Learn About Ag® California Foundation for Agriculture in the Classroom | SMUD®

Middle School Unit

Grades 6-8

Climate-Smart Agriculture & Careers in Sustainable Energy

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Acknowledgments

The California Foundation for Agriculture in the Classroom (CFAITC) develops educational resources that connect agriculture, energy, and sustainability to classroom learning through partnerships with educators, industry leaders, and community organizations.

This curriculum unit was developed with support from Sacramento Municipal Utility District (SMUD) Sustainable Communities program. Climate-Smart Agriculture & Careers in Sustainable Energy introduces students to the role of energy in agriculture, climate-smart practices, and sustainability-focused career pathways.

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Big Ideas

Students explore the connections between energy and agriculture, discovering how innovations like methane digesters and renewable energy systems can reduce environmental impacts. Through case studies and project-based learning, they build systems thinking skills and investigate careers that shape a sustainable future.

Unit Objectives

By the end of this unit, students will:

- Understand how energy is produced, used, and transformed in agricultural systems
- Investigate how methane digesters reduce greenhouse gas emissions
- Analyze systems of energy flow and their impact on people and the environment
- Evaluate real-world solutions and explore career opportunities in sustainability and energy

Lesson Sequence

This five-lesson unit for grades six through eight introduces students to the intersection of energy, agriculture, and sustainability. Through hands-on activities, case studies, and creative projects, students develop systems thinking skills and explore how renewable energy sources, like methane, can support climate-smart agriculture. The curriculum encourages critical thinking, scientific literacy, and career exploration, while supporting academic standards.

In the first lesson, *Exploring Renewable Energy*, students are introduced to energy sources and energy use in agriculture, laying the groundwork for understanding how energy impacts food systems. This foundation is applied in *From Waste to Watts: Building a Methane Digester*, where students build and analyze a model of anaerobic digestion to explore how waste can be converted into energy. The third lesson, *Cow Power: Energy and the New Hope Dairy Digester*, features a virtual field trip and scavenger hunt that connects classroom learning to real-world technology used at a working dairy farm. In *Farm-to-Fuel Systems Mapping*, students synthesize prior learning by tracing energy flow through agricultural systems, visually representing how inputs like sunlight, fuel, or methane are transformed and used. The unit culminates in *Energy Careers & the Future of Sustainability*, where students research green careers, write "day in the life" journal entries, and participate in a mock Green Careers Expo that highlights jobs supporting clean energy and sustainable agriculture.

Each lesson builds on the previous, guiding students from foundational knowledge to application, and ultimately toward envisioning themselves as future problem-solvers and sustainability leaders.

Lesson 1

Exploring Renewable Energy

Time Required: 2 class periods (45–60 minutes each)

Learning Objectives

Students will know:

- The difference between potential and kinetic energy
- The distinction between renewable and nonrenewable energy sources
- How energy powers the food system, particularly on farms

Students will be able to:

- Classify examples of energy as potential or kinetic
- Categorize energy sources as renewable or nonrenewable
- Explain how farms use energy and why renewable alternatives matter

Standards

MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

Materials

- Introductory Video on Energy (optional)
- Student Recording Sheet (page 10)
- Energy Sort Image Cards (page 12-13)
- Visual Step Cards (page 14-17)
- Sticky notes or science notebooks for exit ticket and warm up questions

Day 1

Forms of Energy and Introduction to Electricity

Class Observation and Discussion:

What is energy, and where do you see it in action around you?

Facilitate a brief discussion using student examples. Emphasize that energy powers nearly everything in our lives—including the food we eat. As students share, jot responses on the board. This list may be used in the mini lesson when categorizing energy into potential and kinetic.

If you would like additional support before facilitating the class discussion—or if your students need more background knowledge—you may choose to preview the first three minutes of the video "Potential & Kinetic Energy" by MAD Garden Science. This brief clip introduces potential and kinetic energy using everyday examples and can be helpful for reinforcing key vocabulary or building teacher confidence when introducing the topic.

Optional Video:

Potential & Kinetic Energy

Mini-Lesson: Potential and Kinetic Energy

Teach the difference between potential (stored) and kinetic (in motion) energy using visuals, student-friendly definitions, and by referencing the discussion from the opening activity. Model everyday examples such as stretching a rubber band, lifting a book, or bouncing a ball. Use the provided *Student Recording Sheet* (page 10) to introduce key vocabulary and support structured thinking. For added engagement, have students mimic the actions or go outside to observe energy in motion in their environment.

Activity: Energy Sort

Distribute the image cards (page 10-11) for students to sort into "Potential," "Kinetic," or "Both." Students work in pairs or small groups to complete the task and fill out the student recording sheet. Allow 10 - 15 minutes for the activity. After sorting, debrief as a class. Encourage students to explain their reasoning and connect examples to the vocabulary introduced earlier.

Supplemental Materials:

Student Recording Sheet (page 10)

Energy Sort Image Cards (page 12-13)

Class Discussion: Energy Use on Farms

What is electricity, and how is it used?

Electricity is a form of energy produced by the movement of electrons through a material. This flow of electrons can be used to power devices like lights, computers, and machines.

Begin a whole-class mind map exploring how energy shows up on farms (e.g., powering irrigation, tractors, refrigeration). Use 'Energy on Farms' as the central idea and ask students to brainstorm branches like 'Irrigation,' 'Refrigeration,' 'Tractors,' and 'Processing.' This will bridge the concept of energy to agricultural systems. Let students know that in the next lesson, they'll learn how farms are finding new ways to make their own energy.

Day 2

Energy Sources and Transformations

Warm-Up: Energy Journey from Sun to Breakfast

Where does electricity come from?

Ask students to quickly sketch a comic strip or diagram showing how the energy from the sun helped create their breakfast (e.g., sunlight → plant → cow → milk → cereal).

If students struggle to generate these ideas independently, complete this section as a whole class by selecting two students to model the process and identifying the energy inputs together.

Where did the energy for eachstep come from?

Facilitate a discussion, guiding students to recognize multiple energy inputs (sunlight, fossil fuels, electricity).

