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# Climate Change Economics

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Climate Changed FYE- Fall 2018

## 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

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## But First: What Is Economics?

- How do/should individuals and firms make decisions?
- How is value created by trade? How do goods and services get allocated among entities in society?
- How do "market failures" restrict that value creation?

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## And How Does Economics Contribute to Thinking about Climate Change? A Preview.

- Account for behavioral reactions to climate change
- Estimate / measure costs of climate change damages and costs of fighting climate change
- Design smart policy to minimize costs of fighting climate change

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# Climate Change Science

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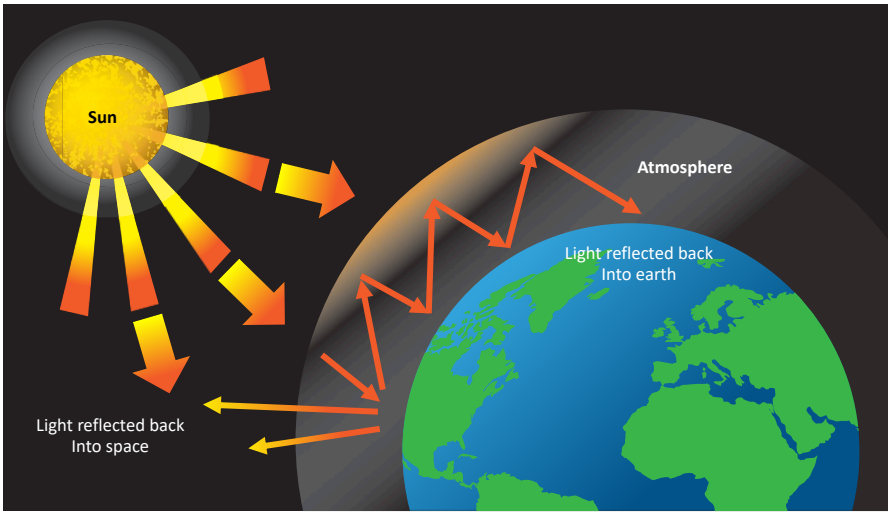
## Intro on the science

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# How Much Pollution Does Society Want?

## Analogy: How Many Oranges Does Society Want?

- In a well function market, price will settle where:

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

- Prices reflect scarcity and social value of resource

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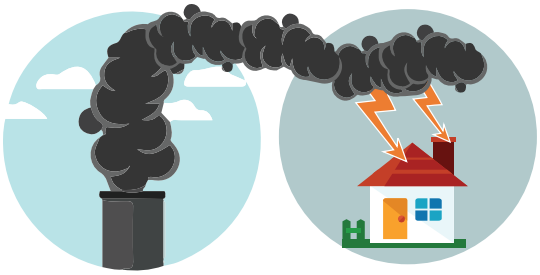
# Pollution Is Different From Oranges

- **Pollution creates a market failure**
- **Externality: when not all effects felt by buyer and seller**
  - Electricity price does not reflect all costs → electricity too cheap → wrong balance! Too much pollution!
- **Goal is not 0 pollution but society's best balance between pollution and other things**



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# Impacts of Climate Change

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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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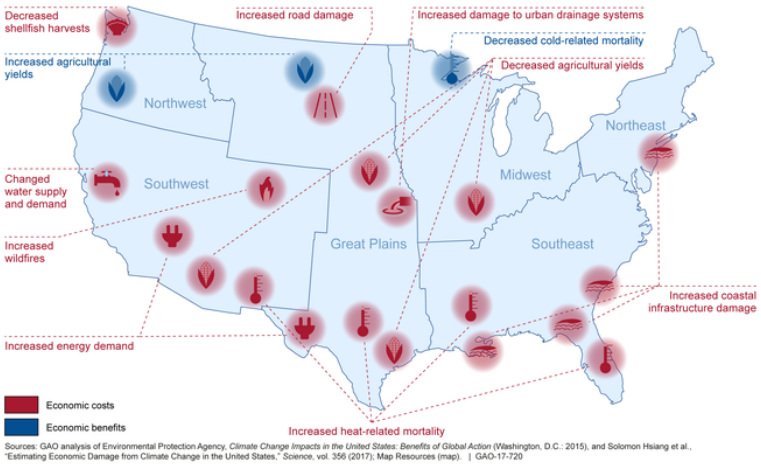
# Projected Damages Vary Across the US But Are Estimated at 1.2% of GDP per 1C Increase




