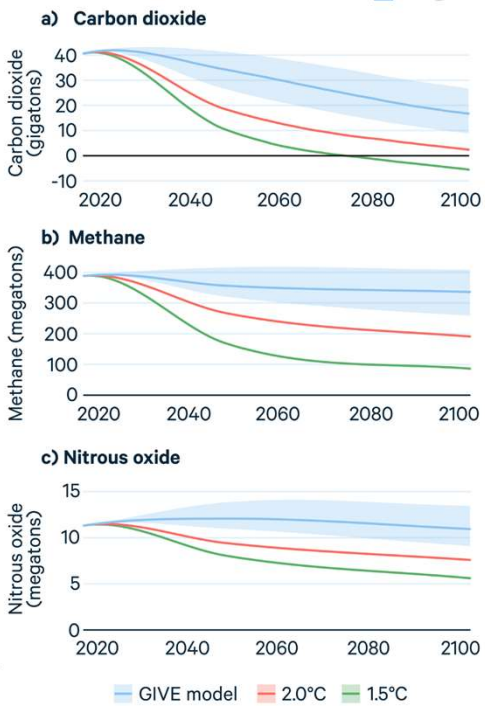
Source: IPCC Assessment Report 5

Newer Estimates

- Pathways of greenhouse gas emissions to keep warming below 2° or 1.5°C



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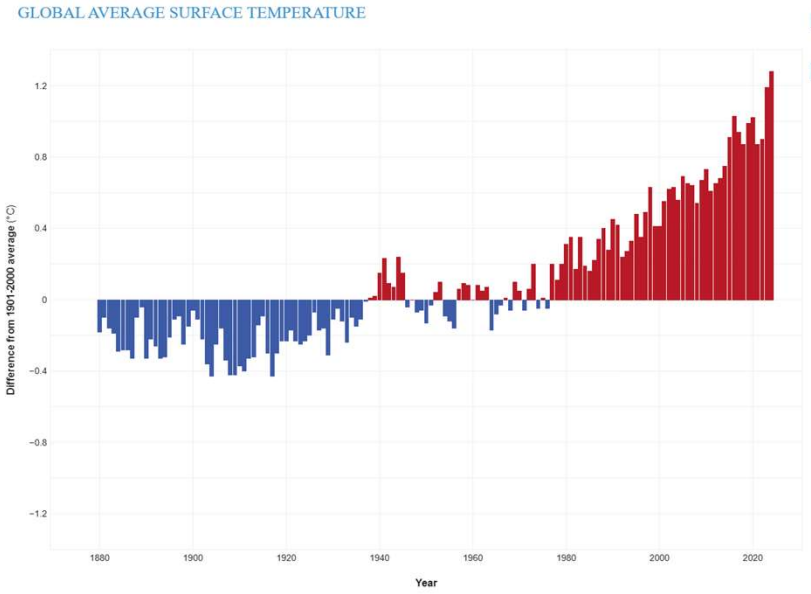
Global Temperatures are Already Changing

Surface temperatures have increased 1.29°C already as of 2024



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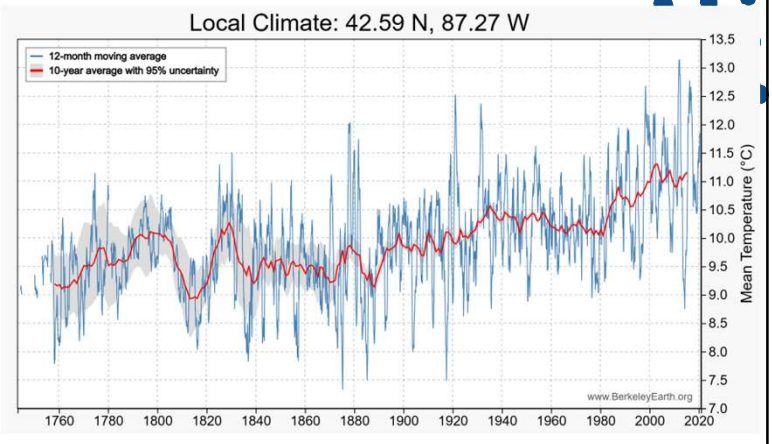
And So Are Local Temperatures

Use https://berkeleyearth.org/temperature-city-list/ to see the temperature history of an area!

Here's Chicago!



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Impacts of Climate Change

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What Do Greenhouse Gas Emissions Do to the Planet?

