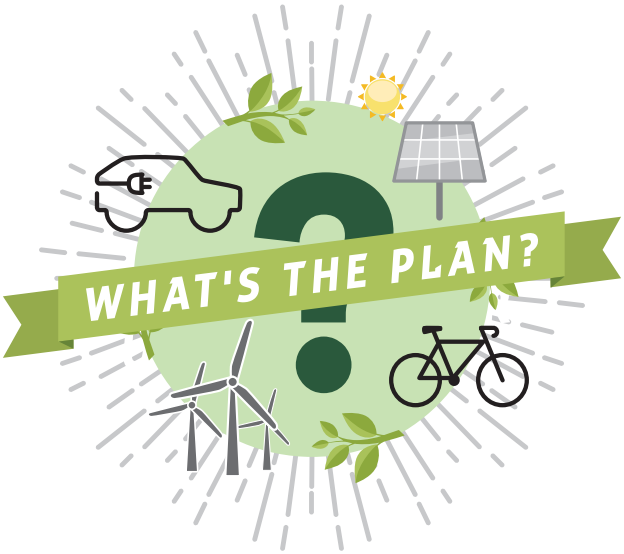
Climate Change



Mitigation

DESCRIPTION

Students investigate actions that individuals can take to decrease their carbon emissions and mitigate climate change. They consider a strategy from several perspectives and analyze the associated benefits and challenges. Students then create a poster to present their analysis of a mitigation strategy and the pros and cons of implementing it.

PHENOMENON

There are many proposed strategies individuals can take to mitigate climate change, but implementing them comes with pros and cons that should be considered.

GRADE LEVEL

9-12

OBJECTIVES

Students will:

- Explain how mitigation strategies can slow or lessen the effects of climate change
- Analyze the challenges and benefits of an individual action to mitigate climate change
- Develop solutions to overcoming the challenges in implementation of an individual mitigation strategy

TIME

45-MINUTES

COMMON CORE STATE STANDARDS

English Language Arts

CCSS.ELA-LITERACY.RI.9-10.8 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-LITERACY.RI.11-12.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

CCSS.ELA-LITERACY.W.9-12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

CCSS.ELA-LITERACY.W.9-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

NEXT GENERATION SCIENCE STANDARDS

Performance Expectation

HS-ESS3-4 Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions	ESS3.C Human Impacts on Earth Systems ESS3.D Global Climate Change ETS1.B Developing Possible Solutions	Stability and Change

BACKGROUND

Since the Industrial Revolution, fossil fuel extraction and combustion have resulted in significant fluxes of fossil carbon to the atmosphere, thus causing a human-induced perturbation in the carbon cycle (Ciais et al., 2013). Increasing atmospheric carbon is resulting in climate change. Several technologies already exist that, when used in combination, can mitigate the effects by reducing or eliminating carbon emissions while meeting the world's energy needs. These include increased vehicle efficiency, building efficiency, power plant carbon capture and storage, wind power, and solar power (Pacala and Socolow, 2004). Scientists have also identified strategies that individuals can implement to reduce their carbon emissions, including having one fewer child, switching to a hybrid car or car-free life, limiting air travel, and eating a plant-based diet (Wynes and Nicholas, 2017). Students evaluate these actions for their feasibility, effectiveness of mitigating climate change, and their social and economic impacts.

MATERIALS

- PowerPoint presentation
- Computer and projector for educator
- Copies of Mitigation Strategy pages, black and white or color [1 set per group]
- Copies of Mini-poster [1 set per group]
- *Optional:* Copy of Stakeholder Cards, copied onto cardstock and cut [1 per class]

PREPARATION

1. Set up a computer and projector and display the PowerPoint presentation.
2. If your students do not have a basic understanding of climate change and the greenhouse effect before starting this activity, you may wish to show or assign one or more of the videos in the extensions section at the end of this guide.
3. Make one Mini-poster for every group of students. Cut each page along the dotted line, align the pages, and tape them together. Alternatively, you may plan to have students assemble their Mini-posters if time permits.
4. If you are using the Stakeholder Cards, copy one set of cards onto cardstock (if available), and cut on the dotted lines.