Sources: GAO analysis of Environmental Protection Agency, *Climate Change Impacts in the United States: Benefits of Global Action* (Washington, D.C.: 2015), and Solomon Hsiang et al., "Estimating Economic Damage from Climate Change in the United States," *Science*, vol. 356 (2017); Map Resources (map). | GAO-17-720

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# Social Cost of Carbon

- The expected cost of damages from each unit of greenhouse gas emissions
- Current EPA estimate: ~$40 per metric ton $CO_2$
- Social cost of carbon will increase over time into the future


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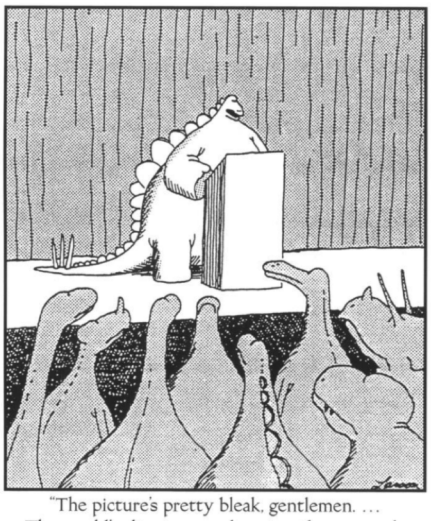

"The picture's pretty bleak, gentlemen. … The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut."

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# Economics of Responding to Climate Change

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# 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.
- **IPCC report in 2014:**
  - Temperature increased already by 0.85 degrees C
- **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

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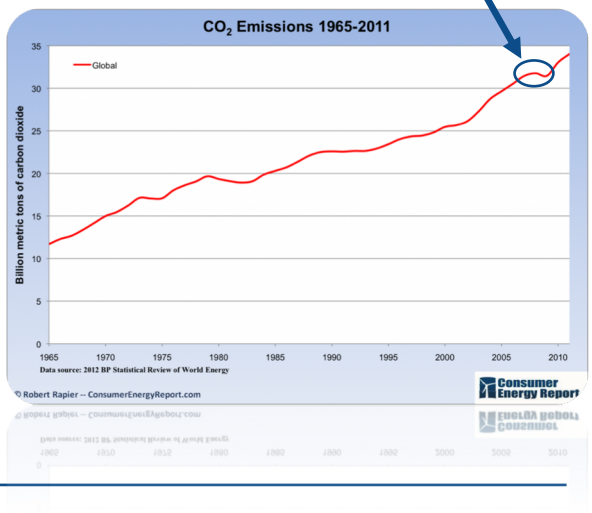
# Recent Progress on Climate Goals

- **IPCC's Fifth Assessment Report (2014)**
  - Goals from previous report (2007) were met!
  - … but mainly because of the Great Recession…
  - … which was not a good thing.

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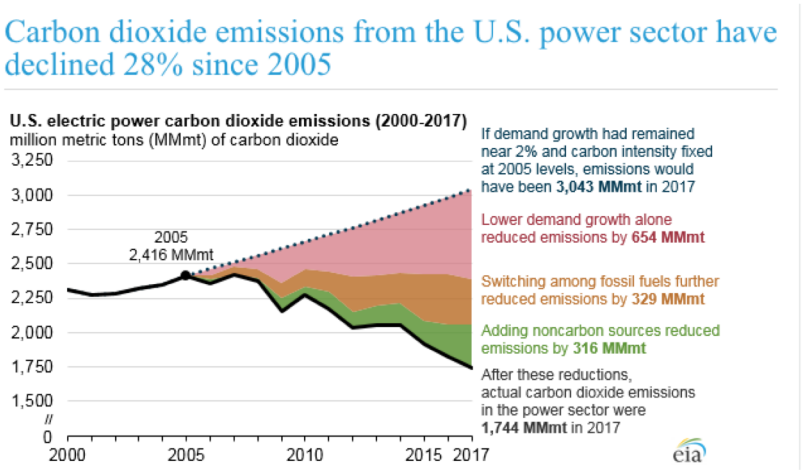
# Carbon Emissions & Energy since 2005





