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Climate Change Economics

Jon Haveman, Ph.D.

CSMFO – Peninsula Chapter

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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
    - Furman (D), Rosen (R), Bernanke (R), Yellen (D), Tyson (D), Goolsbee (D)
  - 3 Nobel Prize Winners
    - Akerlof, Smith, Maskin
- **Delegates: 365 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

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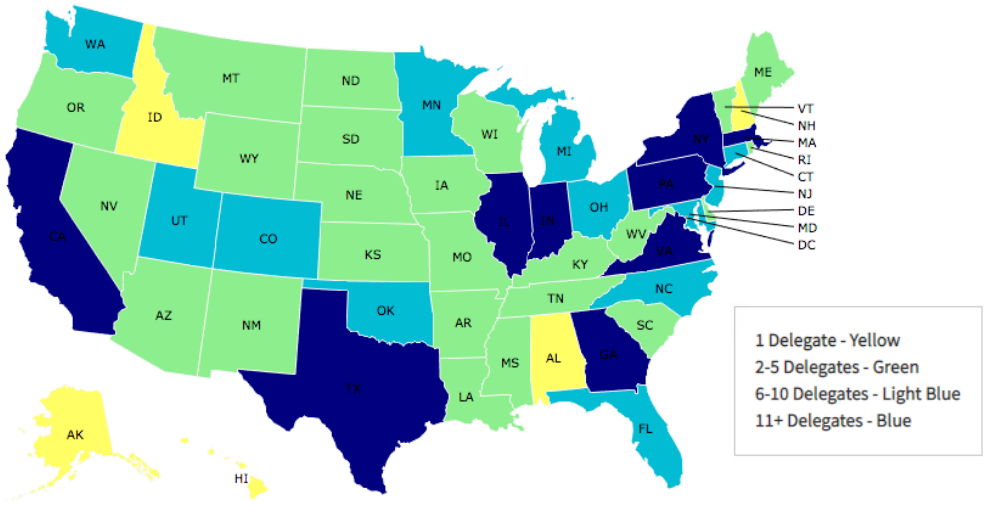
Where Are We?



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Credits and Disclaimer

- **This slide deck was authored by:**
  - Shana Mcdermott, Trinity University
  - Sarah Jacobson, Williams College
  - Sharon Shewmake, Western Washington University
- **This slide deck was reviewed by:**
  - Jason Shogren, University of Wyoming
  - Walter Thurman, North Carolina State University
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  - Such views are those of the presenter and not necessarily those of the National Economic Education Delegation (NEED).

Outline

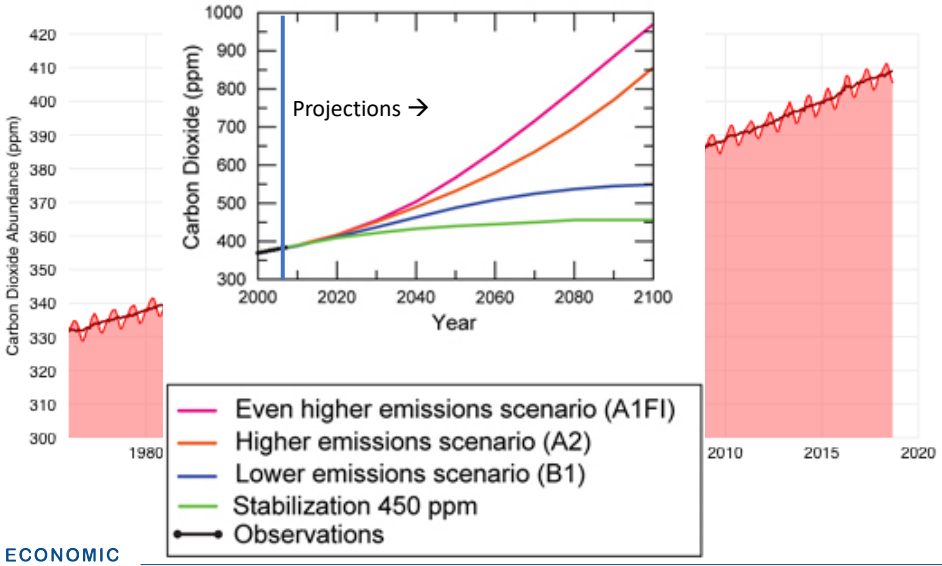
- **Climate change science**
- **Impacts of climate change**
- **Economics of responding to climate change**
- **Addressing the sources of our emissions**
- **Climate change policy**
- **Policy in action**

