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Climate Change Economics

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NEED

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1

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2

Outline

- Economic Building Blocks
- Climate Change
- Impacts of Climate Change
- Reducing Emissions
- Climate Change Policy
- Policy in Action

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3

Economic Building Blocks

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4

How Can Economists Help Fight Climate Change?

- By assessing behavioral reactions to climate change.
- By measuring climate change damages and estimating the costs of fighting climate change.
- By designing smart policies that minimize costs to society.

5

Econ 101: When Everything Is Simple, No Regulation Is Needed for Efficiency

- Simple transactions: buyer and seller feel all costs and benefits of sales
- They choose based on the costs & benefits they feel
- → Efficient number of transactions! (Maximizes social benefits)

6

When Our Decisions Affect Others, We Need Regulation

- **Pollution causes an EXTERNALITY: a side effect (here, a cost) that affects someone else**
  - Polluting things have an "unfair cost advantage" because part of cost is offloaded on others
  - → Too much pollution is generated
  - Regulation limiting pollution has net benefits
- ***The "efficient" amount of pollution balances costs & benefits of pollution***

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Examples of Externalities

- **Negative Externalities:**
  - Heating your house
  - Smoking
  - Getting a dog
  - Pig farming
- **Positive Externalities**
  - Education
  - Growing apples
  - Getting a vaccination
  - Basic scientific research

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8

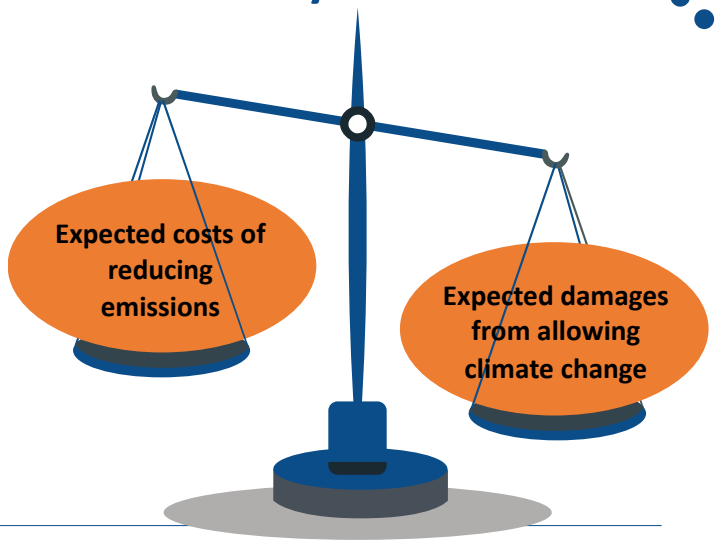
8

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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10

Climate Change

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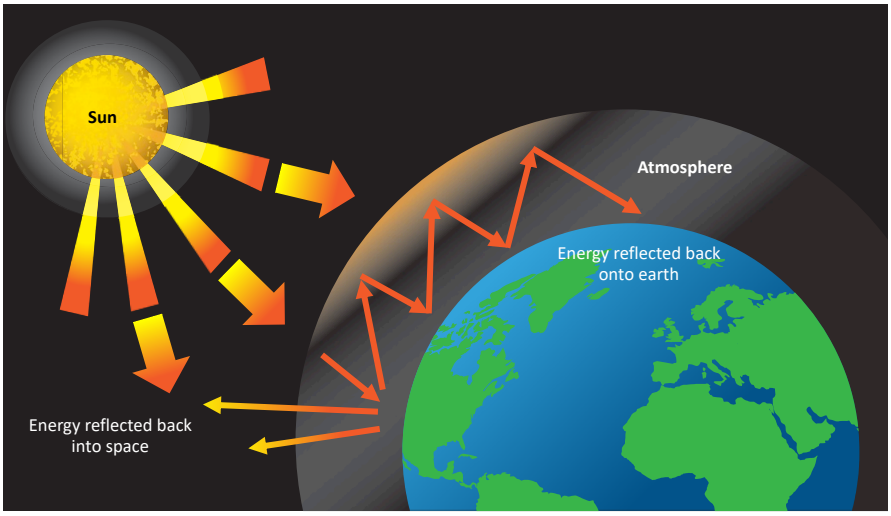
11