- **Increased temperatures**
  - Sea level rise
  - Storm surges
- **Altered precipitation patterns**
- **More variable weather**
- **More powerful storms**
- **Carbon dissolves in ocean**

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How Climate Change Affects Humans

- Agriculture
- Fisheries
- Coastal damages
- Direct health effects, including sickness and death (temperature & drought; also pollution)
- Indirect health effects (vector-borne disease)
- Reduced fresh water availability
- Wildfires
- Shifting zones for important ecosystems, and desertification
- Reduced worker productivity
- Increased violence
- Some of these may cause human migration and/or conflict

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Social Cost of Carbon (SCC)

- The expected cost of damages from each unit of greenhouse gas emissions
- Should increase over time
- EPA used ~$51 per metric ton of CO_2 until 2024
  - About $157/car per year.
  - $32 billion for all vehicles in the US.
- In 2024, adopted new estimate: $190
- 2025: EPA proposes elimination of SCC

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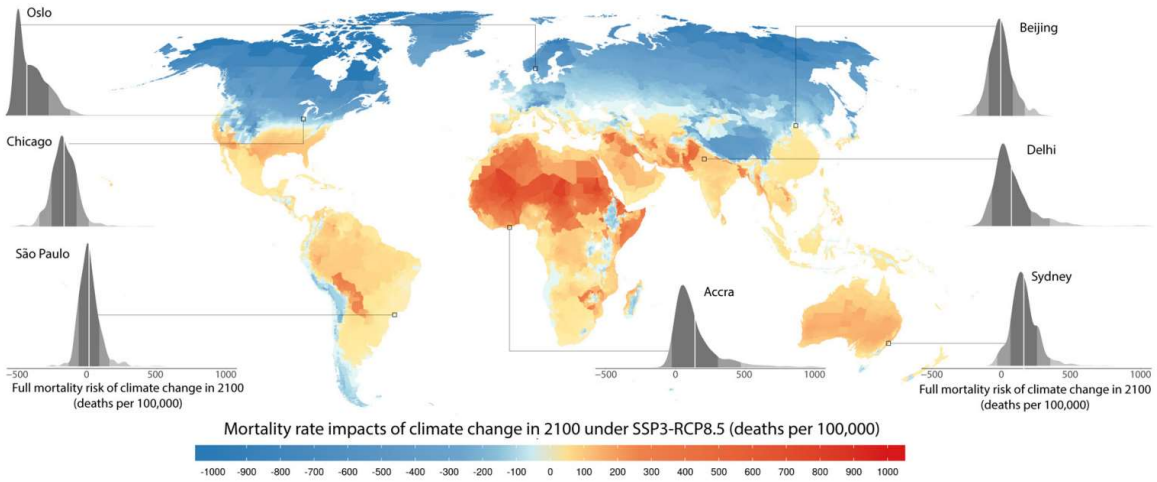
How Damages Will Vary Globally: Mortality as an Example



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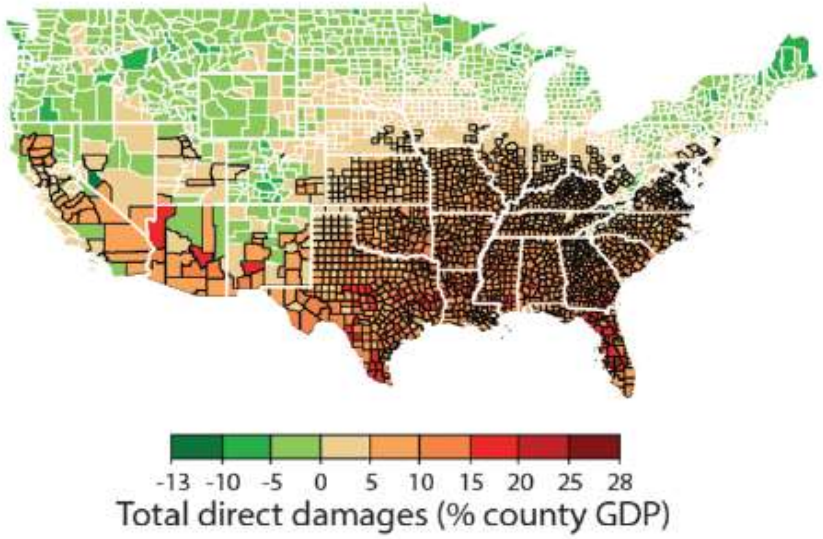
How Damages Will Vary in the US



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Adaptation Reduces Damages

- ***Adaptation***: **costly action that reduce damages from climate change.**
- **The net damage cost to society is the cost of adaptation plus the cost of remaining damages.**
- **People and firms will take some actions on their own, up to the point where they find it worthwhile.**
- **Some adaptation requires government involvement.**

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Individual-Level Adaptation

- **Perhaps you…**
  - Stay inside more.
  - Turn on the air conditioning.
- **Farmers may:**
  - Plant at different times.
  - Plant new crops.
- **Businesses may:**
  - Give outdoor workers water / shade breaks.
- **Everyone might:**
  - Think about moving to a safer place.

