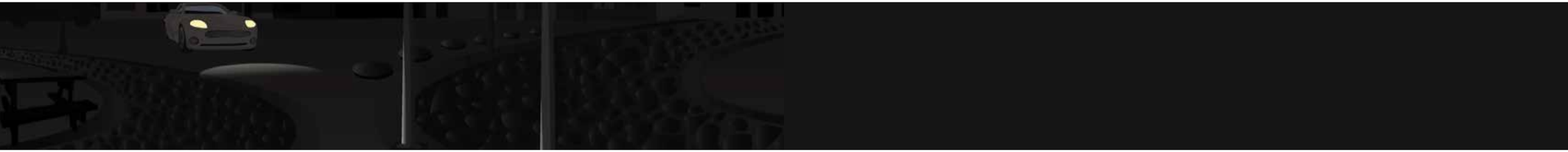
AmplifyScience
CALIFORNIA

Grade 4

## Energy Conversions

# Unit guide



# Welcome to Energy Conversions

Energy can be a challenging concept, even for adults. Given its complexity, it requires a great deal of firsthand exploration and sense-making to help students ground their understanding and integrate their new knowledge. Amplify Science California helps students develop a deeper understanding of energy—where it comes from, how it moves through a system, and what forms it takes—through a variety of multimodal activities and experiences.

## Unlike a typical curriculum, Amplify Science California anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of systems engineers. Their job is to help the fictional town of Ergstown figure out what is causing their frequent blackouts. Working together, they use and construct devices that convert energy from one form to another, build an understanding of electrical systems, and learn to identify energy forms all around them. By the end of the unit, students design a new electrical system for the town and write arguments for why their design choices will make the town's electrical system more reliable.

**Unit Type:** Engineering Design

**Student Role:** Systems Engineers

**Phenomenon:** Why is the fictional town of Ergstown experiencing frequent blackouts?

**Core Concepts:** Understanding how electrical systems work

**Target Performance Expectations:**

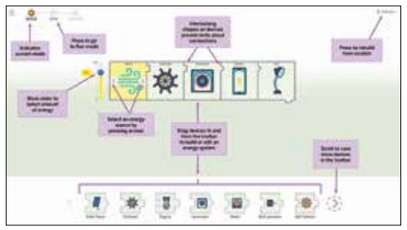
- 3-PS3-1: Relationship Between Speed and Energy
- 4-PS3-2: Energy can be Transferred
- 4-PS3-3: Collisions
- 4-PS3-4: Design an Energy Converter
- 4-ESS3-1: Energy and Fuels
- 3-5-ETS1-1: Defining the Problem
- 3-5-ETS1-2: Developing Possible Solutions

## Students figure out the unit phenomenon through the use of a variety of resources.


**Student Books**

**Hands-On Kit**


**Videos**



**Simulations**

**About technology in this unit:**
All Amplify Science California lessons were designed with device sharing in mind, and never assume that every student has a separate device.

In grade 4, student-facing technology includes Practice Tools and digital Simulations. In this unit, only 6 of the x22 lessons incorporate the use of devices with only 7% of the unit's activities involving the use of a digital tool.

When the use of a digital tool is called for in a lesson, teachers have several implementation options:

- **If limited student devices are available—**teachers can have students do the activities in pairs or small groups.
- **If no student devices are available—**the teacher can project the digital tool to the class and either "drive" the digital tool herself or invite students to "drive" by using her device.
- **If internet access is unavailable—**the teacher can "pre-load" the digital tool on her device or devices for use offline.

# Chapter 1: The storyline begins

## What students investigate:

What happened to the electrical system the night of the Ergstown blackout?

## What they figure out:

The devices stopped working in Ergstown because they weren't able to get electrical energy from the electrical system. To convert energy to light, heat, motion, or sound, devices need to be plugged into the wall and receive electrical energy. During the blackout, the devices weren't getting this electrical energy.