Where do you think your electricity at home comes from?

As students share, sort their responses into renewable and nonrenewable categories on the board. Use this as a bridge to introduce the day's lesson on energy sources.

Why do we care about where our energy comes from?

All energy sources have trade-offs. They can help us grow food and power machines, but some create more pollution or cost more money.

Mini-Lesson: Renewable vs. Nonrenewable Energy

Define common energy sources and sort them into two categories:

1. **Renewable:** solar, wind, hydropower, biomass, geothermal
2. **Nonrenewable:** coal, oil, natural gas

Discuss the environmental and economic impacts of each, especially in relation to farms and food production.

Explain that every energy source has trade-offs. Some create more pollution but are cheaper to use, while others are cleaner but cost more to build. Farmers and food producers rely on energy to grow, process, and transport food. Therefore, the type of energy they use affects both the environment and the economy.

Activity: Energy Transformation Chain

In this systems-thinking challenge, students explore how energy moves through a sequence—beginning with a natural source and ending with a product or action related to agriculture. The activity emphasizes cause-and-effect relationships in energy use.

Supplemental Materials:

Visual Step Cards (page 14-17)

Phase 1: Predict the Energy Flow

- Each group receives a "Start" and "End" card (e.g., Sun → Milk).
- Before receiving the full set of step cards, students brainstorm and sketch or list the steps they think would logically connect the start and end point. Encourage creative thinking and use of prior knowledge.

Prompt:

"How do you think energy travels from the start to the finish in this system?"

Phase 2: Compare, Revise, and Build the Sequence

After brainstorming, provide groups with a set of *Visual Step Cards*.

- Groups revisit their initial ideas and then select, arrange, and refine the energy flow using the cards.
- They finalize either:
  - A sketched flow diagram, or
  - A short role-play/performance showing the transformation.

Continued →

Scenarios (choose one per group):

Sun → Milk

Step cards: sun → grass grows → cow eats grass → digestion in cow → energy stored in milk → milk ready for human use

Food scraps → Vegetables in the garden

Step cards: food scraps collected → compost breaks down → nutrients in soil → roots absorb nutrients → plant grows (vegetable) → vegetable harvested

Grass → Person walking

Step cards: sun → grass grows → cow eats grass → milk produced → person drinks milk → energy used for walking/movement

Seed → Plant Growth

Step cards: seed planted in soil → water absorbed → sun absorbed → seed sprouts (germination) → plant grows leaves and roots → mature plant produces food

After each group presents, pause and discuss as a class:

- What kind of energy movement did we see?
- What caused the energy to change or move?
- How might this process be replicated on a farm?

Exit Ticket

Have students reflect independently using the following prompts:

- Name one renewable energy source.
- What's the difference between potential and kinetic energy?
- How do you think farms could use renewable energy?

Lesson 1 Assessment

Task	Criteria
Energy Sort Activity and Student Recording Sheet	Accurately classifies examples as potential, kinetic, or both with reasoning.
Energy Transformation Chain Activity	Organize step cards in a logical sequence; clearly communicate energy movement in sketch or role-play; use energy terms appropriately.
Exit Ticket	Correctly identifies a renewable energy source and explains energy concepts clearly.

Energy Sort Activity

Student Recording Sheet

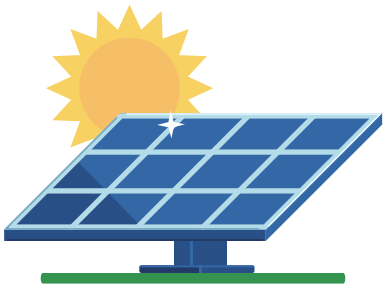
Name: _____

Date: _____ Class Period: _____

Important Vocabulary:

Potential energy is stored energy.
It is the energy something has because of its position or condition

Kinetic energy is the energy of motion.
Anytime something is moving, it has kinetic energy.



Directions:

As you examine each card, decide whether it shows potential energy, kinetic energy, or both. Write your answer and a short explanation.

#	Description	My Answer *(Potential, Kinetic, or Both)*
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Energy Sort Activity

Recording Sheet - Teacher Key

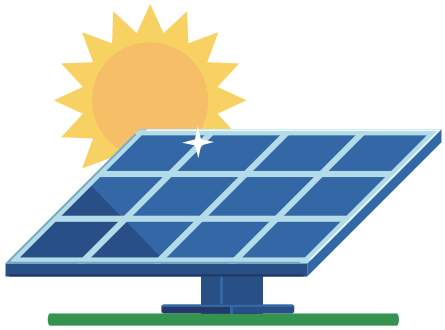
Important Vocabulary:

Potential energy is stored energy.
It is the energy something has because of its position or condition

Kinetic energy is the energy of motion.
Anytime something is moving, it has kinetic energy.

Directions:

As you examine each card, decide whether it shows potential energy, kinetic energy, or both. Write your answer and a short explanation.



#	Example	Energy Type	Demonstration Notes
1	Stretched Rubber Band	Potential Energy	Stretch and hold—do not release
2	Book Held Above Desk	Potential Energy	Hold a book high, show it has stored gravitational energy
3	Backpack on Hook	Potential Energy	Hang a bag—emphasize stored energy due to height
4	Unused Battery	Potential Energy	Show or pass around—discuss chemical energy
5	Students Walking	Kinetic Energy	Ask a student to walk across the room
6	Rolling Ball	Kinetic Energy	Roll a ball on the floor or table
7	Fan Blowing Air	Kinetic Energy	Use a real or pretend fan—observe moving blades
8	Swing in Motion	Kinetic Energy	Rock side-to-side or describe a playground swing
9	Jumping Student	Both	Crouch = potential → Jump = kinetic
10	Bouncing Ball	Both	Drop a ball—watch it fall and bounce
11	Pedaling Bike Uphill	Both	Mime biking up hill—movement builds stored energy
12	Solar Panel in Sunlight	Both	Sunlight provides energy that becomes electricity

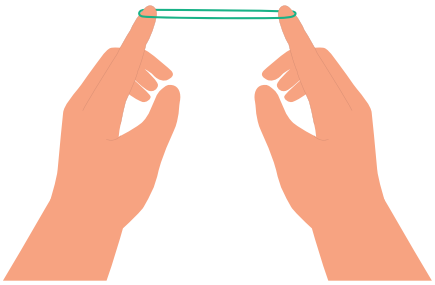
Energy Sort Activity

Printable Energy Sort Cards

Directions: Cut out the cards below. Each card represents a different type of energy in action.

