



UNIT OVERVIEW • GRADE 4






Why are weather-related power outages happening more often in California?

Power Outages and Energy Systems

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OVERVIEW

Unit Question: Why are weather-related power outages happening more often in California?

Humans rely on electricity, but sometimes the power goes out. It seems that the power is going out more frequently in California in recent years. To explore this phenomenon, students begin by figuring out where electricity comes from and how it gets to our homes and schools. They then explore how extreme weather events, such as extreme storms and extreme heat, can lead to power outages. Students then investigate the effects of a warming climate on power outages. Finally, students determine how communities can take action to prepare for power outages and ensure fair decisions around energy resilience.

While investigating power outages, students will

- create initial models to show why power outages are more frequently occurring.
- investigate California's power grid using hands-on materials and case studies.
- determine how extreme weather can cause power outages.
- explore the effects of power outages on different communities and ways to adapt and mitigate the outages.
- use the class consensus final explanatory model to develop an action plan addressing one or more aspects of power outages in California.

Unit Home Discipline: Science

STANDARDS SUMMARY

California Environmental Principles and Concepts

→ Principle 1—People Depend on Natural Systems

The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

- **Concept A.** The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.

→ Principle 2—People Influence Natural Systems

The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

- **Concept C.** The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.

→ Principle 3—Natural Systems Change in Ways That People Benefit from and Can Influence

Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

- **Concept C.** Human practices can alter the cycles and processes that operate within natural systems.

→ Principle 4—There Are No Permanent or Impermeable Boundaries That Prevent Matter from Flowing Between Systems

The exchange of matter between natural systems and human societies affects the long-term functioning of both.

- **Concept A.** The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting by-products.



→ Principle 5—Decisions Affecting Resources and Natural Systems Are Complex and Involve Many Factors

Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

- **Concept A.** There is a spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.

History—Social Science

→ Historical and Social Sciences Analysis Skills

Research, Evidence, and Point of View

- 2) Students pose relevant questions about events they encounter in historical documents, eyewitness accounts, oral histories, letters, diaries, artifacts, photographs, maps, artworks, and architecture.

Historical Interpretation

- 3) Students identify and interpret the multiple causes and effects of historical events.

Science

This lesson builds understanding toward this/these California Next Generation Science Standards Performance Expectation(s):

- **NGSS 4-PS3-2:** Make observations to provide evidence that energy can be transformed from place to place by sound, light, heat, and electrical currents.
- **NGSS 4-ESS3-1:** Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.
- **NGSS 4-ESS3-2:** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

This lesson emphasizes these elements of the California Next Generation Science Standards:

→ Science and Engineering Practices

- **Asking Questions and Defining Problems:**
 - Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
 - Use prior knowledge to describe problems that can be solved.
- **Developing and Using Models:**
 - Develop and/or use models to describe and/or predict phenomena.
 - Develop a model using an ~~analogy~~, example, or ~~abstract representation~~ to describe a scientific principle or ~~design solution~~.
- **Planning and carrying out investigations:**
 - Make observations ~~and/or measurements~~ to produce data to serve as the basis for evidence for an explanation of a phenomenon or ~~test a design solution~~.
- **Analyzing and Interpreting Data:**
 - Analyze and interpret data to make sense of phenomena using logical reasoning, ~~mathematics~~ and/or ~~computation~~.
- **Constructing Explanations and Designing Solutions:**
 - Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
 - Identify the evidence that supports particular points in an explanation.
 - Construct an explanation of observed relationships.
- **Engaging in Argument from Evidence:**
 - Compare and refine arguments based on an evaluation of the evidence presented.
 - Use data to evaluate claims about cause and effect.



