

Lesson 5: Carbon Cap & Trade

The Musical Chairs Game



Question	How would a cap and trade system work to reduce greenhouse gas emissions?
Age-Level	High School
Objectives	Students will create a model of a cap-and-trade market for greenhouse gas emissions. Students will engage in trading of carbon permits with the goal of reducing emissions in the most cost-effective ways. Students will reflect on strengths and weaknesses of the cap-and-trade model.
Time Needed	At least one 45-minute period
Materials	Chairs

ASK YOUR STUDENTS TO SUMMARIZE WHAT THEY ALREADY KNOW ABOUT CLIMATE CHANGE. (5 min)

The following points should be reiterated:

- Heat trapping gasses (greenhouse gasses) released into the atmosphere as a result of human activities are driving climate change.
- 85% of U. S. energy use comes from burning fossil fuels (coal, oil and gas). This is the biggest driver of climate change.
- Greenhouse gases such as CO₂ are very long-lived in the atmosphere and their buildup has consequences over the course of centuries.
- Climate change impacts can disrupt the planet's crucial life-support systems.
- There is a lag between when greenhouse gases are emitted and when the climate fully responds.
- Leading scientists say we must drastically reduce our emissions to avoid the most catastrophic changes. They say we must start now to achieve these reductions.

Sources:

IPCC Fourth Assessment Report, Summary for Policy Makers. 2007.
Navigating by the Numbers, World Resources Institute. 2005.

INTRODUCE YOUR STUDENTS TO THE CONCEPT OF CAP AND TRADE. (5 min)

Explain to your students that one way to reduce greenhouse gas emissions is through a carbon cap and trade system. This is based on economics. Basically, it assumes:

- Increasing greenhouse gas emissions have a cost (for example, more severe droughts, floods, storms, disease, rising sea levels, collapsing ecosystems, species extinction).
- The emitters of these gasses, however, currently do not have to pay the cost. Currently they can dump emissions into the atmosphere for free.
- Therefore, the prices they charge for their products do not reflect the full cost of the products.
- This results in what economists call a "market failure."
- Establishing a market price for greenhouse gas pollution can help correct the market failure.



Notes to Teachers:

- The underlying assumption is that uses of fossil fuels for which people are willing to pay the most must be the most valuable.
- To minimize climate change most uses of fossil fuels will have to move to a different game: the clean energy economy.
- For practical reasons, most cap-and-trade proposals require only fossil fuel suppliers and other large polluters to play directly. They affect the rest of the economy as they pass on their costs.



Lesson 5: Carbon Cap & Trade

The Musical Chairs Game

In a cap and trade system:

- The government establishes a cap that limits the total amount of allowed greenhouse gas emissions.
- The government distributes permits for a “right to pollute.” These permits are either given or sold to polluters. They then become private property.
- The government reduces the number of permits available each year. This creates demand for a new commodity (carbon permits). This provides an incentive for those who can reduce emissions most inexpensively to do so.
- Polluters who reduce their emissions can sell their permits to other companies.

Source:

The Economics of Climate Change, Stern Review Report. 2006.

EXPLAIN THE CAP AND TRADE MUSICAL CHAIRS GAME TO YOUR STUDENTS. (5 min)

The object of the game is to reduce total carbon emissions every year in the most economically efficient way possible. The ultimate goal is to reduce emissions by at least 80%.

- Students will divide equally into groups representing companies.
- Sitting next to their company members, the students will arrange all the chairs into one large circle. Each company will be allotted a chair for every group member. The chairs represent carbon permits.
- Each company receives a hand-out listing potential options for reducing emissions and the relative cost associated with each option.
- Every round, one chair will need to be removed from the circle. This represents the government reducing the cap each year.
- Each company has to decide how and when they can reduce their emissions and sell off their permits.
- Each company must also keep track of how much money they make selling permits (the price for which they sold the permit minus their cost to reduce the emissions necessary to free up the permit).

PLAY THE CAP AND TRADE MUSICAL CHAIRS GAME. (15 min)

- In each round you, the teacher, represent a company that needs to purchase a carbon permit.
- Ask a student to maintain a list of the order in which companies sell permits, the value of the permits sold, and what action the company took to reduce their emissions enough to free up the permit.
- Start the first round by offering to buy a permit for \$5. If no company will sell, slowly increase your offer in increments of \$5.
- Round one ends when a company agrees to sell you one of its permits. That company must state how it reduced emissions to allow them to sell one of its permits. That company must now give you one of their chairs.
- To start the next round, remove the extra chair from the circle. You again represent a company needing to purchase a carbon permit. Start your bidding at the level you bought your permit in the last round. If no company will sell, incrementally increase your offer.
- Continue rounds until either time runs out or chairs are reduced to 80% of their starting number.

