Solar Electric Home Designers Inc.

Sixth Grade
Activity: 1 Part 1
Time: 1 Class Period

General Description

The teacher will introduce the students to the project with a description of the task.

The first step of the project is for students to take an energy inventory of their own home. The teacher will model the inventory process by drawing a floor plan of his or her home to show the location of electrical outlets and light switches and by estimating the amount of appliance use. Students will also estimate the amount of electricity they use and how that would change with the use of solar energy. Finally, students will design a home with solar energy and present their plan to the class and teacher.

Objectives

Students will identify the need for alternative fuels and purpose, design, and create a viable solution to that need.

Arizona State Standards

SC06 S3C2 PO1 Purpose viable methods of responding to an identified need or problem
SC06 S3C2 PO2 Compare possible solutions to best address an identified need or problem
SC06 S3C2 PO3 Design and construct a solution to an identified need of problem using simple classroom materials

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)
W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W06 S3C2 PO2 Write a summary based on the information gathered that include(s):
- a. topic sentence
- b. supporting details
- c. relevant information

W06 S3C3 PO1 Write a variety of functional texts (e.g., directions, recipes, procedures, rubrics, labels, posters, graphs/tables)
W06 S3C4 PO1 Write persuasive text (e.g., essay, paragraph, written communications) that:
- a. establishes and develops a controlling idea
- b. supports arguments with detailed evidence
- c. includes persuasive techniques
- d. excludes irrelevant information

M06 S2C1 PO1 Formulate questions to collect data in contextual situations
M06 S2C1 PO2 Construct a histogram, line graph, scatter plot, or stem-and-leaf plot with appropriate labels and title from organized data
M06 S2C1 PO4 Answer questions based on simple displays of data including double bar graphs, tally charts, frequency tables, circle graphs, and line graphs

M06 S4C4 PO1 Determine the appropriate measure of accuracy within a system for a given Contextual situation
M06 S4C4 PO2 Determine the appropriate tool needed to measure to the needed accuracy

LS E1 Prepare and deliver an organized speech and effectively convey the message through verbal and nonverbal communications with a specific audience
LS E2 Prepare and deliver an oral report in a content area and effectively convey the information through verbal and nonverbal communications with a specific audience
LS E3 Interpret and respond to questions and evaluate responses both as interviewer and interviewee

VP E2 Plan, develop and produce a visual presentation, using a variety of media such as videos, films, newspapers, magazines and computer images

Teacher Information (Project Overview)

Introduce the task to the students as a solution to our country's energy needs.

Students will begin by doing a Home Energy Inventory. Students will complete an inventory that includes drawing the floor plan of their home and identifying the location of the electrical outlets and switches. This will create a visual awareness of the different amounts of electricity required in each room. In addition, the inventory will require a listing of the appliances associated with each outlet or switch and estimating the hours of use. This will provide an example of a typical home appliance set up and typical amount of use.

Part Two will require students to use the data they gathered to design a solar powered home.

Part Three, students will calculate the cost of the solar electric system.

Part Four, students will design their home and create a presentation of their plan.

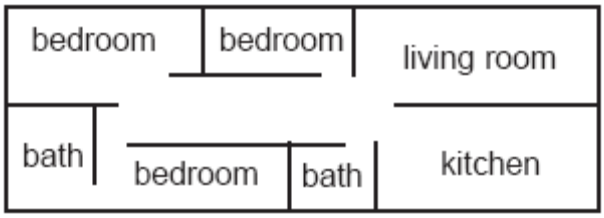
Finally, in Part Five, the teacher will be the "subdivision owner" and "judge" as the groups present their plans. Students will also "judge" each others projects and will need to provide written feedback to each group.

Materials

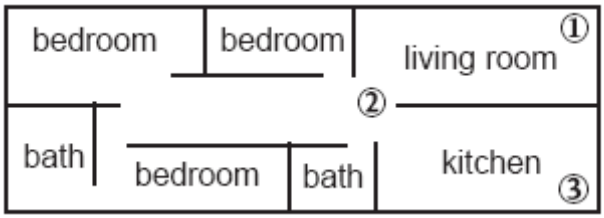
Resources from the Arizona Department of Commerce Energy Office (602-280-1402)
Field trip to APS' STAR (Solar Test and Research) Center at the Ocotillo Power Plant (1500 East University Drive in Tempe). Call 480-350-3137 for a guided tour.
Activity Card 6-1a

Procedures/Exploration

1. Divide the students into groups. Each student will work on their own inventory, later in the project students will do group work.
2. Hand out the Activity Card 6-1a.
3. Model for the students how to create a floor plan of their home. A floor plan is a scale diagram of a room or building drawn as if seen from above. Draw an example of a floor plan on the chalkboard or overhead projector. It should look something like this:



4. Provide students with time to complete this task. Check for understanding by walking around the room.
5. Model for the students how to identify and number the outlets and appliances. See the model below. Show the location of electrical outlets and light switches in the home by drawing small circles in the approximate location on the floor plan.