- Respectfully provide and receive critiques from peers about a ~~proposed procedure~~, explanation or model by citing relevant evidence and posing specific questions.
- Construct and/or support an argument with evidence, data, and/or a model.
- **Obtaining, Evaluating and Communicating Information:**
 - Obtain and combine information from books and/or other reliable media to explain phenomena or ~~solutions to a design problem.~~

→ Disciplinary Core Ideas

- **PS3.A: Definitions of Energy:** Energy can be moved from place to place by moving objects or through sound, light, or electrical currents.
- **PS3.B: Conservation of Energy and Energy Transfer:** Energy can also be transferred from place to place by electrical currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.
- **ESS3.A: Natural Resources:** Energy and fuels that humans use are derived from natural sources and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.
- **ESS3.B: Natural Hazards:** A variety of natural hazards results from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate natural hazards, but can take steps to reduce their impacts.

→ Crosscutting Concepts

- **Patterns:**
 - Identify similarities and differences in order to sort and classify natural objects and designed products.
 - Identify patterns related to time, including simple rates of change and cycle, and use these patterns to make predictions.
- **Cause and Effect:**
 - Routinely identify and test causal relationships and use these relationships to explain change.
- **Systems and System Models:**
 - A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
 - A system can be described in terms of its components and their interactions.
- **Energy and Matter:**
 - Matter is made of particles and energy can be transferred in various ways and between objects.

Common Core English Language Arts

- RI.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- RI.4.2: Determine the main idea of a text and explain how it is supported by key details; summarize the text.
- RI.4.3: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
- RI.4.6: Compare and contrast a firsthand and secondhand account of the same event or topic.
- RI.4.7: Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, timelines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
- W.4.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- W.4.2D: Use precise language and domain-specific vocabulary to inform about or explain the topic.
- W.4.8: Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- W.4.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.
- SL.4.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.



- SL.4.1C: Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
- SL.4.2: Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

BACKGROUND INFORMATION for TEACHERS

This unit is a storyline-driven curriculum that introduces students to the problem of how the number of weather-related power outages in California has been increasing in recent years. Investigations in the unit are designed to help students explain this phenomenon. The unit begins with students observing data about changes in the frequency of power outages in California since the early 2000s and the effect these outages have on people and communities. Throughout the unit, students gain an understanding of how extreme weather can cause power outages and how electricity generation can contribute to climate change. Students also explore alternative energy sources and electricity sources that can potentially lessen the impact of climate change. They consider ways that communities can adapt to the increasing frequency of power outages and mitigate climate change to become energy resilient.

The unit is grounded in three basic science concepts appropriate for fourth grade:

1. Electricity can be transferred from its source at a power plant to where it is used in communities to produce motion, sound, heat, or light.
2. Electricity that humans use is generated from natural sources, such as coal, oil, the Sun, wind, water, or nuclear fuel. Their use affects the environment in multiple ways. Some resources are renewable over time, and some are not; some contribute to climate change, others do not.
3. There is a cause-and-effect relationship between the burning of fossil fuels that emit greenhouse gases that contribute to the greenhouse effect by warming Earth, causing global warming, which contributes to climate change, causing an increase in extreme weather and thus an increased frequency of power outages.

The science and engineering practice of Developing and Using Models is emphasized throughout the unit.

Students create initial models and modify them as their understanding increases. Throughout the unit, these observable features of models are emphasized: (1) defining and clearly labeling all of the essential components (parts); (2) describing the relationships among the components of the model; and (3) using the model to describe or predict using logical reasoning.

One way the unit addresses environmental justice is through the exploration of community stories that illustrate different impacts and solutions for power outages. Students explore how vulnerable communities, often the most impacted by power outages and climate change, have access to the resources, information, and decision-making processes needed to protect themselves. Students explore how communities can become more energy resilient by being prepared for and recovering quickly in response to power outages. Students learn that communities can take steps to ensure access to reliable energy even during disruptions caused by extreme weather events driven by climate change. This resilience often requires a combination of both adaptation and mitigation efforts.



STORYLINE

Lesson 1: ANCHOR

Lesson Question:

Why are weather-related power outages happening more often in California?