## How they figure it out:

- Learning about what makes a system as they read the student book *Systems*
- Investigating several different systems, including a simple circuit powered by a solar cell
- Discussing how scientists and engineers focus on systems in their work as they read the student book *Who Thinks About Systems?*
- Reviewing evidence from the blackout
- Making an argument about what they think caused the blackout

HANDS-ON
READING
SIM
STUDENT-TO-STUDENT DISCUSSION
TEACHER-LED DISCUSSION
WRITING

**Day 1** | Lesson 1.1
**Pre-Unit Assessment**

- Students Write Initial Explanations (20 min)
- Introducing the Problem (15 min)
- Introducing Investigation Notebooks (10 min)

Pre-Unit Assessment

**Day 2** | Lesson 1.2
**Introducing Systems**

- Reflecting on the Unit Problem (5 min)
- Observing a Simple System (15 min)
- Introduction to Synthesizing (15 min)
- Reading: *Systems* (25 min)

On-the-Fly Assessment

**Day 3** | Lesson 1.3
**Exploring Systems**

- Building a Simple Electrical System (25 min)
- Parts of a Simple Electrical System (15 min)
- Parts and Functions (20 min)
- Reading About Systems in Science and Engineering (25 min)

On-the-Fly Assessment

**Day 4** | Lesson 1.4
**Electrical Energy**

- Introducing Energy (10 min)
- Exploring the Simulation (20 min)
- Finding Electrical Energy in the Simulation (20 min)
- What Uses Electrical Energy? (10 min)

On-the-Fly Assessment

**Day 5** | Lesson 1.5
**Forms of Energy**

- Electrical Systems with Different Energy Outputs (20 min)
- Introducing the Reference Book (10 min)
- Reading About and Discussing Forms of Energy (15 min)
- Synthesizing (15 min)

On-the-Fly Assessment

**Day 6** | Lesson 1.6
**Writing an Argument About the Blackout**

- Forms of Energy (15 min)
- Introducing Claims and Evidence (10 min)
- Engaging in Shared Listening (10 min)
- Writing Arguments (25 min)

On-the-Fly Assessment
Self-Assessment

# Chapter 2: The storyline builds

## What students investigate:

What makes the devices in Ergstown output energy or fail to output energy?

## What they figure out:

Energy isn't created or destroyed. Devices can convert electrical energy to light, heat, motion, or sound when they get electrical energy because these are all forms of energy. When all the devices were running, they caused a blackout. The devices needed more energy from the electrical system than was available. Either the town was using too many devices, or the devices were not energy efficient. If more energy is needed from the electrical system than is available, a blackout can occur.

## How they figure it out:

- Exploring different ways to convert energy from one form to another using the Sim
- Investigating the relationship between the amount of energy used and the amount of energy in the electrical system
- Considering how people use electrical devices to do various tasks in their everyday lives and how people accomplished these same tasks before electrical devices were invented as they read the student book *Energy Past and Present*
- Writing their first argument for how to solve the problem of blackouts in Ergstown

HANDS-ON
READING
SIM
STUDENT-TO-STUDENT DISCUSSION
TEACHER-LED DISCUSSION
WRITING

**Day 7** | Lesson 2.1
**Energy Converters**

- Reading About Energy Converters (25 min)
- Energy in Electrical Systems (25 min)
- Reflecting on Learning (10 min)

On-the-Fly Assessment
Optional Flextension: *Energy Conversion Stations*

**Day 8** | Lesson 2.2
**Energy Past and Present**

- Using the Energy Conversions Sorting Tool (15 min)
- Introducing Energy Past and Present (5 min)
- Reading: *Energy Past and Present* (20 min)
- Synthesizing Ideas from the Book (10 min)

On-the-Fly Assessment

**Day 9** | Lesson 2.3
**Energy in the System**

- Critical Juncture: Energy Conversion (10 min)
- Ergstown Changes (10 min)
- Too Many Devices Demonstration (5 min)
- Energy in the System (15 min)
- Discussing Solutions and Criteria (20 min)

On-the-Fly Assessment
Critical Juncture Assessment

**Day 10** | Lesson 2.4
**Design Arguments About Devices**

- Supporting a Claim with Evidence (5 min)
- Gathering Evidence in the Sim (15 min)
- More Evidence from the Reference Book (15 min)
- Writing a Design Argument (25 min)

Self-Assessment

# Chapter 3: The storyline goes deeper

## What students investigate:

Where does the electrical energy for the devices in Ergstown come from?

## What they figure out:

Electrical energy that comes through the electrical grid must have a source and a source converter. There are many possible sources, such as fossil fuels, wind, water, and sunlight. Each source has a converter that changes the energy form of the source to electrical energy. Energy use in Ergstown could have caused a blackout if there wasn't enough energy coming from the source, there weren't enough source converters to convert energy from the source, or the source converters were broken.

