

Osher Lifelong Learning Institute, June 2026

The Economics of Public Policy Issues

University Of Minnesota

Host: Geoffrey Woglom, Director
National Economic Education Delegation



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Available NEED Topics Include:

- US Economy
- Healthcare Economics
- Climate Change
- Economic Inequality
- Economic Mobility
- Trade and Globalization
- Minimum Wages
- Immigration Economics
- Housing Policy
- Federal Budgets
- Federal Debt
- Black-White Wealth Gap
- Autonomous Vehicles
- US Social Policy



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Course Schedule

Contemporary Economic Policy

- Week 1 (10/8): Economic Update & Changes at the Fed, Geoffrey Woglom, Amherst College
- **Week 2 (10/15): Climate Change Economics, Galina Hale, UC Santa Cruz**
- Week 3 (10/22): The Future of Money, Geoffrey Woglom, Amherst College
- Week 4 (10/29): The Economics of Tariffs, Tibor Besedes, Georgia Institute of Technology
- Week 5 (11/5): Economics of Immigration, Roger White, Whittier College
- Week 6 (11/12): Gender Pay Gap, Tibor Besedes, Georgia Institute of Technology



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Submitting Questions

- I encourage questions. Please put questions in the chat and I will answer them periodically during the talk,
- We will do a verbal Q&A once the material has been presented.
- Slides are available from the NEED website
https://needecon.org/delivered_presentations.php.



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Climate Change Economics

Galina Hale, Ph.D.
UC Santa Cruz

Osher Lifelong Learning Institute
Fall 2026



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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).

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Outline

- Economic Building Blocks
- Climate Change
- Impacts of Climate Change
- Reducing Emissions
- Climate and the Food System
- Climate Change Policy
- Climate and Finance



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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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When Everything Is Simple, No Regulation Is Needed for Efficiency

- Simple transactions: buyer and seller feel all costs and benefits of sales
- They make decisions based on the costs & benefits they feel
 - Efficient allocation and production of everything!
(Maximizes social benefits)
- Simple economic assumptions that proved wrong
 - Abundant resources are cheap or free (air, water)
 - “Free disposal” (therefore “more is always better”):
waste is not free for the planet



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Market failure

- *A situation in which free markets produce prices of goods or services and allocation of such goods or services that is not socially optimal.*

It can arise due to

- Externalities (when actions of one agent affect others)
- Public goods



Goods that are **non-excludable** (I can't stop you from using it) and **non-rival** (me using it does not diminish your benefit from using it)



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Market failure

- *A situation in which free markets produce prices of goods or services and allocation of such goods or services that is not socially optimal.*

It can arise due to

- Externalities
- Public goods
- Free rider problem



People can enjoy benefits of others' actions without paying for them (or paying for them insufficiently)



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When Our Decisions Affect Others, We Need Regulation

- Emissions produce an **EXTERNALITY**:
a cost on all others: Polluting things have an “unfair cost advantage” because part of cost is offloaded on others
 - => Too much pollution is generated
 - Regulation of pollution has net benefits
- *The “efficient” amount of pollution balances all costs & benefits of pollution*



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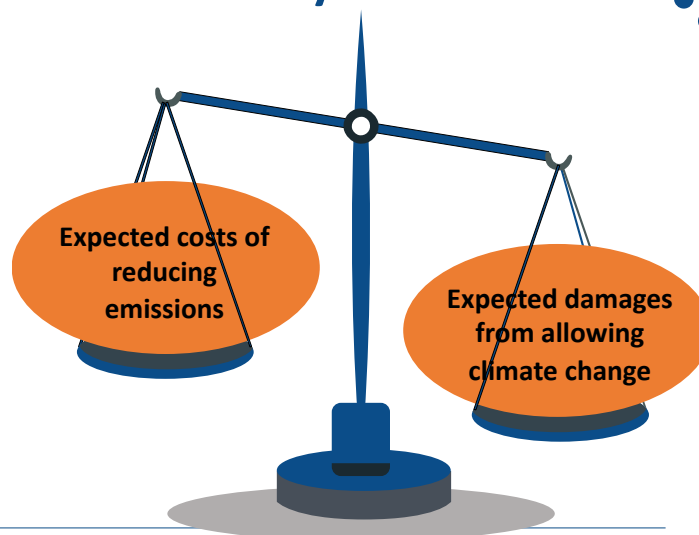
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How Economists Decide How Much to Fight Climate Change: Cost Benefit Analysis

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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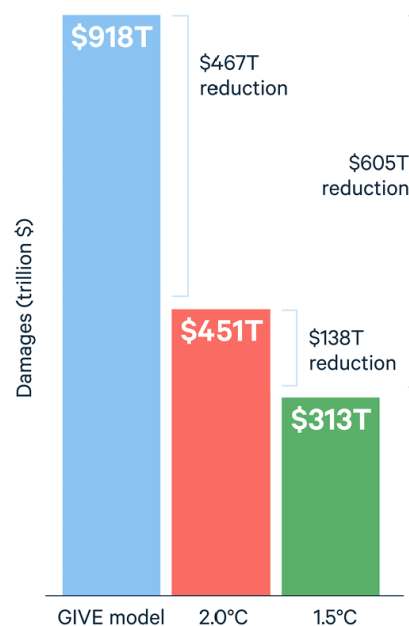
Cost-Benefit Analysis of Fighting Climate Change

- 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

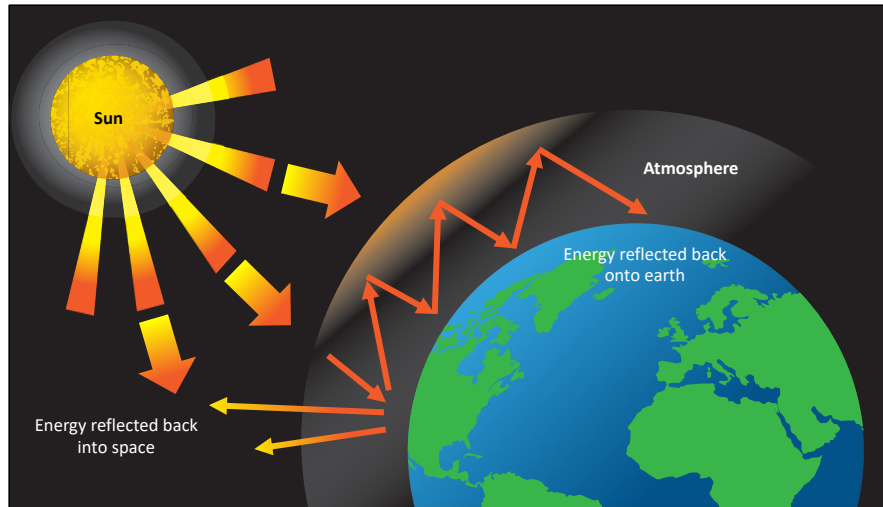


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The Atmospheric Greenhouse Effect