1

Stretched Rubber Band



2

Book Held Above Desk

3

Backpack on Hook

4

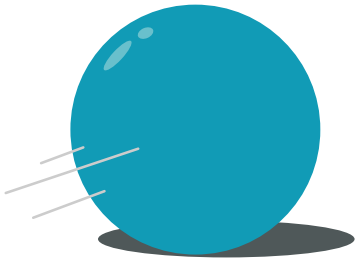
Unused Battery

5

Students Walking

6

Rolling Ball



Energy Sort Activity

Printable Energy Sort Cards

Directions: Cut out the cards below. Each card represents a different type of energy in action.

7

Fan Blowing Air

8

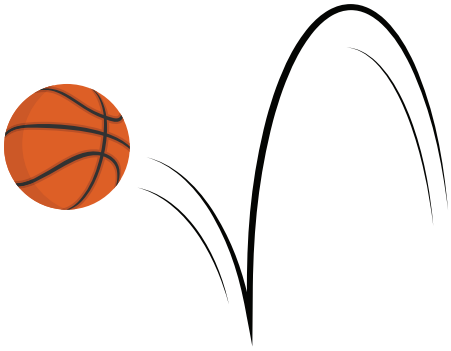
Swing in Motion

9

Jumping Student

10

Bouncing Ball

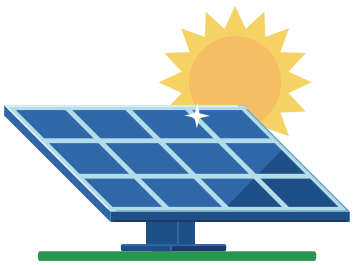


11

Pedaling Bike Uphill

12

Solar Panel in Sunlight



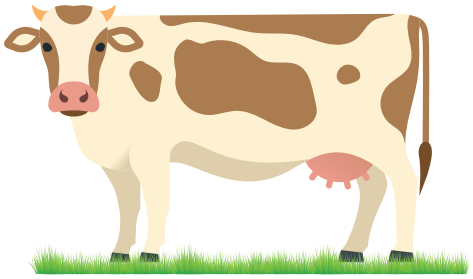
Energy Transformation Chain

Printable Visual Step Cards

Directions: Cut out the cards below. Arrange them in order, starting with where the energy begins in the environment and ending where it finishes.

Milk Ready For Human Use

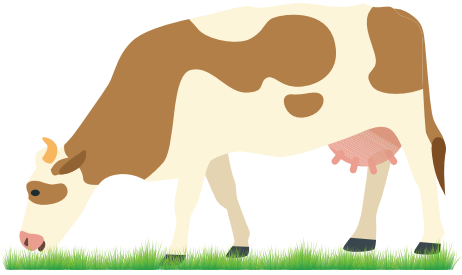
Digestion In Cow



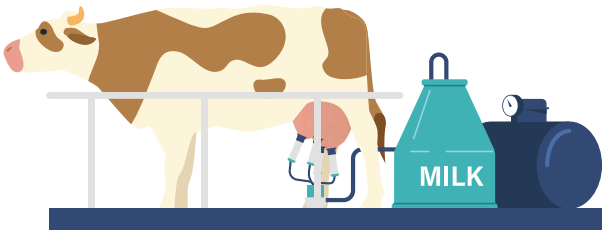
Grass Grows

Sun

Cow Eats Grass



Energy Stored In Milk

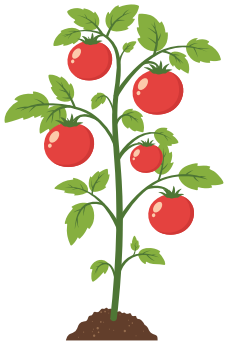


Energy Transformation Chain

Printable Visual Step Cards

Directions: Cut out the cards below. Arrange them in order, starting with where the energy begins in the environment and ending where it finishes.

Plant Grows (Vegetable)



Compost Breaks Down

Vegetable Harvested

Food Scraps Collected

Nutrients In Soil

Roots Absorb Nutrients

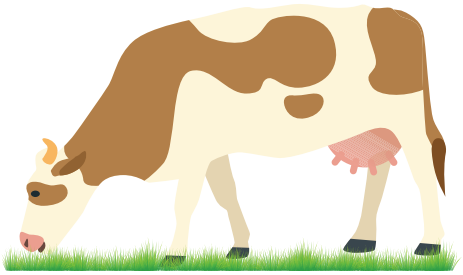
Energy Transformation Chain

Printable Visual Step Cards

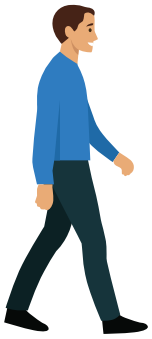
Directions: Cut out the cards below. Arrange them in order, starting with where the energy begins in the environment and ending where it finishes.

Milk Produced

Cow Eats Grass



Energy Used For Walking/Movement



Person Drinks Milk

Grass Grows

Sun

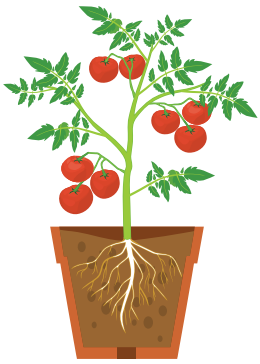
Energy Transformation Chain

Printable Visual Step Cards

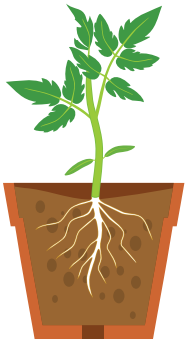
Directions: Cut out the cards below. Arrange them in order, starting with where the energy begins in the environment and ending where it finishes.