6. Number the outlets and light switches. For example see above.
7. Provide the students with time to complete this task. Check for understanding by walking around the room. Students may need to complete this at home.
8. Make a list of the appliances that are plugged into each outlet or that are turned on by each light switch. List each appliance separately in the table provided. See the example below, the outlet number #1 shows two appliances plugged into the same outlet.

Outlet/Switch Number	**Appliance**	**Average Daily Use (hours per day)**
1	TV	4 hours
1	Lamp	2 hours
2	Ceiling fan	1 hour

9. Estimate the length of time that each appliance is turned on in one day. Put this information in the chart. On the student worksheet there is a chart to help the students with the minute conversions
10. Point out to the students the sample on their worksheet. Suggest the assistance of family members to help with the home inventory.

Solar Electric Home Designers Inc.

Sixth Grade
Activity: 1 Part 2
Time: 1 Class Period

Objectives

Students will identify the need for alternative fuels and purpose, design, and create a viable solution to that need.

Arizona State Standards

SC06 S3C2 PO1 Purpose viable methods of responding to an identified need or problem.
SC06 S3C2 PO2 Compare possible solutions to best address an identified need or problem.
SC06 S3C2 PO3 Design and construct a solution to an identified need of problem using simple classroom materials.

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)
W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W06 S3C2 PO2 Write a summary based on the information gathered that include(s):
- a. topic sentence
- b. supporting details
- c. relevant information

W06 S3C3 PO1 Write a variety of functional texts (e.g., directions, recipes, procedures, rubrics, labels, posters, graphs/tables)
W06 S3C4 PO1 Write persuasive text (e.g., essay, paragraph, written communications) that:
- a. establishes and develops a controlling idea
- b. supports arguments with detailed evidence
- c. includes persuasive techniques
- d. excludes irrelevant information

M06 S2C1 PO1 Formulate questions to collect data in contextual situations
M06 S2C1 PO2 Construct a histogram, line graph, scatter plot, or stem-and-leaf plot with appropriate labels and title from organized data
M06 S2C1 PO4 Answer questions based on simple displays of data including double bar graphs, tally charts, frequency tables, circle graphs, and line graphs

M06 S4C4 PO1 Determine the appropriate measure of accuracy within a system for a given Contextual situation
M06 S4C4 PO2 Determine the appropriate tool needed to measure to the needed accuracy

Teacher Information

Students will be given the criteria for their model solar homes. Students will use the criteria and the information gathered in the Home Inventory Worksheet (Activity Card 6-1b) to begin designing their model solar homes. Students will calculate the total amount of electricity required

to power their model homes; this is called the Total Daily Load. The size of the solar electrical system will be based on the Total Daily Load for their solar home.

The size of a solar electric system depends on two factors: the load, which is the amount of electricity being used at any given moment, and the amount of sunlight available to the system. To determine the load, it is necessary to identify the lights, appliances, and other items that will require electricity from the solar electric system. The next step is to determine the wattage of each item. Wattage is the amount of electric power required by an appliance or device to make it Work. The wattage of an item is usually stamped on it or the approximate wattage can be found on the Home Wattage Chart (Activity Card 6-1e). An alternative method for finding wattage is multiplying the amps times the volts of the appliance. The next step is to decide how many hours the appliance is used each day. The Average Daily Load for an appliance is found by the following formula:

watts of the appliance x hours in use = Average Daily Load (watt-hours)

Watt-hours are a measurement of the amount of electricity used. The total amount of electricity that a house will use in a day is found by adding the Average Daily Loads for each appliance or item that uses electricity; this is called the Total Daily Load. This number will be used to determine the size of the solar electric system needed to power the home.