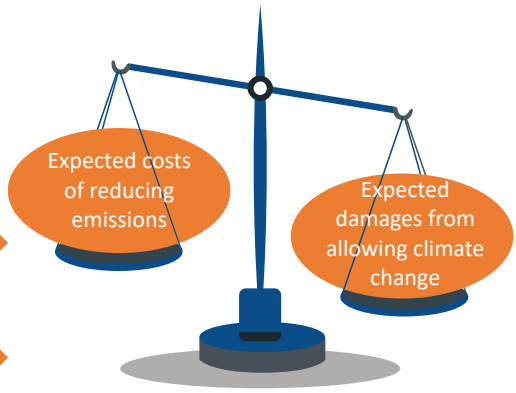

# How Economists Decide How Much to Fight Climate Change

- **Cost Benefit Analysis**
- **Weigh:**

**Expected costs of reducing emissions**

**VS**

**Expected damages from allowing climate change**



## 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 money value on priceless things
  - Uncertainty and risk
  - Discounting
  - Inequality

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# Addressing the Sources of Our Emissions

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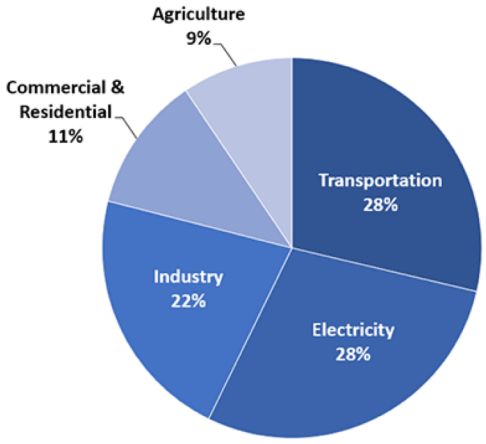
## Total U.S. Greenhouse Gas Emissions by Economic Sector in 2016




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

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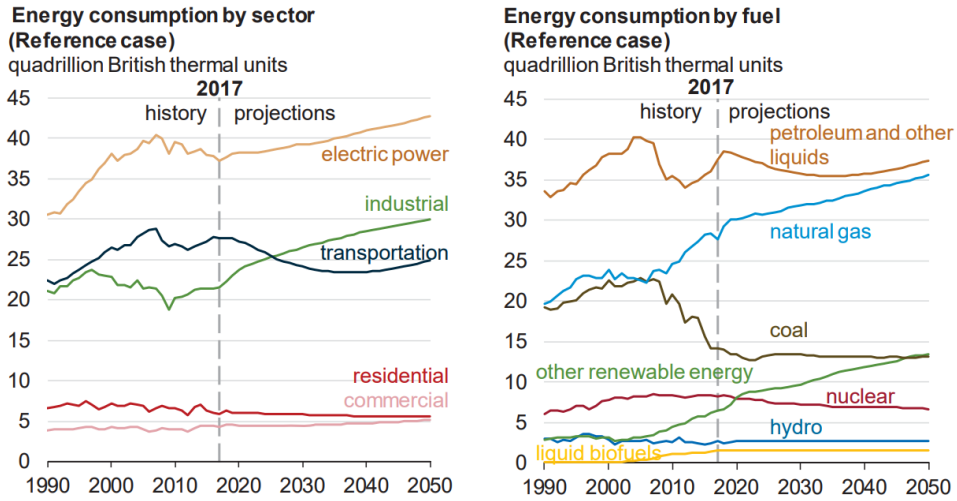
# Fossil Fuels Dominate US Energy Production

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# Climate Change Policy

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## Policies to Fight Climate Change that Are Relatively Indirect

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

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## Policies to Fight Climate Change that Directly Reduce Emissions