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 CO_2 Concentrations



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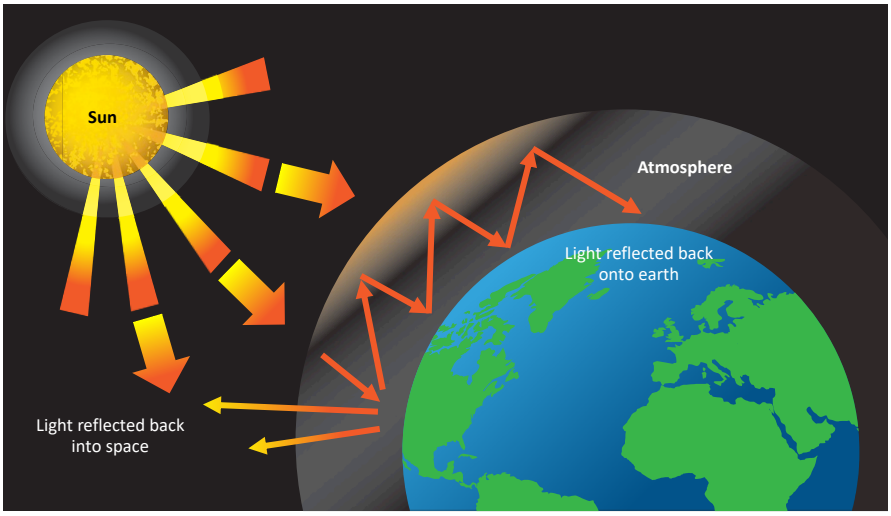
Source: IPCC data distribution center and climate.gov

The Atmospheric Greenhouse Effect



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Uncertainty

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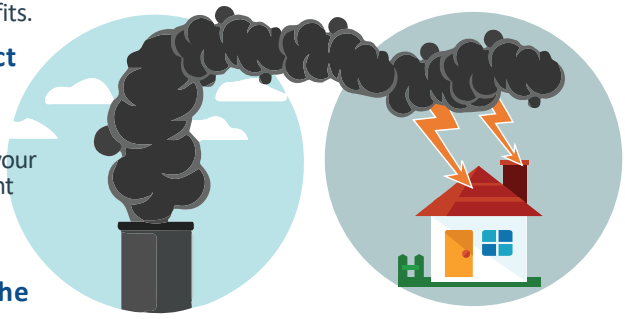
Pollution Is Different From Oranges

- **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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Impacts of Climate Change

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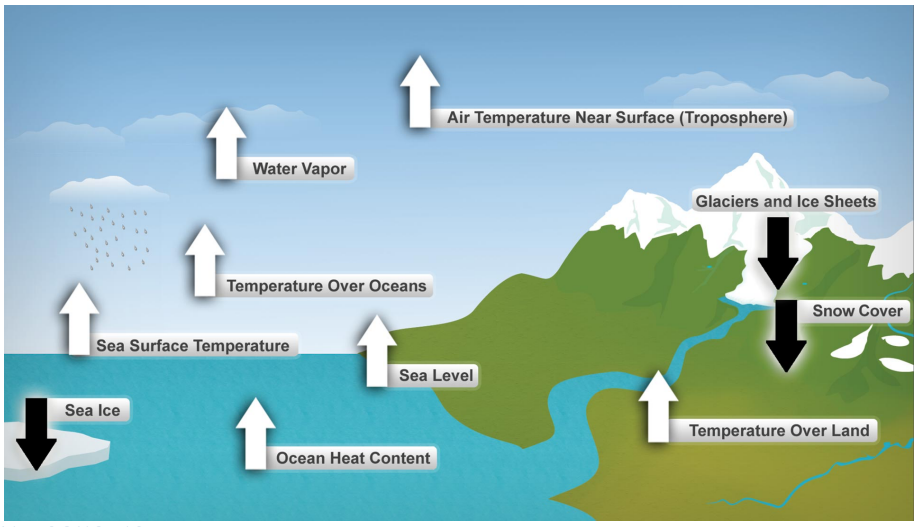
Global Warming Indicators



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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

- Human *adaptations* are costly actions that can reduce damages from climate change.
- The net cost to society is the cost of adaptation plus the cost of the remaining damages.
- People will take some actions on their own, up to the point where they find it worthwhile.
- Some responses require government involvement: large-scale actions or actions with shared benefits.
- Adaptation is already underway.

