Today I Learned About Carbon Pricing

Description:

Carbon pricing, including cap-and-trade and carbon taxes, is one tool in the toolbox governments have to reduce the impacts of climate change. What kind of a tool is it? After an introduction to carbon pricing, students use an online simulator to investigate multiple pathways to a cooler future.

Skills & Objectives

SWBAT

- Explain the basics of a cap-and-trade and carbon tax system.
- Understand some impacts from carbon pricing systems.

Skills

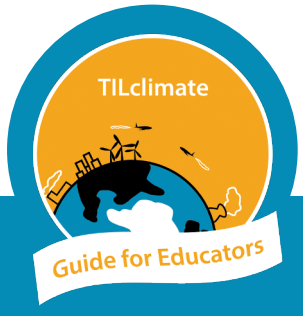
- Graph reading
- Analyzing simulation data

Students Should Already Know That

- Governments use tools such as taxes, policies, laws, and negotiation to affect the behavior of businesses, industries, and organizations.

Standards Alignment:
HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions.
HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem.
RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept.

Disciplinary Core Ideas:
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change



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How To Use These Activities:

Pages with the circular "TILclimate Guide for Educators" logo and dark band across the top are intended for educators. Simpler pages without the dark band across the top are meant for students.

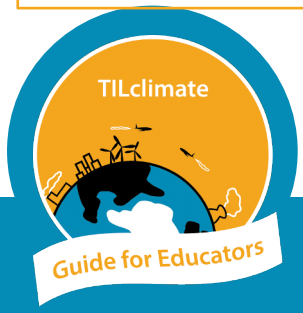
Each of the included activities is designed to be used as a standalone, in sequence, or integrated within other curriculum needs. A detailed table of contents, on the next page, explains what students will do in each activity.

A Note About Printing

All student pages are designed to be printable in grayscale.

The worksheets do not leave space for students to answer questions. Students may answer these questions in whatever form is the norm for your classroom – a notebook, online form, or something else. This allows you, the teacher, to define what you consider a complete answer.

Podcasts in the Classroom: Throughout these Guides for Educators, we invite students to think about how they would share their learning with family and friends. One way to do this is to encourage your students to create their own podcasts - they're shareable, creative, and have multiple options for embedded assessment. We would love to hear any podcasts or see any other projects you or your students create! Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.



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Detailed Table of Contents

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Carbon Pricing

This Educator Guide includes a reading and an online simulation tool. Educators may pick and choose among the pieces of the Guide, as suits their class needs.

Parts of this Guide may align with the following topics:

- Physical science: Impacts of carbon dioxide on the atmosphere.
- Life/environmental science: Climate change and policy.
- History/social science: International agreements, policy, and diplomacy.
- ELA/nonfiction: Describing a complex economic and scientific theory.

MIT Resources

We recommend the following as resources for your own better understanding of climate change or as depth for student investigations. Specific sections are listed below:

- Climate Science, Risk & Solutions, an interactive introduction to the basics of climate change. https://climateprimer.mit.edu/
  - Chapter 02 The greenhouse effect and us
  - Chapter 06 Predicting climate
  - Chapter 09 How long can we wait to act?
  - Chapter 10 What can we do?
- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. https://climate.mit.edu/explainers
  - Carbon Pricing
  - Greenhouse Gases
  - Climate Models
  - Climate Targets
  - Carbon Offsets
  - The Paris Agreement

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Wrap-Up Discussion Questions

- How could you encourage the biggest emitters to innovate, while protecting households and small businesses from higher costs?
- What kinds of innovations can transportation, electricity generation, and industry use to reduce their CO_2 emissions?
- Which actions had the most dramatic effects on 2100 temperature? Did any of the results surprise you? Why or why not?
- How effective is carbon pricing as a tool in the toolbox? Which other tools does it work best with?
- Imagine your region was considering creating a new price on carbon emissions. Who might support this policy? Who might oppose it? How might you balance these sides?
- Develop a spreadsheet or game to model a cap-and-trade system in an imaginary country.

Climate Solutions

Climate solutions can be thought of as falling into four categories outlined below. Across all categories, solutions at the community, state or federal level are generally more impactful than individual actions. For example, policies that increase the nuclear, solar and wind mix in the electric grid are generally more effective at reducing climate pollution than asking homeowners to install solar panels. For more on talking about climate change in the classroom, see “How to Use This Guide”.

