



# Climate Change Economics

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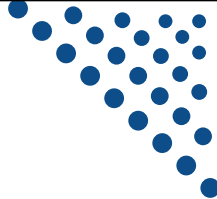
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## How Can Economists Contribute to Thinking about Climate Change?

- By assessing behavioral reactions to climate change.
- By measuring the damage and estimating the economic costs of fighting climate change.
- By designing smart policies that minimize costs.
  - Balance economic growth with GHG emission mitigation.

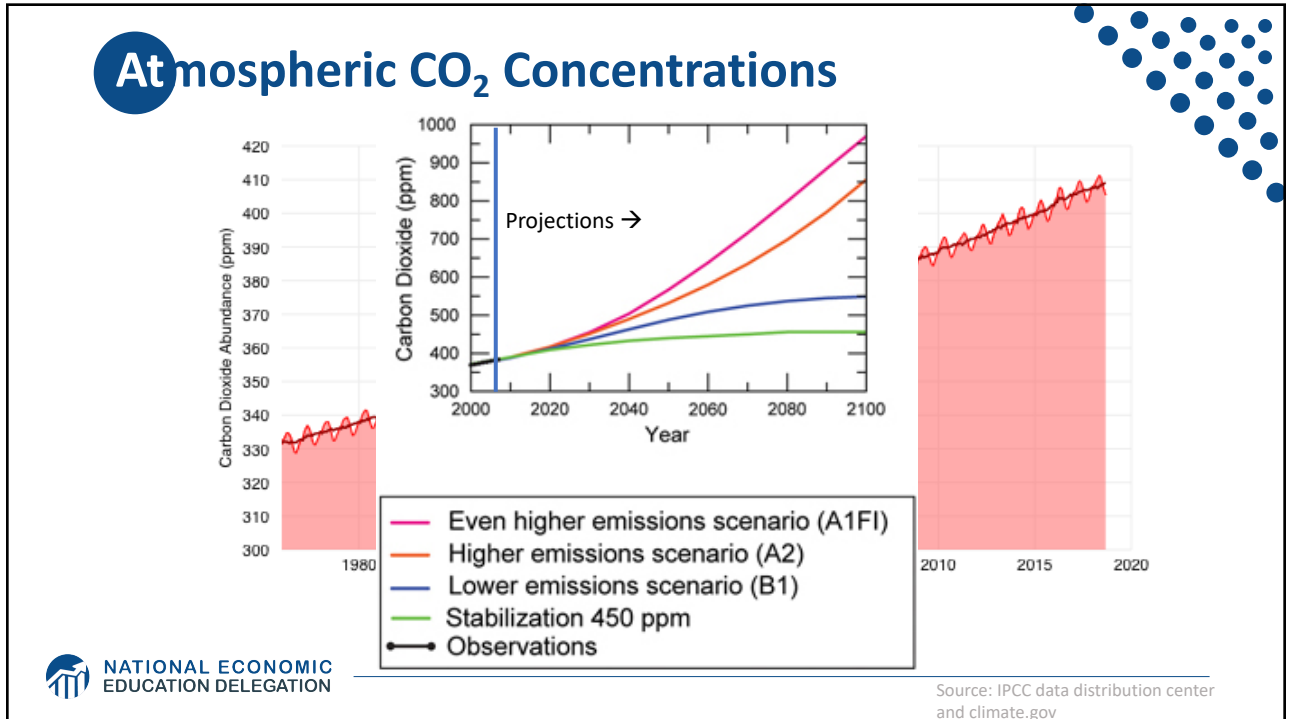


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## Climate Change Science



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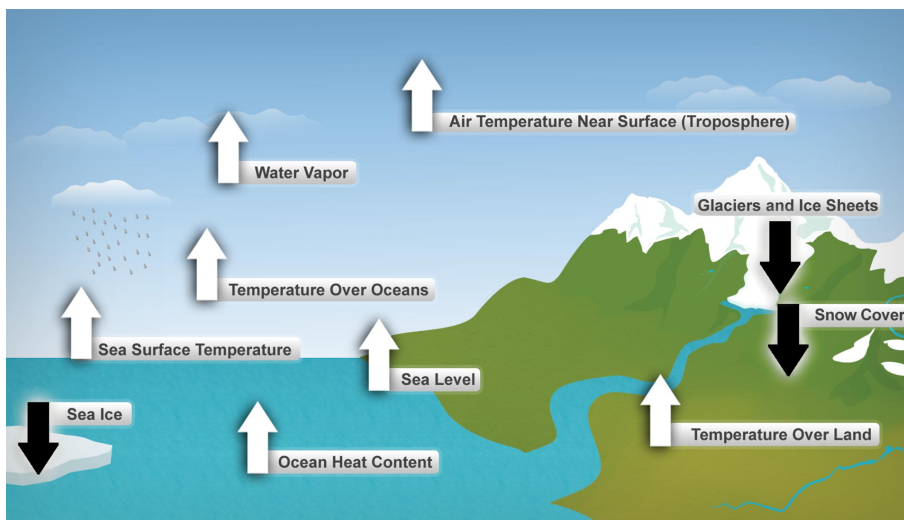
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# Impacts of Climate Change