Materials

Activity Cards 6-1b, 6-1c, 6-1d and 6-1e

Procedures/Exploration

1. Discuss the Home Energy Inventory worksheet (Activity Card 6-1b) from first session with the students. Review the worksheet by asking questions such as: How many outlets were in the living room? The bedrooms? Etc. Why were there different numbers of outlets in each room? Did light switches turn on appliances other than lights? What were some of the appliances found in your house? How long were the appliances turned on in one day? Were there any problems with this activity?
2. Tell the students the groups will begin planning their solar homes. The criterion from the subdivision owner includes two parts. They will work on each part over the next two days.
3. The first part is the Solar Home Floor Plan worksheet (Activity Card 6-1c). By comparing Home Inventories, they will decide as a group the design for the floor plan, electrical outlets and switches, and typical appliances that their solar home will contain. They will draw this on the back of the Solar Home Floor Plan worksheet (Activity Card 6-1c).
4. The second part is calculating the Total Daily Load for their Solar Home.
5. Define Total Daily Load as the total amount of electricity their solar home will need to power all of the lights, appliances, and other items for one day. The subdivision owner also wants to see a chart that describes this calculation.
6. On the Solar Home Total Daily Load worksheet (Activity Card 6-1d), make a list of the electrical appliances that will be plugged into each outlet or turned on by each switch. See

example below. If appliances are not listed on the Home Wattage Chart (Activity Card 6-1e), the wattage may be found on the back of appliance or printed on a nameplate. If students look for specific wattage on appliances, caution them to unplug the appliance first and not to remove any part of the appliance to prevent electric shock.

OUTLET/SWITCH NUMBER	APPLIANCE	WATTS(W)	AVERAGE DAILY USE; HOURS PER DAY (H)	AVERAGE DAILY LOAD (W X H)
1	TV	95	3	95 x 3 = 285
	lamp	60	4	60 x 4 = 240
2	refrigerator	120	approximately 5	120 x 5 = 600
3	ceiling fan	80	4	80 x 4 = 320
			Total Daily Load	1445 watt-hours

7. Do an example on the chalkboard to show the students how to find the Total Daily Load. Using Activity Card 6-1d and show conversions of time as:

   15 minutes = .25 hour
   30 minutes = .50 hour
   45 minutes = .75 hour

   Put the estimated time in the Average Daily Use column for each appliance, light, or item that uses electricity.

Solar Electric Home Designers Inc.

Sixth Grade
Activity: 1 Part 3
Time: 1 Class Period

Objectives

Students will identify the need for alternative fuels and purpose, design, and create a viable solution to that need.

Arizona State Standards

SC06 S3C2 PO1 Purpose viable methods of responding to an identified need or problem
SC06 S3C2 PO2 Compare possible solutions to best address an identified need or problem
SC06 S3C2 PO3 Design and construct a solution to an identified need of problem using simple classroom materials.

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)
W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W06 S3C3 PO1 Write a variety of functional texts (e.g., directions, recipes, procedures, rubrics, labels, posters, graphs/tables)

M06 S2C1 PO1 Formulate questions to collect data in contextual situations
M06 S2C1 PO2 Construct a histogram, line graph, scatter plot, or stem-and-leaf plot with appropriate labels and title from organized data
M06 S2C1 PO4 Answer questions based on simple displays of data including double bar graphs, tally charts, frequency tables, circle graphs, and line graphs
M06 S4C4 PO1 Determine the appropriate measure of accuracy within a system for a given contextual situation
M06 S4C4PO 2 Determine the appropriate tool needed to measure to the needed accuracy

Teacher Information

Students will calculate the cost of the solar electric system by finding the number of solar panels and batteries needed to provide enough electricity for their solar home. They will use the information from Activity Card 6-1d which shows the Total Daily Load or total amount of electricity that their home needs to power all of the lights, appliances, and other electrical items it contains.

A solar electric system (or photovoltaic system or PV) has essentially four parts: solar panels, batteries, an inverter and a charge controller. The solar panels are also called modules. Modules consist of groups of silicon solar cells that collect energy from the sun and convert it to electric current. Batteries store solar generated electricity for use during the night or on cloudy days when the solar cells do not function. An inverter changes the direct current (DC) that is produced by the