- **Energy Shift**
  How do decision-makers make the switch from carbon-producing energy to carbon-neutral and carbon-negative energy?
- **Energy Efficiency**
  What products and technologies exist to increase energy efficiency, especially in heating and cooling buildings?
- **Adaptation**
  How can cities and towns adapt to the impacts of climate change?
- **Talk About It**
  Talking about climate change with friends and family can feel overwhelming. What is one thing you have learned that you could share to start a conversation?

TILclimate Guide for Educators

What solutions are the most exciting in your classes? We would love to hear from you or your students! Images, video, or audio of student projects or questions are always welcome. Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.

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"[It's] free to put greenhouse gases in the air even though they cause cost to society. So in order to fix the market, you can charge -- whether it's firms or customers -- the damage that they're doing when they emit those greenhouse gases in the air."
Professor Christopher Knittel, MIT Sloan School of Management
TILclimate podcast: Today I Learned About Uncertainty

A Warming Planet

As we burn fossil fuels like coal, oil, and natural gas and cut down forests, we release carbon dioxide (CO_2) into the atmosphere. This CO_2 acts like a blanket, trapping heat from the sun. Trapped heat is warming our Earth, air, and ocean – and dramatically changing Earth's climate. These changes include extreme storms, sea level rise, and more.

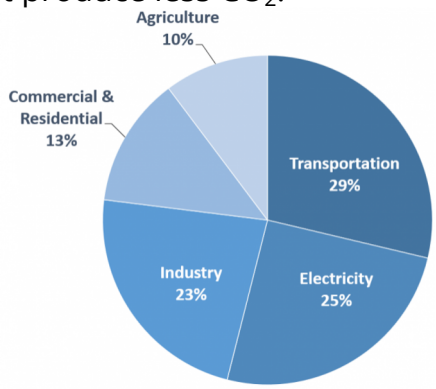
Large amounts of CO_2 are released by individual companies, countries, and machines – but it affects the whole world. In other words – the companies, industries, and countries that produce CO_2 get the benefits, but everyone deals with the costs. The goal of *carbon pricing* is to shift the financial responsibility to the people who are producing the CO_2.

Types of Carbon Pricing

According to the World Bank, there are five main types of carbon pricing[1]. However, most carbon pricing methods in the world fall into two main categories, which are sometimes combined: A *carbon tax* or an *emissions trading system.* (Definitions on the next page.)

In both types of programs, costs to companies and other emitters go up. One way for companies to reduce their costs is to reduce their emissions, which is the goal of the programs. Of course, companies may also raise their prices to offset their higher costs. In many ETS and Carbon Tax systems, money collected from these taxes is returned to households to help pay for electricity or other things that have become more expensive. This way the higher prices on energy don't hurt individuals and families. Carbon pricing plans also usually increase the price or reduce the allowable emissions over time, to encourage emitters to switch to technologies and processes that produce less CO_2.

In the US, carbon pricing methods usually target transportation, electric power plants, and manufacturing for the largest reductions in emissions. By encouraging innovation in these sectors, leaders hope to reduce overall emissions without undue burden on individual households or small businesses. The graph to the right shows 2019 total US heat-trapping gas emissions by economic sector.



1 "What is Carbon Pricing" World Bank https://carbonpricingdashboard.worldbank.org/what-carbon-pricing
Graph from EPA "Sources of Greenhouse Gas Emissions" https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

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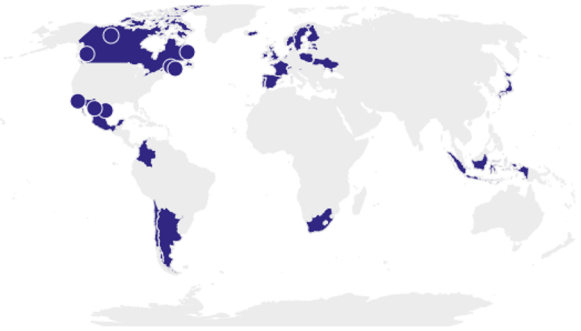
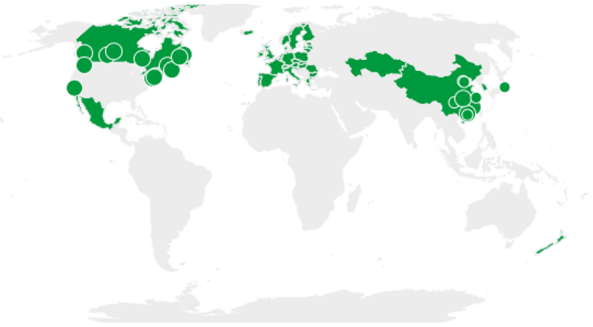
Types of Carbon Pricing

Carbon Tax

A government sets a price per ton of CO_2 emissions. Emitters (companies, power plants, cities, etc.) pay this price or innovate to reduce their emissions to pay less in taxes. The price may grow over time.