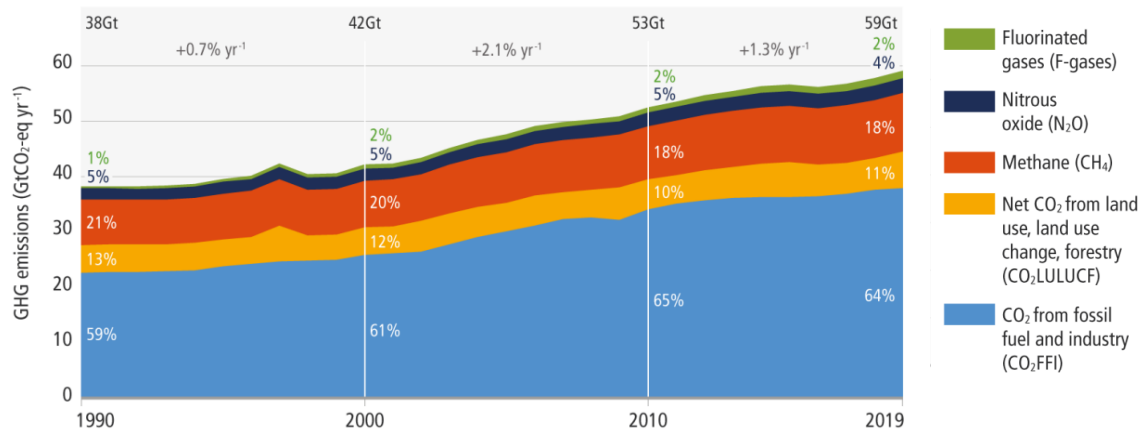


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Greenhouse Gas Emissions 1990-2019

a. Global net anthropogenic GHG emissions 1990–2019 ⁽⁶⁾

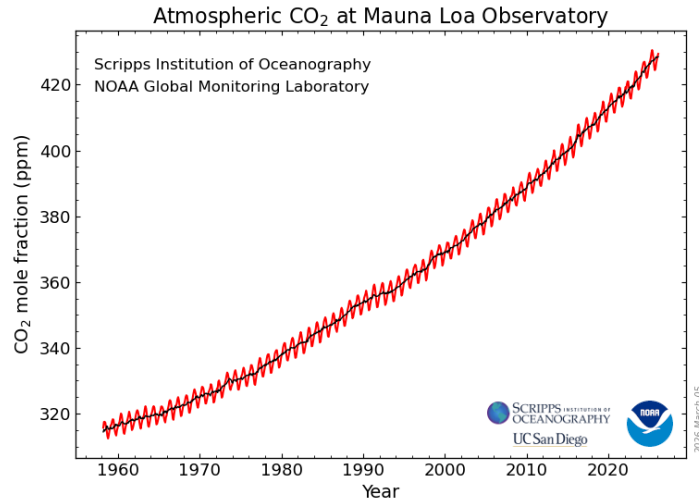


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Source: IPCC

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Atmospheric CO₂ Concentrations Up To Now

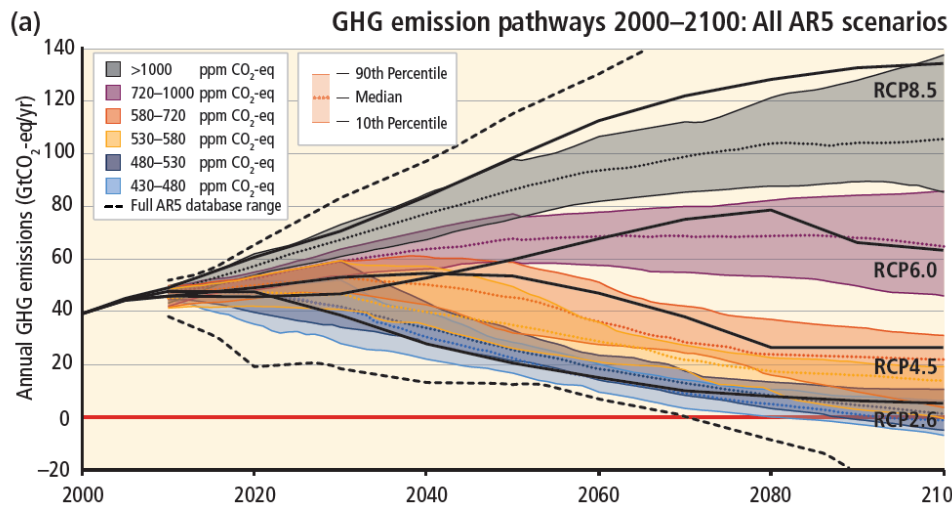


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Source: NOAA

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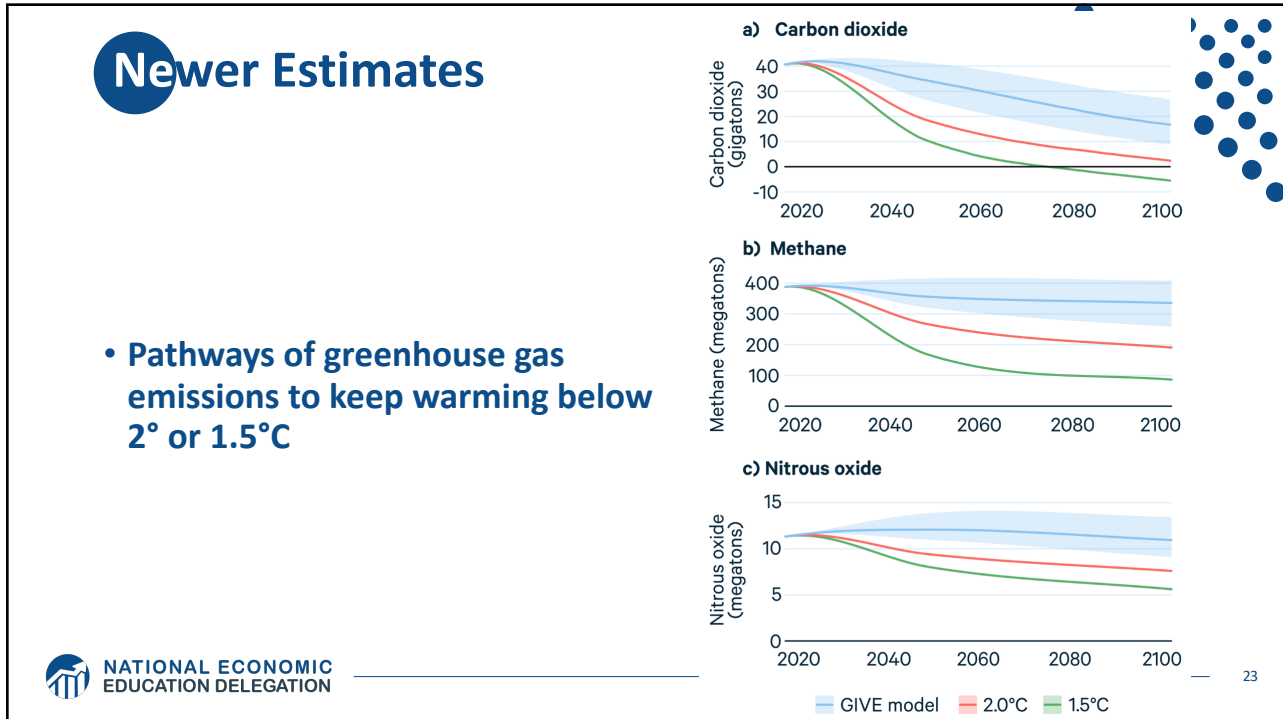
Emissions Trajectories into the Future