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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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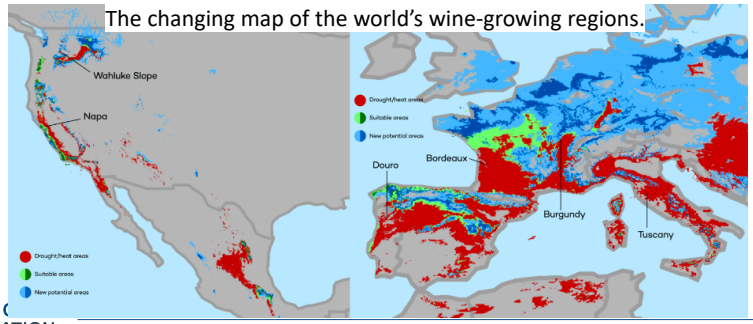
Market Based Adaptation

- **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.

The changing map of the world's wine-growing regions.



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_2.**
  - About $123/car per year.
  - $26 Billion for all vehicles in the US.
- **Social cost of carbon will increase over time.**

Economics of Responding to Climate Change

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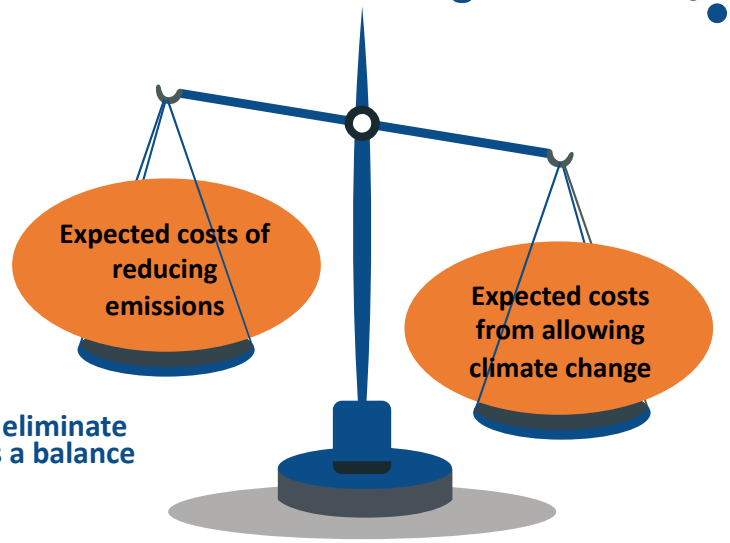
How Economists Decide How Much to Fight Climate Change

- Cost Benefit Analysis
- Weigh:
- This does not necessarily eliminate emissions, but recognizes a balance between economic costs.



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

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This is What Precisely Wrong Looks Like

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.

Addressing the Sources of Our Emissions

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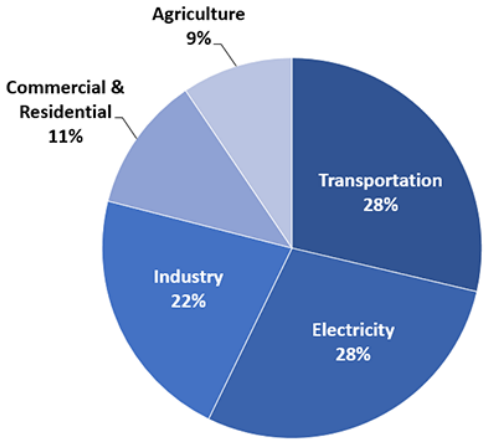
Total U.S. Greenhouse Gas Emissions by Economic Sector in 2016