In 2021, there were 35 carbon tax initiatives in use or scheduled in countries, states, and regions around the world.





Emissions Trading System (ETS)

(cap-and-trade system or baseline-and-credit system)

A government sets a total amount of emissions that are allowed and produces credits equaling that amount. Over time, they may reduce the number of credits available. Emitters can use these credits to "pay" for the CO_2 they are emitting. Emitters who produce less CO_2 can sell their extra credits to emitters who produce more CO_2 than they have credits for.

In 2021, there were 30 ETS programs in use or scheduled in countries, states, and regions around the world. Their exact mechanisms for producing, using, trading, and reducing credits vary.

Questions for Discussion

- How could you create a tax, ETS, or other system that encourages the biggest emitters to innovate, while protecting households and small businesses from higher costs?
- What kinds of innovations can transportation, electricity generation, and industry use to reduce their CO_2 emissions?
- If you were a government decision-maker, would you favor a tax, an ETS, a combination of the two, or something different? What would factor into your decisions?

Maps from The World Bank Carbon Pricing Dashboard https://carbonpricingdashboard.worldbank.org/map_data

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"[Researchers] have done a lot of research comparing alternatives to carbon taxes to reduce CO_2 emissions and there's many: whether it's subsidizing electric vehicles, or subsidizing solar panels, or requiring a certain number of electric vehicles to be bought and sold. And that research suggests that those alternative policies are … not reducing as much pollution as we could."

Professor Christopher Knittel, MIT Sloan School of Management
TILclimate podcast: Today I Learned About Uncertainty

Modeling Climate Policy

What choices have the greatest impact? To understand the impacts of decisions that leaders and individuals make, scientists have developed models to simplify and model the impacts of decisions.

1. Visit https://en-roads.climateinteractive.org/

By default, the two graphs at the top of the screen are "Global Sources of Primary Energy" and "Greenhouse Gas Net Emissions" with a number to the right indicating how many degrees of temperature increase is expected by 2100. You may leave these defaults as they are or change to new graph(s) if they align with your interests. Under the **View** menu, you can also select **Miniature Graphs** to see 12 impacts of your choices.

For more details on any slider, click the three dots above it.

2. At the bottom of the left-hand part of the page, find the slider for **Carbon Price**. Slide to see the effect of medium, high, and very high carbon prices on your chosen graphs.
   (Advanced: Click the three dots next to Carbon Price to change the details of the price structure.)

Observe

How would you describe the effect of a very high carbon price on your chosen graphs?

3. Choose 2-3 other sliders of interest to you.

Predict

How much of an impact do you expect changes to these sliders to have?

4. Move your chosen sliders to your chosen points.

Analyze

Did you see the impact you expected? Why or why not?

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The Paris Agreement

Your challenge is to use the sliders on the En-ROADS tool to achieve a temperature increase between 1.5 and 2°C to keep in line with the 2015 Paris Climate Agreement.

At each stage, note which sliders you used, and what your result was.

Baseline

Use as many sliders as you want, as extremely as you want. What is the lowest temperature you can achieve? What is the highest?

Challenge 1

Use no more than 5 sliders.

Challenge 2

Use as many sliders as you want, but no slider may go more than one level beyond status quo. (i.e. Carbon Price may not go beyond *medium*, Renewables beyond *subsidized*, etc.)

Challenge 3

Use as many sliders as you want, but no slider may go to its fullest extreme.

Questions for Discussion

- Which sliders had the most dramatic effects on 2100 temperature?
- Did any of the results surprise you? Why or why not?
- How effective is carbon pricing as a tool in the toolbox? Which other tools does it work best with?
- Imagine your region was considering creating a new price on carbon emissions. Who might support this policy? Who might oppose it? How might you balance these sides?

Extend

What other questions could you answer using the En-ROADS tool?