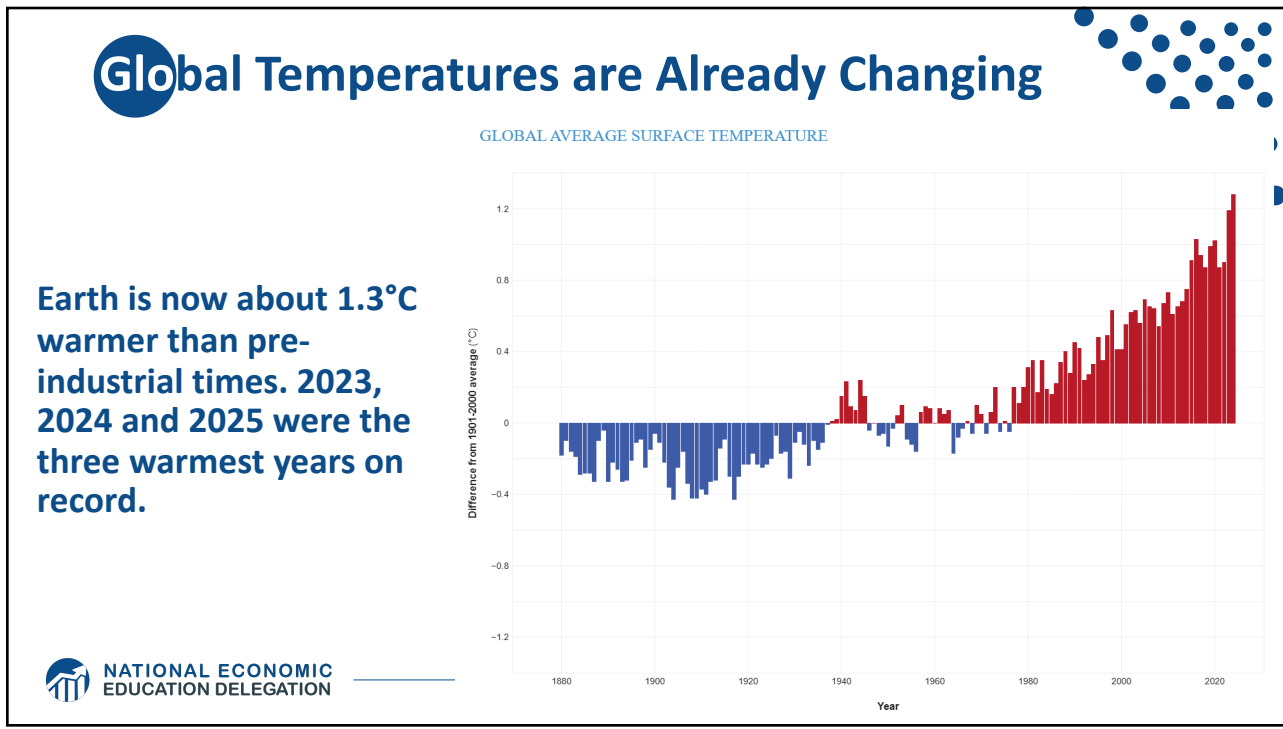
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Source: IPCC Assessment Report 5

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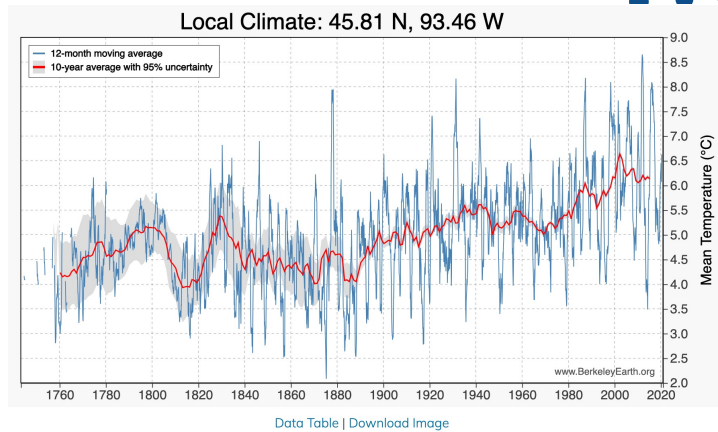
And So Are Local Temperatures

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

Here's Minneapolis!



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Climate Stripes



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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 (warmer water => volume increase + ice melts)
 - Storm surges, increased wave energy
 - Larger number of hotter-than-safe days in many areas
- **Altered precipitation patterns => floods, wildfires, crop yield decline**
- **More variable weather**
- **Carbon dissolves in ocean**
- **Increased loss of biodiversity (change too fast to adapt)**



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How Climate Change Affects Humans

“Chronic effects”

- **Agriculture and Fisheries**
- **Coastal damages**
- **Direct health effects, including sickness and death**
- **Indirect health effects (vector-borne disease)**
- **Reduced fresh water availability**
- **Reduced worker productivity**

“Acute effects”

- **Wildfires**
- **Coastal/riverine damages from floods**

Resulting social consequences

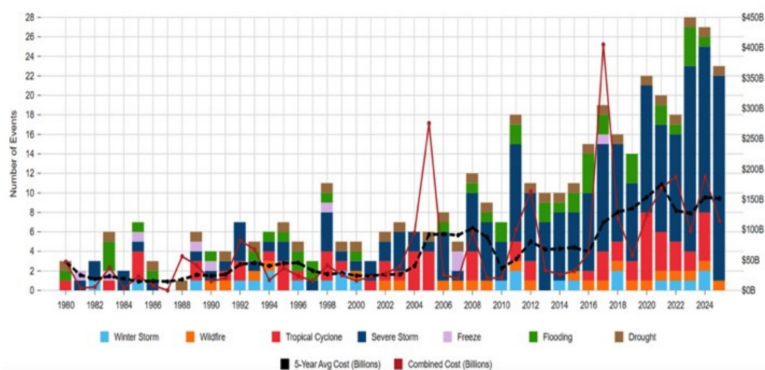
- **Increased violence**
- **Migration and/or conflict**



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Billion-Dollar Disasters Are Becoming More Common



Bars: number of U.S. events by type (left axis). Lines: total cost, \$ billions (right axis).

Source: Climate Central, U.S. Billion-Dollar Weather and Climate Disasters (2025 data; inflation-adjusted). Chart through 2025.

