

Climate Change Economics

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San Rafael Public Library

March 28, 2019



National Economic Education Delegation

- **Vision**

- One day, the public discussion of policy issues will be grounded in an accurate perception of the underlying economic principles and data.

- **Mission**

- NEED unites the skills and knowledge of a vast network of professional economists to promote understanding of the economics of policy issues in the United States.

- **NEED Presentations**

- Are **nonpartisan** and intended to reflect the consensus of the economics profession.

Who Are We?

- **Honorary Board: 44 members**

- 2 Fed Chairs: Janet Yellen, Ben Bernanke
- 6 Chairs Council of Economic Advisers
 - o Furman (D), Rosen (R), Bernanke (R), Yellen (D), Tyson (D), Goolsbee (D)
- 3 Nobel Prize Winners
 - o Akerlof, Smith, Maskin

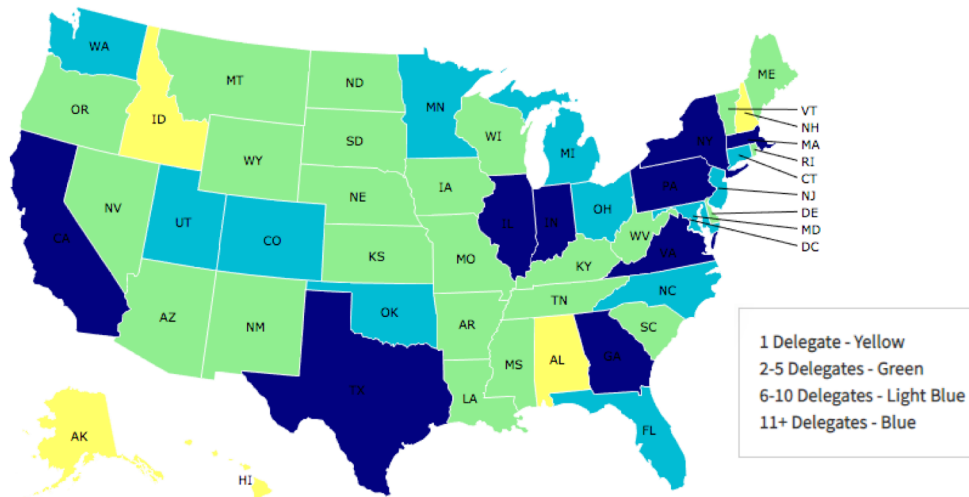
- **Delegates: 361 members**

- At all levels of academia and some in government service
- All have a Ph.D. in economics
- Crowdsource slide decks
- Give presentations

- **Global Partners: 42 Ph.D. Economists**

- Aid in slide deck development

Where Are We?



Credits and Disclaimer

- **This slide deck was authored by:**
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- **This slide deck was reviewed by:**
 - Jason Shogren, University of Wyoming
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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).



Outline

- **Climate change science**
- **Impacts of climate change**
- **Economics of responding to climate change**
- **Addressing the sources of our emissions**
- **Climate change policy**
- **Policy in action**



How Can Economists Contribute to Thinking about Climate Change?

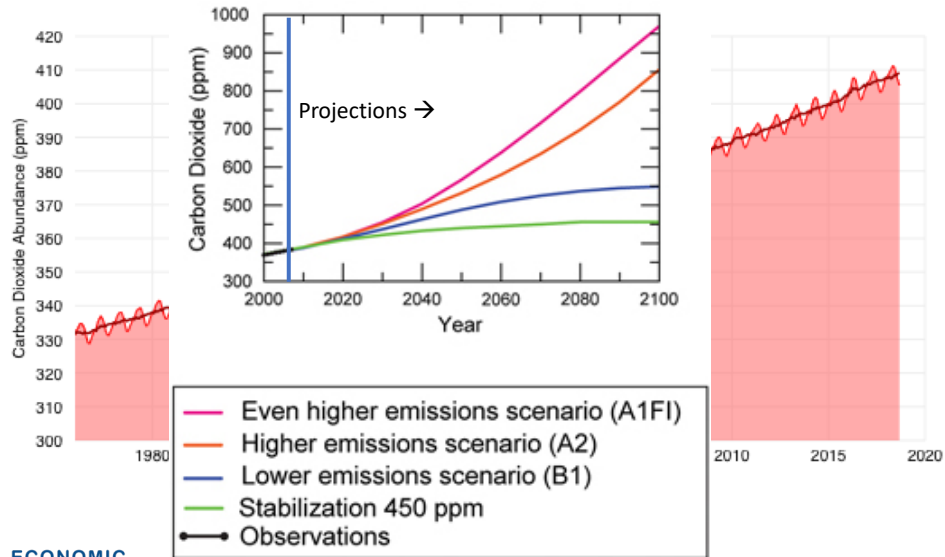
- By assessing behavioral reactions to climate change.
- By measuring the damage and estimate the economic costs of fighting climate change.
- By designing smart policies that minimize costs.
 - Balance economic growth with GHG emission mitigation.



Climate Change Science



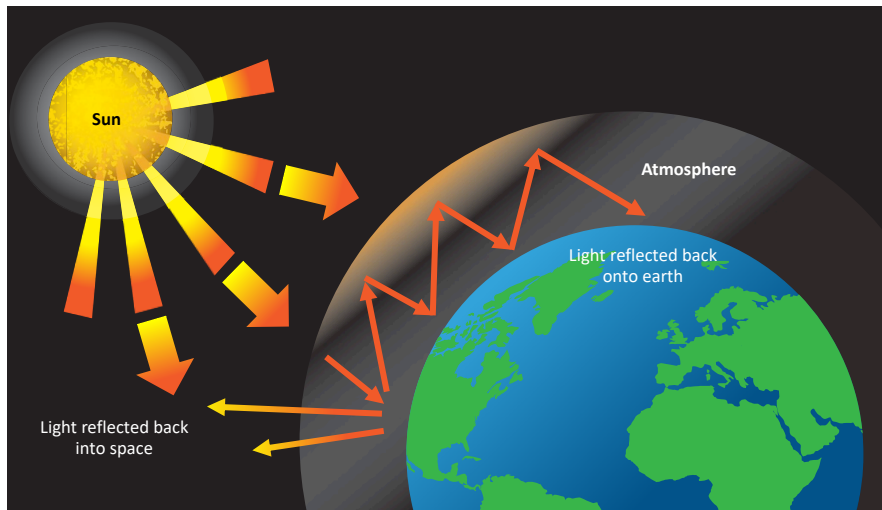
Atmospheric CO₂ Concentrations



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Source: IPCC data distribution center and climate.gov

The Atmospheric Greenhouse Effect



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Uncertainty



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How Much Pollution Does Society Want?