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Public Adaptation

- **Governments can help:**
  - When collective action is less costly than everyone acting alone.
  - When individual action is not possible or likely.
  - When some people can't protect themselves.
- **Sea walls**
- **Ecosystems that provide protection**
- **Policies that protect workers or low-income and vulnerable populations**
- **Planned retreat (moving a community)**

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Reducing Emissions

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Global Net Emissions Are What We Care About

- **For climate impacts, we don't care where they are emitted, only how much**
  - There may be other local impacts
- **Gross emissions (greenhouse gas sources): how much greenhouse gases (including CO2) we put out**
- **Greenhouse gas sinks: ways to pull CO2 out of the air**
  - Existing: oceans, forests
  - Increase sinkage by planting trees, or other measures

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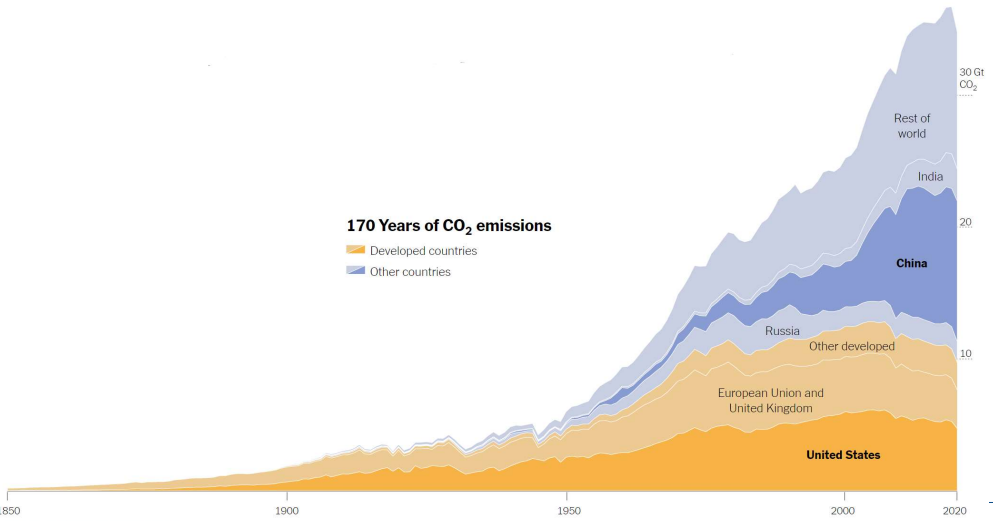
Sources of the Global Flow of Emissions



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Sources of the Global Stock of Emissions

23 rich, developed countries are responsible for half of all historical CO_2 emissions.

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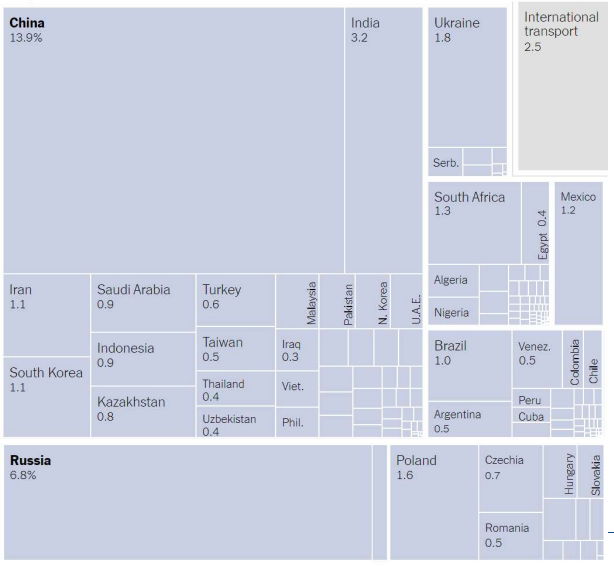
Sources of the Global Stock of Emissions

More than 150 countries are responsible for the other half.