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billion-dollar weather
disasters in the U.S. in
2025

≈ \$115 billion
in total damages



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Social Cost of Carbon (SCC)

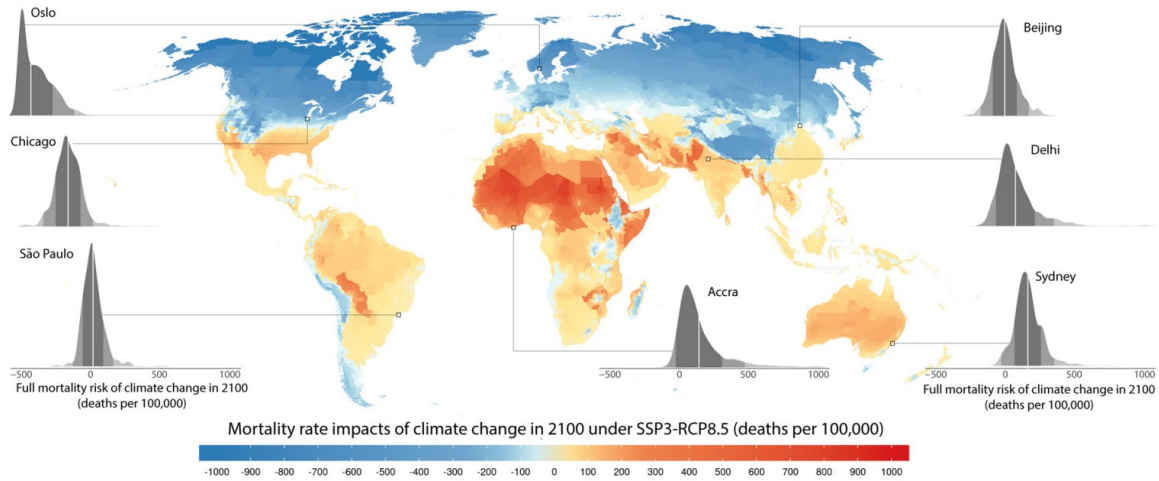
- The expected cost of damages from each unit of greenhouse gas emissions
- Should increase over time
- EPA used ~\$51 per metric ton of CO₂ until 2024
 - About \$157/car per year.
 - \$32 billion for all vehicles in the US.
- 2024: EPA adopted a new estimate: \$190
- 2025: Federal SCC estimates withdrawn



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How Damages Will Vary Globally: Mortality as an Example

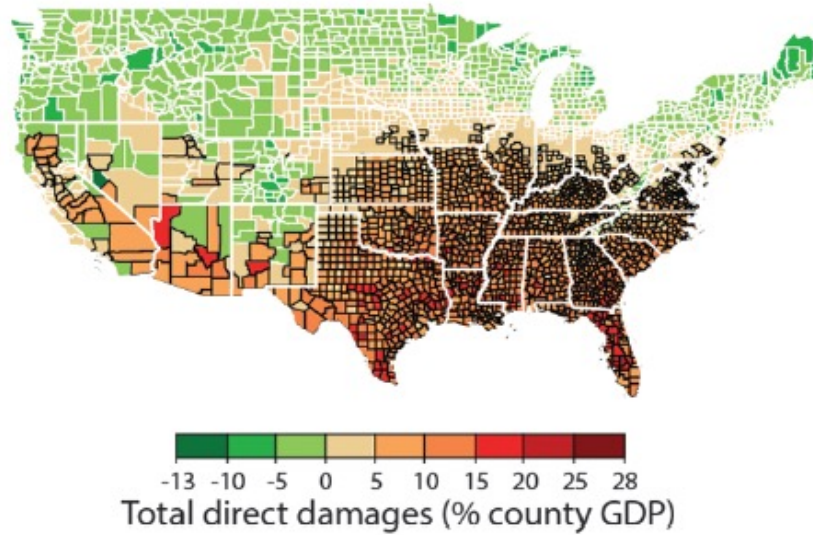


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How Damages Will Vary in the US



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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
- Most adaptation requires government involvement due to its *local public good* nature (privately insufficient investment)



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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

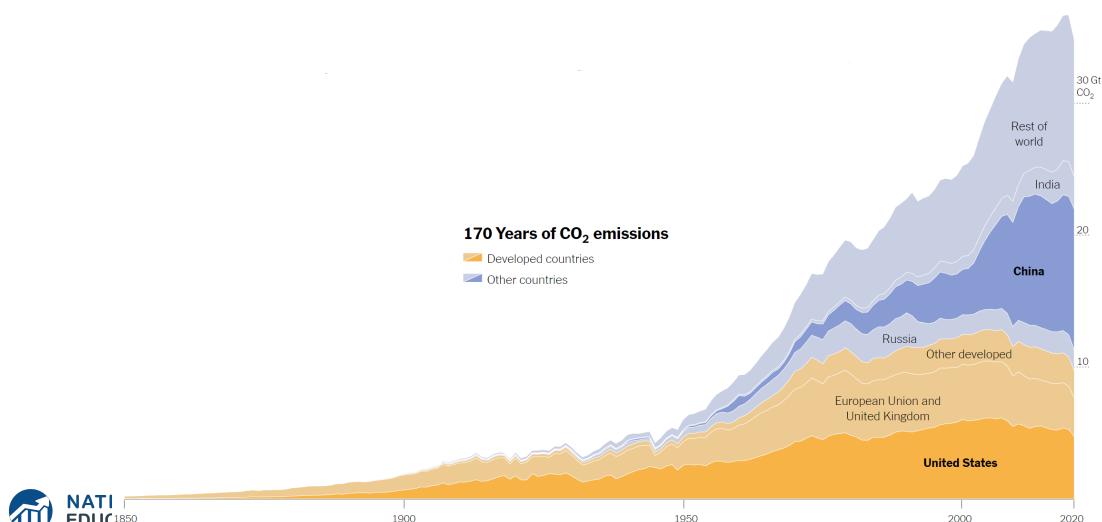
- **For climate impacts, we don't care where they are emitted, only how much**
 - There may be other local impacts
- **Gross emissions (greenhouse gas sources): how much greenhouse gases (including CO₂) we put out**
- **Greenhouse gas sinks: ways to pull CO₂ out of the air**
 - Existing: oceans, forests (1/3 of land-based sink is Amazon)
 - Increase sequestration by planting trees, or other measures



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Sources of the Global Flow of Emissions



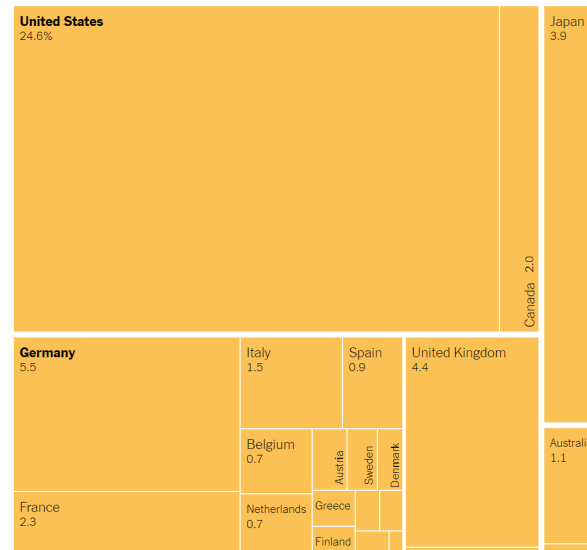
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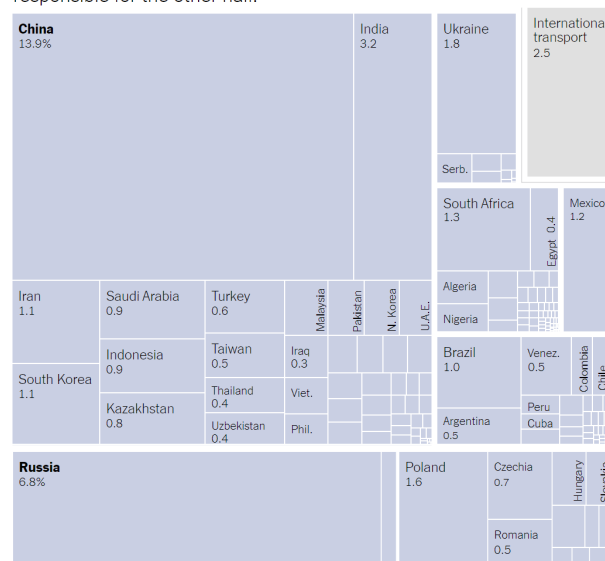
Sources of the Global Stock of Emissions

23 rich, developed countries are responsible for half of all historical CO₂ emissions.