Analogy: How Many Oranges Does Society Want?

- People grow and sell oranges for a price that at least covers costs (**supply**).
- People will not pay more for them than what they consider to be their value (**demand**).
- Prices let **supply** and **demand** balance out. The price settles where:

of oranges people want to sell = # of oranges people want to buy

- This is the “right” number of oranges for society.
- Prices reflect scarcity and the social value of the resource.



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Pollution Is Different From Oranges

- **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—there is too much pollution.
 - Electricity is too cheap. The balance is wrong.



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Social Cost of Carbon

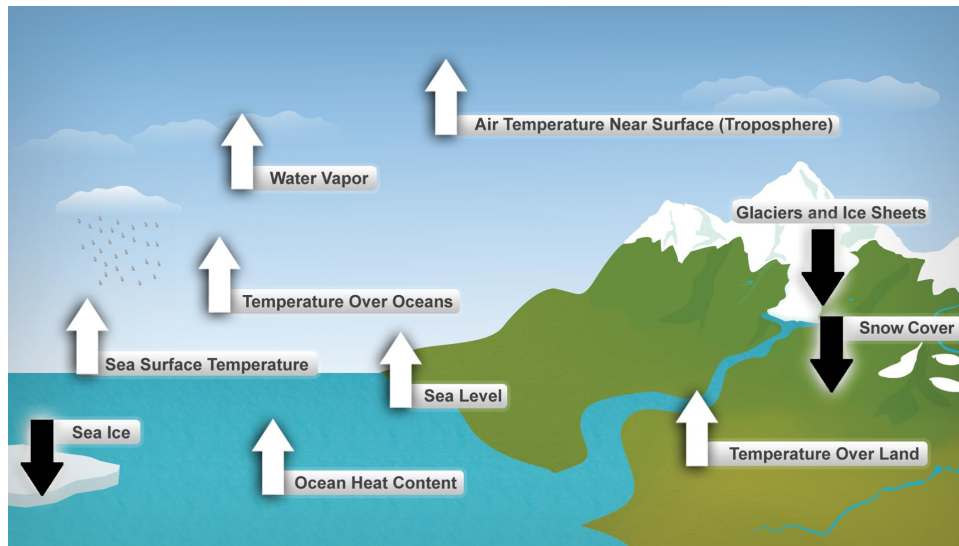
- **Cost above price paid.**
- **The expected cost of damages from each unit of greenhouse gas emissions.**
- **Current EPA estimate: ~\$40 per metric ton of CO₂.**
 - About \$123/car per year.
 - \$26 Billion for all vehicles in the US.
- **Social cost of carbon will increase over time.**



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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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Adaptation Reduces Damages

- *Adaptations*
 - costly actions that can reduce damages from climate change.
- **Net cost to society = cost of adaptation + cost of the remaining damages**
- **People will take some actions on their own:**
 - Up to the point where they find it worthwhile.
 - No guarantee that it will be sufficient.
- **Some responses require government involvement:**
 - large-scale actions or actions with shared benefits.



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Individual-Level Adaptation Examples

- **Do you behave differently on a hot day?**

- Staying inside more.
- Turn on the air conditioning.
- Plant at different times.
- Plant new crops.
- Think about moving.



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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**

- **Supporting low-income and vulnerable populations**

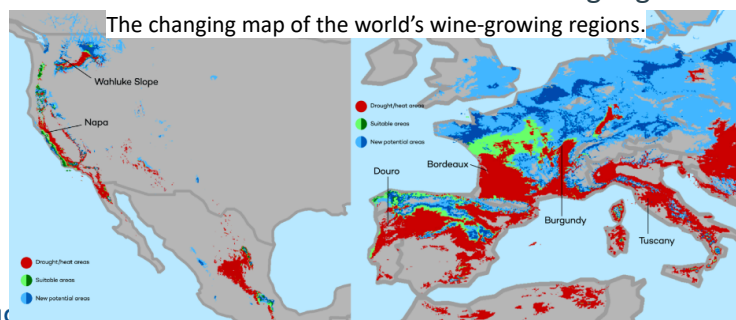
- **Moving residents of a town**



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Market Based Adaptation

- **Prices and costs influence behavior.**
 - Where to live.
 - Where/when/what to plant.
- **Avoid barriers to market adjustment.**
 - Trade barriers, immigration restrictions, federal flood insurance, agricultural subsidies, and zoning regulations.