Seed Sprouts (Germination)

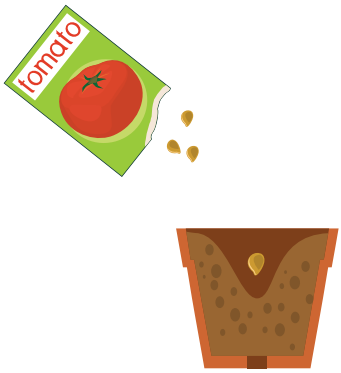
Mature Plant Produces Food



Plant Grows Leaves And Roots

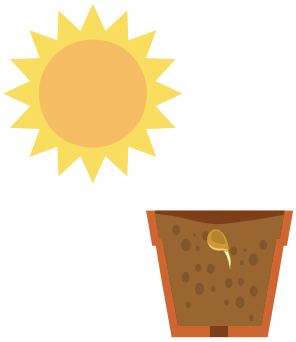


Seed Planted In Soil



Water Absorbed

Sun Absorbed



Lesson 2

From Waste to Watts: Building a Methane Digester

Time Required: 2–3 class periods (45–60 minutes each)

Learning Objectives

Students will know:

- Methane is a renewable energy source produced through anaerobic digestion of organic waste
- Energy can be transformed from chemical to thermal and mechanical forms

Students will be able to:

- Explain how methane gas is produced from organic waste
- Design, build and test a simple model of a methane digester
- Record and analyze gas production data using a structured observation tracker
- Illustrate energy transformation within a biological system using a flow diagram and energy vocabulary

Standards

MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-ESS3-3: Design a method for monitoring and minimizing human impact on the environment.

Materials

- Renewable Energy - Powered by Poop | California Academy of Sciences
- Methane Digester Visual Aid and Structured Observation Tracker (page 22-23)

Materials to build methane model

(per group of 2–4 students)

- 1 clean 2-liter plastic bottle
- 1 latex balloon
- 1 funnel
- 1 cup of organic material (manure, compost, or food scraps)
- Warm water
- Rubber band or tape
- Safety goggles and gloves (optional - per group or per student depending on what type of organic material you choose)
- Measuring string and ruler (optional)
- Balloon grid overlay (optional for visibility)

Day 1

Introduction and Construction

Class Observation and Discussion:

Begin by showing students a short, video clip of a methane digester in action.

Video: Renewable Energy - Powered by Poop | California Academy of Sciences

Dairies in California generate over 10 million tons of manure each year—what if we could turn that waste into energy? Can manure power a lightbulb?

Allow students time to respond, then guide the discussion with prompts like:

- What do you already know about electricity?
- How could manure be part of the process?
- What forms of energy could waste produce?
- What are the benefits of using waste to generate energy?

Mini Lesson: Energy Transformation

Today, we'll explore these ideas by building our own simple digester model.

Introduce the term anaerobic digestion and explain it as the natural breakdown of organic material by microbes in the absence of oxygen. Emphasize that this process produces methane gas, which can be captured and used as a renewable energy source. Review the concept of energy transformation, reinforcing that this system converts chemical energy stored in organic waste into thermal and mechanical energy.

Clarify the energy transformation process and provide visual aid.

Tell students that inside the digester, tiny microbes eat the organic waste and release **chemical energy.** This energy is transformed into **methane gas**, which contains stored energy. When methane is burned or used to power equipment, the stored chemical energy changes into **thermal energy (heat)** or **mechanical energy (movement)**—just like when we burn fuel to heat water or run a motor. California's 1.7 million dairy cows produce millions of tons of manure every year, which presents a huge opportunity to turn waste into renewable fuel through a methane digester.

Make connections to previous learning.

Connect back to Lesson 1 by asking:

- "How is energy entering and exiting this system?"
- "How does this energy transformation compare to what we saw in the Energy Transformation Chain activity?"
- "Where is the chemical energy stored in this system?"

Activity: Build a Methane Digester

Present the design challenge.

In teams, students will design and build a working model of a methane digester that simulates gas production from waste. Explain that students will observe the models over several days and analyze how energy changes forms throughout the process.

Guide students through construction.

Each group fills a 2-liter plastic bottle halfway with organic material (manure, compost, or food scraps) and warm water. Using a funnel, they carefully transfer materials into the bottle and stretch a balloon over the opening, securing it with a rubber band or tape. Students label their bottles and place them in a warm area to encourage microbial activity.

Supplemental Materials:

Methane Digester Visual Aid and Structured Observation Tracker (page 22-23)

Exit Ticket

Have students respond to the following prompts in writing:

- What do you predict will happen to your balloon? Why?
- Where is the energy coming from in your system?
- What questions do you still have about methane or digesters?

Day 2

Observation, Data Collection, and Analysis

Class Review and Discussion:

Begin by reviewing students' day 1 predictions. Have groups retrieve their digesters and observe for signs of gas buildup, such as balloon inflation, changes in size, or condensation.

Provide each group with a data tracker (page 23) to record observations. Students should document the day, time, and visual notes on balloon changes.

Optional: Measure balloon circumference or estimate volume using a ruler or string. Prompt groups to connect their observations to what they know about the methane production process.

Use whole-class discussion to debrief:

- Where did the energy come from?
- How was energy captured in your system?
- What parts of a real digester were missing from our model?

Lesson 2 Assessment

Task	Criteria
Model Construction	Builds a functioning model with visible gas capture.
Observation Tracker	Accurately documents visual changes and connects observations to the methane production process.
Reflection Questions	Demonstrates understanding of energy transformation and real-world application.