## How they figure it out:

- Investigating a variety of energy sources that provide power to Ergstown
- Learning about Dr. Ashok Gadgil, an engineer, and his students who have worked together to design a solar water heater for use in Guatemala as they read the student book *Sunlight and Showers*
- Designing and building a wind converter that can power an electrical device
- Comparing the strengths and weaknesses of two possible solutions to the problem

HANDS-ON
READING
SIM
STUDENT-TO-STUDENT DISCUSSION
TEACHER-LED DISCUSSION
WRITING

**Day 11** | Lesson 3.1
**Investigating Energy Sources**

- Energy in Ergstown (10 min)
- Exploring Sources in the Sim (20 min)
- Synthesizing Ideas About Energy Sources (10 min)
- Reading About Energy Sources (20 min)

On-the-Fly Assessment

**Day 12** | Lesson 3.2
**Converting Energy from Sources**

- Observing an Electric Generator (20 min)
- Sorting Energy Converters (20 min)
- Explaining Energy Converters (15 min)
- Energy for the Ergstown Hospital (5 min)

On-the-Fly Assessment

**Day 13** | Lesson 3.3
**Sunlight and Showers**

- Critical Juncture: School Backup Electrical System (15 min)
- Thinking About Engineering Practices (10 min)
- Reading: *Sunlight and Showers* (25 min)
- How We Were Engineers (10 min)

Critical Juncture Assessment

**Day 14** | Lesson 3.4
**Designing a Wind Turbine**

- Introducing Possible Solutions (10 min)
- Getting Ready to Design (10 min)
- Designing a Wind Turbine (40 min)

On-the-Fly Assessment

**Day 15** | Lesson 3.5
**Redesigning Wind Turbines**

- Introducing the Design Cycle (15 min)
- Peer Review of Wind Turbine Designs (10 min)
- Redesigning Wind Turbines (20 min)
- Reflecting on Designs (15 min)

On-the-Fly Assessment

**Day 16** | Lesson 3.6
**Design Arguments About Converters**

- A New Proposal for Ergstown (5 min)
- Gathering Evidence (15 min)
- Discussing Solutions and Criteria (20 min)
- Writing a Design Argument (20 min)

On-the-Fly Assessment
Self-Assessment

# Chapter 4: Application to a new context

### What students investigate:

How does energy get to the devices all over Ergstown?

### What they figure out:

The energy that comes from the source is transferred through the electrical grid. The devices won't function if the wires that connect the source converter and the devices are broken. This can happen if the connections between the grid and the converters aren't strong enough, if the wires aren't in a secure location, or if there aren't enough backup wires.

### How they figure it out:

- Learning about real-life blackouts that have occurred around the world as they read the student book *Blackout!*
- Reviewing evidence from Ergstown
- Analyzing the efficiency of various converters
- Assessing different improvements to the electrical system
- Designing and presenting two possible "best" solutions

HANDS-ON
READING
SIM
STUDENT-TO-STUDENT DISCUSSION
TEACHER-LED DISCUSSION
WRITING

**Day 17** | Lesson 4.1
**Blackout!**

- Introducing System Failure (10 min)
- Building and Analyzing Failing Systems (30 min)
- Reading: Blackout! (20 min)

On-the-Fly Assessment

**Day 18** | Lesson 4.2
**Investigating System Failure**

- Synthesizing Ideas About System Failure (25 min)
- Introducing the Electrical Grid (20 min)
- Reviewing Evidence from Ergstown (15 min)

On-the-Fly Assessment

**Day 19** | Lesson 4.3
**Improving the Electrical Grid**

- Roundtable Discussion (20 min)
- Critical Juncture: Explaining Ergstown's Blackout (15 min)
- Introducing Grid Solutions (5 min)
- Discussing Solutions (20 min)

On-the-Fly Assessment
Critical Juncture Assessment

**Day 20** | Lesson 4.4
**System Improvements**

- Criteria for Improving the System (10 min)
- Considering System Improvements (25 min)
- Gathering Evidence of Efficiency (25 min)

On-the-Fly Assessment

**Day 21** | Lesson 4.5
**Arguments for System Improvements**

- Preparing for the Town Hall Meeting (20 min)
- Town Hall Meeting (40 min)