PRESENTATION

INTRODUCTION

1. **Slide 2**: carbon moves around the planet via the carbon cycle. Humans have modified the carbon cycle by burning fossil fuels, which release carbon, in the form of carbon dioxide, into the atmosphere.
2. **Slide 3**: carbon dioxide is a greenhouse gas that traps heat inside the atmosphere. This causes many changes to the earth's climate and also results in feedback loops, which release even more carbon dioxide into the atmosphere. For example, warming the atmosphere melts the polar ice caps, causing sea levels to rise. Sea level rise destroys coastal ecosystems, which take up carbon dioxide from the atmosphere more quickly than most other ecosystems, resulting in more carbon dioxide in the atmosphere. If time permits, discuss one or more of the other examples listed on the slide:
   - Disease spread: The distribution of disease vectors such as mosquitos, fleas, and ticks is limited by climate. A changing climate may allow these animals to spread to new habitats and increase disease risks.
   - Growing season changes: Warmer temperatures earlier in the year are expanding plant growing seasons, which may be beneficial in agriculture.
   - Habitat loss: For some species, changes in temperature and precipitation are making their current habitats uninhabitable. Many marine mammals are moving towards the poles in search of cooler water as ocean temperatures rise.
   - Extreme weather patterns: Changing ocean and air temperatures lead to stronger and more frequent hurricanes and tornadoes. Climate change models also predict more intense droughts and winter storms in the future.
3. **Slide 4**: give students a minute to brainstorm major ways humans release carbon into atmosphere and ways that humans reduce or prevent the release of carbon into the atmosphere. [Answers for releasing carbon may include: using cars and other transportation, burning coal and gas for electricity, cutting down trees, and raising livestock. Answers for reducing carbon emissions might include: driving less, biking, walking, using renewable energy, conserving energy, planting trees, and reducing, reusing, and recycling.]

MITIGATION

1. **Slide 5**: mitigation is any action that reduces the severity of something. Climate change mitigation strategies slow or lessen the effects of climate change by reducing the amount of greenhouse gases entering the atmosphere or by removing them from the atmosphere. The data in this infographic is from a study (Wynes and Nicholas, 2017) that investigated the most effective ways for individuals to reduce their carbon emissions. Today, you will choose one of the strategies to analyze and refine.
2. **Slide 6**: mitigation of any problem is complicated, with sound arguments that can be raised for or against any action. The strategies in the previous slide have been researched extensively, and implementing them can reduce carbon emissions. However, there are social, cultural, economic, and safety challenges with all of them. It is your job to think critically about these challenges, try to address them, and determine if the strategy is feasible.
3. **Slide 7**: as a class, you will analyze one strategy together. Solar energy is electricity generated by solar panels. Scientists have estimated that carbon emissions would be reduced by 0.5 Pg/year (Pg or petagram is equal to 10^{15} grams, or approximately the weight of 6 million blue whales) if we replaced 1000 GW of coal-generated electricity with solar-generated electricity. This would require three billion solar panels. A few

challenges to implementing solar energy and a few steps that could help to make it happen are listed on the slide.
   a. [Optional] To encourage students to examine this strategy from a variety of perspectives, you can pass out one Stakeholder Card to each student. Ask them to think about the idea of using solar energy from the perspective on their card. Give students a minute to read their card and discuss with their neighbor the opinions their stakeholder might have about solar energy.
4. **Slide 8**: what are the biggest challenges to using solar energy? [Possible answers: the space needed for solar panels, the initial set up costs, resistance from the fossil fuel industry, the difference between peak energy production times and peak energy use times, and a limited supply of materials for solar panels and batteries.]
   a. [Optional, if using Stakeholder Cards] Which stakeholders in the room have a strong argument against using solar energy?
5. **Slide 9**: whose responsibility is it to lead the effort to transition to solar energy? Is it up to individuals, corporations, governments, or someone else? Where in the world could this happen? Can poor countries implement solar energy? Are there parts of the world where it would be a bad idea to build solar farms? For example, it rains and it overcast a lot in Seattle, so that is probably not a good place for solar farms. There is plenty of space in Antarctica, but there is little sunlight there during half of the year.
   a. [Optional, if using Stakeholder Cards] Which stakeholders have a responsibility to lead the effort to transition to solar energy?
6. **Slide 10**: who will pay for installing solar panels? Should it be individual people who want them, the government, or power companies? Who will benefit? [Possible answers: everyone gets cleaner air; power companies don't have to mine coal anymore; businesses that build solar panels will expand.] Who will be hurt by it? [Possible answers: people who currently work in the fossil fuel industry may lose their jobs. Places where the materials for solar panels are mined could be harmed.]
   a. [Optional, if using Stakeholder Cards] Can/would any of the stakeholders take responsibility to help pay for solar panels?
7. **Slide 11**: what are the pros and cons of switching to solar energy? [Possible answers for pros: cleaner air and water, less expensive energy in the long run, will slow climate change, and will save people money. Possible answers for cons: will cost a lot of money up front, thousands of people rely on the coal and gas industry for jobs, and solar panels are made with materials that have to be mined, harming the environment.] Does investing in solar energy mean that you are ignoring another type of renewable energy that could be more effective? Hydroelectric, tidal, geothermal, and wind energy might be better options in some places.
   a. [Optional, if using Stakeholder Cards] Are there any stakeholders that would like to share the pros and cons of switching to solar energy from their perspective?
8. **Slide 12**: if you were in charge of making sure we switch to solar energy, how would you do it? Where would you find space? How would you address the cost? Would you need to change people's habits or the law to make sure it happens?
9. **Slide 13**: this slide is an example of a Mini-poster that summarizes our evaluation of the strategy. Question 7 on the poster asks how to address the challenges that the class identified.