International Climate Policy Goals

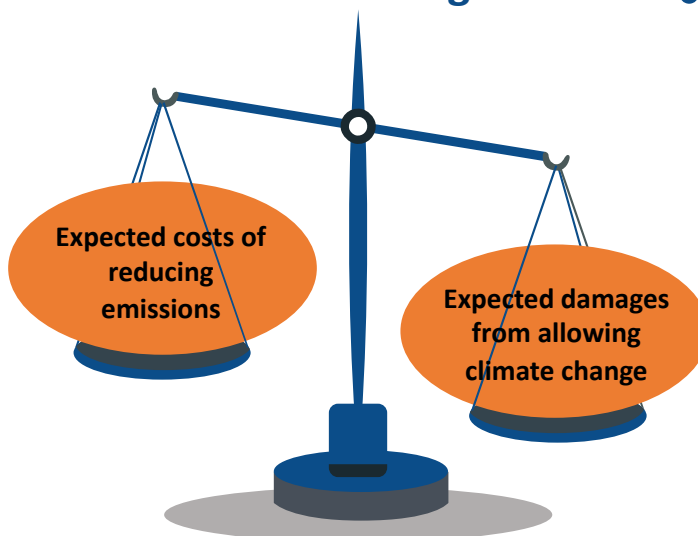
- **Intergovernmental Panel on Climate Change (IPCC)**
 - Global effort to fight climate change
 - Reports on consensus of climate science, including economics
- **IPCC report in 2007:**
 - Recommended goal: < 2 degrees C (3.6 degrees F)
 - Industrialized countries should reduce GHG emissions between 25% and 40% below 1990 levels by 2020.
- **2016 Paris Agreement:**
 - Basic goal of 2 degrees C: requires 40-70% GHG reduction 2010 → 2050
 - Reach goal of 1.5 degrees C: requires 70-95% GHG reduction 2010 → 2050
- **IPCC report in 2018:**
 - Temperature has already increased by 1.0 degrees C - Recommended: < 1.5 C

Economics of Responding to Climate Change



How Economists Decide How Much to Fight Climate Change

- Cost Benefit Analysis
- Weigh:



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.
 - Stern Report estimate: damages could be as high as **20% of worldwide GDP**.
- **Caveats:**
 - Putting a monetary value on priceless things
 - Inequality
 - Uncertainty and risk



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This is What Precisely Wrong Looks Like



This is What Precisely Wrong Looks Like



Facebook's office may be fully underwater by 2100, based on worst-case scenario sea level rise projections. Shayanne Gal/ Business Insider

This is What Precisely Wrong Looks Like



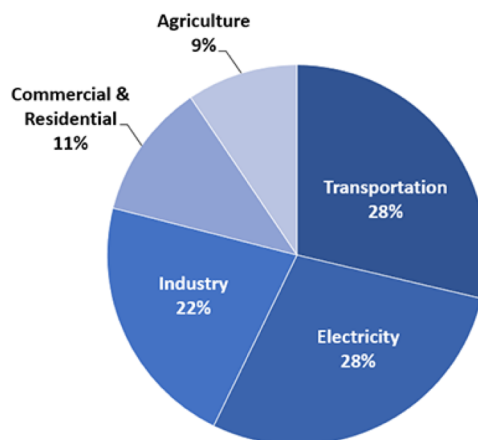
This is What Precisely Wrong Looks Like



Addressing the Sources of Our Emissions

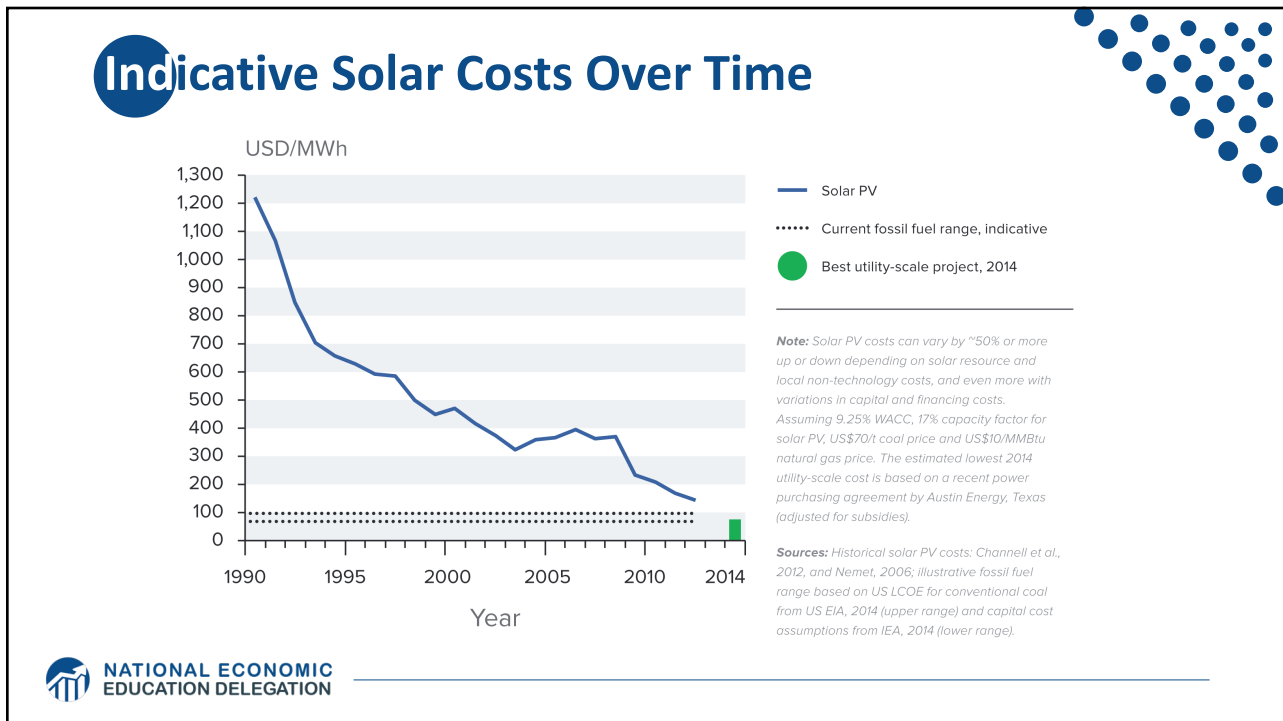
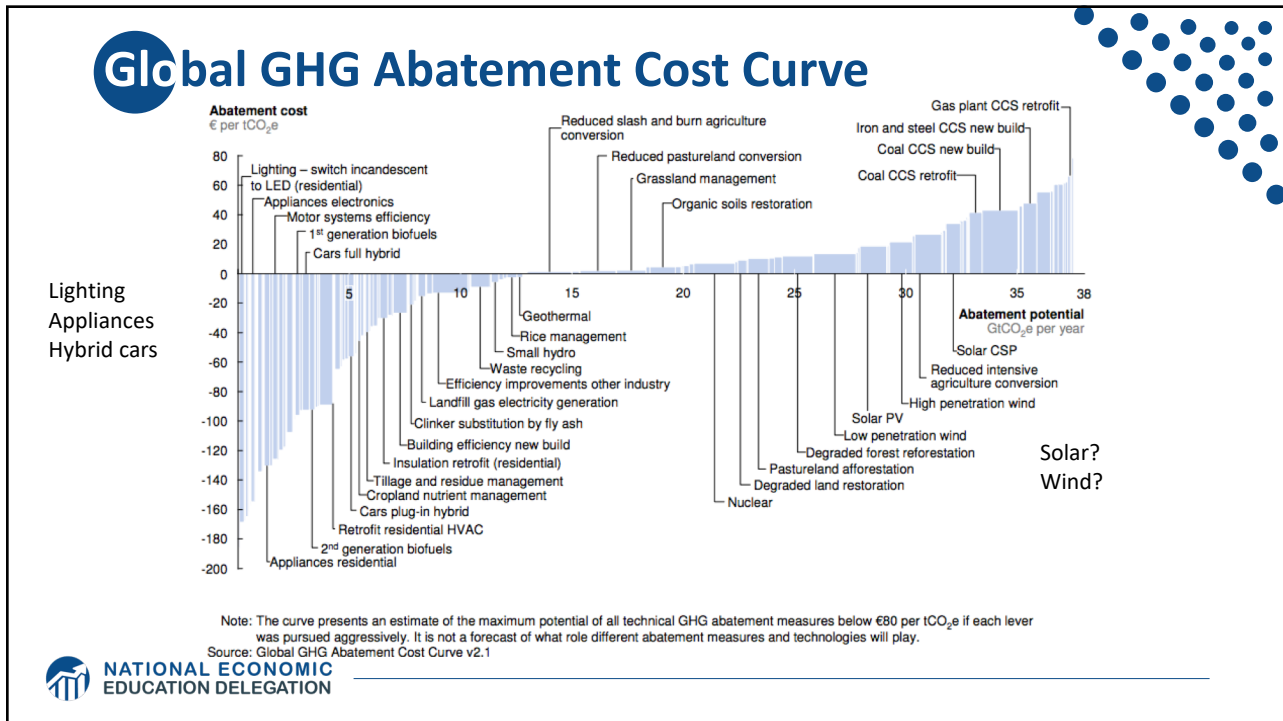