Lesson 5: Carbon Cap & Trade

The Musical Chairs Game



ASK STUDENTS TO SUMMARIZE WHAT HAPPENED DURING THE GAME. (5 min)

Ideally in a cap and trade market:

- The total amount of emissions decreases every year.
- Companies that can reduce their emissions most cheaply do so first.
- As the cap tightens each round, fewer permits are available, so the players with unneeded permits can charge the buyers higher prices.
- The price can go as high as it takes to motivate one of the companies to give up one of its permits.
- The last players remaining in the game are those who can afford to pay the most and those who have the least flexibility to reduce emissions.

ASK YOUR STUDENTS TO REFLECT ON STRENGTHS AND WEAKNESSES OF THE CAP AND TRADE SYSTEM AS A MECHANISM FOR REDUCING GREENHOUSE GAS EMISSIONS. (10 min)

Potential strengths include:

- It is a market-based solution.
- It puts a cost on greenhouse gas emissions to help correct the market failure.
- Newly created profit opportunities (from trading carbon permits) can drive continuous innovation and investment. In contrast to government-mandated reduction targets, profit-driven reductions can encourage reductions that go beyond the regulatory standard.
- Although it will increase the cost of carbon-based fuels and consumer products, it is not a carbon “tax.” This may make it more politically appealing.
- If the permits were auctioned, the government could return the auction proceeds to the public to help offset increased energy costs. This could be done in a progressive manner (benefiting lower-earning households who spend a greater proportion of their income on energy).

Potential weaknesses include:

- Questions arise about whether or not it is ethical to make a profit from carbon trading.
- Fossil fuel prices will rise. The cost will be passed on to consumers. It is likely to impose hardships on low-income households (to correct for this the government could use revenue from auctioning off the permits to support “carbon cost rebate” measures to alleviate pressures on low-income households).
- If there is not an international agreement about cap-and-trade markets and one country tries to do it by itself, companies in that country may decide it would be cheaper to move to another country that continues to let them emit greenhouse gasses for free. Similarly, products and energy could be imported from companies already operating in areas not included under the cap. This is called “leakage.”
- If the cap and trade system became complex like our tax system, it could be expensive to manage. Complexity could also open opportunities for loopholes.



Notes to Teachers:

- The underlying assumption is that uses of fossil fuels for which people are willing to pay the most must be the most valuable.
- To minimize climate change most uses of fossil fuels will have to convert to the new clean energy economy.
- For practical reasons, most cap and trade proposals require only fossil fuel suppliers and other large polluters to play directly. They affect the rest of the economy as they pass on their costs.



Lesson 5: Carbon Cap & Trade

The Musical Chairs Game



Notes to Teachers:

- This game is adapted with permission from "Cap-and-Trade: An Illustration of Managed Scarcity using Musical Chairs," a PowerPoint presentation by Dr. Holmes Hummel of the UC-Berkeley Energy Resources Group.



- For a more detailed explanation of the concepts involved, view the full presentation at <http://www.holmeshummel.net/ClimatePolicyDesign/>

- The relative costs of abatement presented in the game handouts are loosely based on results of the McKinsey Company's report "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?" The entire report is available at <http://www.mckinsey.com/client-service/ccsi/greenhousegas.asp>

- For comparison with another potential market-based strategy for reducing carbon emissions, see the lesson on Carbon Tax.

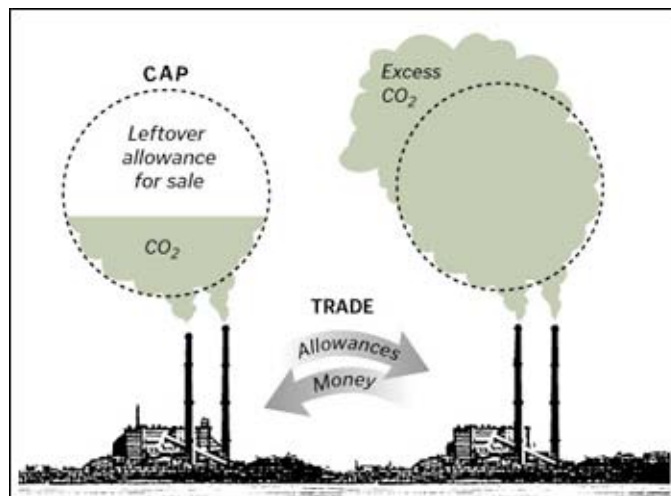
- For more information about designing a cap and trade system, see the Pew Trust Climate Change 101: Cap and Trade at: <http://www.pewclimate.org/docUploads/Cap&Trade.pdf>

- Certain carbon reductions may be difficult to verify and may not be permanent. For example, carbon permits from the Agriculture sector may not be guaranteed into the distant future—for example, if there were a fire, the carbon stored would be released to the atmosphere. This is an example of how a cap and trade system could result in a weakened cap.

- Questions arise about how to initially distribute the permits—giving them away or selling all or some of them in an auction. Giving some away could allow companies that receive them to have unfair advantages over companies that have to purchase them.
- Questions arise about whether or not our political institutions can be reliable enough to manage this massive new market.
- Federal climate policy would need to be forthcoming quickly. The complicated nature of a cap and trade system, however, might slow the legislative process.