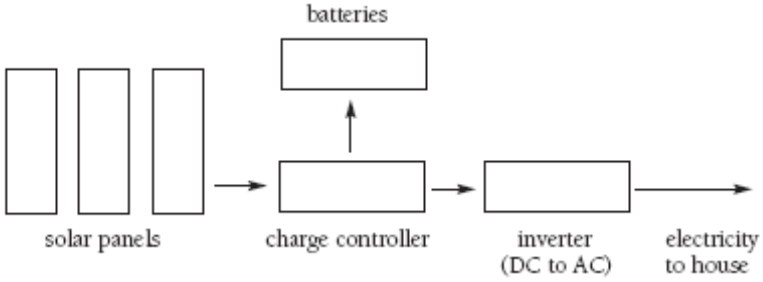
solar cells or battery to alternating current (AC) that is used by most home appliances. A charge controller protects batteries from excessive charge when the modules produce more electricity than the batteries can store. It also protects the battery from releasing electricity if their charge is too low.

Materials

Activity Cards 6-1d and 6-1f

Procedures/Exploration

1. Allow the students time, if needed, to finish their Total Daily Load work sheet (Activity Card 6-1d).
2. Review the definition of Total Daily Load. Teacher sample questions: What are some examples of Total Daily Load numbers from the groups? What unit is used (watt-hours) and what this means (the total amount of electricity used in one day for the entire household).
3. Once the size of the Total Daily Load from Activity Card 6-1d is determined, the next step is to calculate the cost of the solar electric system; this will be an estimate of the cost of a solar electric system to provide the electricity needed. This calculation should include the cost of: □ solar panels □ batteries □ inverter
4. Discuss the parts of a solar electric system. Write the words and the definitions on the board. The diagram below can be used to model a solar electric system.



5. Tell the students that today they will figure the cost of the solar electric system for their solar home. This information will be used for their presentation.
6. Hand out the Solar Home Electric System Cost worksheets (Activity Card 6-1f).
7. Read through the handout and provide examples for the Number of Solar Panels for the Total Daily Load and for Inefficiencies of the System.

   NOTE: This assumes that the house will use 50 watt solar panels and the house will reside in Arizona which receives approximately six hours of peak sun each day (on average throughout the whole year including summer and winter). Discuss with students that other solar panels could be used (they range from 10 to 300 watts). Ask how this would affect the number of solar panels. Also ask how the number of solar panels would change if this house was in a location that received less hours of sunlight.

8. Provide examples of battery calculations.

   NOTE: This is a typical size battery and these also come in different sizes. Also discuss that batteries only last 3-10 years and can pose problems because they have hazardous materials inside and have to be discarded carefully.

9. The inverter size is dependent on the largest estimated load put on the system at one time. A good estimate is found by adding the wattage of the five largest users of electricity that could be on at one time.
10. Demonstrate how to fill in the Total Cost Chart (Activity Card 6-1f) and do the final calculations for the Cost of the Solar Electric System.
11. Challenge them to suggest ways to make solar energy more cost effective and to report these ideas when they give their presentations.

Solar Electric Home Designers Inc.

Sixth Grade
Activity: 1 Part 4
Time: 2-3 Class Periods

Objectives

Students will identify the need for alternative fuels and purpose, design, and create a viable solution to that need.

Arizona State Standards

SC06 S3C2 PO1 Purpose viable methods of responding to an identified need or problem
SC06 S3C2 PO2 Compare possible solutions to best address an identified need or problem
SC06 S3C2 PO3 Design and construct a solution to an identified need of problem using simple classroom materials.

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)
W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W06 S3C2 PO2 Write a summary based on the information gathered that include(s):
- a. topic sentence
- b. supporting details
- c. relevant information

W06 S3C3 PO1 Write a variety of functional texts (e.g., directions, recipes, procedures**,** rubrics, labels, posters, graphs/tables)
W06 S3C4 PO1 Write persuasive text (e.g., essay, paragraph, written communications) that:
- a. establishes and develops a controlling idea
- b. supports arguments with detailed evidence
- c. includes persuasive techniques
- d. excludes irrelevant information

LS E1 Prepare and deliver an organized speech and effectively convey the message through verbal and nonverbal communications with a specific audience
LS E2 Prepare and deliver an oral report in a content area and effectively convey the information through verbal and nonverbal communications with a specific audience
LS E3 Interpret and respond to questions and evaluate responses both as interviewer and interviewee

VP E2 Plan, develop and produce a visual presentation, using a variety of media such as videos, films, newspapers, magazines and computer images

Teacher Information

Students will begin putting their presentations together. They will draw their floor plan and create a chart of their solar home electric cost on large sheets of white paper or poster board. They will also plan the oral portions of the presentation and determine who will present for each part. Other "extras" for their presentations will also be planned. Other presentation formats might be a Power Point presentation, a skit, a brochure, or an advertisement.