Total U.S. Greenhouse Gas Emissions by Economic Sector in 2016

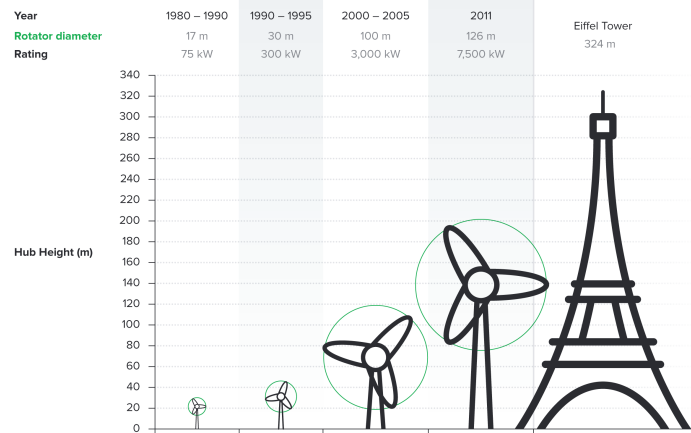


U.S. Environmental Protection Agency (2018). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016





Wind Turbines Have 100 Times More Power Generation Capabilities Than 30 Years Ago



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





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.



Atlanta and Barcelona Have Similar Populations but Very Different Carbon Productivity

Atlanta			Barcelona		
Built-up area			Built-up area		
					
Population	Urban area	Transport carbon emissions	Population	Urban area	Transport carbon emissions
2.5 million	4,280 km ²	7.5 tonnes CO ₂ /person (public + private transport)	2.8 million	162 km ²	0.7 tonnes CO ₂ /person (public + private transport)



Source: New Climate Economy Report, 2014

Land Use: Restoration Is Possible



1953

Climate Change Policy

Policies That Reduce Emissions: Directly

- **Regulation**

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

- **Market oriented policies**

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



How Does Cap and Trade Work?

- **Activities to be covered are determined.**
- **Acceptable emissions levels are indicated.**
- **“Permits” that allow acceptable emissions levels are distributed.**
 - How?
 - o According to historical emissions?
 - o Evenly across emitters?
 - o 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:
 - o The cost of emitting.
 - o The cost of eliminating further emissions.
- **Agency determines equality of permits in possession and emissions.**

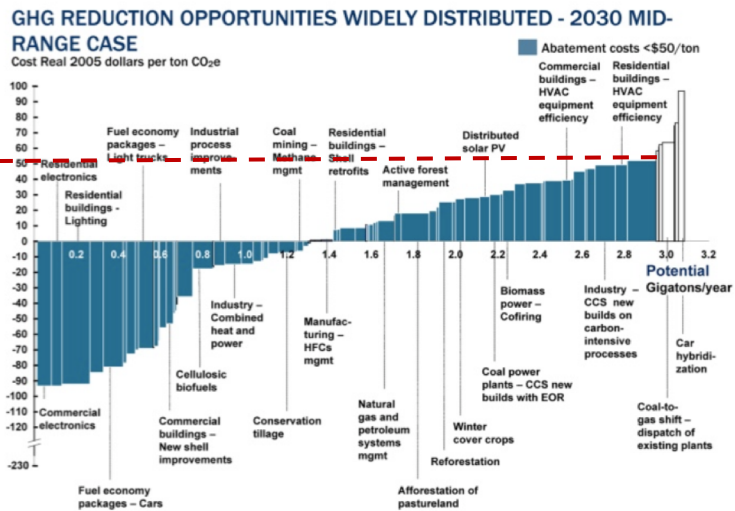


How Does a Carbon Tax Work?