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

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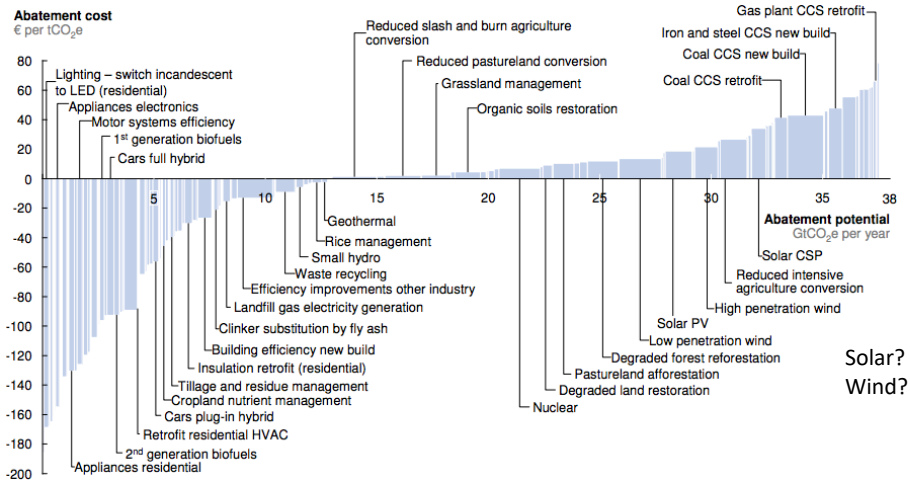
Global GHG Abatement Cost Curve

Lighting
Appliances
Hybrid cars



Solar?
Wind?

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

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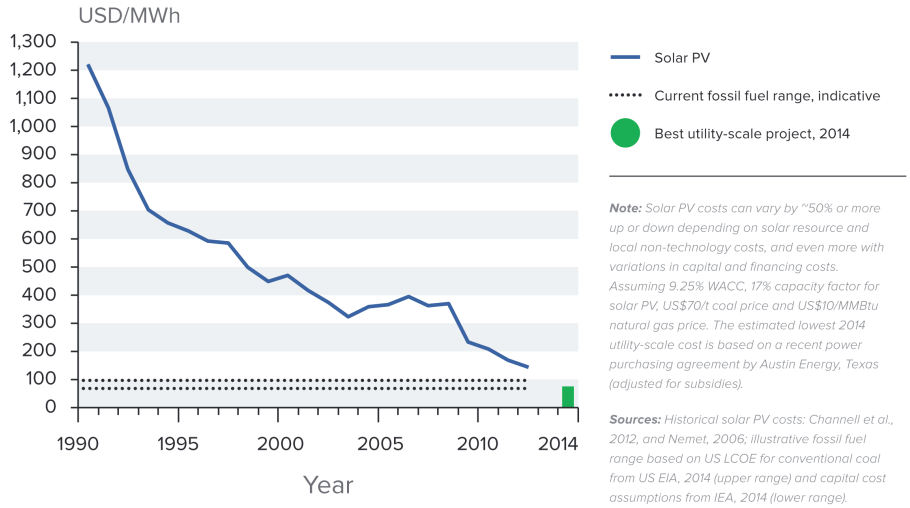
Indicative Solar Costs Over Time



Note: *Solar PV costs can vary by ~50% or more up or down depending on solar resource and local non-technology costs, and even more with variations in capital and financing costs. Assuming 9.25% WACC, 17% capacity factor for solar PV, US$70/t coal price and US$10/MMBtu natural gas price. The estimated lowest 2014 utility-scale cost is based on a recent power purchasing agreement by Austin Energy, Texas (adjusted for subsidies).*

Sources: *Historical solar PV costs: Channell et al., 2012, and Nemet, 2006; illustrative fossil fuel range based on US LCOE for conventional coal from US EIA, 2014 (upper range) and capital cost assumptions from IEA, 2014 (lower range).*