Group presentations can take a variety of forms. The suggested format includes having all members of the group speak during the presentation (even if it's just a small part). Students should focus on the criteria for their presentations as well as the method of presenting.

Materials

Activity Cards 6-1g, 6-1h and 6-1i

Procedures/Exploration

1. Hand out the Solar Home Design Presentation Planning worksheet (Activity Card 6-1g). Read through each section and give examples of what is expected. Encourage students to use their imaginations as these guidelines are just the bare minimum standards for their presentations.
2. Go through the Presentation Evaluation worksheet (Activity Card 6-1h) and the Solar Home Rubric (Activity Card 6-1i) explaining to students that this will be the rubric that will be used to grade their presentation.
3. Direct students to the area where supplies (such as butcher paper, colored pencils, markers, rulers, pictures from magazines, etc.) are located.
4. This portion may take 2-3 class sessions depending on group size.
5. Allow students to divide up work and begin their planning and creating. Sample jobs can be: to draw posters, to color posters, to organize the speech, to be in charge of "extras" for the presentation.

Solar Electric Home Designers Inc.

Sixth Grade
Activity: 1 Part 5
Time: 1-2 Class Periods

Objectives
Students will identify the need for alternative fuels and purpose, design, and create a viable solution to that need.

Arizona State Standards
SC06 S3C2 PO1 Purpose viable methods of responding to an identified need or problem
SC06 S3C2 PO2 Compare possible solutions to best address an identified need or problem
SC06 S3C2 PO3 Design and construct a solution to an identified need of problem using simple classroom materials.

LS-E1 Prepare and deliver an organized speech and effectively convey the message through verbal and nonverbal communications with a specific audience
LS-E2 Prepare and deliver an oral report in a content area and effectively convey the information through verbal and nonverbal communications with a specific audience
LS-E3 Interpret and respond to questions and evaluate responses both as interviewer and interviewee

VP-E2 Plan, develop and produce a visual presentation, using a variety of media such as videos, films, newspapers, magazines and computer images

Teacher Information
Students will present their solar home to the subdivision owner for bidding and analysis. Each group will describe their floor plans, special features, analysis of the amount of energy required, and cost estimate for their solar home. The "subdivision owner" will be the teacher and other students who will analyze the presentation to see if it meets the set criteria and then bid on the house with an overall rating. Inviting others from your campus will up the level of concern and the quality of the students work.

Materials
Activity Cards 6-1g, 6-1h, 6-1i and 6-1j

Procedure/Exploration
1. Reiterate that the purpose of the project is to design a home powered by solar electricity for bidding and analysis by a subdivision owner. Tell the students the teacher will act as the subdivision owner but the audience will help in the bidding and analysis of the solar homes. Teacher will use Presentation Evaluation Sheet Activity Card 6-1h and the Solar Home Rubric Activity Card 6-1i.

2. Have students get out their Solar Home Design Presentation Planning sheet, Activity Card 6-1g. Go over each part of the presentation and the amount of points possible for each section. Tell students they will help bid on each solar house by analyzing the presentations in these four areas.
3. Hand out the small bidding cards, Activity Card 6-1j. Tell students they will fill one card out for each solar house presentation. For each presentation they are to analyze the introduction, poster, chart of cost, and the closing address by writing comments about each section. At the end of each presentation the student will give an overall rating from 1-5 as described on the cards. Students will hand the cards to the teacher after each presentation.
4. Students should put their names on the back of the cards.
5. Student groups will take turns presenting their solar home design. The teacher will announce the winning solar home design(s) after conclusion of presentations. The students will begin putting their presentations together. They will draw their floor plan and create a chart of their solar home electric cost on large sheets of white paper or poster board. They will also plan the oral portions of the presentation and determine who will present for each part. Other "extras" for their presentations will also be planned. Other presentation formats might be a Power Point presentation, a skit, a brochure, or an advertisement.

Solar Letter

Sixth Grade
Activity: 1 Part 1
Activity Card: 6-1a

Student's Name: **Date:**

Dear Architectural Design Companies:

I am planning to build a new subdivision in Arizona called “Solar Villas”. I want the houses to be powered partially by solar electricity. I am requesting your company to design floor plans for a model home and estimate the cost of the solar electric system to power typical appliances in that home.