From Waste to Watts

Energy Transformation in a Methane Digester

Step-by-Step Energy Flow

Thermal Energy

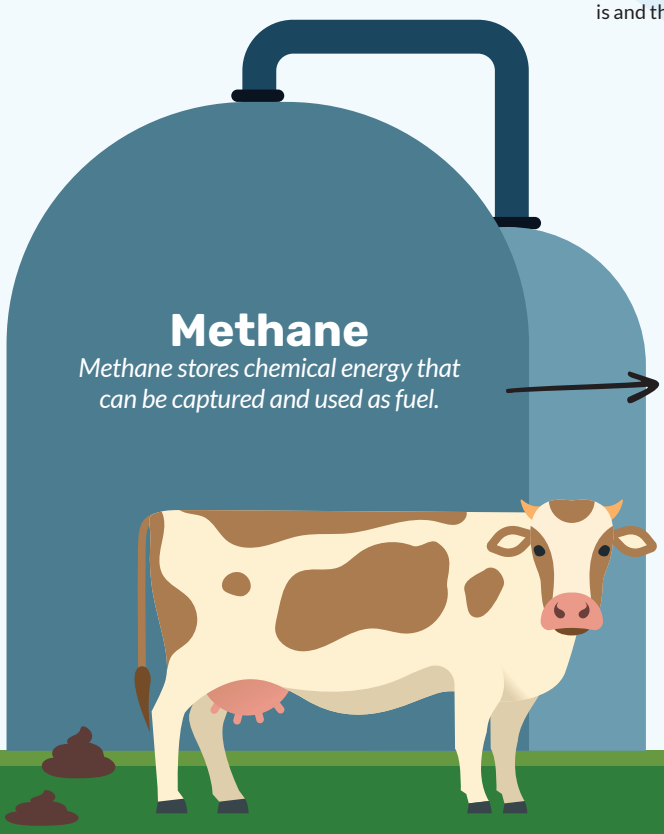
Thermal energy is the energy something has because its particles (tiny pieces) are moving. The faster the particles move, the warmer the object is and the more thermal energy it has.

Energy Use

When burned or processed, methane turns into:

Methane

Methane stores chemical energy that can be captured and used as fuel.



Anaerobic Digestion

Microbes break down waste in the absence of oxygen, releasing methane gas.

Manure

Organic waste that contains chemical energy stored in organic molecules.

Mechanical Energy

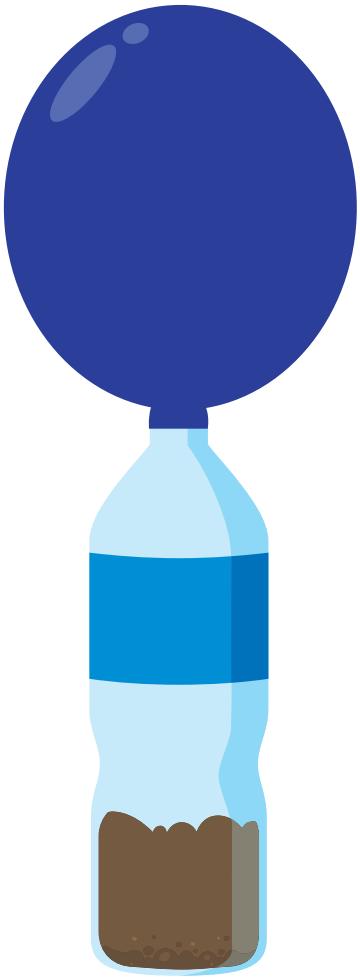
Mechanical energy is the energy an object has because of its motion or its position. If something is moving or has the potential to move (like a stretched rubber band or a raised weight), it has mechanical energy.

Reflection Prompts:

- Where does the energy in manure come from?
- How does the methane get released?
- What energy transformations are happening in this system?

From Waste to Watts

Energy Transformation in a Methane Digester



Make Your Own Methane Digester!

Materials (per group):

1 clean 2-liter plastic bottle

1 latex balloon

1 funnel

1 cup organic material (manure, compost, or food scraps)

Warm water

Rubber band or tape

Safety goggles and gloves

Instructions:

1. Fill the bottle halfway with organic material and warm water.
2. Use the funnel to pour the organic material and warm water into the bottle carefully.
3. Stretch the balloon over the bottle opening and secure it.
4. Label your bottle and place it in a warm spot.

Safety Tips:

- Always wear gloves and goggles when handling organic waste.
- Wash hands thoroughly after the activity.

End-of-Day Reflection Questions:

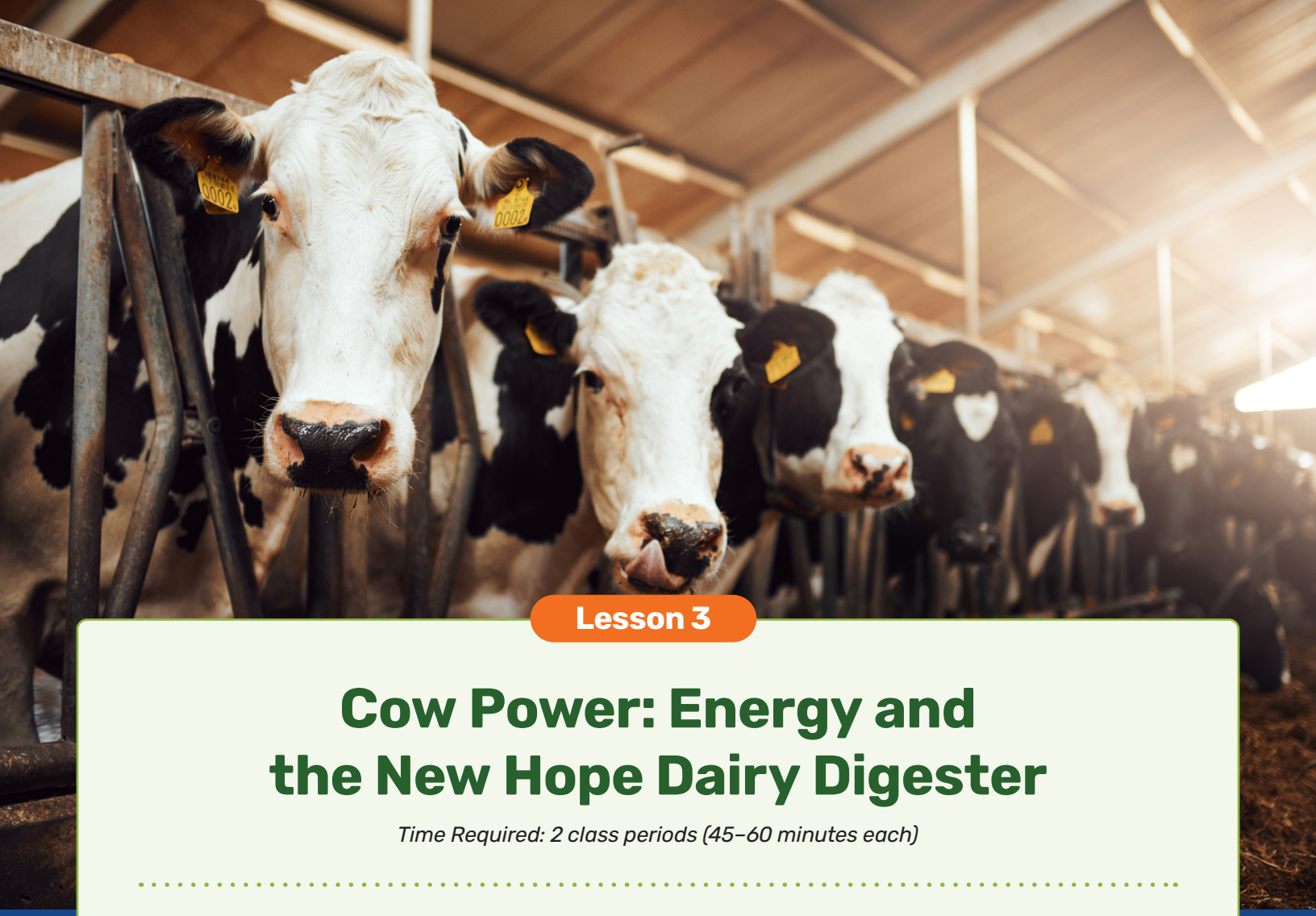
What do you predict will happen to your balloon over the next few days?

