Global and Local Solutions to Climate Change

Overview

Students focus on global and local climate change solutions, using evidence gleaned from previous activities to support their predictions of the effectiveness of their proposed solutions. They come to understand that scientists and engineers are working to slow or stop climate change and to lessen the effects of climate change; people, businesses, communities, and governments can make choices that reduce their carbon footprints; and that possible solutions to climate change can involve chains of possible causes and effects.

Learning Outcomes

Students will be able to:

- Create climate change solution flowcharts, engage in discussions, and provide evidence that proposed solutions may have an impact on causes and effects of climate change.
- Describe how a solution will decrease the amount of heat-trapping gases in the atmosphere (mitigation) or prepare for inevitable increase in global temperature (adaptation).
- Reason logically about addressing the causes and lessening the effects of climate change.

17 **Use Wind Power and Solar Power**

Electricity is used to power a huge number of things, from televisions to computers to the lights in a football stadium. Energy to power electrical devices can be made in several different ways. Most energy is made through the burning of fossil fuels, especially coal. When fossil fuels are burned, they release heat-trapping gases, such as CO_2, into the atmosphere. Wind power and solar power are two other ways to produce energy. They are both renewable sources of energy, meaning that we will never run out of them. Wind and solar power also do not release heat-trapping gases into the atmosphere.

Wind power: As wind turbines turn, they convert wind energy to electricity. Some states have built offshore wind farms to capture wind energy along the coastline, while others have built inland wind farms. In 2012, wind power was responsible for just over 4 percent of the electricity generated in the United States.

Solar power: Solar power comes from the sun. Solar panels take light energy from the sun and convert it to electricity, so they work best in places that receive a lot of sunlight. Many states have built large solar power stations.

California is one state that already has laws that require 33 percent of all electricity in the state to come from renewable resources such as wind and solar power by 2020. You can write letters to your local power company or state government asking them to increase the amount of wind or solar power they use. You could even try changing your school's energy source to wind or solar!

Wind turbines generate electricity without burning fossil fuel.

Solar panels capture energy from sunlight.

Color Sheet—Ocean Sciences Sequence 3.11, 3.12

NGSS Connections

- **Disciplinary Core Ideas:** MS.ETS1.B: Developing Possible Solutions; MS.ESS3.D: Global Climate Change; HS.ESS3.C: Human Impacts on Earth Systems; HS.ESS3.D: Global Climate Change; HS.ETS1.B: Developing Possible Solutions
- **Science and Engineering Practice:** Constructing Explanations and Designing Solutions
- **Crosscutting Concepts:** Cause and Effect, Systems and System Models

Ocean Literacy Principles

- 6.G Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

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Students focus on global and local climate change solutions, using evidence gleaned from previous activities to support their predictions of the effectiveness of their proposed solutions. They come to understand that scientists and engineers are working to slow or stop climate change and to lessen the effects of climate change; people, businesses, communities, and governments can make choices that reduce their carbon footprints; and that possible solutions to climate change can involve chains of possible causes and effects.

Learning Objectives

Students will be able to:
- Create climate change solution flowcharts, engage in discussions, and provide evidence that proposed solutions may have an impact on causes and effects of climate change. Specifically:
  o Describe how a solution will decrease the amount of heat-trapping gases in the atmosphere (mitigation) or make adjustments in behavior to prepare for or accommodate the inevitable increase in global temperature (adaptation).
  o Connect a particular cause with effects on Earth and to reason logically about addressing the causes and lessening the effects of climate change.
  o Connect issues of heat-trapping gases, average temperature in the atmosphere, changes in the ocean, effects on people or organisms, and mitigating the effects of climate change, based on their selected solutions.

Students will understand that:
- Scientists and engineers are working to slow or stop climate change and to lessen the effects of climate change. (OSS 3.10)
- People, businesses, communities, and governments can make choices that reduce their carbon footprints (OSS 3.11)
- Possible solutions to climate change can involve chains of possible causes and effects. (OSS 3.12)

Educator Note: OSS (above) refers to the curriculum *Ocean Sciences Sequence: The Ocean–Atmosphere Connection and Climate Change* available from the Lawrence Hall of Science. This curriculum provides additional activities addressing climate change and the underlying concepts supporting a

deeper understanding of the Earth system and climate change.

http://mare.lawrencehallofscience.org/curriculum/ocean-science-sequence/oss68-overview