The diagram of the floor plan should include: a kitchen, living room, three bedrooms, two bathrooms, a typical number of electrical outlets and switches, and the location of typical appliances. If your floor plan is chosen, a model home will be built and furnished with the suggested appliances. The floor plan should NOT include: appliances to heat and cool the home, hot-water heater, clothes dryer, dishwasher, and kitchen stove as these appliances will not be operated by the solar electric system. I also want a chart showing the Total Daily Load for the model solar home.

The estimated cost should be in a chart showing the calculations for the cost of the solar panels, batteries and the inverter. The solar panels should be 50 watt panels and the batteries should have a capacity of 1320 watt-hours.

I have requested design services from several companies. I will listen to presentations from each of the companies and select a model solar home to build based on how well the company meets the above criteria.

Sincerely,

Ms. Photovoltaic

Home Energy Inventory

Sixth Grade
Activity: 1 Part 1
Activity Card: 6-1b

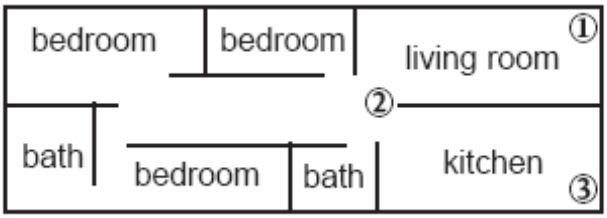
Student's Name: **Date:**

Background Information:

Investigate your own home to get an idea of the types of appliances and number of electrical outlets and switches found in a typical home. Ask family members to help you with your inventory.

Directions

1. Draw a sketch of the floor plans for the house or apartment that you live in now. Pretend that you cut the roof off and are looking down. On the back of this sheet draw what you would see.
2. Show the location of each electrical outlet or light switch by drawing small circles.
3. Number each outlet or light switch by putting a number in each circle.
4. The drawing should look something like this:



5. Fill in the data chart below by listing the type of appliance that is plugged into each outlet or the device that is turned on by each light switch. List each appliance separately if more than one is plugged into the same outlet. (See example in the chart below.)
6. Estimate how many hours per day each item is used and put this in the chart. For minutes use:

5 minutes = .08 hours	25 minutes = .42 hours	45 minutes = .75 hours
1 0 minutes = .17 hours	30 minutes = .5 hours	50 minutes = .83 hours
15 minutes = .25 hours	35 minutes = .58 hours	55 minutes = .92 hours
20 minutes = .33hours	40 minutes = .67 hours	

Sample table

Outlet/Switch Number	Appliance	Average Daily Use (hours per day)
Example: 1	TV	4 hours
	lamp	2 hours
2	ceiling fan	1 hour

Table to fill in with your information.

Outlet/Switch Number	Appliance	Average Daily Use (hours per day)

APS Power Posse™

Solar Home Floor Plan

Sixth Grade
Activity: 1 Part 2
Activity Card: 6-1c

Student's Name: **Date:**

Use the information from Home Inventory Worksheet to help you plan the design for your solar home.

1. The criteria from the subdivision owner for the floor plans are:
   Floor plan - the design company must provide a floor plan diagram showing the following:
   - kitchen
   - living room
   - three bedrooms
   - two baths
   - a typical number of electrical outlets and switches
   - the location of each electrical outlet and light switch
   - the location of typical appliances because the model home will be furnished so buyers can see the types of appliances available in a solar home
   - appliances to heat and cool the home, a hot-water heater, clothes dryer, dishwasher, and kitchen stove should NOT be included in the drawing as these will not be operated by the solar electric system

2. Discuss and compare your Home Energy Inventory worksheet (Activity Card 6-1b)with your group. Share your home's floor plans and appliance chart with your group to get an idea of the number and location of outlets and switches. Think about the types of appliances in a typical house.
3. Decide where you want the rooms, electrical outlets and switches. Label each electrical outlet and switch with a number in a small circle. Put this drawing on back of this sheet.
4. Decide which appliances you want in your solar home. Draw these on the floor plans.