What is producing the gas?

How does this model help us understand renewable energy?

Structured Observation Tracker:

Date	Time	Balloon Change *(Color, Size, Shape)*	Condensation *(Yes or No)*	Notes



Lesson 3

Cow Power: Energy and the New Hope Dairy Digester

Time Required: 2 class periods (45–60 minutes each)

Learning Objectives

Students will know:

- How methane is captured and transformed into renewable energy
- The role of SMUD in integrating biofuels and reducing emissions
- Environmental and community impacts of agricultural energy systems

Students will be able to:

- Describe the methane digester process using evidence from the virtual tour
- Represent the digester process visually

Standards

MS-PS3-3: Apply scientific principles to design a method for minimizing human impact on the environment

MS-ESS3-3: Design a solution to monitor and minimize human impact on natural systems

Materials

- Video: Renewable Energy - Powered By Poop
- SMUD's Dairy Digester Virtual Field Trip
- SMUD's Teacher Guide
- SMUD's Dairy Digester Scavenger Hunt and Observations
- Scavenger Hunt Worksheet Answer Key
- Colored pencils, markers, or digital art tools for comic
- Comic Template Worksheet (page 27)
- Notebook or paper for quickwrite

Day 1

Engage and Explore

Class Observation and Discussion

Start by watching this video that shows how a dairy farm is using a methane digester to turn cow poop into electricity.

Supplemental Materials:

Video: Renewable Energy - Powered By Poop

SMUD's Teacher Guide

Mini Lesson: SMUD and New Hope Dairy

Introduce SMUD's role in renewable natural gas (RNG) and their partnership with New Hope Dairy.

Consider the following talking points:

- SMUD (Sacramento Municipal Utility District) is a local energy provider working to lower carbon emissions.
- One innovative solution is using RNG, renewable natural gas, from farms.
- SMUD partnered with New Hope Dairy, where cow waste is turned into methane, captured, cleaned, and added to the energy grid.
- This process helps reduce methane emissions and provides a sustainable fuel source for homes and businesses.
- SMUD's work is part of a broader push for climate-smart agriculture and renewable energy solutions in California. Climate-smart means making choices that help protect the planet and reduce pollution that causes climate change.

Virtual Field Trip: New Hope Dairy

Tell students they will now take a virtual field trip of New Hope Dairy to explore how farms can transform cow waste into renewable energy.

Guide students through the virtual field trip experience using the SMUD site. Provide a printed scavenger hunt worksheet to focus their attention on specific aspects of the digester process. Students may work individually or in pairs to complete the activity.

Review answers to scavenger hunt worksheets.

Supplemental Materials:

SMUD's Dairy Digester Virtual Field Trip

SMUD's Dairy Digester Scavenger Hunt and Observations

Exit Ticket

Bring the class together and review key takeaways from the scavenger hunt. Ask:

- What surprised you most about the digester process?
- What are the pros and cons of using cow manure for energy?
- How does this compare to your expectations from earlier in the unit?

Day 2

Elaborate and Reflect

Class Review and Discussion:

Begin the lesson by reviewing key takeaways from the virtual field trip and scavenger hunt. Ask:

- What part of the digester process stood out to you?
- Why do you think SMUD is investing in energy from farms?

Activity: From Cow to Kilowatts

Students will create a 5-panel illustrated comic strip that explains how cow waste is turned into renewable energy. Each panel should include a drawing and a brief caption using accurate science vocabulary.

Supplemental Materials:

Comic Template Worksheet (page 27)

Required panels:

- A cow produces manure
- Manure enters the methane digester
- Microbes break down waste and release methane
- Methane is cleaned and transported as RNG
- Renewable energy is used to power homes, buses, or equipment

Exit Ticket

Close the lesson with a reflection discussion or journal prompt:

- Why is renewable energy from farms important for our future?
- What challenges do you think large-scale digesters face?

Lesson 3 Assessment

Task	Criteria
Scavenger Hunt	Completes observation notes and identifies key digester components and processes.
Comic Strip	Creates an accurate visual representation of waste-to-energy process. Includes captions outlining major steps of the digester process and accurate science vocabulary.
Discussion and Participation	Shares ideas, listens actively, and poses questions during discussion. Thoughtful responses show engagement with the topic.