Session 1 • 45 min

Students will

- Explore an Anchoring Experience: Gallery Walk
- Explore an Anchoring Experience: Prior Knowledge
- Explore an Anchoring Experience: Data

Session 2 • 45 min

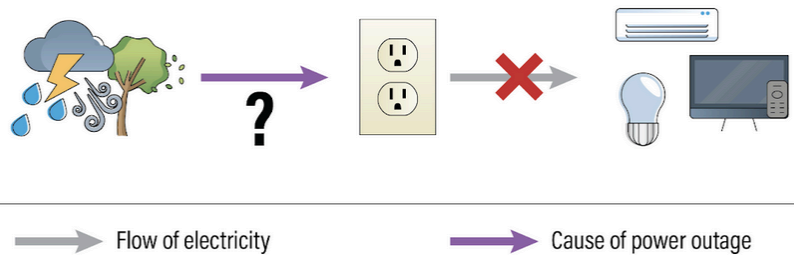
Students will

- Generate an Initial Explanatory Model
- Generate a Driving Question Board
- Navigate

What students figure out:

- Weather-related power outages are happening more often in California.
- People are impacted differently by power outages.

Sample Initial Model:



▲ In **Lesson 1**, we *figure out* that power outages are happening more frequently and that they impact different people/communities differently. *This leaves us wondering about* where our electricity comes from and how it gets to our homes and schools in **Lesson 2**. ▼

Lesson 2: INVESTIGATION

Lesson Question:

Where does our electricity come from, and how does it get to our homes and school?

Session 1 • 45 min

Students will

- Navigate
- Gather Information and Evidence

Session 2 • 45 min

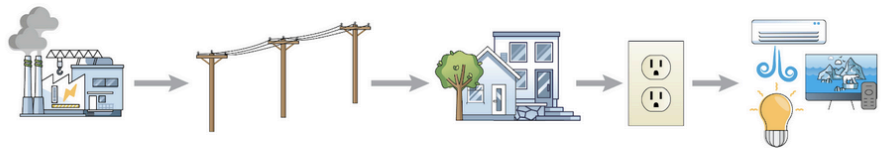
Students will

- Gather Information and Evidence
- Generate an Explanation
- Navigate

What students figure out:

- Electricity flows in a complete circuit, from the power source to where it is used in our devices.
- Electricity is generated in power plants and transferred through transmission lines to where it is used in a system called the energy grid.

Sample Model:



→ Flow of electricity

▲ In **Lesson 2**, we *figure out* that electricity flows in a circuit from a power plant, through transmission lines, to where it is used.. This leaves us wondering why our power goes out sometimes and why it is happening more frequently in **Lesson 3**. ▼



Lesson 3: INVESTIGATION

Lesson Question:

How can the weather cause a power outage?

Session 1 • 45 min

Students will

- Navigate
- Gather Information and Evidence

Session 2 • 45 min

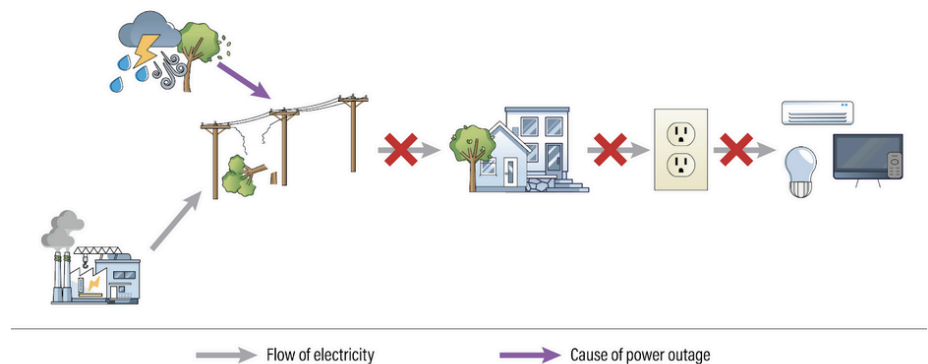
Students will

- Gather Information and Evidence
- Generate an Explanation
- Navigate

What students figure out:

- Extreme storms can cause power outages by making power lines fall down or break, usually due to tree branches falling on power lines.
- Communities are affected differently by power outages caused by extreme weather, but all communities can work to solve problems related to power outages.