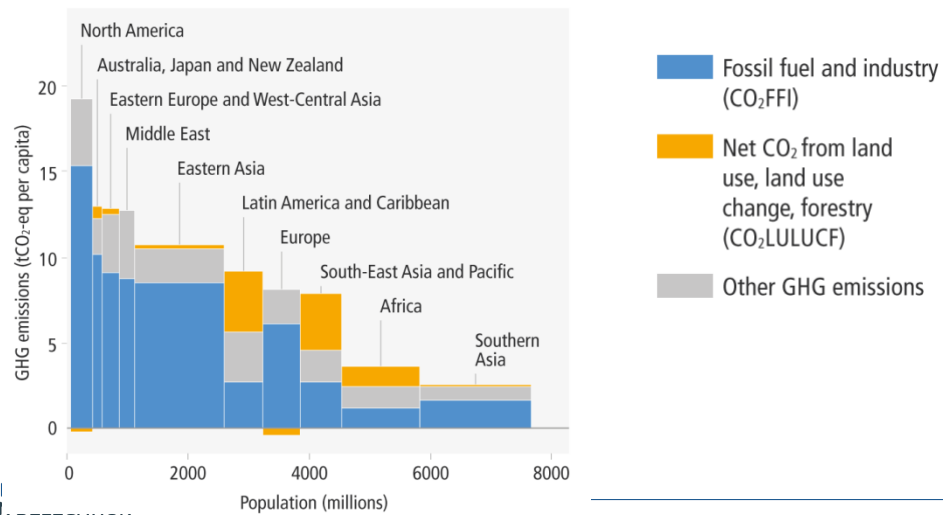
Sources of the Global Stock of Emissions

More than 150 countries are responsible for the other half.



How Does This Look Per Capita (Per Person)?

c. Net anthropogenic GHG emissions per capita and for total population, per region (2019)



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What does it mean for future emissions?

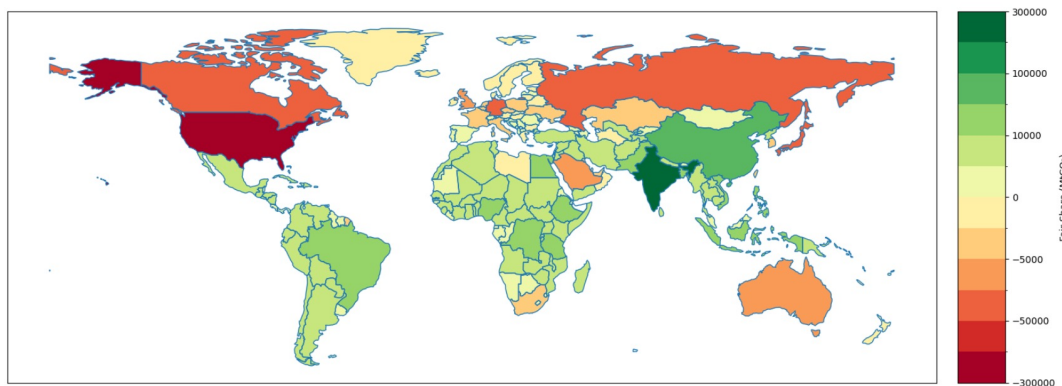
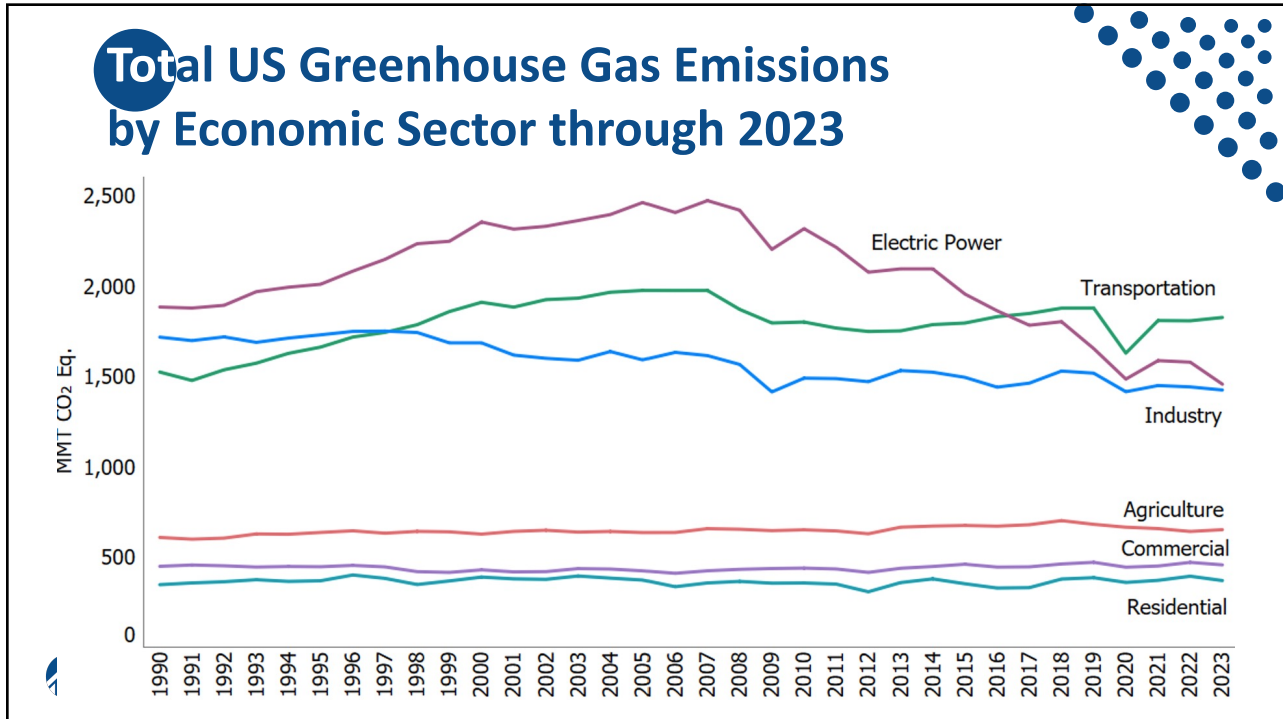
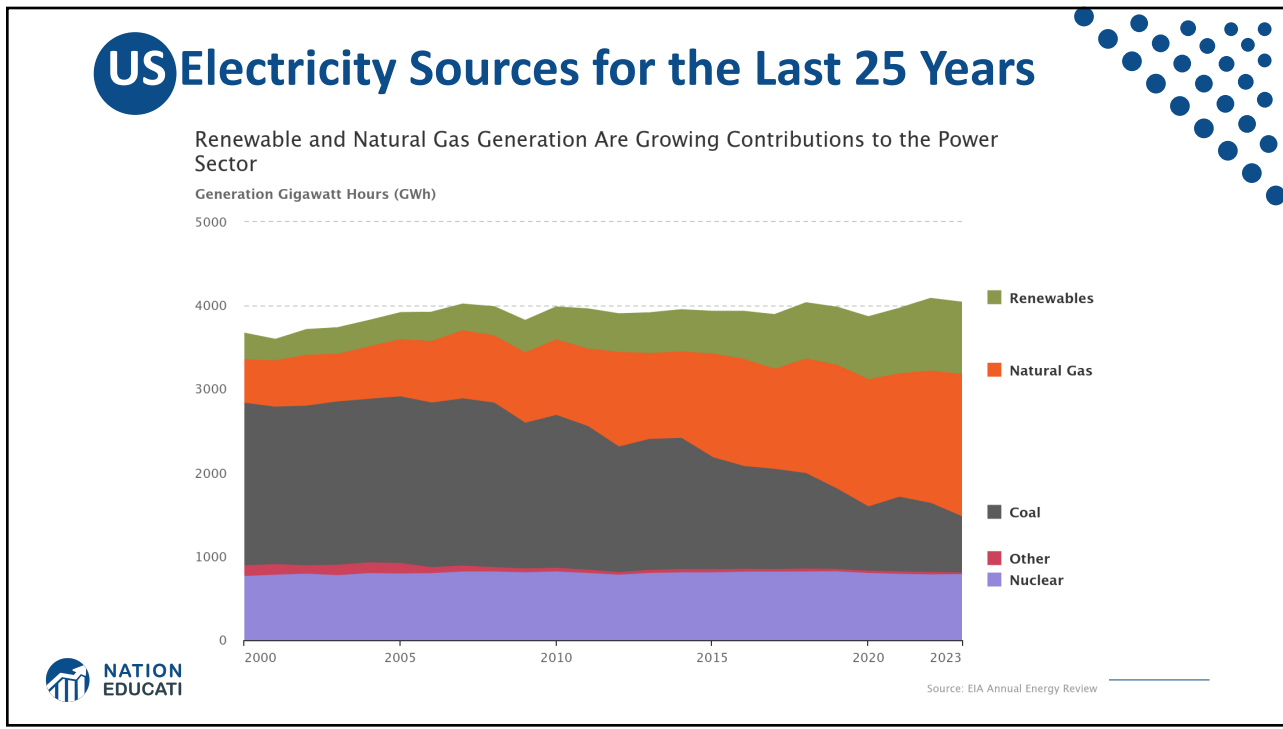