## Global Warming Indicators



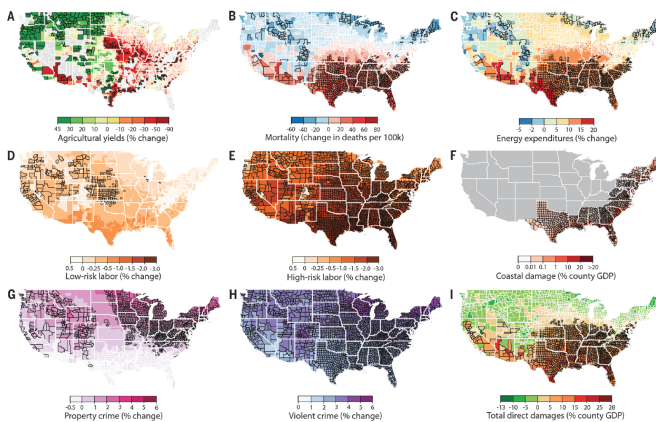
## How These Impacts Affect Humans

- 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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## Projected Effects Vary Across the U.S. but Are Estimated at 1.2% of GDP per 1C Increase



**Fig. 2. Spatial distributions of projected damages.** County-level median values for average 2080 to 2099 RCP8.5 impacts. Impacts are changes relative to counterfactual “no additional climate change” trajectories. Color indicates magnitude of impact in median projection; outline color indicates level of agreement across projections (thin white outline, inner 66% of projections disagree in sign; no outline, ≥83% of projections agree in sign; black outline, ≥95% agree in sign; thick white outline, state borders; maps without outlines shown in fig. S2). Negative damages indicate economic gains. (A) Percent change in yields, area-weighted average for maize, wheat, soybeans, and cotton. (B) Change in all-cause mortality rates, across all age groups. (C) Change in electricity demand. (D) Change in labor supply of full-time-equivalent workers for low-risk jobs where workers are minimally exposed to outdoor temperature. (E) Same as (D), except for high-risk jobs where workers are heavily exposed to outdoor temperatures. (F) Change in damages from coastal storms. (G) Change in property-crime rates. (H) Change in violent-crime rates. (I) Median total direct economic damage across all sectors [(A) to (H)].



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## Poll

How important is cooperation with other countries in when dealing with climate change?

- Very important
- Somewhat important
- Not important



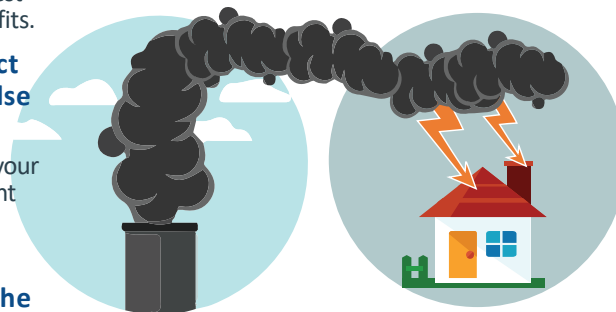
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## Pollution is an externality

- **Human activity creates pollution.**
  - The goal is not zero pollution but society's best balance between pollution and human benefits.
- **Pollution is an EXTERNALITY: a side effect (cost or benefit) that affects someone else when something is bought or sold**
  - The power company sells you electricity for your house, but the pollution from the power plant affects everyone, not just you.
  - This is a *market failure*.
- **All of the effects are not always felt by the buyers and sellers.**
  - The price of electricity does not reflect all of the costs, leading to too much pollution
  - Electricity is too cheap. The balance is wrong.