Sample Model:



▲ In **Lesson 3**, we *figure out* that power outages occur in extreme storms because power lines break. We figure out that different communities respond differently to power outages and that all communities can work together to solve problems related to power outages. *This leaves us wondering about* other types of extreme weather that could lead to power outages in **Lesson 4**. ▼



Lesson 4: INVESTIGATION

Lesson Question:

How do other extreme weather events cause power outages?

Session 1 • 45 min

Students will

- Navigate
- Gather Information and Evidence

Session 2 • 45 min

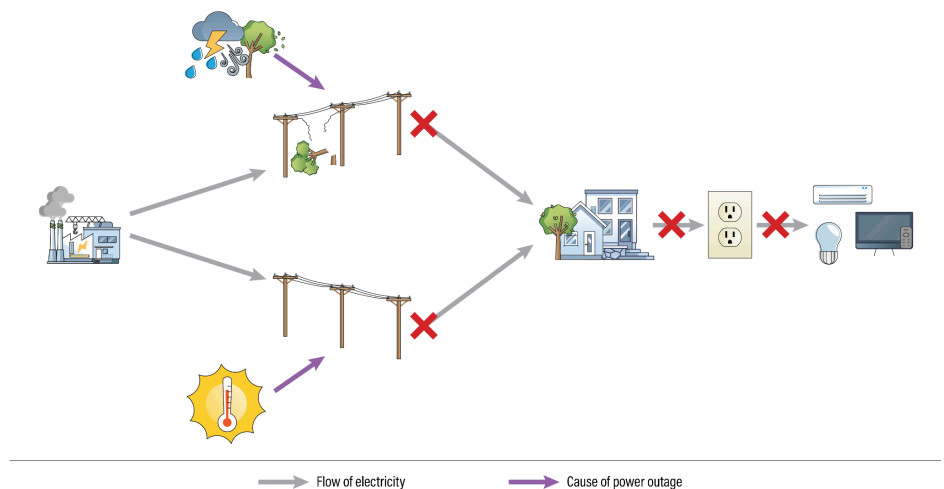
Students will

- Gather Information and Evidence
- Generate an Explanation
- Navigate

What students figure out:

- The number of high heat and high fire danger days are increasing in California.
- During extreme heat events, there is a high demand on the electrical system, which may cause the power to be intentionally turned off (e.g., blackout or brownout) to save energy.
- During high fire danger days, system operators turn off parts of the electrical system to prevent wildfires.
- Different communities are affected differently by power outages caused by high heat and high fire danger days, but all communities can work to solve problems related to power outages.

Sample Model:



▲ In **Lesson 4**, we *figure out* that extreme heat and extreme fire danger days can overload the electrical system with too many people needing energy. System operators plan and implement an outage to reduce energy consumption and reduce the danger of wildfires. We also figure out that different communities respond differently to power outages and that all communities can work together to solve problems related to power outages. *This leaves us wondering* what is causing the weather to become more extreme in **Lesson 5**. ▼



Lesson 5: INVESTIGATION

Lesson Question:

What is causing the weather to become more extreme?

Session 1 • 45 min

Students will

- Navigate
- Gather Information and Evidence

Session 2 • 45 min

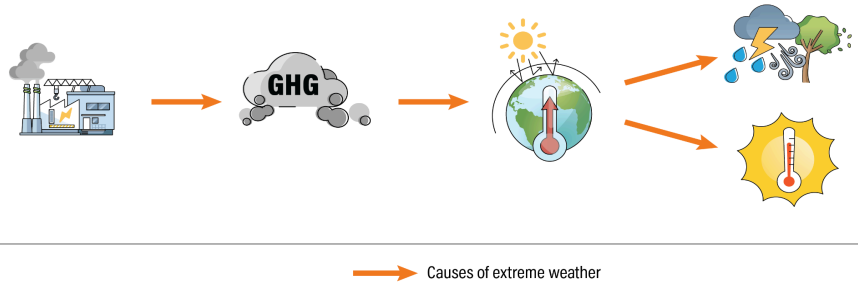
Students will

- Generate an Explanation
- Navigate

What students figure out:

- Burning fossil fuels increases the amount of greenhouse gases in the atmosphere, which can influence the greenhouse effect and warm the planet.
- When Earth's average surface temperature increases, it can cause changes to the climate and an increase in extreme weather events, resulting in more power outages.