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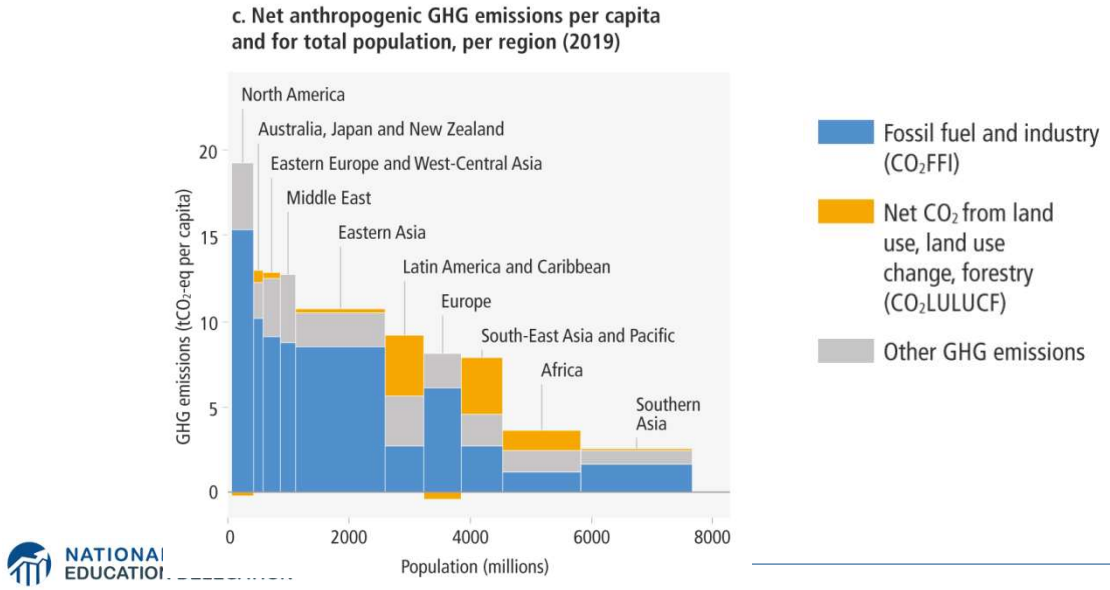
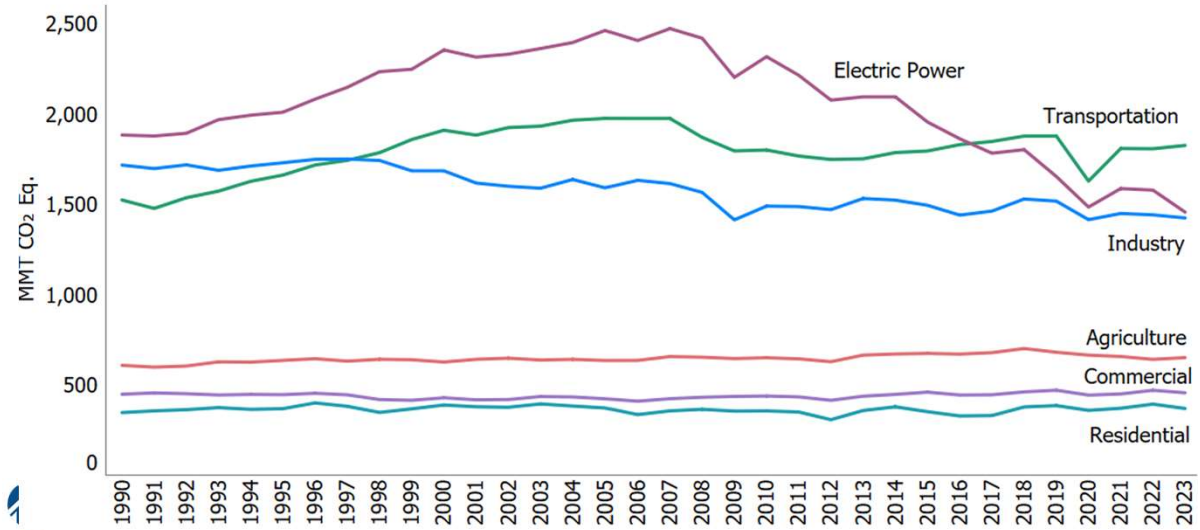
How Does This Look Per Capita (Per Person)?