The Atmospheric Greenhouse Effect



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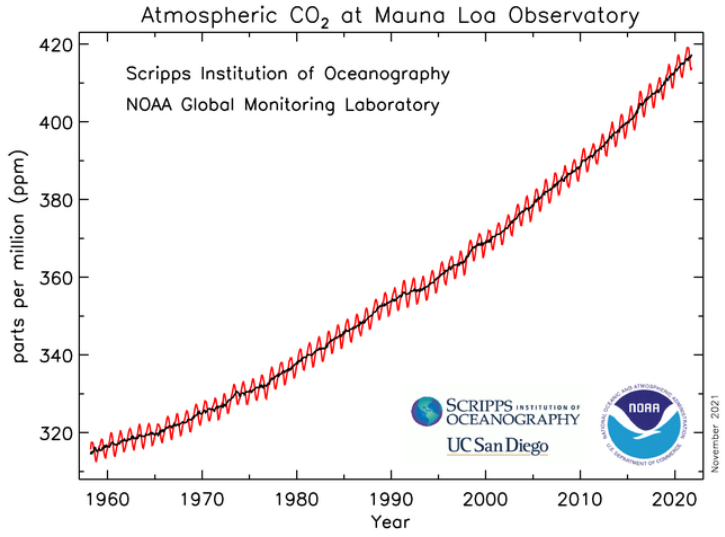
Atmospheric CO_2 Concentrations Up To Now



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Source: NOAA

13

What Do Greenhouse Gas Emissions Do?

- **Increase temperatures**
  - Sea level rise
  - Storm surges
- **Alter precipitation patterns**
- **More variable weather**
- **More / more powerful storms**
- **Carbon dissolves in ocean**

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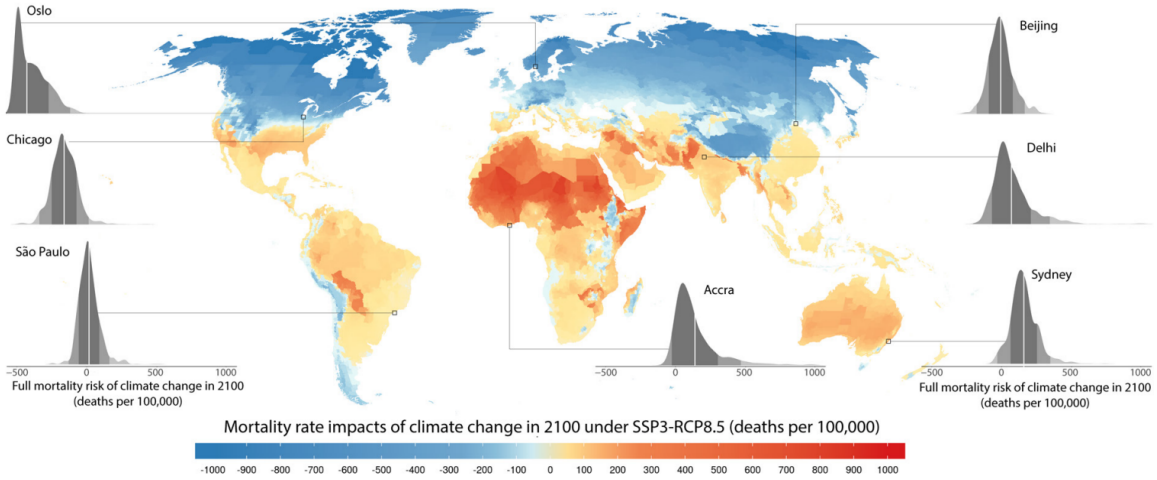
14

How Damages Will Vary Globally: Mortality as an Example



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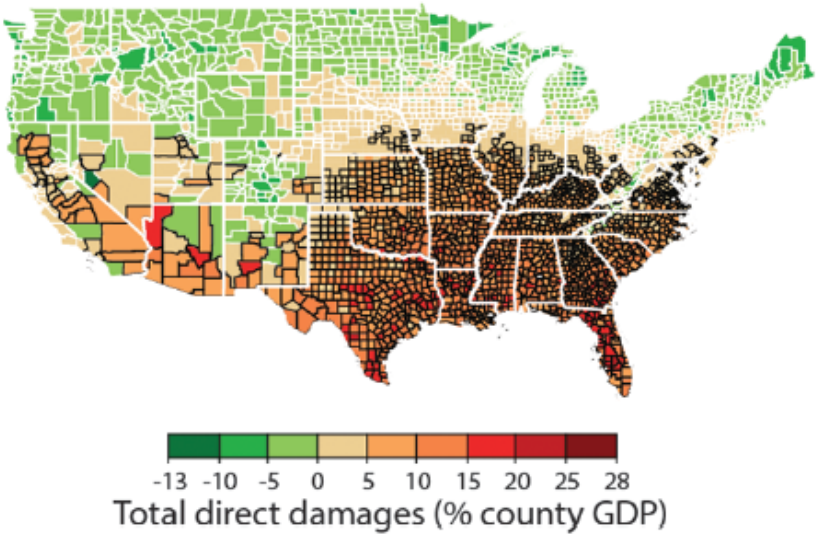
How Damages Will Vary in the US