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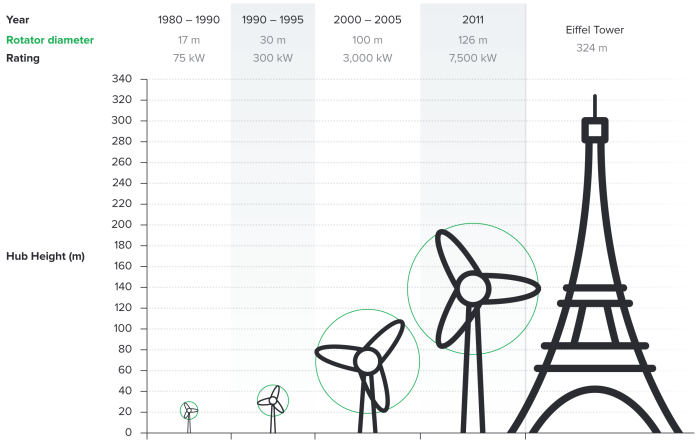
Wind Turbines Have 100 Times More Power Generation Capabilities Than 30 Years Ago



Source: Adapted from the European Wind Energy Association.

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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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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 km²	7.5 tonnes CO_2/person (public + private transport)	2.8 million	162 km²	0.7 tonnes CO_2/person (public + private transport)

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Source: New Climate Economy Report, 2014

Land Use: Restoration Is Possible

South Korea restored its forest cover from 35% to 64% of the country's total area

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Climate Change Policy

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Policies That Reduce Emissions: Directly

- **Regulation**
  - Emissions standards or limits
- **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?

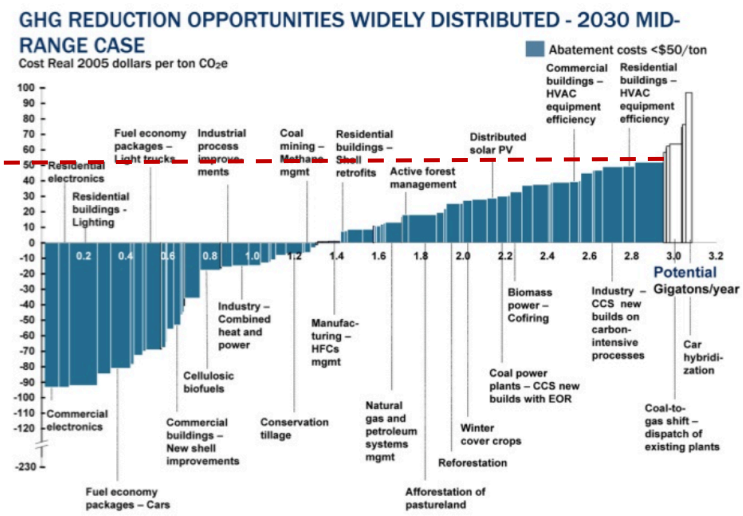
- Activities to be covered are determined.
- Acceptable emissions levels are indicated.
- "Permits" that allow acceptable emissions levels are issued.
- A "market" is developed.
- Those desiring to emit will have to buy sufficient permits to accommodate their emissions.
- Those wishing to abate will offer their permits on the "market".
- Gov't 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 is determined.
  - Presumably some relation to the social cost of polluting.
- Emissions are measured.
- Taxes are determined.

Putting a Price on Carbon

Suppose a Social Cost Of Carbon of $50



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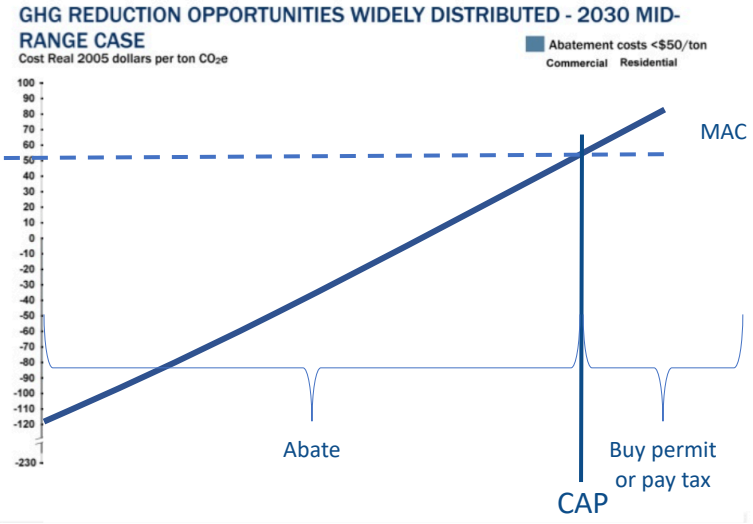
Putting a Price on Carbon

TAX
=
Permit Price
=
Carbon Price



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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:**
  - Firms might leave to flee regulation.
  - It is necessary to monitor emissions.
  - Regressive
    - Costs weigh more heavily on low-income people.