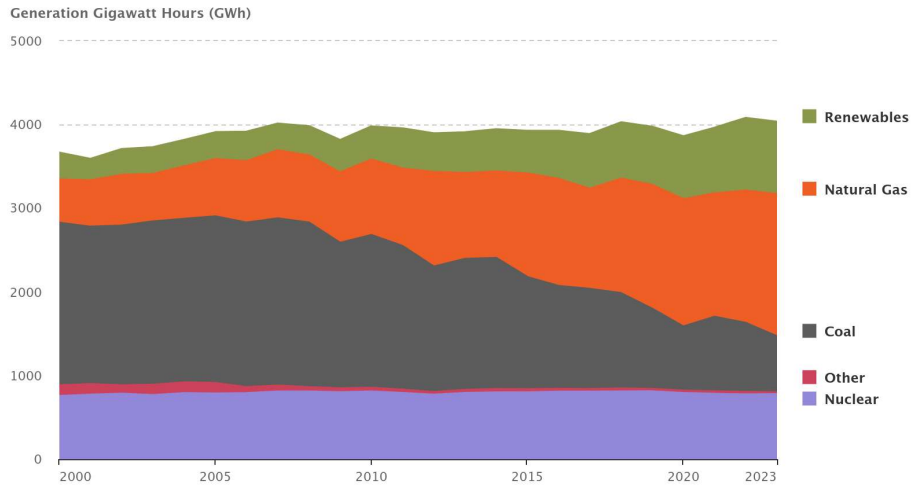


Total US Greenhouse Gas Emissions by Economic Sector through 2023



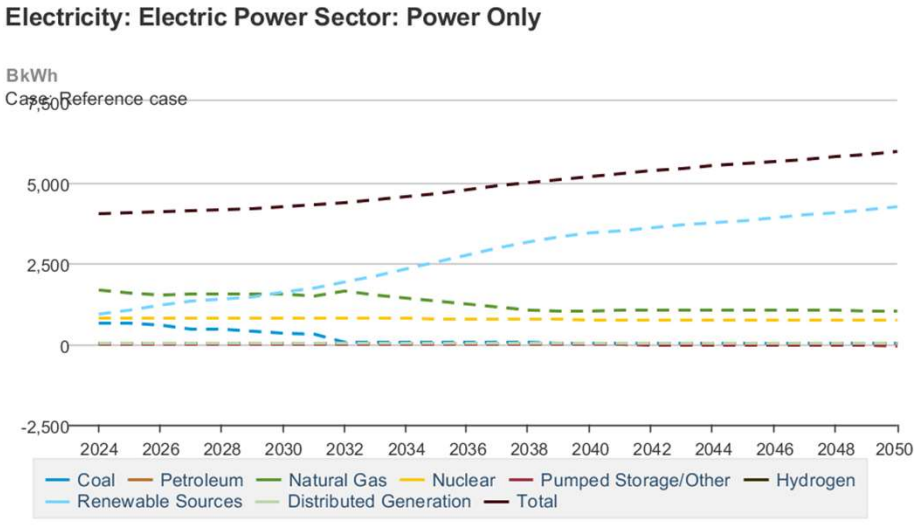
US Electricity Sources for the Last 25 Years

Renewable and Natural Gas Generation Are Growing Contributions to the Power Sector



Source: EIA Annual Energy Review

US Electricity Sources - Future Projections



Data source: U.S. Energy Information Administration

Which Emissions Should We Cut?

- List all possible ways to reduce emissions
- Figure out how much each can reduce in total
- Figure out how much each costs per unit of emissions reduced
- Line them up in order: cheapest to costliest ("marginal abatement cost curve")
  - → Tackle first the cheapest ones!

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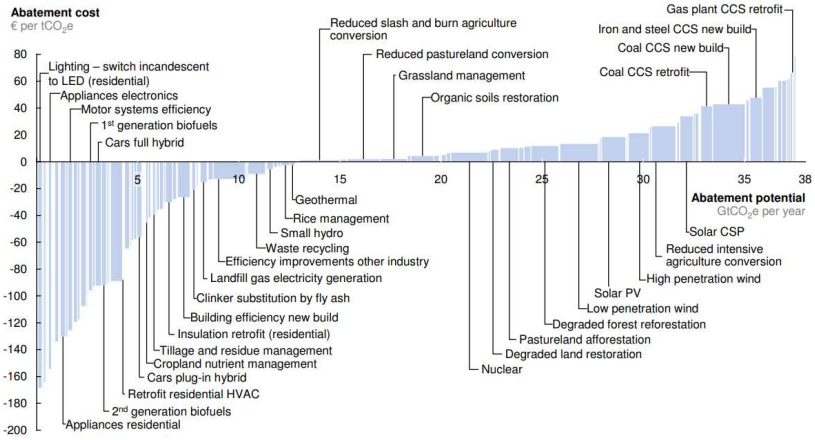
Example Abatement Cost Curve

(Don't trust these numbers, this is just to show the idea)