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A Climate Change Ladder

- Emissions
- Mitigation (a.k.a. Abatement)
- Adaptation
- Damages

17

Impacts of Climate Change

18

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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Social Cost of Carbon

- The expected cost of damages from each unit of greenhouse gas emissions.
- Current EPA estimate: ~$51 per metric ton of CO_2 (but estimates vary a lot!)
  - About $157/car per year.
  - $32 Billion for all vehicles in the US.
- Social cost of carbon will increase over time.

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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.**
- **Some adaptation requires government involvement.**

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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.
  - Move to a more hospitable climate.
- **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
  - Increase sinkage by planting trees, or other measures

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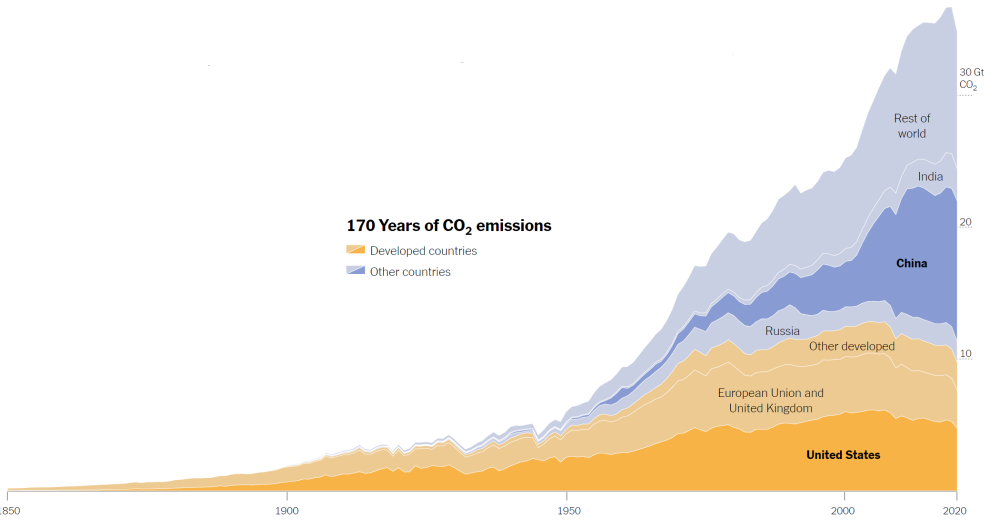
25

Sources of the Global Flow of Emissions



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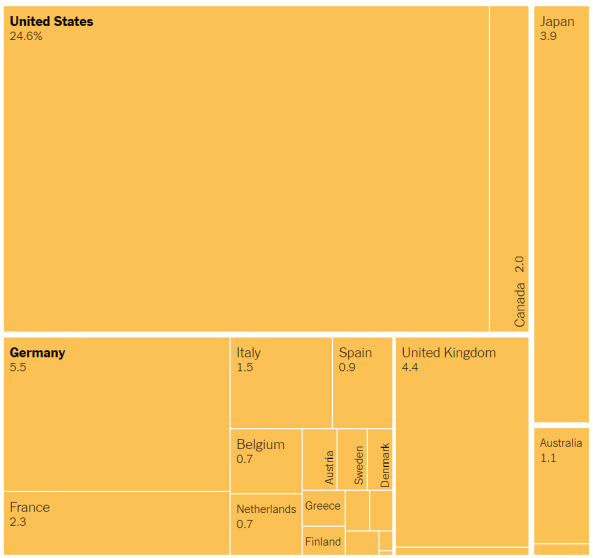
26

Sources of the Global Stock of Emissions

23 rich, developed countries are responsible for half of all historical CO_2 emissions.