Figure 1. Fair Shares of the Remaining Carbon Budget

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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 per unit of emissions!



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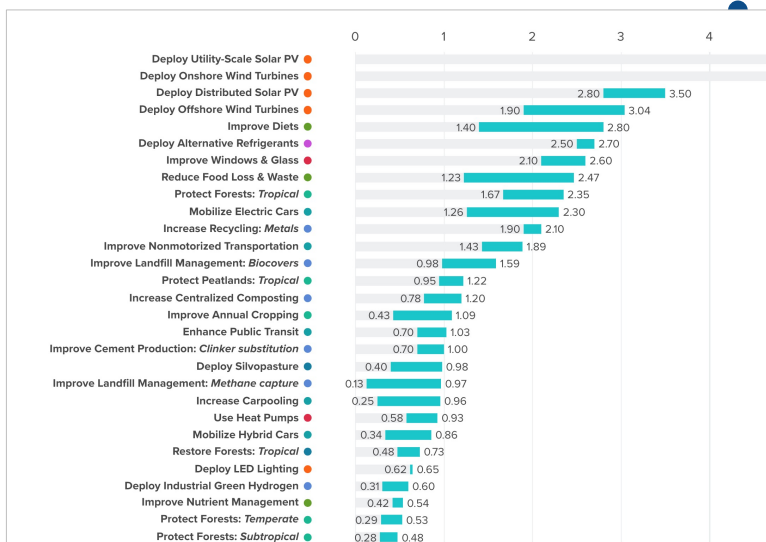
Ranking solutions more generally

- Project Drawdown compares more than 100 climate solutions
- **Solar and wind** are 4 top solutions
- **Improving diets** is the biggest food solution: 1.4–2.8 billion tonnes CO₂-eq a year
- **Reducing food loss and waste** is close behind, and it saves money
- Both rank alongside clean electricity and electric cars

Source: Project Drawdown, Drawdown Explorer
(drawdown.org/explorer)



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Emissions avoided, billion tonnes CO₂-eq per year (low–high estimate). Top two bars run off the scale.

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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.)**
 - Still very expensive
- **Solar geoengineering: make the atmosphere reflect more light to regain earlier thermal balance**
 - Totally theoretical
 - Potentially risky



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Climate and the Food System



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Food Is Both a Cause and a Victim

~1/3

of global greenhouse gas emissions come from the food system: farming, land clearing, processing, transport and waste

~32%

of human-caused methane comes from livestock (digestion and manure)

21%

lower global farm productivity since 1961 because of climate change

Cause: what we eat changes the climate. **Victim:** climate change makes food harder to grow.

Sources: Crippa et al. (2021), Nature Food; UNEP & CCAC, Global Methane Assessment (2021); Ortiz-Bobea et al. (2021), Nature Climate Change.



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Sources of Food Emissions

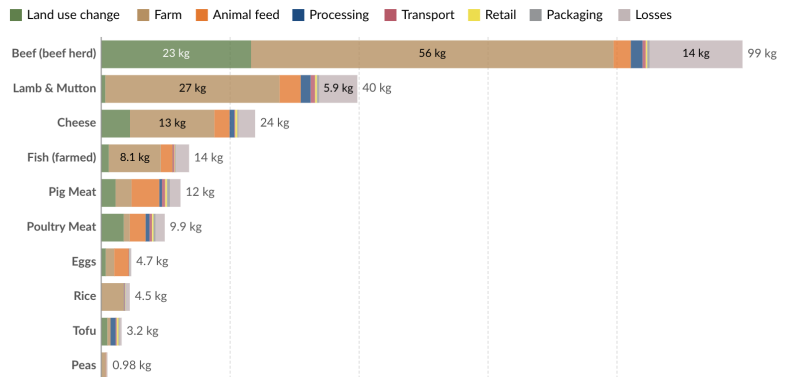
- Beef emits about 100 times more per kilogram than peas
- Most emissions happen on the farm and from clearing land, not from transport
- Methane is ~80× as potent as CO₂ over 20 years but fades in about a decade, so cutting it slows warming fast

Food: greenhouse gas emissions across the supply chain

Greenhouse gas emissions are measured in carbon dioxide-equivalents (CO₂eq) per kilogram of food.

Our World in Data

+ Add food ☐ Relative



Source: Joseph Poore and Thomas Nemecek (2018).