On-the-Fly Assessment

**Day 22** | Lesson 4.6
**End-of-Unit Assessment**

- Writing a Design Argument (40 min)
- Synthesizing Ideas About Energy (20 min)

End-of-Unit Assessment
Self-Assessment

# All students. All standards.

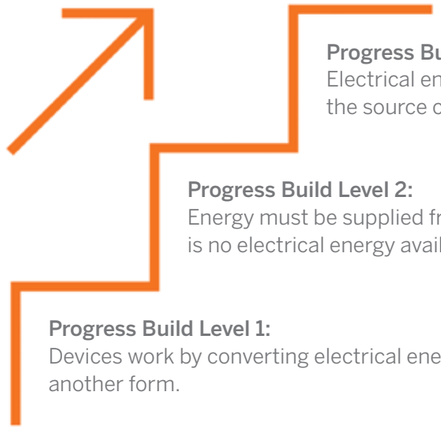
Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, we successfully made the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how a students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

## *Energy Conversions* Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of what causes a blackout and devices to stop working.



**Progress Build Level 3:**
Electrical energy can be transferred by wires connecting the source converter to the device.

**Progress Build Level 2:**
Energy must be supplied from a source and converted or there is no electrical energy available for devices to convert.

**Progress Build Level 1:**
Devices work by converting electrical energy to another form.

## Examples of differentiation in this unit

In addition to unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science California makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief.**

Below are a few examples of strategies embedded in this unit.

### For English learners:

- **Sentence starters for Roundtable Discussion (Example from Lesson 2.3)**
  You may wish to provide students with sentence starters to help them form questions and responses during the Roundtable Discussion. Sentence starters help students get started expressing their ideas, yet leaves the cognitive work for them to do as they complete the sentence sentences. Some helpful sentence sentences for responding include:
  - I think this solution makes sense because_____.
  - I do not think this solution makes sense because _____.
  - If people have to stop using some devices it will be _____.
  - If the town installs more LED lights it will be _____.
  - I think the solution that best meets the criteria is _____.

### For students needing more support:

- **Explicit instruction about text features (Example from Lesson 3.1)**
  Before students read *It's All Energy*, the teacher can describe and model the use of the titles and headings in the text. Explicitly showing students how to engage with a reference book and how to use the tools embedded in the text helps all students succeed with this genre. Reading science texts, especially reference books, may be unfamiliar to many students and explicitly modeling for students how to find essential information gives them an entry point to engage purposefully with the reference text.

### For students ready for a challenge:

- **Additional writing opportunity (Example from Lesson 1.4)**
  Ask students to write a summary of what they discovered when using the Simulation. Encourage them to use the new vocabulary words: *parts, function, electrical energy*, and *electrical device* in their summary.

# 3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

The 3-D Statement document is made all the more effective by color-coding the three dimensions for easy recognition.

**KEY:** Practices | Disciplinary core ideas | Crosscutting concepts

## *Energy Conversions* 3-D Coverage

### Unit Level

Students investigate—through firsthand experiences, a digital model, and by obtaining information by reading—how electrical systems convert and transfer energy (systems and system models, energy and matter). They use what they learn to design, test, and evaluate improvements to cause the electrical system to be more reliable, even during natural hazards and to make arguments based on evidence for the best improvements (cause and effect).

### Chapter Level

**Chapter 1: What happened to the electrical system the night of the blackout?**

Students obtain information about electrical systems and the different forms of input and output energy (systems and system models, energy and matter) by reading and by using a digital model. They then apply what they have learned about systems and energy (systems and system models, energy and matter) to explain what might have caused the problem with the electrical system (cause and effect).

**Chapter 2: What makes the devices in Ergstown output or fail to output energy?**

Students read, use a digital model, and analyze data to figure out that there are many ways that energy can be converted from one form to another (systems and system models, energy and matter). They then construct arguments to support a claim about one solution for reducing blackouts (cause and effect) in Ergstown.