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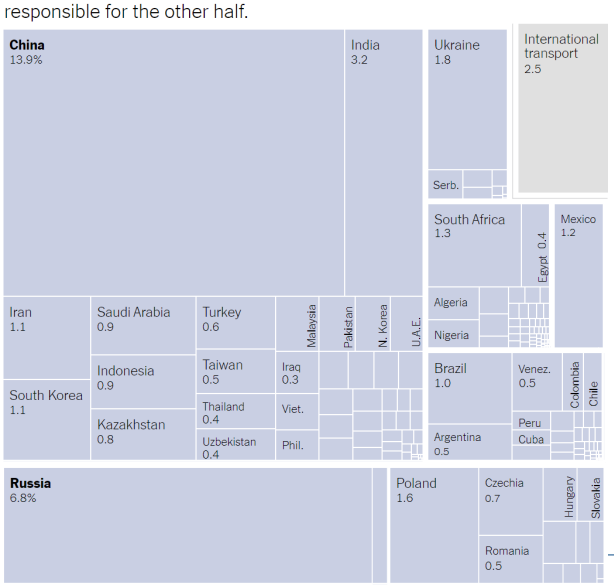
Sources of the Global Stock of Emissions

More than 150 countries are responsible for the other half.



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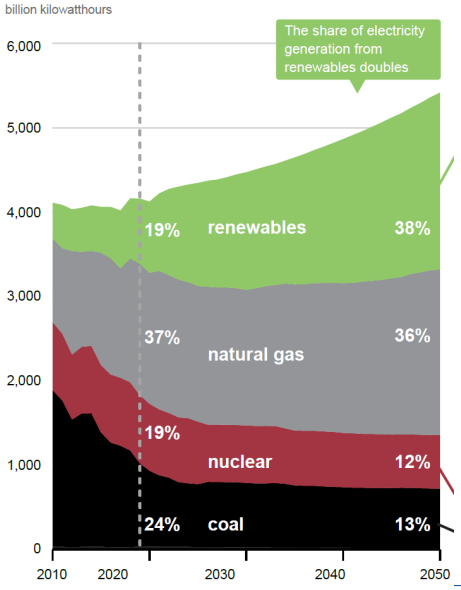
US Electricity Sources



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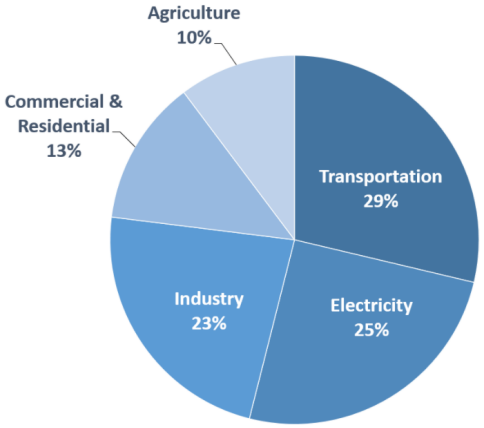
29

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2020



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Total Emissions in 2019 = 6,558 Million Metric Tons of CO2 equivalent. Percentages may not add up to 100% due to independent rounding.

30

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 ones!

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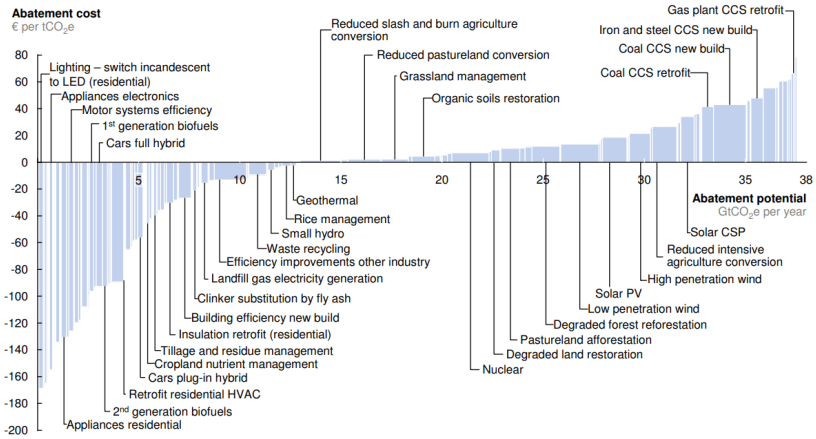
31

Example Abatement Cost Curve

(Don't trust these numbers, this is just to show the idea)

V2.1 Global GHG abatement cost curve beyond BAU – 2030



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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

32

But Are Costs So Easy 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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33

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.).**
  - Not yet proven at scale
- **Solar geoengineering: make the atmosphere reflect more light to regain earlier thermal balance.**
  - Totally theoretical
  - Potentially risky

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34

Climate Change Policy

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35

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)

- **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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36

36

How Does a Carbon Tax Work?