V2.1 Global GHG abatement cost curve beyond BAU – 2030



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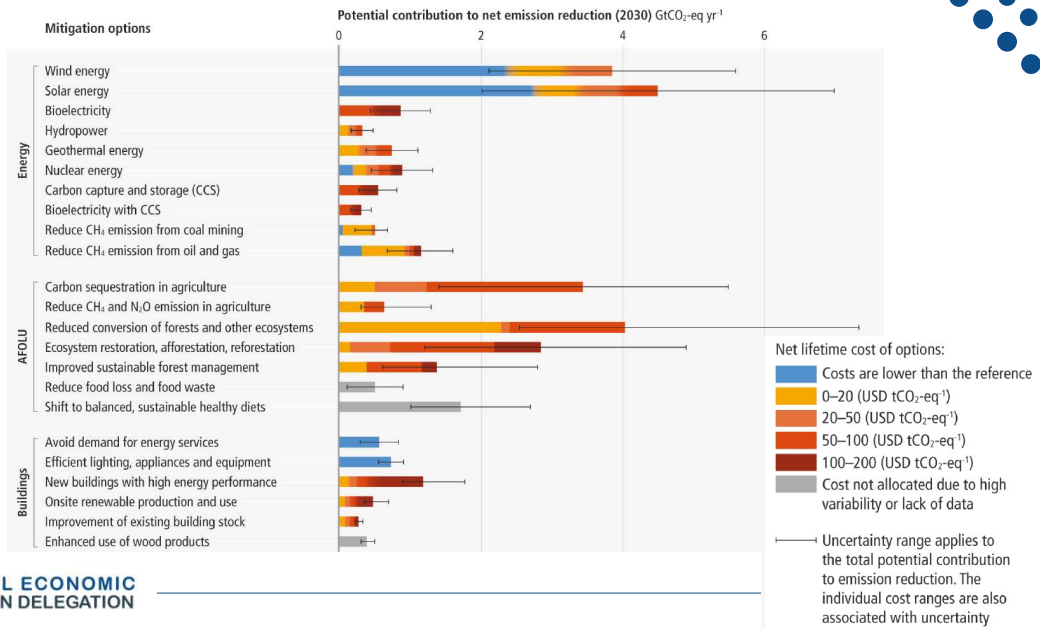
Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €80 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: Global GHG Abatement Cost Curve v2.1

Newer Estimated Abatement Cost Curve



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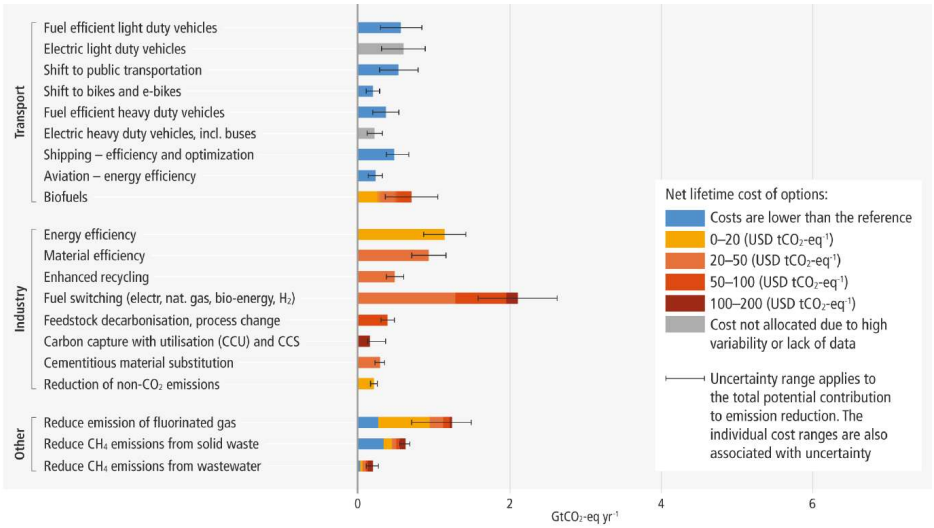
Newer Estimated Abatement Cost Curve



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Costs and Barriers Can Be Difficult to Assess

- **Difficult to project future costs for new technology**
  - Costs of renewables have been dropping fast
- **Investments in research and development and infrastructure (e.g., EV charging) can lower future costs**
- **Barrier to expanding renewable energy: intermittency**
  - Battery technology under development

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Geoengineering and Carbon Capture

- **Technical pathways to reduce climate change without reducing emissions**
- **Carbon capture: captures CO2 emissions and stores them or "utilizes" them (for energy, pressure, etc.)**
  - Not yet proven at scale
- **Solar geoengineering: make the atmosphere reflect more light to regain earlier thermal balance**
  - Totally theoretical
  - Potentially risky

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Climate Change Policy

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Policies That Reduce Emissions Directly

- **Command and control regulation**
  - Emissions standards or limits (e.g., Clean Water Act discharge limits)
  - Tech standards (e.g., require scrubbers on power plants)

- **Incentive-based policies**
  - Putting a price on emissions – leveling the playing field!
    - Tax or cap & trade
    - Subsidizing green energy (*e.g.*, feed-in tariffs)

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Command and Control vs. Incentive-Based Regulation

- **Efficiency**
  - Both can achieve the same amount of emissions reduction.
  - Incentive-based policies can achieve emissions reduction at much lower cost.
- **Equity**
  - Both have may regressive impacts (low-income families bear costs that are a larger percent of their incomes vs hi-income families)
    - However, new evidence increasingly questions this.
  - Cap and trade and carbon tax can generate revenues that can be used to offset the regressivity.
    - E.g.: "carbon dividend"
  - Command and control regulations do not.