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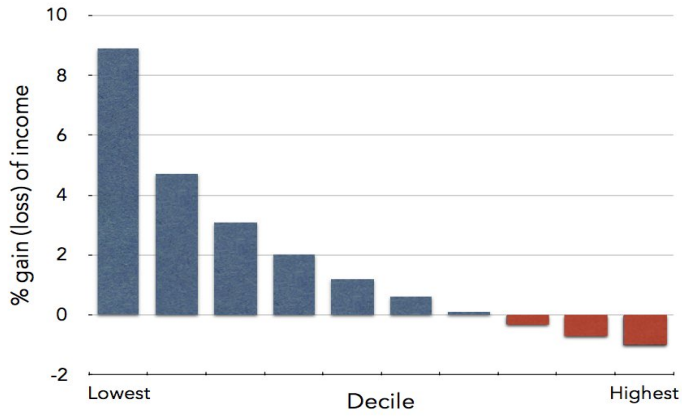
Revenue Dividend Eliminates Regressivity

IMPACT OF CARBON DIVIDENDS ON U.S. FAMILY INCOMES



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Source: U.S. Treasury, 2017

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 Predictability	Susceptible to lobbying Only generates revenue if government sells permits Cap can be changed by regulator Less certainty over future

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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)**

Thoughts on Regulation vs Market Oriented

- **Equity**
  - Both types of policies are regressive
    - Cap and Trade and a Carbon Tax both have the ability to offset the regressive nature of reducing carbon emissions.
    - 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?

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:
    - 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.

Climate Change Policy in Action

Cap and Trade

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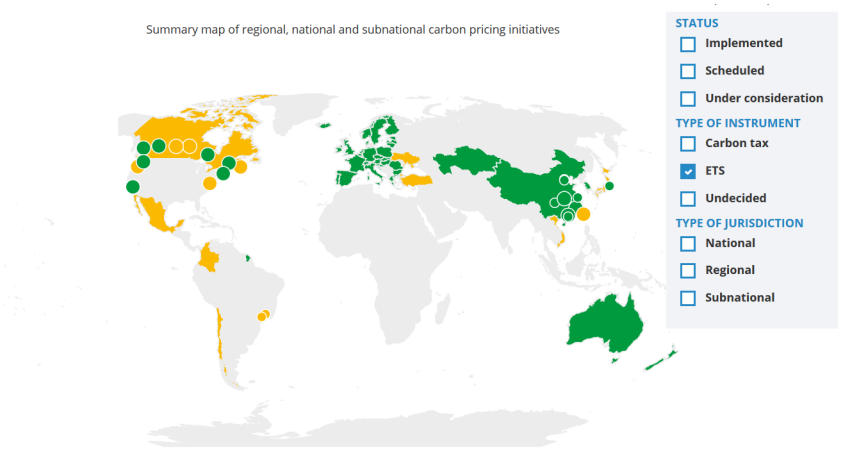
Cap and Trade Policies Around the World



ETS = Emissions Trading System = Cap and Trade

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Source: World Bank - Carbon Pricing Dashboard

European Union's Emissions Trading Scheme

4%

of global greenhouse gas emissions
Circa 2005

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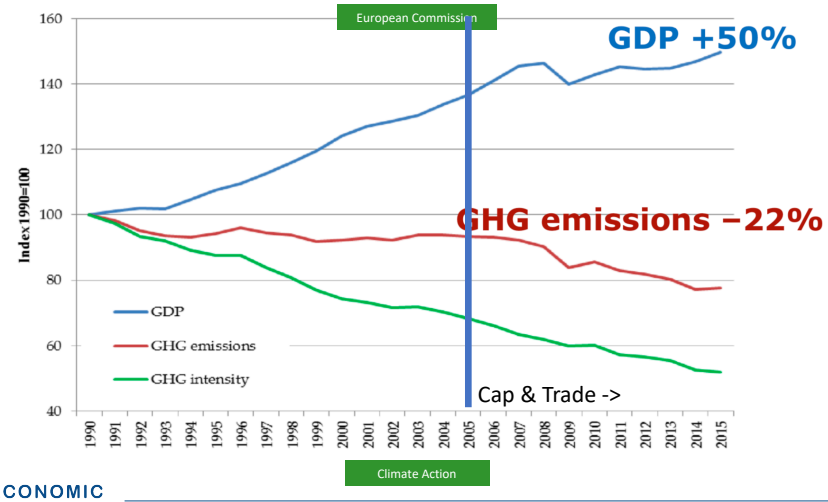
EU Has Decoupled Economic Growth from Greenhouse Gas Emissions