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

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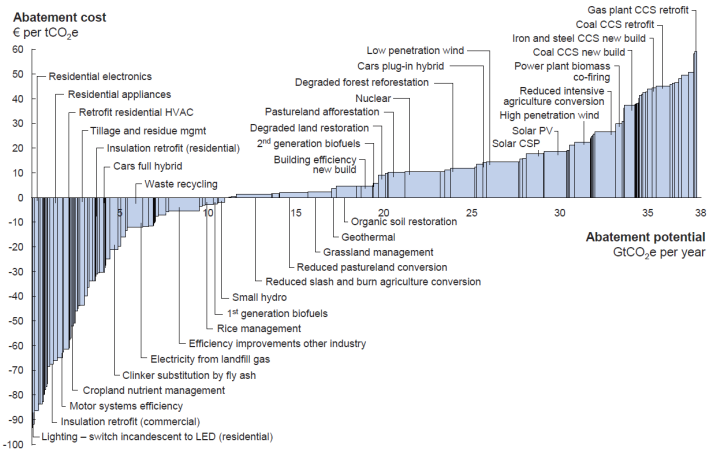
# Global GHG Abatement Cost Curve Beyond Business-as-usual - 2030




Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 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 v2.0

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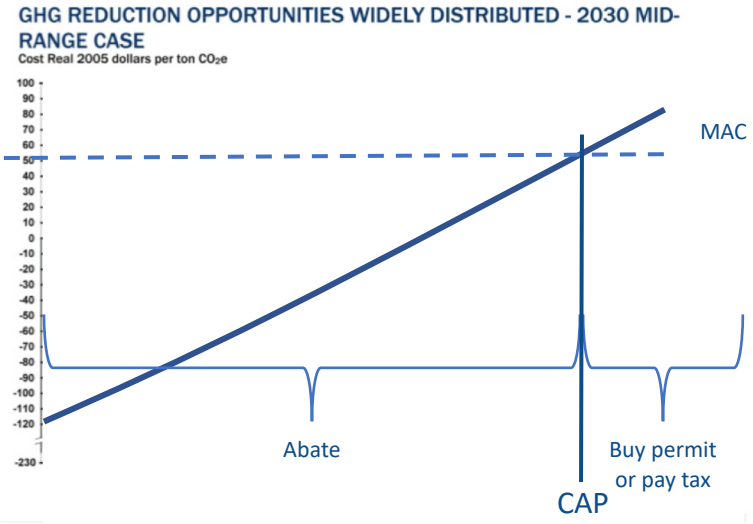
# Putting a Price on Carbon

TAX =
Permit Price
=
Carbon Price

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# Carbon Prices: the Good and Bad

- **Good:**
  - Provide price signal to lower greenhouse gas emissions
  - Yield low-cost reductions in emissions: emitters choose how to reduce, and they choose the cheapest way
  - Market certainty
- **Bad:**
  - Regressive (costs weigh more heavily on low-income people)
    - Can refund revenues to balance this; and would be true for any form of regulation
  - Firms might leave to flee regulation
    - Doesn't seem to be a big problem in practice
  - Monitoring costs


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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<br>- May require legislation to change | - May be more susceptible to lobbying<br>- Only generates revenue if government sells permits<br>- Cap can be changed by regulator |

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# Climate Change Policy in Action

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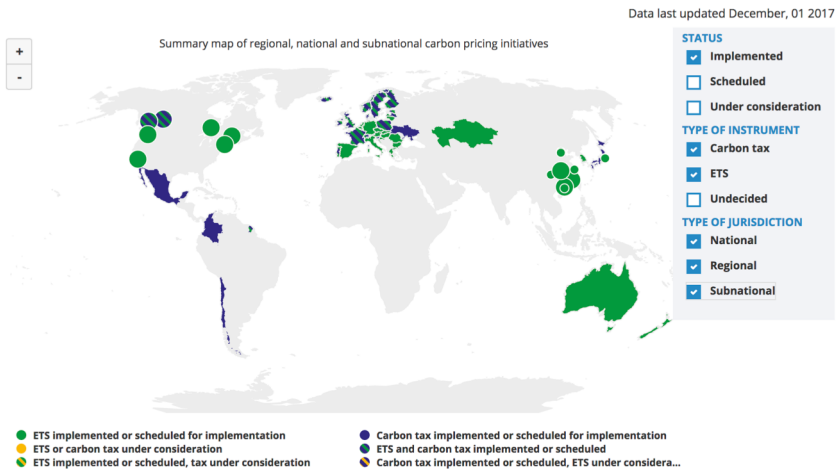
# Carbon Policies Across the World