- **Choose activities to be covered**
  - E.g., extraction, 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.**

37

How Does Cap and Trade Work?

- **Choose activities to be covered (e.g., electricity sector, all emitters, etc.).**
- **Set maximum emissions level ("cap").**
- **That many pollution permits are 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.**
  - Polluters with **low** abatement costs will make / save money by **abating** and selling / not buying permits
  - Polluters with **high** abatement costs will buy permits and **pollute**

38

Both Policies are Work Through Prices

Full video: https://www.youtube.com/watch?v=XHK1OBSBpwc

Thoughts on Regulation vs Market-Oriented

- **Equity.**
  - Both types of policies might be 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?

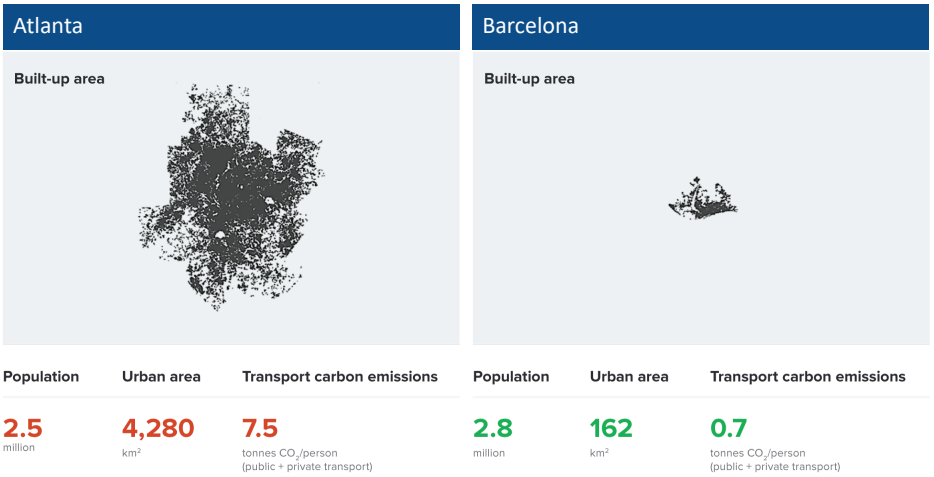
Efficiency: CAFÉ vs Carbon Tax

- **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.

Examples of Other Policies that Reduce Emissions

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

Atlanta and Barcelona Have Similar Populations but Very Different Carbon Productivity



Atlanta			Barcelona		
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

43

Climate Change Policy in Action

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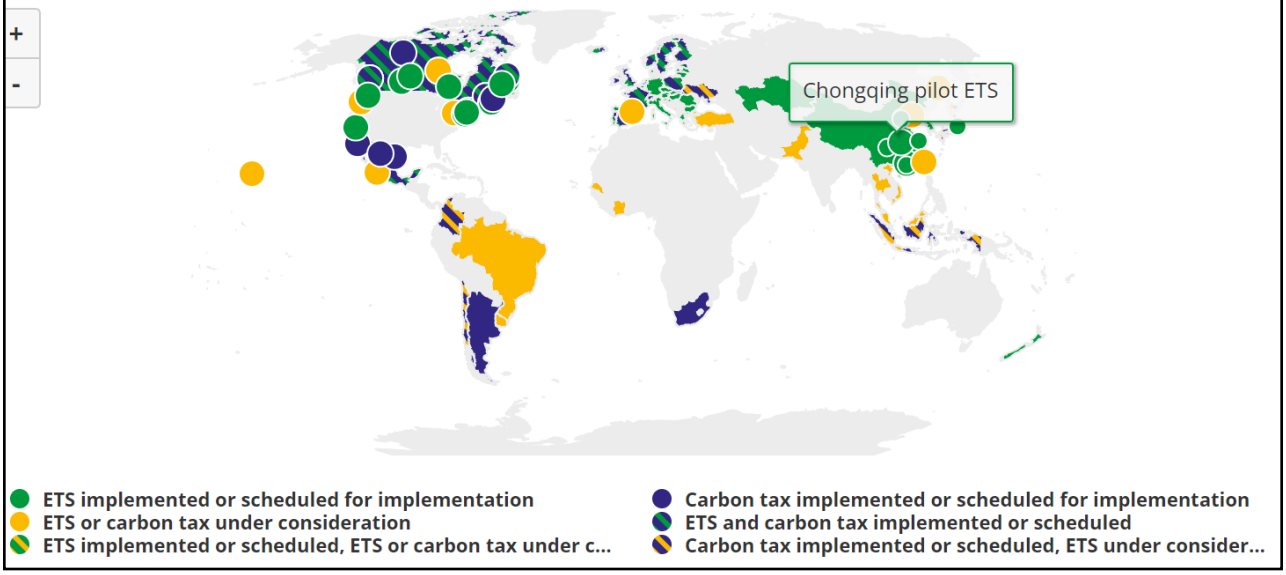
44