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California's Cap and Trade System: 2012+

0.7%

of global greenhouse gas emissions

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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

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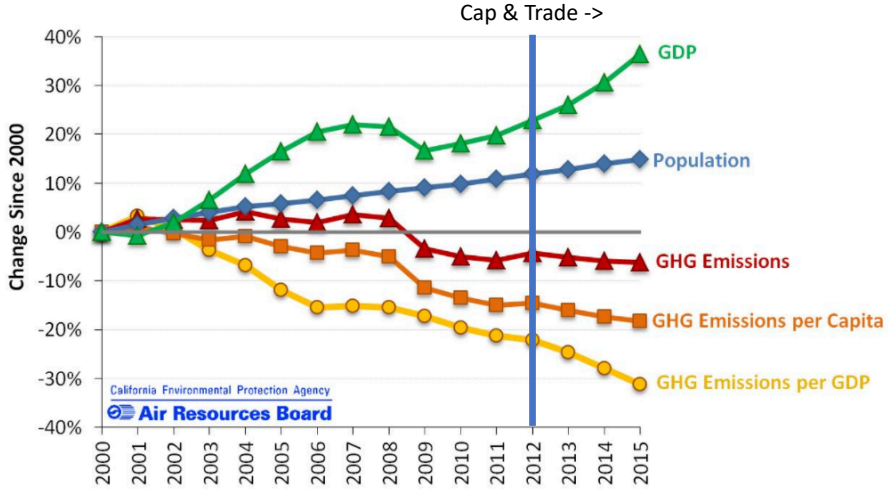
Change in California GDP, Population, and GHG Emissions since 2000



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Worldwide Carbon Taxes

26
carbon tax programs

24
national jurisdictions covered

5.3%
of global greenhouse gas emissions

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Sweden's Carbon Tax Policy

Oldest Carbon Tax

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Sweden's Carbon Tax Policy

Started in 1991

Currently at $140/ton

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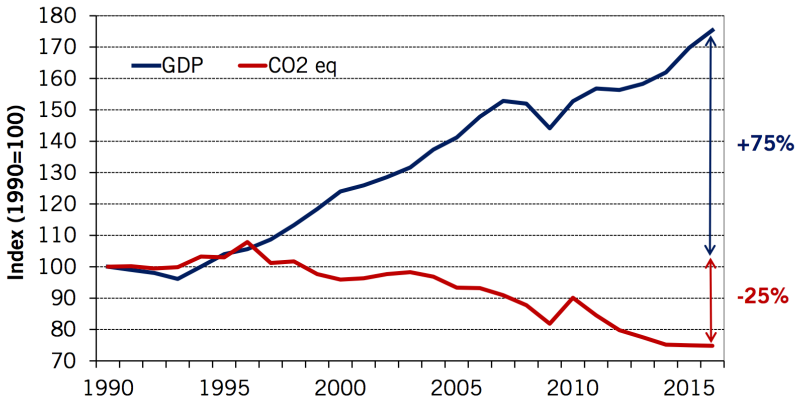
Real GDP and Domestic CO_2eq Emissions[1] In Sweden, 1990-2016



[1] In accordance with Sweden's National Inventory Report, submitted under the UNFCC and the Kyoto Protocol. CO_2 = approx. 80 % of total CO_2eq emissions. Preliminary data for 2016.

Sources: Swedish Environmental Protection Agency, Statistics Sweden

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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.**
  - ***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.

Thank you!

Any Questions?

www.NEEDelegation.org
Jon Haveman, Ph.D.
Jon@NEEDelegation.org

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