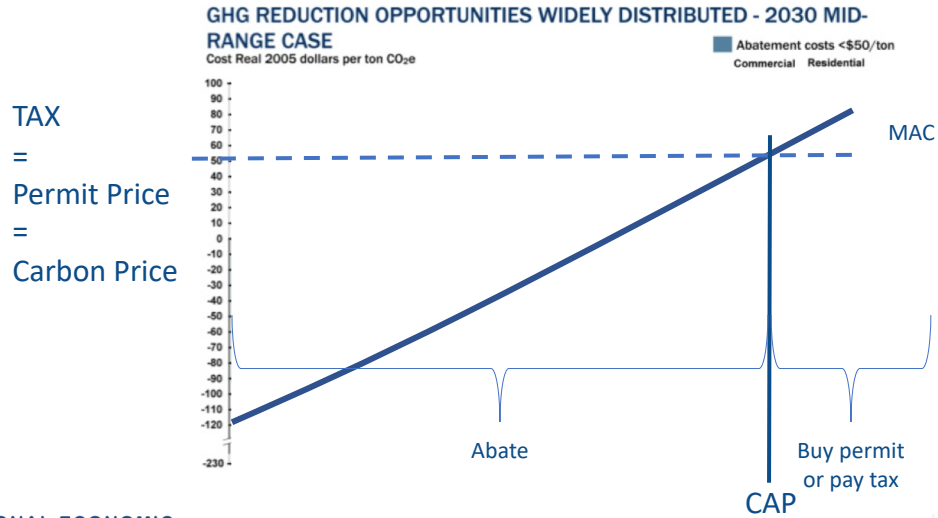
- Activities to be covered are determined.
- The price of emissions (tax) is determined.
 - Presumably some relation to the social cost of polluting.
- Emissions are measured.
- Taxes are determined and paid.
- Q: What happens to the revenue?

Putting a Price on Carbon

Suppose a Social Cost Of Carbon of \$50



Putting a Price on Carbon



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Carbon Prices: the Good and Bad

- **Good:**
 - Provide price signal to lower emissions.
 - They yield low-cost reductions in emissions.
- **Bad:**
 - Regressive
 - Costs weigh more heavily on low-income people.
 - Firms might leave to flee regulation.
 - It is necessary to monitor emissions.



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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	Always generates revenue May require legislation to change	May be more susceptible to lobbying Only generates revenue if government sells permits Cap can be changed by regulator

Policies That Reduce Emissions: INDirectly

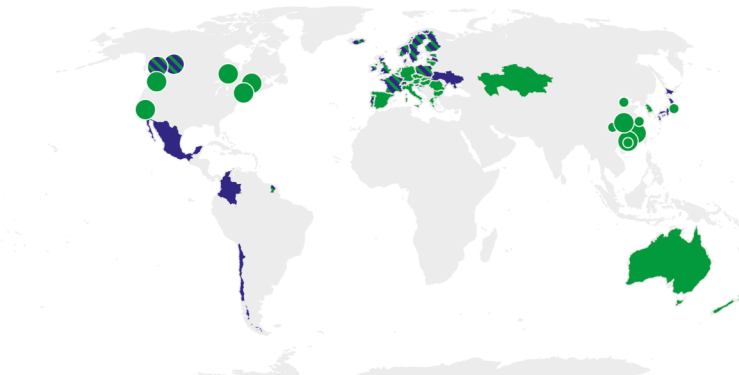
- **Subsidizing R&D**
- **Grid / infrastructure**
- **Land use policies**
- **Energy efficiency mandates and subsidies**
- **Mandating renewable energy (*e.g.*, renewable portfolio standards)**

Climate Change Policy in Action

Carbon Policies Across the World

Data last updated December, 01 2017

Summary map of regional, national and subnational carbon pricing initiatives



- STATUS**
 - Implemented
 - Scheduled
 - Under consideration
- TYPE OF INSTRUMENT**
 - Carbon tax
 - ETS
 - Undecided
- TYPE OF JURISDICTION**
 - National
 - Regional
 - Subnational