Solar Home Total Daily Load

Sixth Grade
Activity: 1 Part 2
Activity Card: 6-1d

Student's Name: **Date:**

1. On the chart below make a list of the electrical appliances that will be plugged into each outlet or turned on by each switch in your solar home.
2. Using the Home Wattage Chart (Activity Card 6-1e), find the number of watts for each appliance and put this in the watts column.
3. Your group should then estimate how many hours per day each appliance will probably be turned on or be used. Put this in the Average Daily Use column.
4. For each appliance multiply the watts by the average daily use: W x H. This is how much electricity that appliance uses in one day. This is called the daily load for that appliance.
5. Finally, add up all of the average daily loads to get the Total Daily Load. This will show the total amount of power in watt-hours that your house requires.

Outlets/ Switch Number	Appliance	Watts (W)	Average Daily Use-Hours per Day	Average Daily Load (WxH)

Total Daily Load _____ watt-hours_____

APS Power Posse™

Home Wattage Chart

Sixth Grade
Activity: 1 Part 2
Activity Card: 6-1e

Student's Name: **Date:**

APPLIANCE	WATTAGE		APPLIANCE	WATTAGE
KITCHEN			OFFICE EQUIP.	
Clothes washer	540		Computer	200
Refrig.(Sun Frost)	120		Printer - dot	180
Blender	400		Answering machine	30
Clock	2		Fax machine	140
Coffee maker	625		Typewriter	120
Crock pot	200		Printer - laser	576
Food processor	450			
Garbage disposal	390		MISC.	
Mixer	150		Fan - box	160
Toaster	900		Fan - ceiling	80
Toaster oven	1100		Fan - oscillating	50
Waffle Iron	1200		Vacuum cleaner	1100
Microwave	1200		Vaporizer	650
			Water bed heater	500
BATHROOM	20		Humidifier	115
Curling iron	20		Iron	1200
Hair dryer	600		Electric blanket	190
			Alarm clock - LED	3
ENTERTAINMENT				
Radio	15		LIGHTS	
Tape player	120		Fluorescent	
CD player	120		2 foot	20
CB radio	13		4 foot	40
Satellite dish	60		8 foot	75
TV - 19"	100		Incandescent	
VCR	30		(light bulbs)	40
				60
				75
				100

These figures are averages for typical home appliances. The actual wattage for a specific appliance is usually stamped or printed on the rear of the unit. If the unit lists VA (volts x amps), that will give the approximate wattage. If amps and volts are listed separately, multiply the amps by the volts to get the wattage. If you choose to look for specific wattage, unplug the appliance and do not remove any part of the appliance's case or covering to avoid electric shock.

Solar Home Electric System Cost

Sixth Grade
Activity: 1 Part 3
Activity Card: 6-1f

Student's Name: **Date:**

At this point you should know the Total Daily Load for your solar home as found on the Total Daily Load worksheet (Activity Card 6-1d). This Total Daily Load number is the amount of electricity your solar home will need for all of its appliances.

To provide this electricity your solar home electric system needs three items:

a. solar panels - to produce electricity by changing the sun's energy into electrical energy
b. inverter - which is a device that changes the electrical energy from the solar panels (DC) into the kind needed for typical home appliances (AC)
c. batteries - to store energy to use during the night or on cloudy days

The total cost of these three items will give you a rough estimate of the cost of your solar home electric system. The directions for finding the amount and cost of these items is explained below.

Cost of Solar Panels

The amount of electricity a solar panel can produce depends on the number of hours the sun shines on the panel and the wattage of the panel. The amount of daily sun changes throughout the year so an average number is used. Solar panels can range in size from 10-300 watts. The numbers we'll use are:

solar panels = 50 watts Arizona's average daily sun = 6 hours

Therefore the amount of electricity the solar panels can produce daily is:

50 watts x 6 hours = 300 watt-hours (amount of electricity that one panel can produce in one day)

Number of Solar Panels for the Total Daily Load

To determine how many solar panels your house needs to produce enough electricity for all its appliances, use the following formula:

$$\frac{\text{Total Daily Load}}{\text{300 watt-hours}} = \text{Number of Solar Panels for Total Daily Load}$$

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Number of Solar Panels for the Inefficiencies of the System

Because the parts of the solar electric system, such as the inverter and the batteries, are not 100% efficient, they will also require some energy from the solar panels. Inefficiencies can vary from 10-30% depending on the brand of the products. To take into account these inefficiencies, the Total Daily Load must be multiplied by the estimated amount of inefficiency. We'll use 20%. Therefore:

Total Daily Load x .2(20%) = 300 watt-hours

Number of Solar Panels for Inefficiencies of System

Cost of Batteries

Battery capacity is the amount of watt-hours of electricity a battery can store. Batteries come in a variety of sizes; for this project we'll use a typical battery which stores:

Battery Capacity = 1320 watt-hours of stored electricity

Number of Batteries for the Total Daily Load

The number of batteries required to store enough energy to use for one day is found by calculating: (Be sure to round up!)