HOMEWORK:

While the thoughts are fresh, each student should add a journal entry about opinions and thoughts raised by the lesson. The journal will serve as the starting point for each student to craft a position statement. The position statements will cover topics from each lesson. The more specific details each student includes in his or her journal, the easier it will be to write a position statement. A recommended format would be to record several ideas or opinions, each with at least three supporting statements, based in concepts presented in the lesson.



Lesson 5: Carbon Cap & Trade

The Musical Chairs Game



OIL COMPANY (PICK A NAME FOR YOUR COMPANY)

- Your company is allotted one carbon pollution permit (represented by a chair) for each member of your team.
- Your objective is to reduce your company's carbon emissions in the most economical way possible and to sell the permits you no longer need.
- You decide how and when you should reduce emissions and sell off a permit.
- You must also keep track of how much money you make selling permits (profits = price for which you sell the permit – your cost to reduce the emissions).
- You can use each option only one time.

<u>Options for reducing emissions</u>	<u>Cost</u>
Replace some sales of petroleum with cellulosic biofuels	\$70
Natural gas and petroleum systems management	\$105
Replace some sales of diesel with biodiesel	\$155

CHEMICAL COMPANY (PICK A NAME FOR YOUR COMPANY)

- Your company is allotted one carbon pollution permit (represented by a chair) for each member of your team.
- Your objective is to reduce your company's carbon emissions in the most economical way possible and to sell the permits you no longer need.
- You decide how and when you should reduce emissions and sell off a permit.
- You must also keep track of how much money you make selling permits (profits=price for which you sell the permit – your cost to reduce the emissions).
- You can use each option only one time.

<u>Options for reducing emissions</u>	<u>Cost</u>
Manage HFCs (hydrofluorocarbons, potent greenhouse gases) in manufacturing	\$90

POWER COMPANY (PICK A NAME FOR YOUR COMPANY)

- Your company is allotted one carbon pollution permit (represented by a chair) for each member of your team.
- Your objective is to reduce your company's carbon emissions in the most economical way possible and to sell the permits you no longer need.
- You decide how and when you should reduce emissions and sell off a permit.
- You must also keep track of how much money you make selling permits (profits = price for which you sell the permit – your cost to reduce the emissions).
- You can use each option only one time.

<u>Options for reducing emissions</u>	<u>Cost</u>
Replace some energy production from coal with wind energy	\$100
Replace some energy production from coal with new nuclear plants	\$115
Build new coal-fired power plants with Carbon Capture and Storage (CCS)	\$132
Replace some energy production from coal with solar	\$135
Retrofit old coal-fired power plants with CCS	\$140
Shift from burning coal to burning natural gas, dispatch of old power plants	\$150

COAL COMPANY (PICK A NAME FOR YOUR COMPANY)

- Your company is allotted one carbon pollution permit (represented by a chair) for each member of your team.
- Your objective is to reduce your company's carbon emissions in the most economical way possible and to sell the permits you no longer need.
- You decide how and when you should reduce emissions and sell off a permit.
- You must also keep track of how much money you make selling permits (profits = price for which you sell the permit – your cost to reduce the emissions).
- You can use each option only one time.

<u>Options for reducing emissions</u>	<u>Cost</u>
Coal mining methane management	\$85





Lesson 5: Carbon Cap & Trade

The Musical Chairs Game



AGRICULTURE COMPANY

(PICK A NAME FOR YOUR COMPANY)

- Your company is allotted one carbon pollution permit (represented by a chair) for each member of your team.
- Your objective is to reduce your company's carbon emissions in the most economical way possible and to sell the permits you no longer need.
- You decide how and when you should reduce emissions and sell off a permit.
- You must also keep track of how much money you make selling permits (profits=price for which you sell the permit – your cost to reduce the emissions).
- You can use each option only one time.

<u>Options for reducing emissions</u>	<u>Cost</u>
Conservation tillage	\$75
Afforestation of pastureland	\$103
Winter cover crops	\$115
Afforestation of cropland	\$130

CITY (PICK A NAME FOR YOUR CITY)

- Your city is allotted one carbon pollution permit (represented by a chair) for each member of your team.
- Your objective is to reduce your city's carbon emissions in the most economical way possible and to sell the permits you no longer need.
- You decide how and when you should reduce emissions and sell off a permit.
- You must also keep track of how much money you make selling permits (profits = price for which you sell the permit – your cost to reduce the emissions).
- You can use each option only one time.

<u>Options for reducing emissions</u>	<u>Cost</u>
Reduce the power draw from electronics	\$2
Replace incandescent lighting in buildings with LEDs	\$5
Make the fleet of cars and trucks fuel efficient	\$7
Retrofit old buildings to make them more energy efficient	\$55