ETS = Emissions Trading System = Cap and Trade

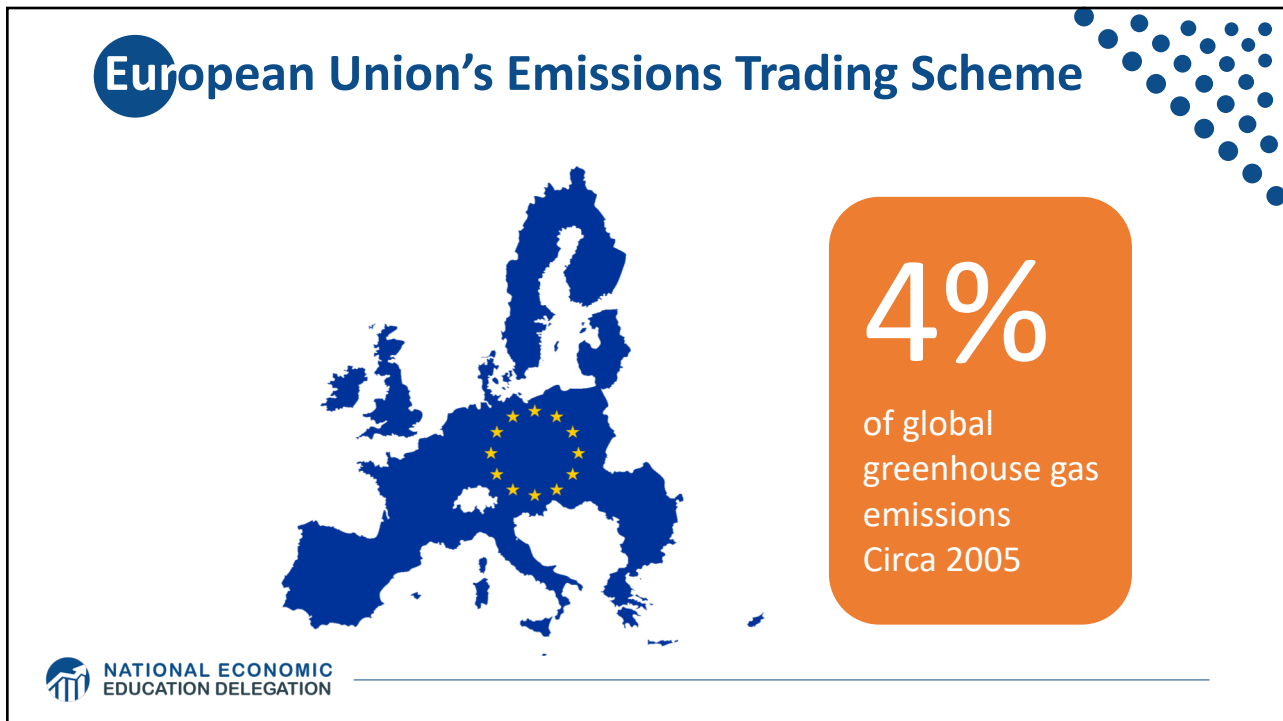
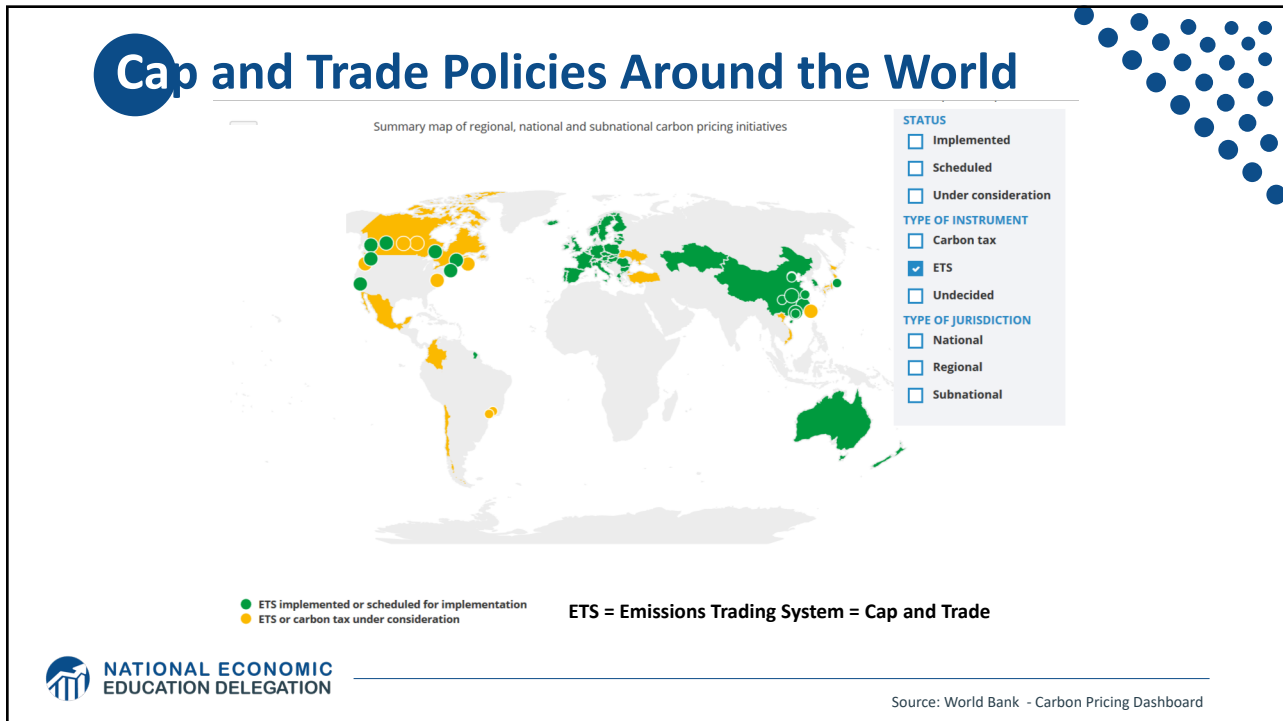
- ETS implemented or scheduled for implementation
- Carbon tax implemented or scheduled for implementation
- ETS and carbon tax implemented or scheduled



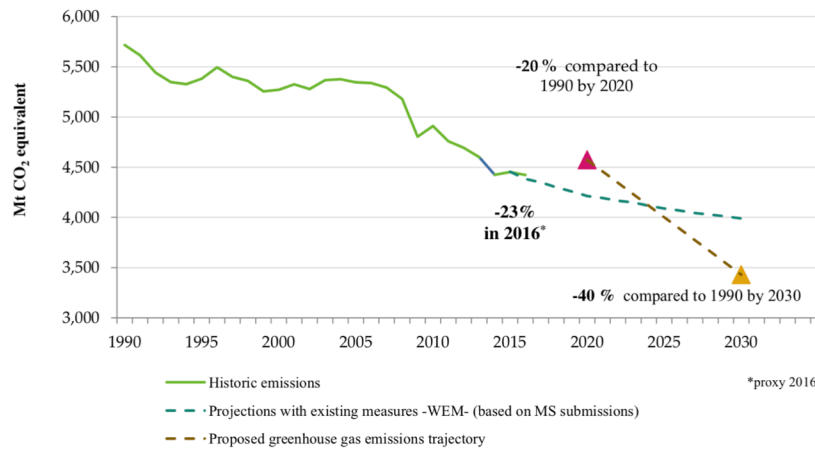
Source: World Bank Carbon - Pricing Dashboard