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Source: World Bank Carbon - Pricing Dashboard

# Cap and Trade


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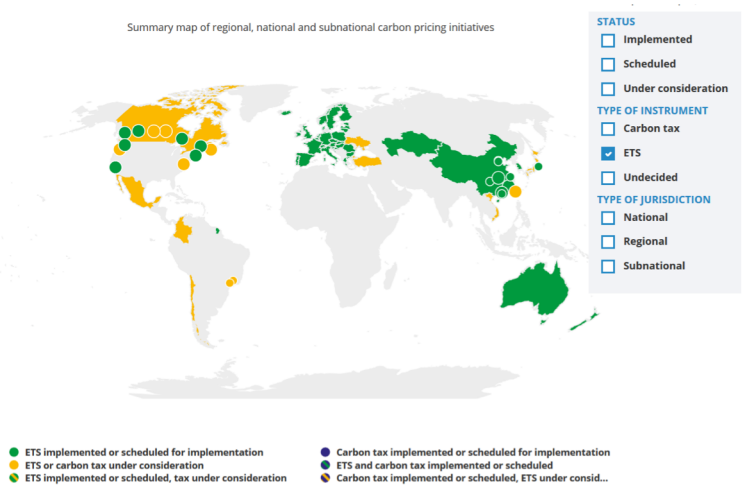
# Cap and Trade Policies Around the World

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Source: World Bank - Carbon Pricing Dashboard

# European Union's Emissions Trading Scheme

**4%**

of global greenhouse gas emissions

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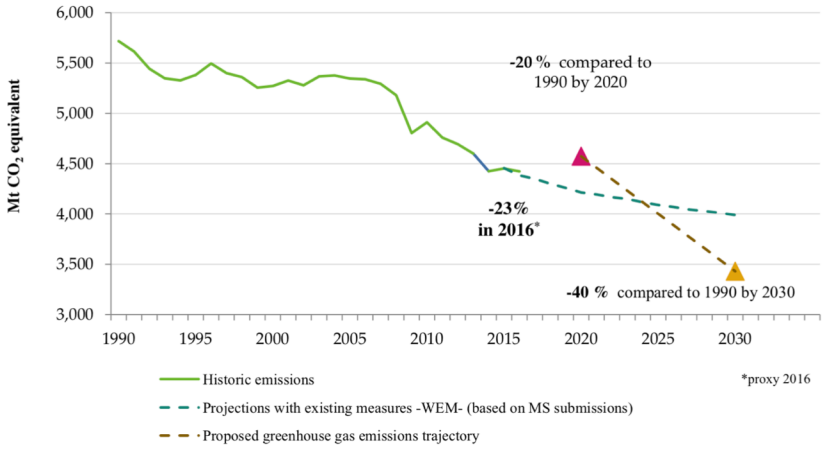
# Progress Towards Meeting Europe 2020 And 2030 targets (EU Total GHG Emissions)

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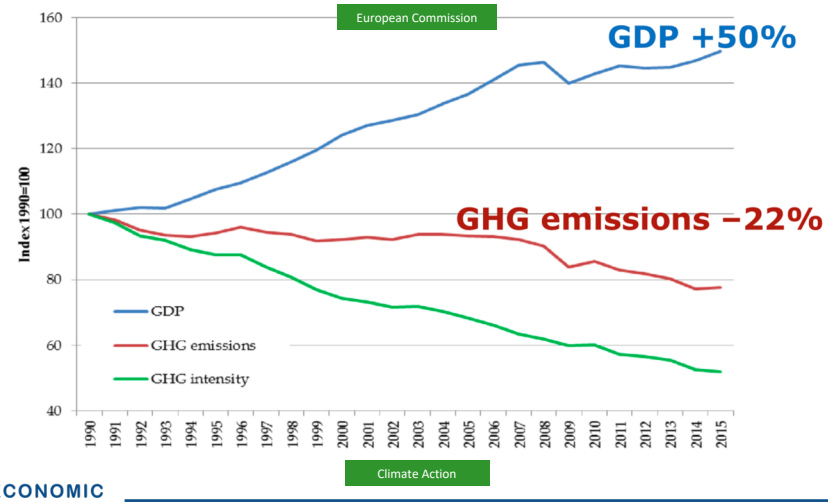
## EU Has Decoupled Economic Growth from Greenhouse Gas Emissions