How Does a Carbon Tax Work?

- **Choose activities to be covered (e.g., electricity sector, all emitters, etc.).**
- **Set tax level.**
  - Optimally, it represents the social cost of polluting.
- **Polluters must pay a tax for every unit emitted.**
  - Polluters with **low** abatement costs will **abate** to avoid the tax
  - Polluters with **high** abatement costs will pollute and **pay the tax**

How Does Cap and Trade Work?

- **Choose activities to be covered (e.g., electricity sector, all emitters, etc.).**
- **Set maximum emissions level ("cap").**
- **That many pollution permits are issued.**
  - Can be auctioned off or given to polluters
- **Every polluter in a covered sector must have a permit for every unit of pollution.**
- **Polluters buy and sell ("trade") permits on a market as they wish.**
  - Polluters with **low** abatement costs will make / save money by **abating** and selling / not buying permits
  - Polluters with **high** abatement costs will buy permits and **pollute**

Examples of Other Policies that Reduce Emissions

- **Research and development subsidies**
- **Renewable energy mandates (e.g., renewable portfolio standards)**
- **Energy efficiency mandates and subsidies (e.g. CAFE fuel economy standards)**
- **Grid / infrastructure improvements**
- **Public transportation**
- **Land use / zoning policies**

Climate Change Policy in Action

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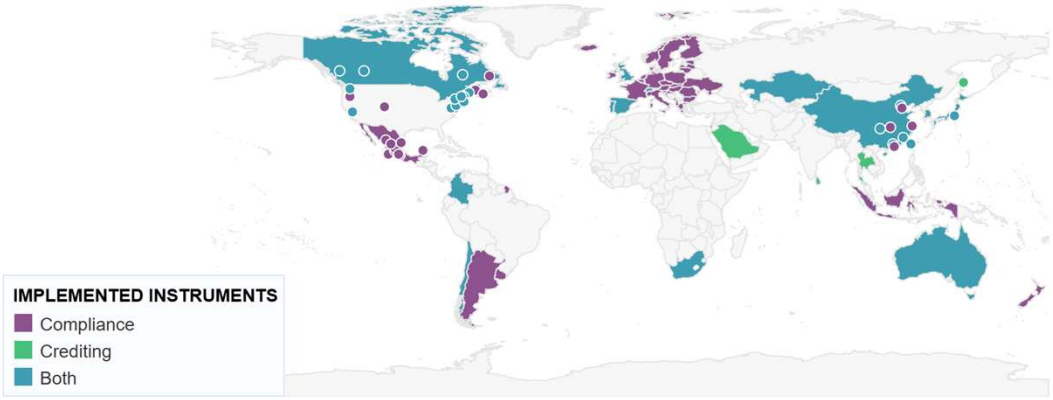
Incentive-Based Climate Policies Right Now

Carbon pricing instruments around the world, 2025

Map shows jurisdictions that have implemented Direct Carbon Pricing Instruments - Compliance instruments (Emissions Trading Systems (ETS) and Carbon taxes) and/or domestic carbon crediting mechanisms, subject to any filters applied. The year can be adjusted using the slider below the map.



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Source: World Bank Carbon - Pricing Dashboard

California's Cap and Trade System Since 2013

0.7%

of global greenhouse gas emissions

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California's AB32: Global Warming Solutions

- **Passed in 2006**
- **California's goals:**
  - Reduce emissions to 1990 levels by 2020
  - An 80% reduction in emissions from 1990 levels by 2030
- **California's Tools:**
  - Cap and Trade
  - Renewable Portfolio Standard
  - Clean Cars Program
  - Low Carbon Fuel Standard