Cap and Trade



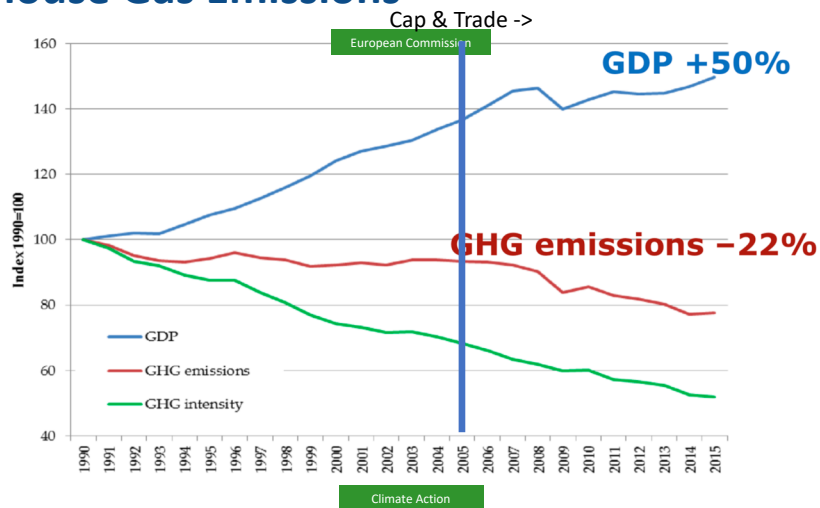


Progress Towards Meeting Europe 2020 And 2030 Targets (EU Total GHG Emissions)



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EU Has Decoupled Economic Growth from Greenhouse Gas Emissions



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California's Cap and Trade System: 2012+



0.7%

of global
greenhouse gas
emissions

California's System Is Flexible



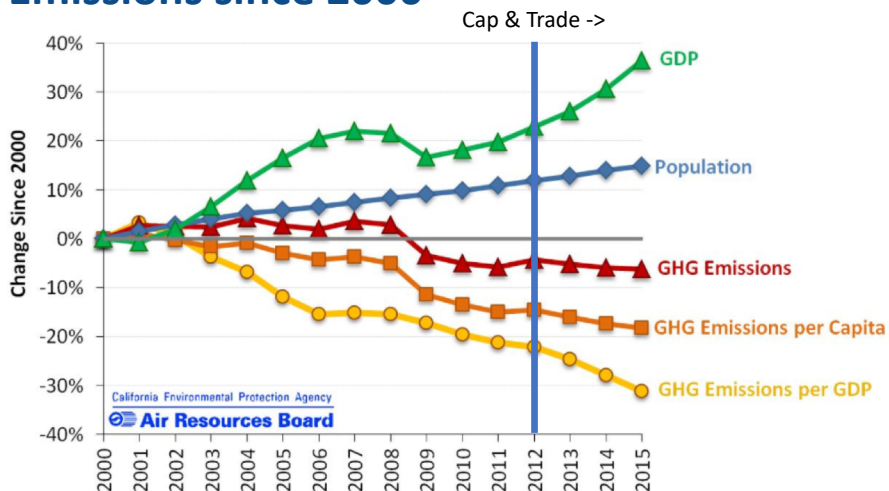
- **California's goals:**

- 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

Change in California GDP, Population, and GHG Emissions since 2000



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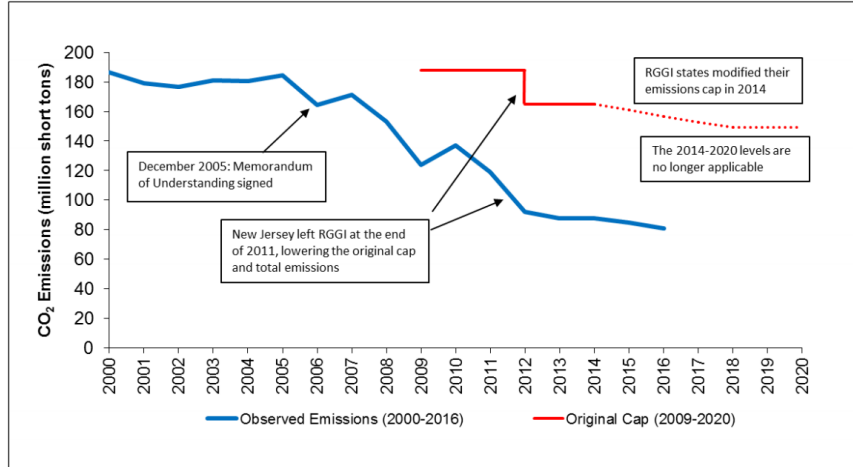
RGGI: the Regional Greenhouse Gas Initiative

- **Participants: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont**
 - 7% of US emissions
- **Covers power plants**
- **First implemented in 2009**
- **Caused emissions reduction of 24% below what they would have been**

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RGGI's Effect on Emissions

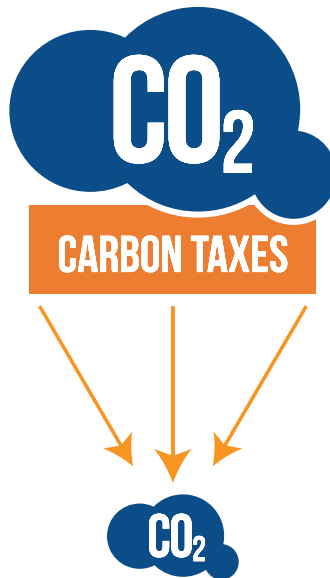
Figure I. Observed Emissions Compared to the Original Emissions Cap



Source: Prepared by CRS; observed state emission data (2000-2016) provided by RGGI at <http://www.rggi.org>.