ANALYZE A MITIGATION STRATEGY

1. Divide students into small groups, pairs, or choose to have them work individually.
2. Pass out a set of Mitigation Strategy pages and a copy of the Mini-poster to each group.
3. **Slide 14**: each group will choose one of the five mitigation strategies from the Mitigation Strategy pages to analyze and refine.
   a. Each group will create their own Mini-poster like the one for solar energy on the previous slide. The Mini-poster has several questions to help you consider different aspects of your proposed strategy.
   b. You can use the Mitigation Strategy pages to get started, but most of the information you will fill out on your poster will not be included on the pages. You will have to think critically about the world to come up with a strategy you think will work to mitigate climate change.
   c. Try to consider the strategy from many different perspectives, just like we did in the solar energy example.
      i. [Optional] If you chose to use the Stakeholder Cards for the class example discussion of solar panels, students will not be using them for this activity. Simply instruct them to keep in mind the perspectives of all the stakeholders as they complete the activity.
   d. Discuss and answer all of the questions on the poster before answering question 7 because you might come up with ways to improve the strategy as you discuss and think about the challenges, pros, and cons.
4. **Slide 15**: this slide shows all the mitigation strategies proposed in the paper mentioned earlier. Leave this up as students

begin their work. You may give students the rest of class to work, or you may stop them 10 minutes before the end of class to share their strategies and have a class discussion about which strategies will be most successful and are most feasible.

EXTENSIONS

1. If you have access to computers, students can do their own research on their mitigation strategy to find other challenges and solutions they have not considered or to search for examples of successful implementation of the strategy.
2. Display the infographic on slide 5 and have students choose one of the mitigation actions and conduct one or both of the following:
   a. Create a plan for how they could incorporate one of the mitigation actions into their own lives.
   b. Develop a public education effort in their community to raise awareness about the strategy. After conducting more research as needed, students could create graphics for social or print media, create a video advertisement for television, YouTube, or TikTok, and/or write a letter to the editor of the local paper, for example.
3. If students need more background on climate change, you may want to show or assign one of these videos:
   - CIRES videos- Our Shared Climate Future https://www.youtube.com/watch?v=sGrQdLH1K74
     - This video explains the greenhouse effect, the science of measuring atmospheric carbon dioxide, and the impacts of warming on the planet.
   - Global Weirding- Southern Great Plains & Southwest https://www.youtube.com/watch?v=wd6w6mTQGwc
     - This video explains the region-specific impacts of climate change, including extreme weather events, drought, wildfire, and enhanced climate variability. It does not include an explanation of the greenhouse effect. The Global Weirding with Kathrine Hayhoe YouTube Channel is created by PBS Digital Studios and Texas Tech University Public Media and has videos on every region of the US.
   - Intergovernmental Panel on Climate Change (IPCC)- Climate Change 2013: The Physical Science Basis. https://www.youtube.com/watch?v=6yiTZm0y1YA&feature=player_detailpage
     - This video is fairly technical. It is appropriate for older students who have some familiarity with climate change and the greenhouse effect.

ADDITIONAL RESOURCES

Pacala, S. and R. Socolow. 2004. Stabilization wedges: solving the climate problem for the next 50 years with current technologies. Science 305: 968-972.

Wynes, S. and K.A. Nicholas. 2017. The climate mitigation gap: education and government recommendations miss the most effective individual actions. Environmental Research Letters: 12.