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## California's Cap and Trade System

**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
  - 100% clean energy act of 2018
- **California's Tools:**
  - Cap and Trade
  - Renewable Portfolio Standard
  - Clean Cars Program
  - Low Carbon Fuel Standard

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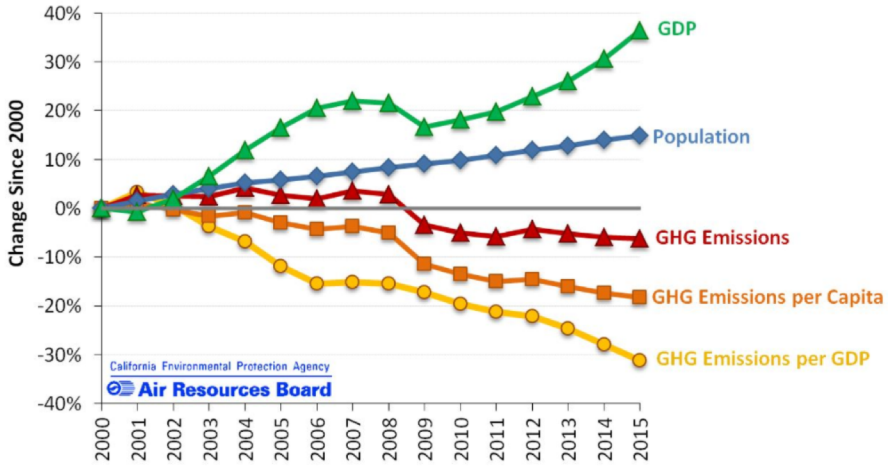
# Change in California GDP, Population and GHG Emissions since 2000

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# 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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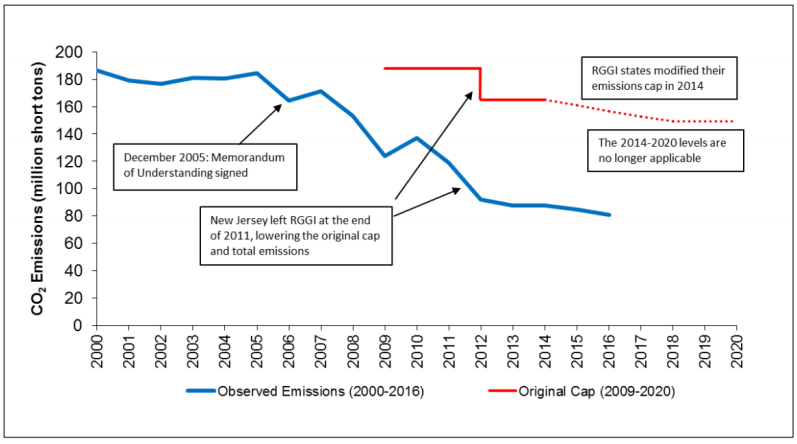
# RGGI's Effect on Emissions

**Figure 1. 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.

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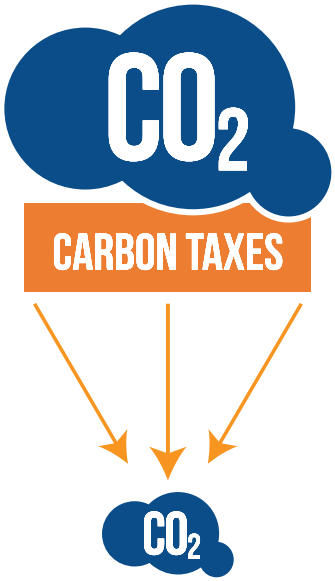
## Carbon Tax

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**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