Incentive-Based Climate Policies Right Now

Summary map of regional, national and subnational carbon pricing initiatives



45

California's Cap and Trade System Since 2012

0.7%

of global greenhouse gas emissions

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46

California's AB32: Global Warming Solutions

- **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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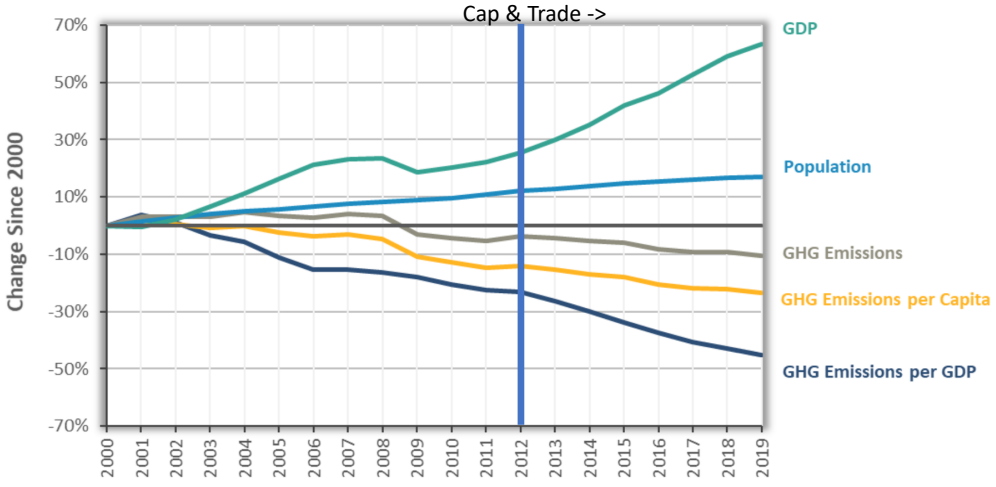
47

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



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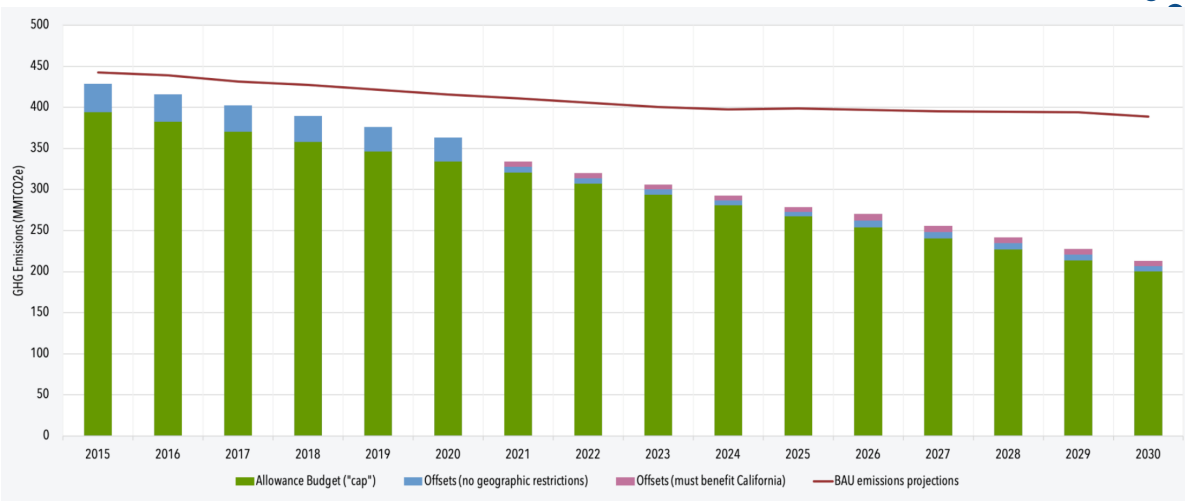
48

Projected trends in California's emissions



49

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.**
  - For example, cap and trade and emissions taxes!
- **We also need policies to help with adaptation and support those bearing the greatest damages.**

50

Thank you!

Any Questions?

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