OurWorldInData.org/environmental-impacts-of-food • CC BY



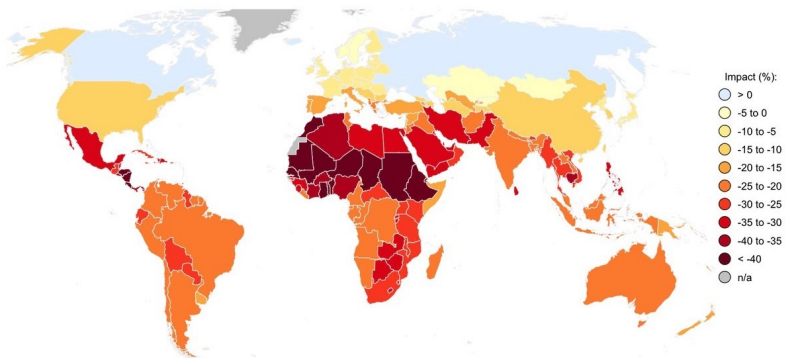
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Climate Change Hurts Farms, Especially in Poorer Places

- Hotter, drier places, often lower-income countries, lose the most farm productivity
- Higher food prices and lower farm incomes hit those who can least afford it
- Farmers adapt (new seeds, irrigation, planting dates), but adaptation costs money



Estimated effect of climate change on agricultural productivity (total factor productivity), %



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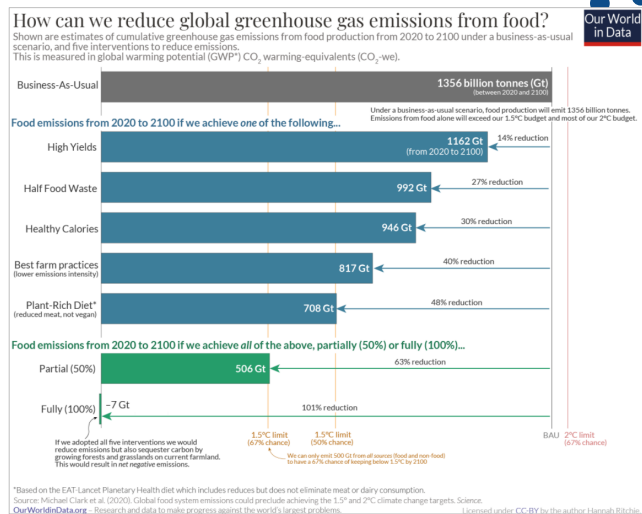
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Cutting Food Emissions

- **Waste less:** about 1/5 of food available to consumers is wasted; food loss and waste cause up to 10% of global emissions
- **Shift diets toward plants:** cuts food emissions by about half (not vegan, just less meat)
- **Better farm practices and new alternative proteins**
- **Economist's toolkit:**
 - put a price on methane
 - redirect farm subsidies toward low-emission foods
 - fund research and development



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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)
- Bans (e.g. no gas appliances in new residential developments)

- **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.
 - Cost of inaction is also regressive
- Cap and trade and carbon tax can generate revenues, Command and control regulations do not.



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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**



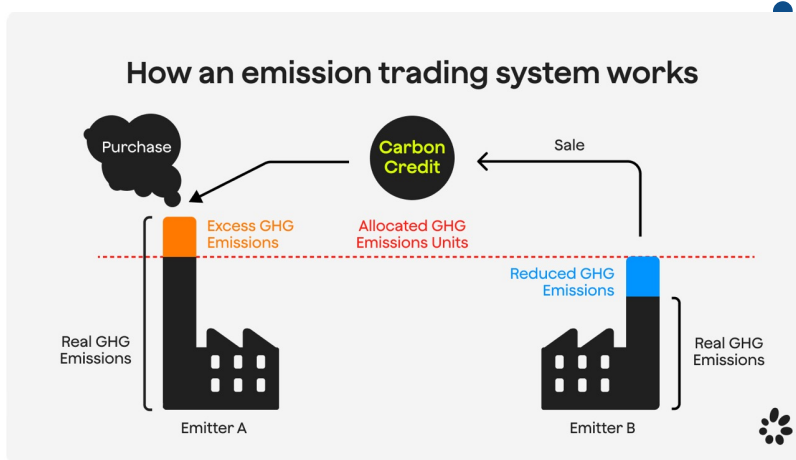
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How Does Cap and Trade Work?

- Choose activities to be covered
- Set maximum emissions level ("cap") to determine # of permits 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.



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Examples of Other Policies that Reduce Emissions

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



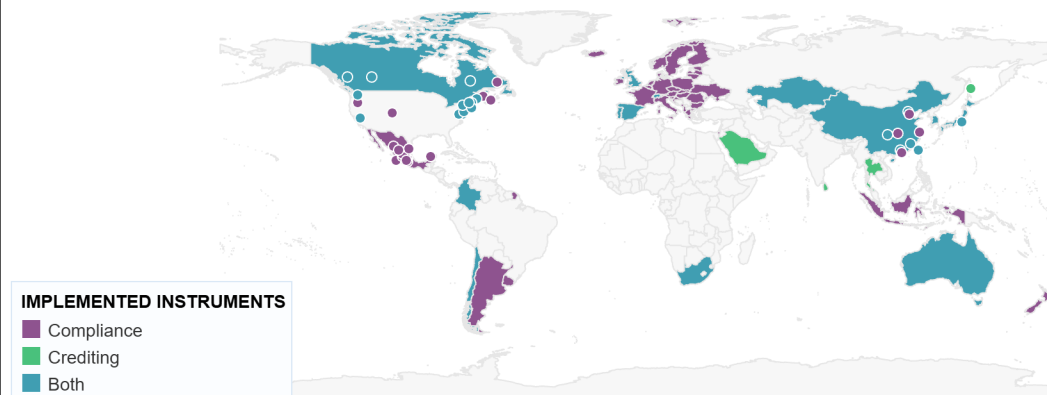
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Incentive-Based Climate Policies Right Now

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

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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