Materials Needed

For the educator:
- 2-3 examples of Solutions Flow Charts' student work

For the class
- PowerPoint presentation
- Digital/data projector
- Whiteboard or flip chart paper and pens
- 1 set of Climate Change Solutions Color Sheets (set/24)
- Climate Change Solutions class chart (see Preparation of Materials)
- Masking tape
- (optional) 24 sheet protectors (for Climate Change Solutions Color Sheets)
- (optional) document camera

For each participant
- Handout: Climate Change Solutions
- (Optional) Handout: Tools for Writing about Solutions

For each pair
- 1 packet of small sticky notes
- 1 sheet 9x12 blank paper
- Student cause and effect flow charts from previous activity

Preparation of Materials

1. **Post chart.** Make a *Climate Change Solutions* chart, writing the title across the top, and labeling two columns as follows: Brief description of solution; and How affects climate change. Find a place to post the *Climate Change Solutions* chart where everyone will be able to see it.
2. **Plan location for Climate Change Solutions color sheets.** Student pairs will select three or more of these sheets to read during the session. Plan for space to set them out on tables, desks, and counters so a pair of students can be seated near the sheet they're reading. You will set out the sheets during the session, right after explaining the activity.

3. **Preview solution sheets.** Skim the information on as many of the solution sheets as possible so you're familiar with what students will be reading. You might want to put each sheet in a sheet protector.

4. **Access to cause and effect flow charts from previous sessions.** Make sure that your students have access to the cause and effect flow charts completed previously.

5. **Decide if you would like to add additional examples of global climate change solutions.** The book described below includes the 100 most substantive solutions to reverse global warming, based on meticulous research by leading scientists and policymakers around the world: *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*, edited by Paul Hawken, 2017, Penguin Books.

6. **Decide if you will assign homework before starting activity.** You might consider assigning students homework to do a web search to find examples of **global** solutions to climate change. They can then share the examples they found and together work to categorize the solutions.

7. **Write question starters on the board or chart paper.** Write question starters on the board (or on a piece of chart paper and post where it will be visible to all participants).
   a. What is your evidence that__will cause____?
   b. Will ___really be a big enough change to cause_____?
   c. Will____also cause_____?

8. **Make copies.**
   a. Climate Change Solutions 2pg handout (one for each student)
   b. Climate Change Solutions Color Sheets (one copy of each of the 24 sheets, in color, for the class)
   c. (Optional) Tools for Writing about Solutions 2pg handout (one for each student).

Session at a Glance

Task	Description	Time (minutes)
A. Science Briefing & Activity: *Exploring global solutions to climate change*	Students brainstorm **global** solutions to climate change. A science briefing defines categories of solutions and carbon footprint. They then investigate Climate Change Solution Sheets and discuss the category of solution, whether it reduces the carbon footprint, and if it seems feasible.	40
B. Activity: *Local solutions flow charts*	Students create **local** solution flow charts and are challenged to provide evidence that their solution may have an impact on the	25

	local effect of climate change.	
C. Optional Assessment: *What was learned – causes, effects & solutions of climate change?*	Students select one of the solutions discussed in class and explain how that solution will address effects of climate change. They use evidence from their cause and effect flow chart to discuss the reasons why this solution will help. An optional handout can be used to help scaffold their writing.	20

Session Details

A. Science Briefing and Activity: *Exploring global solutions to climate change*

*Educator Note: Before starting this activity, you might consider assigning students homework to do a web search to find examples of **global** solutions to climate change. They can then share the examples they found and together work to categorize the solutions as described below.*

Categorize example solutions

1. **Introduce global solutions to climate change.** Tell students that we have been learning a lot about the causes and effects of climate change, both global and local. Explain that now the focus is on solutions – specifically, global effects and solutions.

2. **Introduce *Climate Change Solutions* class chart and small group brainstorm.** Have students work in a group and discuss the following prompts:
   a. What are some global solutions to climate change that you have heard about?
   b. Based on what you have learned about climate change, what do *you* think would be a possible global solution?
   Remind students that these ideas need to be focused on **global** effects and solutions, not local effects and solutions.

3. **Record solutions on class chart.** Lead a whole group discussion, eliciting ideas from each of the small groups. Record their ideas using brief, summary statements in the first column on the *Climate Change Solutions* class chart. (**Instructor note:** *one person from each small group can record their group's ideas on the class chart, or the teacher can record as they share whole group.*)

4. **Focus now on global solutions; later on local solutions.** Point out any local solutions shared by the students and tell them the next activity will focus more explicitly on the local or regional

climate change effects and solutions. Circle, or otherwise highlight the local solutions on the class chart to refer to later.