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## Social Cost of Carbon

- Cost above price paid.
- The expected cost of damages from each unit of greenhouse gas emissions.
- Current EPA estimate: ~\$40 per metric ton of CO<sub>2</sub>.
  - About \$123/car per year.
  - \$26 Billion for all vehicles in the US.
- Social cost of carbon will increase over time.



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## Economics of Responding to Climate Change

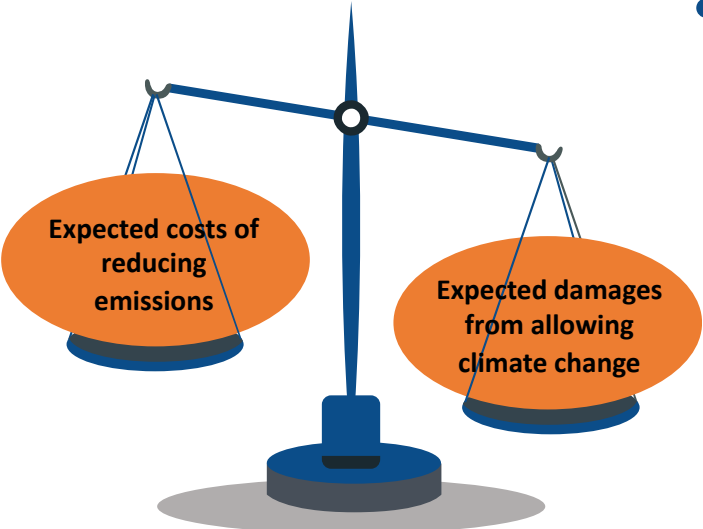


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## How Economists Decide How Much to Fight Climate Change

- Cost Benefit Analysis
- Weigh:



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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.
  - Costs amount 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.**
- Caveats:
  - Putting a monetary value on priceless things
  - Inequality
  - Uncertainty and risk

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## **Economic Growth and Climate Change Action Are Compatible**

- Abating greenhouse gas emissions is costly...  
... but climate change damages are even more costly.
- Economic growth comes with consequences that we have to deal with, including climate consequences.
- Economies with environmental regulations can still be dynamic.
- Goal: design policies that reach climate goals at the least possible cost.

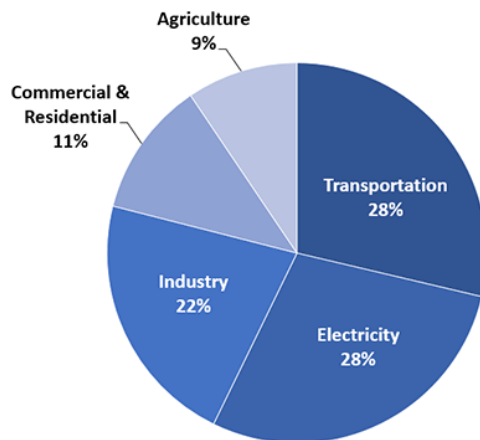
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# Addressing the Sources of Our Emissions



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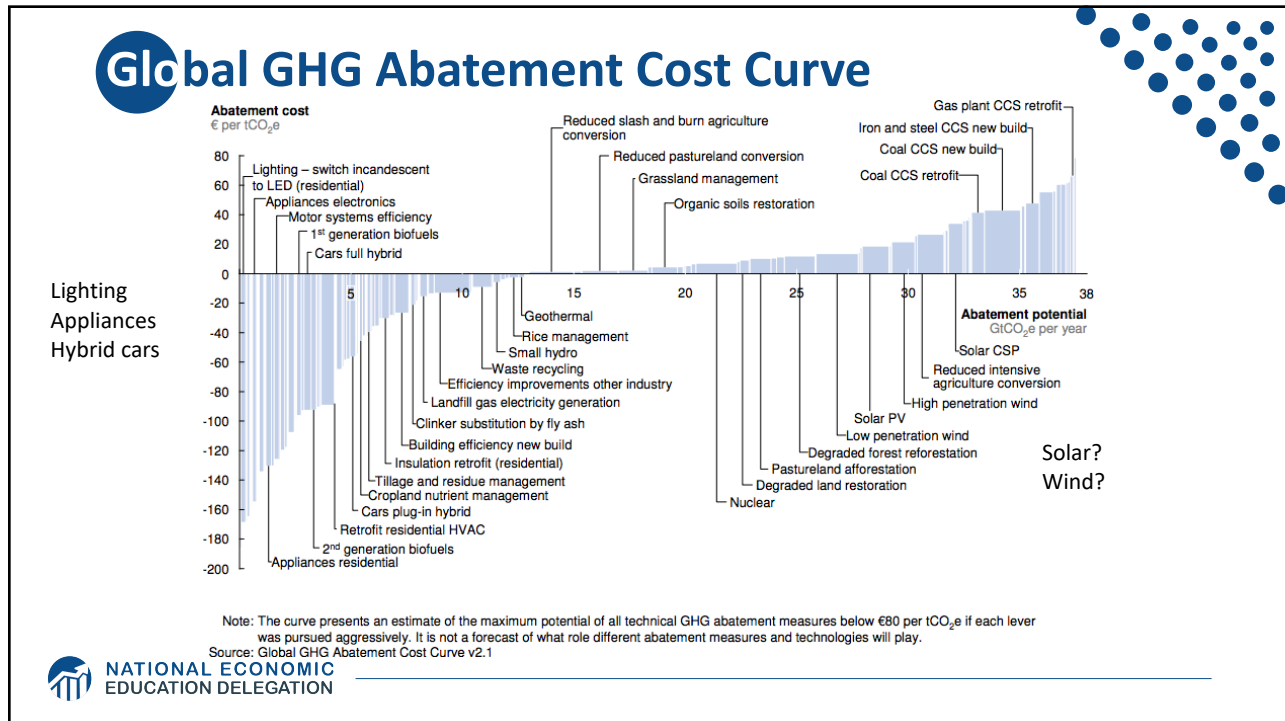
## Total U.S. Greenhouse Gas Emissions by Economic Sector in 2016