Comic Template

From Cow to Kilowatts: How Cow Waste Becomes Energy

Name: _____

Date: _____ Class Period: _____

Student Directions:

Create a comic strip or visual storyboard to show how cow waste is transformed into energy.

Use what you learned during the SMUD virtual field trip to illustrate each step in the journey—from cow to power! Include arrows, captions, or speech bubbles to explain what's happening in each scene.

My Comic Book Title:

_____

Step 1: What starts the process? (Hint: It begins with a cow!)

Step 2: Where does the waste go? (How is it collected and moved?)

Step 3: What happens inside the digester? (Who breaks down the waste?)

Step 4: How is methane prepared and moved? (Where does it go?)

Step 5: How is the renewable energy used? (Think: homes, buses, machines!)

Lesson 4

Farm-to-Fuel Systems Mapping

Time Required: 1–2 class periods (45–60 minutes each)

Learning Objectives

Students will know:

- How manure and other inputs are transformed into usable energy through a farm-based digester system
- Key stages of the agricultural energy cycle
- How farmers, utilities, and consumers are connected in an energy system

Students will be able to:

- Create a visual map that shows energy flow from farm to grid
- Identify energy inputs, outputs, and transformation points within the system

Standards

MS-ESS3-3: Apply scientific principles to monitor/minimize human impact.

MS-PS3-5: Construct, use, and present arguments that when the kinetic energy of an object changes, energy is transferred to or from the object.

Materials

- Completed SMUD's Dairy Digester Scavenger Hunt and Observations from Lesson 3
- Chart paper or digital slides
- Coloring supplies or digital tools (e.g., Canva, Google Slides)
- Optional: energy icons or arrows for visual maps (printed or digital)

Engage and Explore

Class Discussion:

Think about your lunch—where did it come from, and how did it get to you?

Help guide students trace common lunch items through the food system: production → processing → transportation → consumption → waste. Prompt them to consider energy used at each step.

Mini-Lesson: What is an Energy System?

Today we are going to start by thinking about what a system is. A system is a set of connected parts that work together. It has inputs (things that go in), processes (things that happen), and outputs (things that come out).

Let's think again about our example from lunch. The inputs include sunlight, water, and seeds that help plans grow. Farmers who harvest the crops and the outputs would be food scraps.

Build Background Knowledge

Write or display the following system terms and definitions on chart paper or the board. Consider turning these into a mini anchor chart or handout:

Term	
Input	Where the energy starts (e.g., sun, manure, fuel)
Transformation	A change in how energy appears or is used (e.g., methane is burned to create heat)
Output	What the energy becomes or does (e.g., electricity, fuel, movement)
User	Who or what uses the energy (e.g., a pump, home, tractor, consumer)
Impact	The result or effect of the energy use (e.g., reduced emissions, pollution)

Model the Process: Think-Aloud

Show a simple sample system on the board (e.g., sun → solar panel → electricity → refrigerator). Walk through several together, using the vocabulary:

"The sun is our input. It provides the starting energy. That energy is transformed into electricity by the solar panel, and then the output is electricity power the refrigerator. The refrigerator is the user, the impact is cold food

Let students help label the rest of the map using the vocabulary terms.

Group Work: Mapping Energy Systems

In small groups, students will design a visual map showing how energy flows in an agricultural system.

Each group will choose one pathway, such as:

- Manure → methane → electricity → refrigeration appliance
- Solar energy → crops → consumers
- Fossil fuels → tractors → harvest and transport → consumers

Their maps must include:

- Energy inputs
- Energy transformations
- Energy outputs & users
- Energy impacts

Groups should use arrows and icons to show energy movement. Students may create a paper poster or digital display.

Group Task Expectations:

- Clearly label each part of the energy system.
- Include brief written descriptions with systems terms.
- Be neat, clear, and ready to present.

Share and Compare: Gallery Walk of Presentation

Have each group present or display their systems map while students tour the room. Ask:

- What similarities or differences do you notice between the systems?
- What did you notice about the impact of these different energy systems?
- Discuss how energy might be used differently on different types of farms or food products.

Exit Ticket

Ask students to complete a written reflection:

- What is one way the food system uses energy that surprised you?
- Who do you think is most affected by how we use energy in agriculture?

Lesson 4 Assessment

Task	Criteria
Systems Map Construction	Creates a visual clearly illustrates energy flow from source to output with labeled inputs, transformations, and outputs.
Visual Presentation	Creates a neat, organized, and includes arrows, icons, and a brief written explanation or legend.
Exit Ticket Reflection	Student reflects on a new insight about energy use in the food system.

Lesson 5

Energy Careers & the Future of Sustainability

Time Required: 2-3 class periods (45–60 minutes each)

Learning Objectives

Students will know:

- A range of energy- and sustainability-related careers that exist in their region
- The basic skills, education, and training needed for those careers
- The connection between their learning and real-world opportunities

Students will be able to:

- Conduct career research using digital tools and provided templates
- Write a creative "Day in the Life" journal entry from the perspective of a sustainability professional
- Design a mock business card and prepare a short oral career pitch
- Participate in a role-play Green Careers Expo that highlights diverse jobs in agriculture, energy, and sustainability

Standards

CCSS.ELA-LITERACY.W.6.2: Write informative texts to examine a topic and convey ideas clearly.

CCSS.ELA-LITERACY.SL.6.4: Present claims and findings with relevant facts and descriptive details.

CA CTE Anchor Standards (Career Planning): Apply appropriate career planning concepts to explore multiple pathways.

Materials

- Career Choice Menu Handout (page 35)
- "Day in the Life" Journal Prompt Sheet (page 36)
- Business Card Template
- Career Pitch Prep Sheet (page 37)
- Optional: Classroom decorations and/or props for mock "Green Careers Expo"

Day 1

Explore Career Options

What kinds of jobs help reduce emissions, use renewable energy, or improve sustainability in agriculture and energy systems?

Explain that today's focus is exploring real jobs that support the goals of businesses like SMUD including:

- Generating renewable energy (e.g., from methane, solar, or wind)
- Improving sustainability in farming, food systems, and land use
- Supporting community health and reducing climate impacts

Make connections to previous learning.