5. **Define categories of global solutions.** Tell students that global solutions to climate change, like they just brainstormed, typically fall into one of the following three categories: 1) put less carbon into the atmosphere [less use of fossil fuel], 2) take back some of the carbon that is already in the atmosphere [scrubbing or trapping devices or processes], and 3) lessen the effects of climate change [e.g., living on houseboats or building large dikes to hold back water].

6. **Small groups discuss example global solutions.** Have small groups pick (or assign them) one of the solutions on the class chart to discuss in a small group using the following prompts:
   a. Describe the solution, and the benefits and possible drawbacks;
   b. Which of the categories of solutions does it fit best? Explain your rationale and get feedback and critique from your group members to strengthen/modify/change your ideas;
   c. Be ready to share one of the solutions with the whole group and to support your ideas about how you categorized it using what you have learned about the carbon cycle and climate change.

7. **Small groups share in whole group.** Have students share their ideas with the whole group. When students are sharing, challenge them to explain how each idea will address the causes of climate change or some of its effects. Encourage other students to ask questions as the groups share ideas so that they practice making strong connections between their solutions and climate change.

8. **Explain carbon footprint.** Explain that solutions, which reduce CO_2 in the atmosphere, are said to reduce our "carbon footprint." Carbon footprint means the amount of heat-trapping gases a person, business, or government is responsible for releasing into the atmosphere. A carbon footprint is focused on the use of energy and resources—the CO_2 that is released into the atmosphere by people using transportation, electricity, food, clothing, and other products. Mention that it's called a carbon footprint because it has to do with the effects we produce by our activities on Earth, like a footprint that is left behind as we walk on the ground. We can each monitor our own carbon footprint and relate that to local, regional and global solutions.

9. **Share scientists and engineers solutions.** Tell participants that the following slides feature different creative solutions to climate change; the first four deal with release and capture of atmospheric CO_2, and the last two address some effects (shrinking sea ice and sea level rise) of

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climate change. Project and briefly explain each of the six slides. (**Educator Note:** Decide if you would like to replace or add additional examples from the web or the *Drawdown* book.)

    a. **Store Carbon in Rocks.** It may be possible to capture CO_2 when it is released from burning fossil fuels, combine it with minerals and store it as part of rocks. A group of scientists in Europe is studying how to do this, which may help to store carbon in a very stable form for long periods of time.

    b. **Capture CO_2 from the Atmosphere.** Scientists are developing technology that will absorb large amounts of carbon dioxide on multiple panels as air passes through the tall towers.

    c. **Capture CO_2 from Factories BEFORE It Reaches the Atmosphere.** Brazilian scientists have improved techniques of absorbing carbon dioxide produced by factories before it reaches the atmosphere. They use tiny ceramic spheres, which act as "cages" for trapping CO_2.

    d. **Reduce Cow and Other Ruminant Gas**. Researchers from Argentina were surprised to find that a single cow produces between 800 and 1,000 liters of methane gas each day. Scientists are trying new diets to improve the cows' digestion and reduce the heat trapping methane gas they put out. By feeding cows clover and alfalfa instead of grain, scientists report that you can reduce cows' methane output by 25 percent.

    e. **Paint Roofs White.** This idea has to do with the climate-change effect of shrinking sea ice, glaciers and ice sheets. Due to its light color, ice reflects a lot of heat back into space so it doesn't warm Earth's atmosphere as much. As the ice shrinks, we have less white area on Earth to reflect heat. Scientists have suggested that everyone paint their roofs white to imitate ice cover. This may help slow climate change by making up for some of the ice that has disappeared. An inventor has even hired a team to start painting a section of the Andes Mountains white. These mountains used to be covered in snow.

    f. **Build Houseboats**. As sea level starts to rise, there may be flooding in coastal areas. In response, many areas are building communities of houseboats that can float and stay above the rising sea level.

10. **Introduce and define terms.** Introduce the terms **Adaptation** and **Mitigation** and contrast and define them as follows:

    a. Mitigation – dealing with the **causes** of climate change such as making changes in behavior that will have a direct effect on an undesired change (e.g. CO_2 emissions), Mitigation solutions attempt to alter the carbon cycle by increasing a carbon sink (capturing or absorbing more carbon) or decreasing an anthropogenic (human caused) carbon source.

    b. Adaptation – dealing with the **consequences** of climate change, such as making a behavioral change to prepare for or accommodate an inevitable change (i.e. building higher levees for sea level rise, or shifting to harvest summer flounder off of New Jersey rather than North Carolina as the species shift northward). Adaptation solutions prepare communities for the consequences of global warming.

    c. **Share some of the following examples.** Regarding the six slides shown previously, the first four are mitigation strategies, whereas the last one is an adaptation strategy. Painting roofs white is an interesting example - on first glance it appears to be merely adaptation, but if the result causes people to use less air conditioning, then it could be considered mitigation.