U.S. Environmental Protection Agency (2018). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016



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# Climate Change Policy

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## Poll

Policies aimed at reducing the effects of global climate change generally \_  
to the environment.

- Do more good than harm
- Do more harm than good
- Make no difference

Policies aimed at reducing the effects of global climate change generally \_  
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## Policies That Reduce Emissions: Directly

### • Regulation

- Emissions standards or limits
  - E.g., CAFE standards

### • Market-oriented policies

- Putting a price on emissions
  - Subsidizing green energy (e.g., feed-in tariffs)
  - Tax or cap & trade



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## How Does Cap and Trade Work?

- **Activities to be covered are determined.**
- **Acceptable emissions levels are indicated.**
- **“Permits” that allow acceptable emissions levels are issued.**
  - How?
    - According to historical emissions?
    - Evenly across emitters?
    - Sold at some price?
- **A “market” is developed.**
- **Those desiring to emit will have to buy sufficient permits to accommodate their emissions.**
- **Those wishing to abate will offer their permits on the “market”.**
  - The price of a permit indicates:
    - The benefit of eliminating further emissions.
    - The cost of emitting.
- **Gov’t agency determines equality of permits in possession and emissions.**



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## How Does a Carbon Tax Work?

- **Activities to be covered are determined.**
- **The price of emissions is determined.**
  - Presumably some relation to the social cost of polluting.
- **Emissions are measured.**
- **Taxes are determined.**
- **Q: What to do with the tax revenue?**



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## Carbon Prices: the Good and Bad

### • Good:

- Provide price signal to lower emissions.
- They yield low-cost reductions in emissions.
- They spur innovation in clean technologies.

### • Bad:

- Firms might leave to flee regulation.
- It is necessary to monitor emissions.
- Potentially regressive
  - o Costs may weigh more heavily on low-income households.

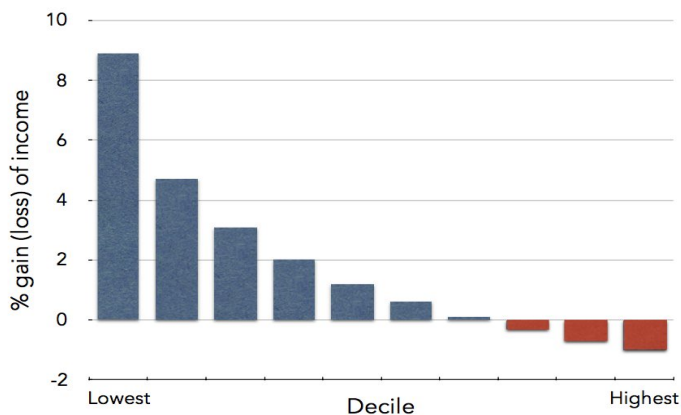


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## Revenue Dividend Eliminates Regressivity

### IMPACT OF CARBON DIVIDENDS ON U.S. FAMILY INCOMES



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Source: U.S. Treasury, 2017

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## Carbon Tax and Cap & Trade: the Differences