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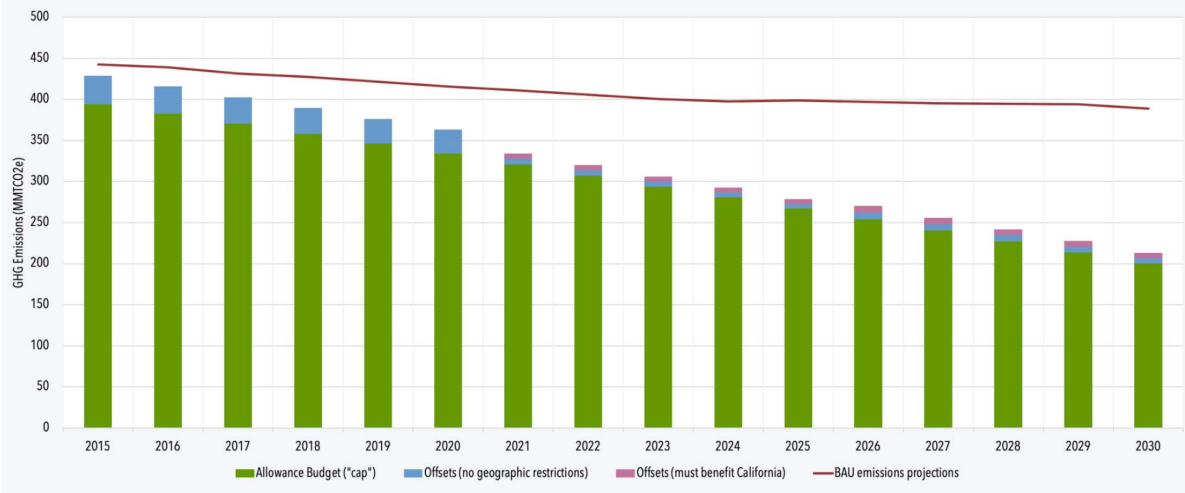
Emissions Cap Designed to Tighten over Time



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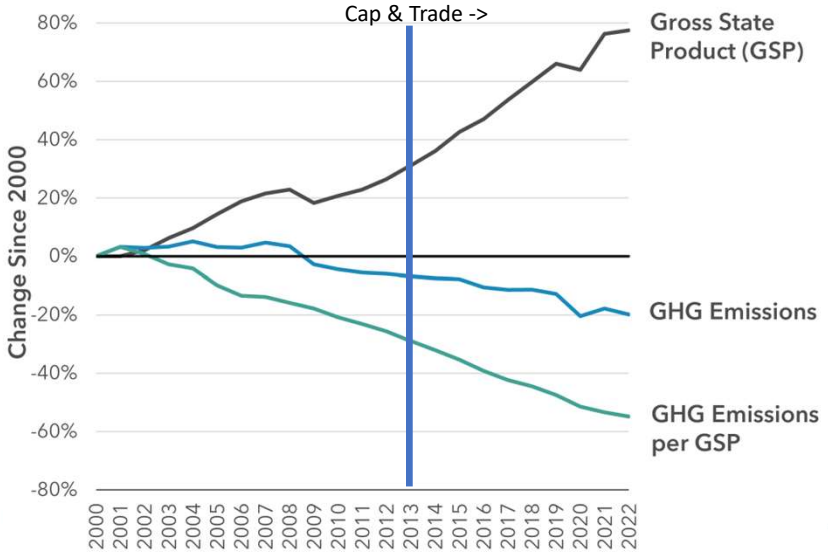
Changes in California Gross State Product and GHG Emissions since 2000



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Summary

- **Climate change is real, is caused by human actions, and has impacts we're already feeling.**
- **This problem won't solve itself; we need policy intervention, and fast.**
- **Smart policy can reduce greenhouse gas emissions by the right amount and at the lowest possible cost.**
  - For example, cap and trade and emissions taxes!
- **We also need policies to help with adaptation and support those bearing the greatest damages.**

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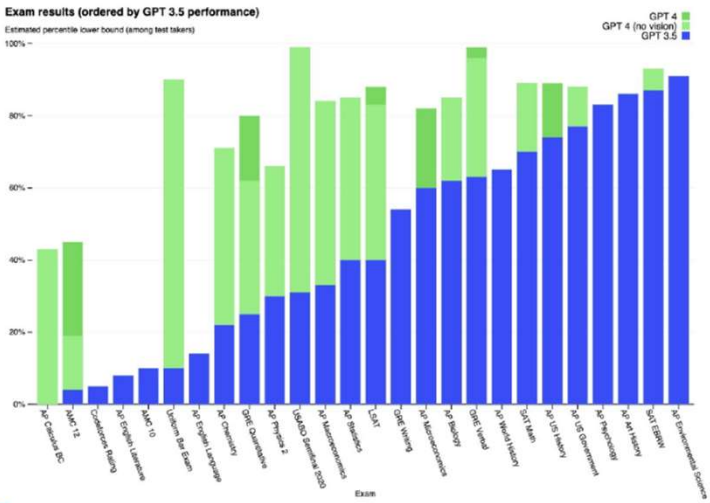
Next Week: AI Is Getting "Smarter"



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Eloundo, Manning, Mishkin, Rock (2023) https://ar5iv.labs.arxiv.org/html/2303.10130

Thank you!

Any Questions?

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