Explain to students that as they explore careers, today look for jobs that connect to what we've learned in this unit—especially around energy transformation, methane digesters, and systems thinking. SMUD and similar organizations hire people in engineering, environmental science, communications, policy, and technical trades. Your task is to find one that interests you and connects to the work we've studied.

1. Distribute the *Career Choice Menu (page 31)* template. Students must select at least one job from the provided list that connects to prior lessons.
2. Students complete a first-round of research using job descriptions to fill in the basics: job title, typical duties, work environment, skills required, education/training, and optional salary range.
3. After students complete the first draft of their career research, ask them to circle or highlight how their chosen job connects to one or more of the following:
   - Renewable energy
   - Climate-smart agriculture
   - Reducing human impact
   - Community or environmental health

Supplemental Material:

Career Choice Menu Handout (page 35)

Day 2

"A Day in the Life" + Business Cards

Instruct students to write a creative journal entry titled: "A Day in the Life of a [Career Title]." Their entry should include what they do, where they work, who they help, and how their job connects to sustainability or energy.

Provide students with a business card template to design a related business card including name, title, company, and job slogan or logo. Cards may be drawn by hand or created digitally.

Students prepare a 30–60 second career pitch answering the prompt: "What do you do, and why is your job important to our future?"

Supplemental Materials:

"Day in the Life" Journal Prompt Sheet (page 36)

Business Card Template

Day 3

Green Careers Expo

(Optional Showcase)

Transform the classroom into a mock Green Careers Expo. Each student sets up a station with their name tag, business card, and journal entry. Split the class in half. Half of the students will stay at their station and give their prepared pitch as the students rotate. Then, groups switch so that all students have an opportunity to give their pitch and circulate the stations. Peers rotate through the room, visiting each booth to learn about different careers.

Optionally, have students dress up in professional attire and practice formal introductions. To support meaningful peer interactions, provide optional guiding question such as:

- What does this job help people or the planet with?
- What kinds of training or education is needed?
- Would you be interested in a job like this? Why or why not?

Supplemental Material: Career Pitch Prep Sheet (page 37)

Lesson 5 Assessment

Task	Criteria
"Day in the Life" Journal Entry	Demonstrates understanding of daily tasks, required skills, and connection to unit themes.
Business Card	Professionally designed and aligned with chosen role.
Green Careers Expo Pitch	Delivers clear pitch with appropriate vocabulary, business card, and professional tone.

Optional Extension Activity: Explore SMUD's Student Internship and Job Opportunities

SMUD offers real-world internships and leadership programs for students interested in clean energy, technology, education, and community service.

Explore the options here:

smud.org/Careers/Students-and-Early-Career

Examples of student opportunities:

- **High School Internship (Paid, 6 weeks):** Work in areas like education, engineering, or sustainability.
- **College Internships:** Support departments like cybersecurity, marketing, and environmental science.
- **Youth Energy Summit:** A leadership program focused on clean energy solutions.
- **Shine Awards:** Funding for student-led community impact projects.

Quick Reflection (optional)

- Which opportunity interests you most?
- What skills do you think the opportunity would help you build?
- Could you see yourself doing something like this in the future?

Why This Matters:

Remind students that energy careers include more than science. They involve creativity, problem-solving, and making a difference in your community.

Career Choice Menu

Jobs in Energy, Farming, and Sustainability

Choose one career from the menu below to explore. Each job connects to what we've learned about energy, agriculture, and building a cleaner future.

Engineering & Tech Jobs

Work with machines, energy systems, and cool designs

Renewable Energy Project Manager
Plans clean energy projects like wind farms or methane digesters.

Mechanical Engineer
Designs machines that help farms and energy plants run better.

Electrical Engineer
Works with power systems to keep electricity flowing.

GIS Technician
Uses digital maps to plan energy and farming projects.

Environment & Agriculture Jobs

Protect the planet and help farms use energy wisely

Environmental Scientist
Studies air, water, and soil to help us stay healthy.

Sustainability Coordinator
Helps farms and companies reduce pollution and waste.

Soil & Water Specialist
Works with farmers to improve land and save water.

Agricultural Engineer
Creates better tools and systems for growing food.

Planning & Business Jobs

Work with data, planning, and big ideas

Energy Analyst
Looks at numbers to help save energy and money.

Supply Chain Manager
Helps farms and companies move products and energy.

Policy Analyst
Researches rules and laws that support clean energy.

Grant Writer
Helps farms and schools get money for green projects.

Skilled Trades

Hands-on jobs that build and fix important systems

Lineman/Linewoman
Builds and repairs power lines that carry electricity.

Electrician
Installs and fixes electrical systems on farms and in homes.

Facility Engineer
Makes sure energy buildings and equipment work safely.

Communication & Media Jobs

Share science and stories with the world

Science Educator
Teaches people about energy and farming in fun ways.

Social Media Manager
Posts updates and videos about clean energy projects.

Drone Technician
Uses flying cameras to film farms and energy systems.

Graphic Designer
Makes posters, websites, and infographics about sustainability.

What Next?

Choose one job that sounds interesting to you. You'll:

1. Fill out a Energy Careers & the Future of Sustainability Journal Prompt Sheet.
2. Write a "Day in the Life" journal entry.
3. Create a business card for your role.
4. Share what you learned at our Green Careers Expo!

Energy Careers & the Future of Sustainability

Journal Prompt Sheet

Name: _____

Date: _____ Class Period: _____

"A Day in the Life" of a _____

What do they do? Where do they work? Who do they help? Why does their job matter?

How does someone in this career typically begin their day?

What tasks would this person try to accomplish?

What tools or technology are required?

Who or what does this person serve/help?

What types of energy are involved in this job?

How does someone in this career typically end their day?

Career Pitch Prep Sheet

Name: _____

Date: _____ Class Period: _____

"What do you do, and why is your job important to our future?"

Write a brief introduction.

What do you do?

Why does this job matters?

Connect your ideas to what we have learned in this unit about energy and agriculture.

Write a closing line.

Climate-Smart Agriculture & Careers in Sustainable Energy

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