**0.1%**

of global greenhouse gas emissions

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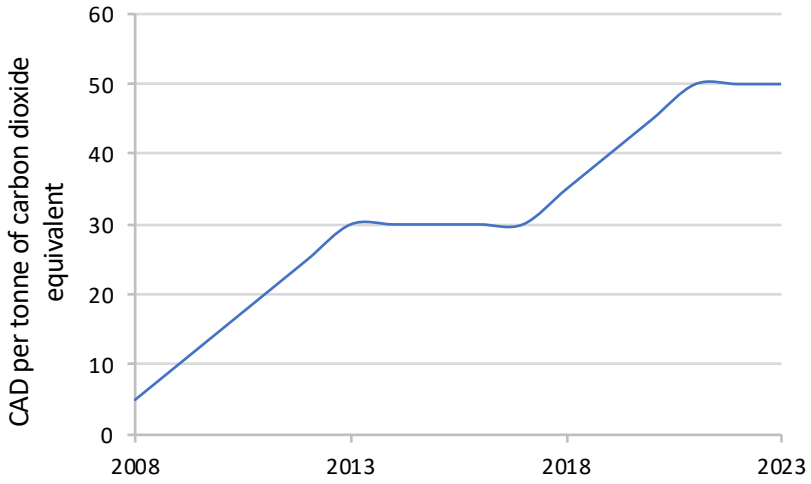
> "Tax the pollution we do not want, and return the money for what we do want — money in people's pockets, jobs and investment. „
>
> - B.C. Government - Carbon Tax Brochure

## British Columbia's Tax on Carbon

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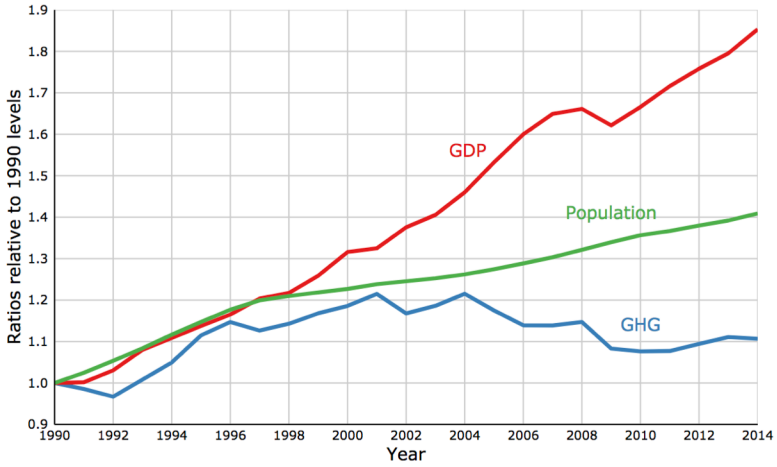
## Relative Greenhouse Gas Emissions, Gross Domestic Product & Population Size

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# Oldest Carbon Tax

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## Sweden's Carbon Tax Policy

# Started in 1991

Currently at $140/ton

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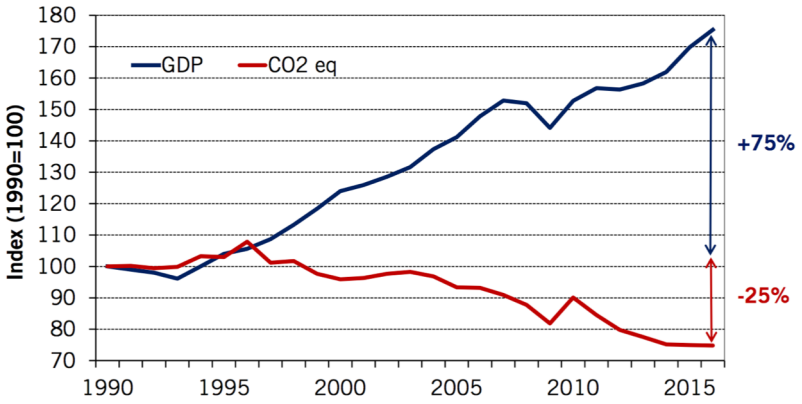
## Real GDP and Domestic $Co_2eq$ Emissions[1] In Sweden, 1990-2016




[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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## 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
- Scientists and the IPCC recommend that we work to keep warming below 2 degrees C
- 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!

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"Economic policies will be central to accomplishing the goals we choose"

~ Harris and Roach (2007)