11. **Add to *Climate Change Solutions* chart.** Have students categorize their small group's assigned solution as either mitigation or adaptation and add this to the second column on the class *Climate Change Solutions* chart.

Investigating climate change solution sheets (OSS 3.10 and 3.11)

1. **Introduce solution sheets; project slide, 24 Solutions.** Tell students this is a list of 24 ideas, similar to the ones they brainstormed. These are all things people, businesses, communities, and governments can do to reduce their carbon footprints or prepare for some of the effects of climate change. Some of the solutions shown are mitigation strategies, whereas others are adaptations to deal with some effects of climate change.

2. **Explain solution sheets procedure.** Tell students that there will be one sheet about each of the 24 solutions listed on the slide. The sheets will be placed in different locations around the classroom. They will work in pairs, and pairs will go around and read at least three of the sheets about solutions they find interesting. Let them know they will have about 10 minutes for this activity.

3. **Distribute Climate Change Solutions handout.** Distribute the *Climate Change Solutions* handout to each student. Explain that they'll read and discuss a solution sheet together with their

partner, then each of them will record information on his or her own handout. Partners should both be prepared to share what they learn about the solutions they selected.

4. **Set out the sheets and clarify logistics.** Set out the sheets on tables around the room, have students choose a partner, and get started. After students complete a reading and fill in the information in their handout, they should move on to another solution sheet until time is called.

Debriefing the Solution Sheets

1. **Discuss solutions.** When students have completed 3-5 solution sheets, have them return to their seats to discuss as a class. Have volunteers share which of the solutions they found most interesting and which they found most doable. Encourage input from others, including questions from those that may not have read the sheet being discussed. Ask questions such as:
   a. How does this solution reduce the carbon footprint?
   b. How does this solution deal with one of the causes (making behavior changes that will directly affect a desired change) or consequences (making a behavioral change to prepare for or accommodate an inevitable change) of climate change?
   c. Do you think you could do this?
   d. How could you encourage others to do this?

2. **Optional: Students write a key concept.** Have students summarize what they have learned about solutions to climate change by writing a sentence as a key concept. After they write their key concepts, students can also add additional notes about specific solutions. You might invite a few students to share their key concepts with the class.

3. **Share Key Concepts.** Display the following key concepts and lead a class discussion about the evidence they have gathered that support these ideas.
   – Scientists and engineers are working to slow or stop climate change and to lessen the effects of climate change.
   – People, businesses, communities, and governments can make choices that reduce their carbon footprints
   – Possible solutions to climate change can involve chains of possible causes and effects.

B. Activity: *Local Solutions Flow Charts*

Educator Note: sample student Solution Flow Charts are provided in case you are interested in seeing examples of middle school students' completed work.

1. **Introduce small group brainstorm for local solutions.** Tell students they will now work in a small group to brainstorm **local** climate change solutions for some of the causes and local effects discussed previously and included on their Cause and Effect Flow Charts. Groups should be ready to explain whether their ideas reflect adaptation or mitigation strategies and their rationale for putting forth that local solution.

2. **Small groups brainstorm.** Have students refer to their Cause and Effect flow charts and focus on the local effects they added previously. Give students about 10 minutes to work in their small group to brainstorm ideas for solutions to the local effects of climate change included on their flow charts, and any others that come to mind at this time. Encourage them to think broadly and identify solutions to natural, ecological, economic and sociocultural effects.

3. **Add local solutions to the climate change solutions chart.** Have students add their selected solutions to the class chart already started. Highlight the local solutions to set them apart from the global solutions.

4. **Refer to local solutions on class chart.** Have pairs of participants quickly discuss their two top-choice local solutions. Call on pairs to share which local solution they would like to focus on and try to have the possible solutions distributed among different pairs.

5. **Discuss uncertainty about effects.** Say, "When predicting the future effects of an action, such as the climate change solutions we've discussed, scientists can never be completely sure about what will happen. They use evidence about climate, the atmosphere, the ocean, CO_2, and Earth's history to support their predictions, but there is always some uncertainty about what will happen. This uncertainty is a natural part of all science."