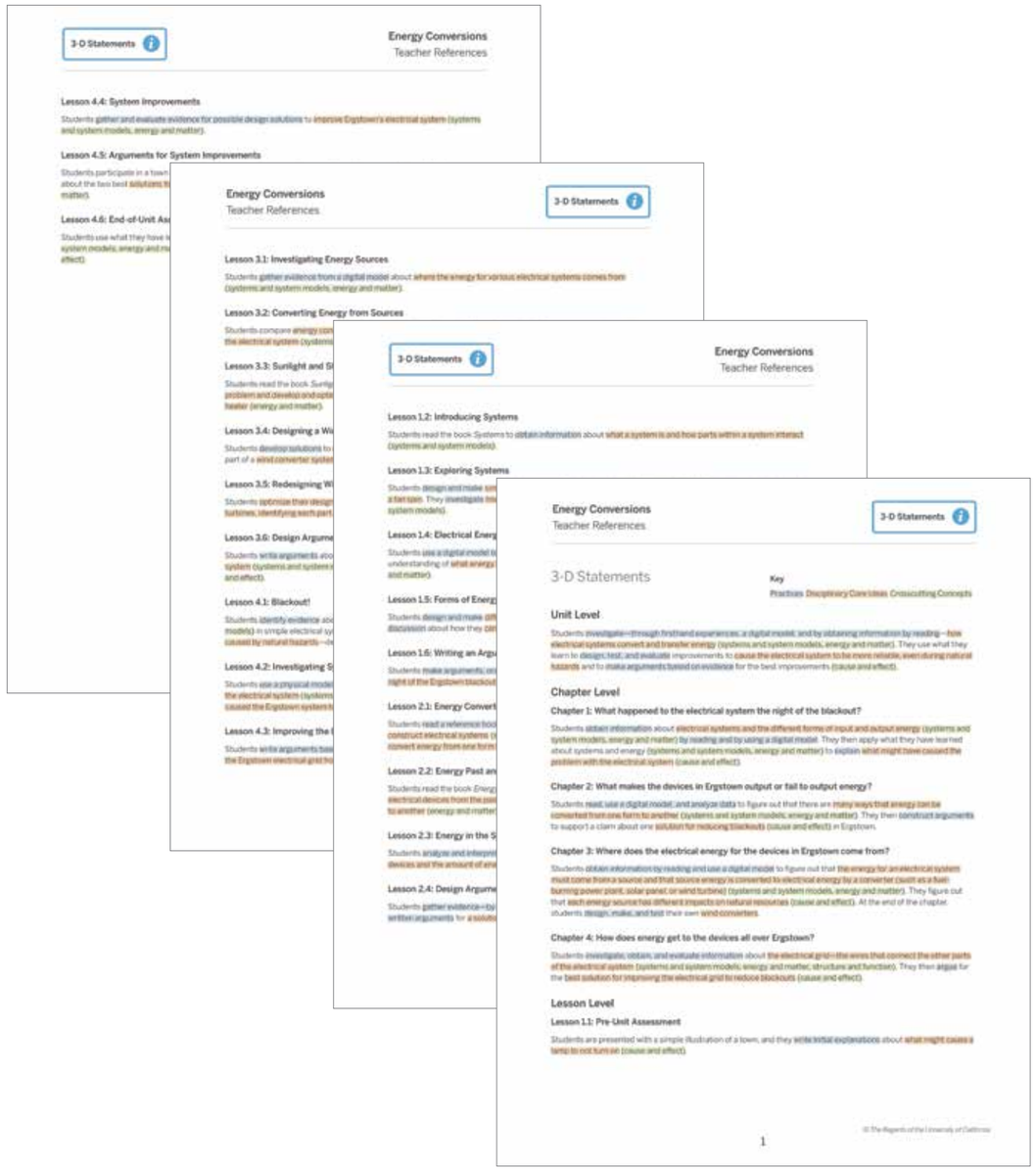
**Chapter 3: Where does the electrical energy for the devices in Ergstown come from?**

Students obtain information by reading and use a digital model to figure out that the energy for an electrical system must come from a source and that source energy is converted to electrical energy by a converter (such as a fuel-burning power plant, solar panel, or wind turbine) (systems and system models, energy and matter). They figure out that each energy source has different impacts on natural resources (cause and effect). At the end of the chapter, students design, make, and test their own wind converters.

**Chapter 4: How does energy get to the devices all over Ergstown?**

Students investigate, obtain, and evaluate information about the electrical grid—the wires that connect the other parts of the electrical system (systems and system models, energy and matter, structure and function). They then argue for the best solution for improving the electrical grid to reduce blackouts (cause and effect).

**To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.**



For more information on Amplify Science, visit **amplify.com/california.**

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