Sample Model:



▲ In **Lesson 5**, we *figure out* that the generation of electricity can result in greenhouse gas emissions, which can influence the greenhouse effect and lead to climate change. Climate change can increase the frequency of extreme weather events and lead to more power outages. *This leaves us wondering about* other sources of electricity that can be used that don't contribute to climate change in **Lesson 6**. ▼

Lesson 6: INVESTIGATION

Lesson Question:

How are different sources of electricity related to extreme weather events and climate change?

Session 1 • 45 min

Students will

- Navigate
- Gather Information and Evidence Part 1

Session 2 • 45 min

Students will

- Gather Information and Evidence Part 1, continued

Session 3 • 45 min

Students will

- Gather Information and Evidence Part 2
- Gather Information and Evidence: Pros and Cons

Session 4 • 45 min

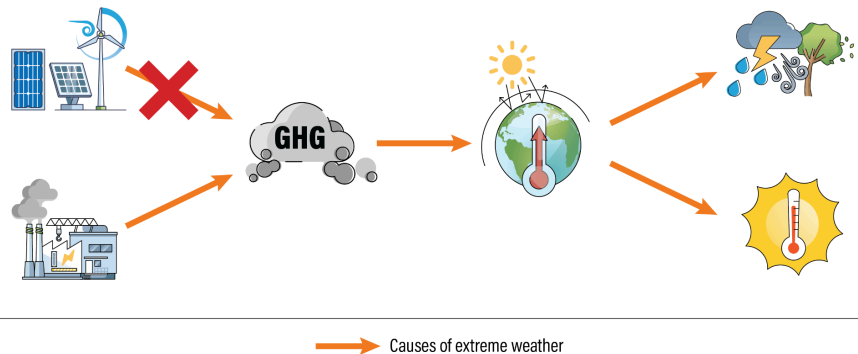
Students will

- Gather Information and Evidence: Pros and Cons
- Generate an Explanation
- Navigate

What students figure out:

- Some energy sources burn fossil fuels to generate electricity which contributes to climate change. Others do not use fossil fuels and do not contribute to climate change.
- Some energy sources are renewable, while others are nonrenewable. California has a goal to shift to more renewable, non-fossil fuel energy sources.
- Each energy source comes with different kinds of benefits and downsides..

Sample Model:



▲ In **Lesson 6**, we *figure out that* there are multiple sources of electricity available to Californians. Some of these sources use fossil fuels while others do not, and some sources use nonrenewable resources while others use renewable resources. *This leaves us wondering about* how communities can choose wisely and equitably for their energy sources and what actions they take to help when a power outage occurs in **Lesson 7**. ▼

Lesson 7: INVESTIGATION

Lesson Question:

How can our community take action and make fair decisions to become more energy resilient?

Session 1 • 45 min

Students will

- Navigate
- Gather Information and Evidence

Session 2 • 45 min

Students will

- Gather Information and Evidence
- Generate an Explanation
- Navigate

What students figure out:

- Solutions for power outages need to address the needs of the community and be fair and just.
- Communities can take mitigation actions that can help prevent more weather-related power outages from occurring in the future.
- Communities can also take adaptive actions that help respond to and recover from power outages that continue to happen.
- Communities are resilient when they can withstand changing conditions and difficulties, such as those caused by increased numbers of power outages.