	Carbon Tax	Cap & Trade

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## Carbon Tax and Cap & Trade: the Differences

	Carbon Tax	Cap & Trade
Carbon Price	Certain	Uncertain
Emissions	Uncertain	Certain
Ease of Implementation	May be easier to implement	
Additional concerns	1) Always generates revenue 2) May require legislation to change 3) Predictability	1) Susceptible to lobbying. 2) Only generates revenue if government sells permits. 3) Cap can be changed by regulator. 4) Less certainty over future. 5) Regulations reduce efficacy of Cap & Trade

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## One Other Thing: Cap and Trade vs. Carbon Tax

- **Emissions regulations and Cap and Trade can work at cross purposes.**
  - Regulations that lower emissions from big polluters...
    - Lower the demand for permits
    - Lowers the price of permits
    - Reduces incentives for other industries to cut emissions
- **Regulations can undermine the effectiveness of Cap and Trade.**
- **The same is not true of a carbon tax.**
  - Though regulations might cut tax revenue, revenue is not the goal of the carbon tax.



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## Thoughts on Regulation vs Market-Oriented

- **Equity.**
  - Both types of policies are regressive.
    - Cap and Trade and a Carbon Tax can offset the regressivity.
    - Regulations do not.
- **Efficiency.**
  - Market-oriented policies tend to achieve emissions reduction at much lower cost.
    - Example: CAFÉ Standards vs Carbon Tax
      - Tax is significantly more efficient.
      - Why?



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## Efficiency: CAFÉ vs Carbon Tax

- **CAFÉ = Corporate Average Fuel Efficiency**

- A fuel economy standard mandating that an auto-maker's vehicle fleet must meet minimum fuel economy standards.

- **Horse Race**

- Tax on fuel applies to ALL vehicles, not just new.
- Rebound Effect:
  - o Driving a more efficient vehicle lowers the cost per mile driven
    - leading to more miles driven.
- Slower turnover of inefficient vehicles: higher cost of new.

- **Summary**

- A given level of emission reductions **costs 3-14 times more with CAFÉ** standards than under a comparable carbon tax.



## Policies That Reduce Emissions: INDIRECTLY

- **Subsidizing R&D**
- **Grid / infrastructure**
- **Energy efficiency mandates and subsidies**
- **Mandating renewable energy (e.g., renewable portfolio standards)**
- **Land use policies**



## Challenges with Renewable Energy

- **It's intermittent - only produced if there is sun or wind.**
- **Energy is needed all day and night, with peak times.**
- **Limited w/o storage.**
  - Creative storage options are under development.



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## Infrastructure and Climate Change

- **\$90 trillion in investment will be needed for U.S. infrastructure, 2015-2030.**
- **Add \$4 trillion (< 5%) to make it low-carbon infrastructure.**
  - This would also reduce climate damage to infrastructure.
  - Railway, urban transport, renewables.
- **The electrical grid is particularly troublesome.**
  - It is outdated and not suited for renewable energy storage.
  - Those with solar panels use the grid but contribute little to its upkeep.



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## Biden's Climate Plan

- **Regulation and infrastructure investment aimed at meeting specific climate targets and creating jobs**
- “He also pressed the need to link environmental advocacy to racial justice, describing pollution and other toxic harms that disproportionately affect communities of color. His plan calls for establishing an office of environmental and climate justice at the Justice Department and developing a broad set of tools to address how “environmental policy decisions of the past have failed communities of color.” “
  - “Mr. Biden set a goal for disadvantaged communities to receive 40 percent of all clean energy and infrastructure benefits he was proposing. He also made explicit references to tribal communities and called for expanding broadband access to tribal lands.”
- **Plan will be paid for using corporate income taxes.**

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**“ Economic policies will be central to accomplishing the goals we choose.”**

- Harris and Roach (2007)

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## Summary

- Climate change is real, is caused by human actions, and has impacts we're already feeling.
- We need to reduce emissions to balance the costs of action against the costs of inaction.
- Scientists and the IPCC recommend that we work to keep warming below 1.5 degrees celcius.

- *Economists believe that this goal is well worth the costs!*



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## Summary – *continued*

- There are many ways to reduce emissions.
- Economics-inspired policies can help us do this at the lowest cost.
- Taxes and cap and trade are proven effective tools to fight climate change!
- Other tools may also be necessary.



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**Thank you!**

## Any Questions?

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