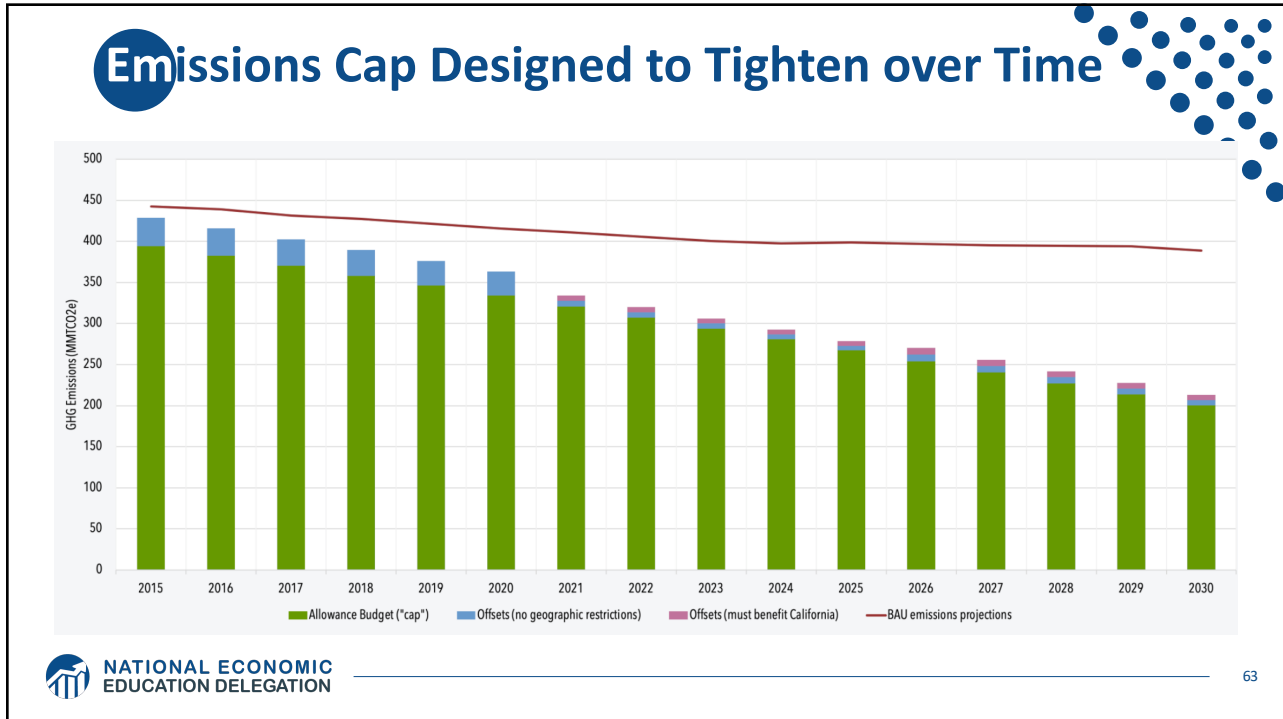


- **Passed in 2006**
- **California's goals:**
 - Back to 1990 levels by 2020 (met in 2016)
 - 40% below 1990 levels by 2030 (SB 32)
 - Net-zero emissions by 2045 (AB 1279)
- **California's Tools:**
 - Cap-and-Trade, renamed "Cap-and-Invest" and extended to 2045 (2025)
 - Renewable Portfolio Standard
 - Clean Cars Program
 - Low Carbon Fuel Standard

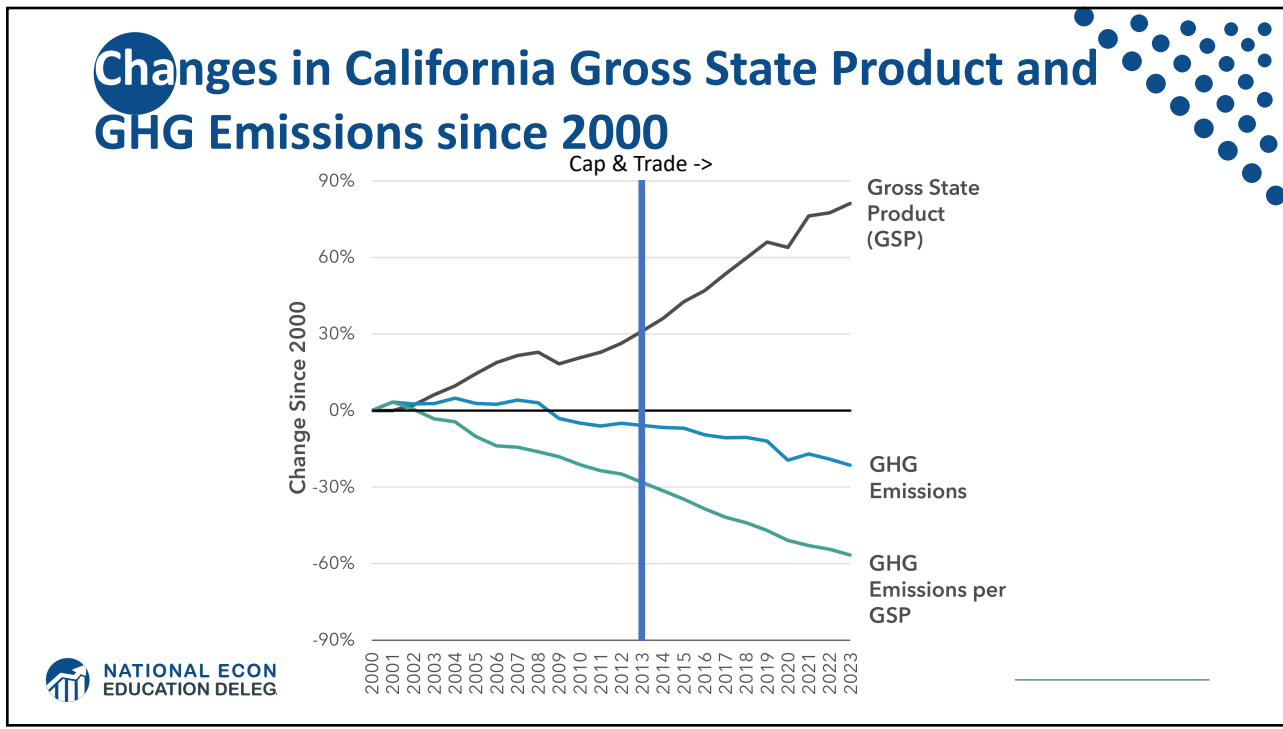


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Climate and Finance



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Climate Risk Is Financial Risk

Physical risk

Floods, fires, storms and heat damage homes, farms and businesses → losses for households, insurers, banks and investors

Transition risk

New policies, technologies and tastes can make polluting assets lose value ("stranded assets," e.g., coal plants) → losses for their owners and lenders

Delay doesn't avoid transition risk, it raises it:
the longer we wait, the faster and costlier the shift has to be.



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Insurance Is on the Front Line

- Insurers are raising premiums or leaving high-risk areas (California, Florida, Louisiana)
- State “insurer of last resort” plans are growing → risk shifts to other policyholders and taxpayers
- Premiums that reflect risk send a useful price signal, but raise affordability concerns and can lower home values
- Mortgages need insurance → climate risk spreads to banks and the wider financial system

~\$40B

estimated insured losses, Jan. 2025 Los Angeles fires

+43%

growth in California's FAIR Plan, Sept. 2024 – Dec. 2025



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Interest Rates and the Green Transition

- Solar and wind cost a lot to build but little to run, so the cost of borrowing matters a lot
- As interest rates rose after 2022, solar power got more expensive than gas power did
- Tax credits softened the blow (+12% instead of +18%)
- Central-bank decisions and lending costs shape how fast the transition happens

Increase in U.S. electricity cost from higher interest rates

Solar



Solar, with tax credits



Gas power plant



Source: Wilson, Shrimali & Caldecott (2025), “Financing costs and the competitiveness of renewable power,” iScience. Real interest rate rising from –0.5% to 2.5%.



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Following the Climate Money

\$1.9T

global climate
finance in 2023, a
record

\$6T+

per year needed to
meet climate goals

\$4T+

in green bonds
issued to date

\$107B

raised by carbon
prices worldwide in
2025

- Rich countries pledged \$300B a year for developing countries by 2035 (COP29) and to triple adaptation finance (COP30)
- Private money now provides over half of climate finance, but voluntary bank pledges have faded (the Net-Zero Banking Alliance shut down in 2025)

Sources: Climate Policy Initiative (2025); Climate Bonds Initiative (2026); World Bank, State and Trends of Carbon Pricing (2026); UNFCCC.



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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.
- We also need policies to help with adaptation and support those bearing the greatest damages.
- The food system is a big, often overlooked source of emissions, and it is highly exposed to climate damages.
- Finance prices climate risk and pays for the transition: insurance and interest rates matter.



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The Future of Money

Geof Woglom
Associate Director, NEED



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Let's Hear from You!

Questions?

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