Sample Model:

Adaptation actions	Mitigation actions	How to be resilient
Buying extra batteries and flashlights	Using solar panels	Meeting with other people in the community to organize
Installing a generator or backup battery to power equipment	Building alternative energy sources like wind	Attending first aid and emergency training
Learning survival skills and relying on the natural world to live without electricity	Inspecting utility poles and trimming branches to prevent outages	Setting up cooling centers for people
Planning ahead and using energy earlier or waiting to use appliances until later in the day when there is a Flex Alert	Developing clean energy solutions to reduce reliance on polluting generators during storms	
	Studying in college to have a career in addressing climate change	

▲ In **Lesson 7**, we *figure out* that communities become more resilient if they have developed and implemented ways to mitigate climate change at its root causes and/or ways to adapt to existing conditions that protect them when there is an outage. *This leaves us wondering about* how we can synthesize our understanding in **Lesson 8**. ▼



Lesson 8: CONSENSUS MODEL BUILDING

Lesson Question:

Why are weather-related power outages happening more often in California?

Session 1 • 45 min

Students will

- Navigate
- Generate a Class Final Explanatory Model

Session 2 • 45 min

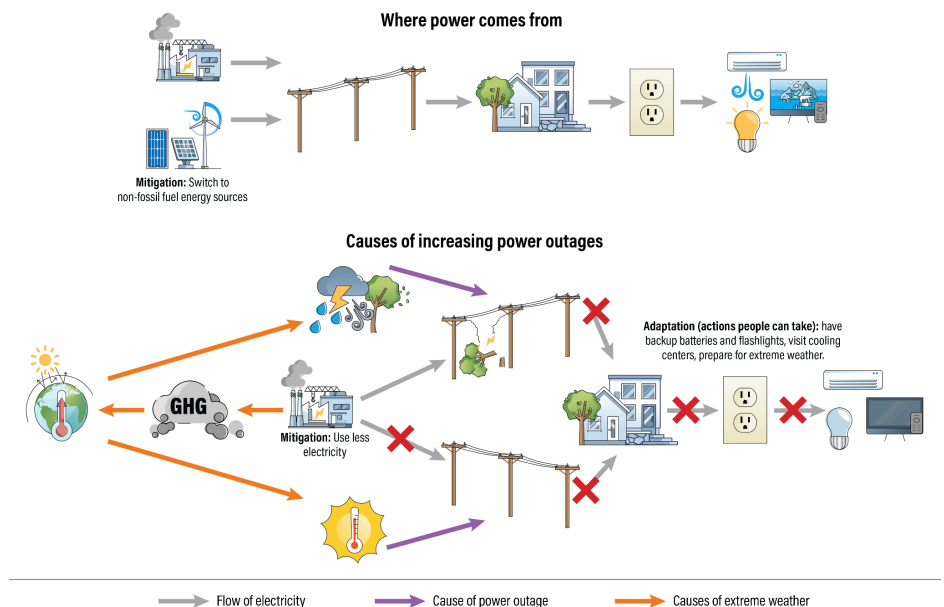
Students will

- Generate a Class Final Explanatory Model
- Navigate

What students figure out:

- The increasing number of power outages in California is due to extreme weather events brought on by climate change.
- Some of the ways we generate electricity can contribute to climate change, and others do not.
- Our communities can respond to increased numbers of power outages by responding and adapting and/or addressing climate change.

Sample Final Model:



▲ In **Lesson 8**, we *review* the cause-and-effect relationship between the burning of fossil fuels, climate change, extreme weather, and power outages. We review the need for communities to become resilient through mitigation and adaptation processes that are fair and equitable. We *reflect* on actions we might take to help lessen the impacts of climate change as we start **Lesson 9**. ▼



Lesson 9: CULMINATING ENGAGEMENT

Lesson Question:

How can we identify actions to better prepare and protect ourselves and our community from power outages?

Session 1 • 45 min

Students will

- Navigate
- Develop an Action Plan

Session 2 • 45 min

Students will

- Putting the Plan into Action
- Reflect and Connect

What students plan:

- A project to inform parents and community members about the causes and impacts of extreme-weather-driven power outages, motivating them to join efforts to make the community more resilient and equitable in responding to these disruptions.

Sample Model:

There is no model update for this Lesson.

▲ In **Lesson 9**, we *plan* a solution to the challenge of power outages in California that builds upon the ideas learned throughout the unit and incorporates equity and justice.