Carbon Tax



Worldwide Carbon Taxes

26

carbon tax programs

24

national jurisdictions covered

5.3%

of global greenhouse gas emissions



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British Columbia's Carbon Tax Policy: 2008



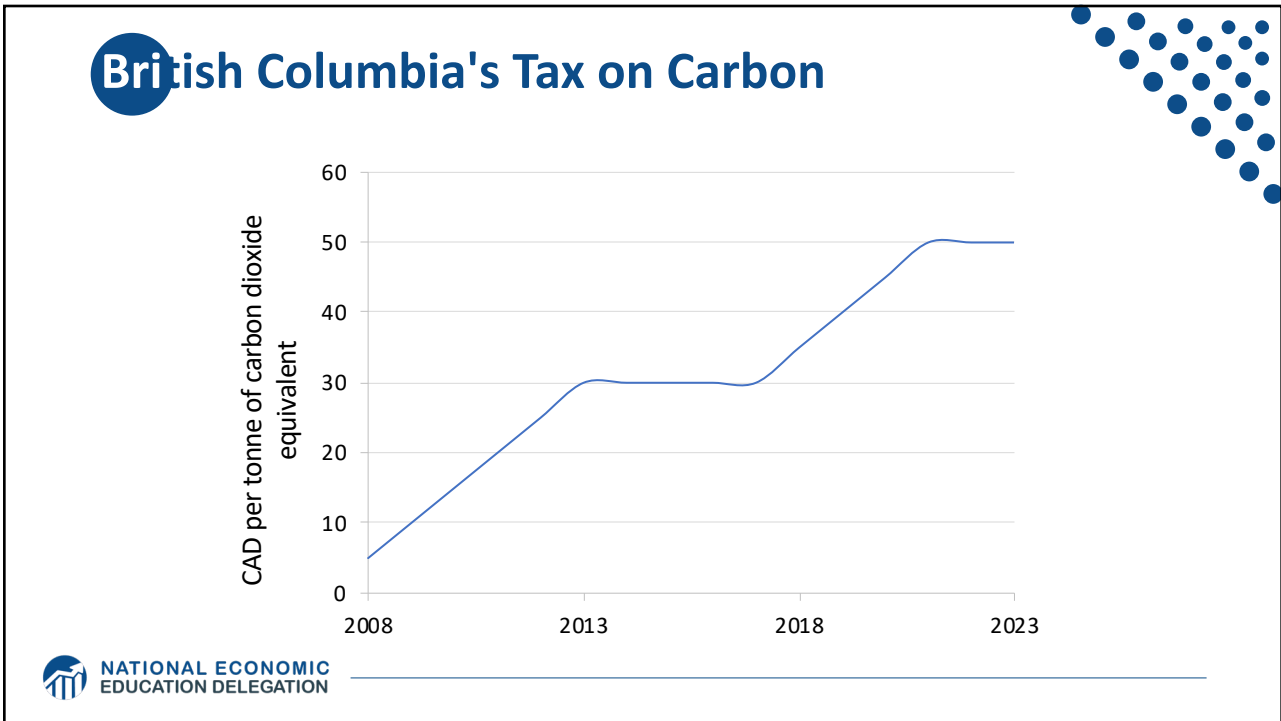
0.1%

of global greenhouse gas emissions

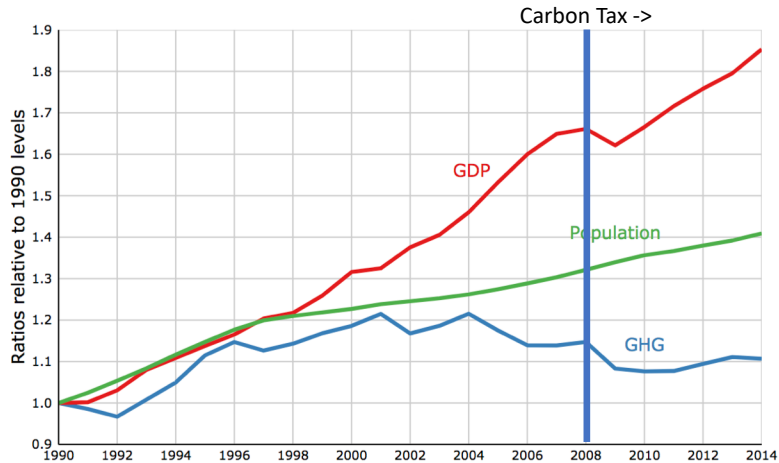


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“ Tax the pollution we do not want, and return the money for what we do want — money in people’s pockets, jobs and investment. ”
- B.C. Government - Carbon Tax Brochure



Relative Greenhouse Gas Emissions, GDP & Population Size: British Columbia




Sweden's Carbon Tax Policy



Oldest Carbon Tax

Sweden's Carbon Tax Policy

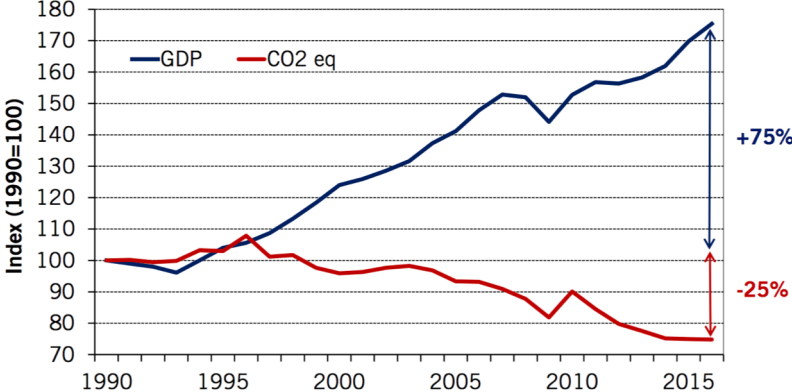


Started in 1991

Currently at \$140/ton

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Real GDP and Domestic CO₂eq Emissions¹ In Sweden, 1990-2016



Year	Real GDP (Index 1990=100)	Domestic CO ₂ eq Emissions (Index 1990=100)
1990	100	100
1995	105	105
2000	125	95
2005	145	90
2010	155	80
2016	175	75

¹ In accordance with Sweden's National Inventory Report, submitted under the UNFCCC and the Kyoto Protocol. CO₂ = approx. 80 % of total CO₂eq emissions. Preliminary data for 2016.

Sources: Swedish Environmental Protection Agency, Statistics Sweden

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U.S. Carbon Tax Plans

- Climate Leadership Council
- Citizens Climate Lobby
- States and municipalities:
Washington state, Oregon,
Washington, DC



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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 2 degrees Celsius (1.5 degrees?).

- *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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