6. **Introduce local solution flowchart.** Tell participants that they will create a **solution** flowchart, similar to the cause and effect flowcharts they made earlier. Describe the steps as follows:
   a. Choose one local solution from the chart (e.g. paint roofs white), write the action you would take on a sticky note and place it at the top of a 9x12 sheet of paper.
   b. Add results or effects of taking that action on another sticky note (e.g. reflects more light/absorbs less light than dark surfaces).
   c. On another sticky note describe how the results/effects (e.g., less absorbed light on Earth) would lead to addressing an aspect of climate change (e.g., less warming of the atmosphere). Explain that this flowchart could grow with additional sticky notes as there could be many effects from addressing an aspect of climate change.

      d. Write evidence for the cause/effect/solution relationships along the arrows on the flow charts connecting the sticky notes. Evidence can come from activities we have done in class or things you have read.

7. **Distribute 9x12" sheet of paper and sticky notes to make flow chart.** Tell them that they will work together in pairs to create their own sticky notes to place on the 9x12" sheet that will become a cause and effect flow chart. Emphasize that each pair will make one flow chart.

8. **Pairs create flow charts.** Tell students that they should start by creating one sticky note for the action in their solution. Then they will add sticky notes for the chain of effects resulting from that action. (***Instructor note****: If you have time and participants have access to the Internet, have them do additional research about the solution for which they plan to create a flow chart.*)

9. **Circulate, probe for evidence and assist as needed.** Walk around the room as pairs work and ask, "What is your evidence that this cause would lead to this effect?" As needed, remind them of previous activities that can help them predict chains of cause and effect.

10. **Have pairs add arrows and evidence.** Once the pairs are satisfied with the content and placement of their sticky notes, have them add arrows and evidence connecting and explaining the causes and effects.

Discussing Solution Flow Charts

1. **Discuss flow charts and predictions they show.** Say, "We'll ask questions about the evidence that backs up these predictions. Scientists ask each other tough questions, not to be disrespectful, but to help the whole scientific community be more careful in its thinking."

2. **Introduce question starters.** Write the question starters on the board or post the chart you made previously. Explain that these are just some of the kinds of questions they can ask each other as solutions are being shared. They can also ask other questions as well.
   a. What is your evidence that__will cause____?
   b. Will ___really be a big enough change to cause_____?
   c. Will____also cause_____?

3. **Give examples of posing questions**. Say, "For the example we gave regarding painting roofs white, you might ask, 'Would the action of painting roofs white really reflect enough light to have the effect of slowing down the warming of the atmosphere?' and the person who created this

chart might answer: 'I'm not sure; you might need to paint many thousands of roofs before it would make a difference.'" Invite volunteers to suggest other questions that could be asked about this example, using the question starters on the board. [What is your evidence that slower warming of the atmosphere would mean less melting of glaciers? Could making extra paint for roofs also cause more carbon to be emitted by factories?]

4. **Discuss use of qualified language.** Point out where it says on the flow chart example that warming of the atmosphere would slow down, not stop. It also says there would be fewer types of organisms in danger, not that all organisms would be safe. Say, "Any one climate change solution will not completely stop climate change and its effects."

5. **Presentations in small groups.** Combine pairs to form groups of six or eight. Have each pair take a turn presenting their flow chart to the other pairs and answering any questions.

6. **Discuss one pair's flowchart.** Invite a volunteer pair to share their flow chart with the class. If you have a document camera, use it to project the pair's chart. Otherwise, quickly copy the chart onto the board. Invite students to pose questions about the chart. Invite the students who created the chart to respond to questions from others. Reassure the students who made the chart that all scientists' work faces tough questions; it's actually a good sign of scientific thinking if some of the questioning makes the participants want to make changes to their chart.

7. **Discuss other flowcharts as time allows.** Repeat this process with as many pairs' flowcharts as time allows.

C. Optional Assessment: *What was learned about climate change causes, effects and solutions?*

1. **Explain the activity.** Explain that students will now complete a final writing activity to demonstrate how much they have learned about climate change. Display the prompt:
   – Select one of the solutions we've discussed in class and explain in writing how that solution will address effects of climate change. Use evidence from your cause and effect flow chart to discuss the reasons why this solution will help.

2. **(Optional) Distribute Tools for Writing about Solutions handout.** Distribute this resource page to each student to help scaffold their writing.

3. **Criteria for assessing solution explanations.** What to look:

    a. Whether their explanation describes how the solution will decrease the amount of heat-trapping gases in the atmosphere (mitigation) or make adjustments in behavior to prepare for or accommodate the inevitable increase in global temperature (adaptation).

    b. Whether students were able to connect a particular cause with effects on Earth and to reason logically about addressing the causes and lessening the effects of climate change.

    c. Whether students connected issues of heat-trapping gasses, average temperature in the atmosphere, changes in the ocean, effects on people or organisms, and mitigating the effects of climate change, based on their selected actions.