Total Daily Load = Number of Batteries for the Total Daily Load
1320 watt-hours

Number of Batteries for Inefficiencies of the System

Because the solar electric system is not 100% efficient, extra batteries are needed to account for this. Use the formula: (Be sure to round up!)

Total Daily Load x .2(20%) = Number of Batteries for Inefficiencies
1320 watt-hours

Cost of Inverter

The cost of the inverter depends on the size of the inverter. To find the proper size of the inverter, an estimate of the maximum load put on the system at one time is needed. To do this, look on the Total Daily Load worksheet (Activity Card 6-1d) and pick out the five biggest users of power that could be turned on at one time (for example: the refrigerator, toaster oven, etc.). Add up the watts of those five appliances.

Total Cost of Solar Electric System

Fill in the numbers from your calculations in the chart below. Add up the numbers in the last column to get the cost of the solar electric system.

Number of Panels for Total Daily Load	Number of Panels for Inefficiencies	Cost of Each Panel
_____+	_____X	$320.00=_____
Number of Batteries for Total Daily Load	Number of Panels for Inefficiencies	Cost of Each Battery
_____+	_____X	$275.00=_____
Number of Inverters	Total Number of Watts	Cost Per Watt for 5 Biggest Appliances
1 X	_____X	$1.00=_____

Solar Home Electric System Cost _____

Design Presentation Planning

Sixth Grade
Activity: 1 Part 4
Activity Card: 6-1g

Student's Name: **Date:**

Today your group will begin planning your presentation to the subdivision owner. Decide who in the group will do each job. The presentation guidelines are described below but these are just the basic requirements. Brainstorm with your group creative ideas to help make your presentation more interesting. Your objective is to make your home design the most appealing! At your teacher's direction, fill in the point value for each part of the presentation pieces in the blanks below.

_____Pts. Possible - Introduction

Plan an opening speech that includes the name of your architect design company, the names of your company members, and general information about solar homes and electricity, the effect solar homes have on the environment, etc. Be creative!

_____Pts. Possible - Poster of Floor Plan/Total Daily Load Chart

Draw your solar home's floor plan on a piece of large white paper or poster board. Draw the electrical outlets and light switches as you did on your sketch from Activity Card #6-3. Add as much detail as possible including furniture, appliances, outdoor plants, etc. Be ready to explain each room of the floor plan including the number of electrical outlets and switches in each room and why your group chose that amount in each room. Be sure to point out the best features of your home. Make the poster neat and colorful! You should also provide a chart that shows the calculation of your Total Daily Load from Activity Card 6-1f.

_____Pts. Possible - Chart of Solar Home Electric System Cost

Draw a chart similar to the one found on the Solar Home Electric System Cost worksheet (Activity Card 6-6) on a piece of large white paper or poster board. This chart should be large so that the whole class can see the numbers. Be ready to explain how you calculated the numbers on the chart. Your cost should be affordable and reasonable. You may also want to include a comparison of solar electricity with typical electricity. Also discuss ways that solar electricity could be made more affordable.

_____Pts. Possible - Closing Address

This part of the presentation should include one last attempt to "sell" your solar home design to the subdivision owner. Provide an explanation why your solar home design is the best. This may also be the time where you put additional creative ideas into the presentation such as a jingle or song, home-made buttons or business cards to hand out, a video-clip, a brochure, or an interview with other satisfied customers who have used your solar design company.

Overall Bid Rating

The following rubric will be used by the "subdivision owner" and fellow students to rate your group's work and presentation.

1= did not meet criteria	4=superb presentation
2= barely met set criteria	5= excellent, show be chosen as the winner
3= average presentation	

Presentation Rubric

The following rubric will be used by the "subdivision owner" and fellow students to rate your group's work and presentation.

Oral Presentation Rubric: Solar Home Design

CATEGORY	4	3	2	1
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes 1-2 words that might be new to most of the audience, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (5 or more) words or phrases that are not understood by the audience.
Listens to Other Presentations	Listens intently. Does not make distracting noises or movements.	Listens intently but has one distracting noise or movement.	Sometimes does not appear to be listening but is not distracting.	Sometimes does not appear to be listening and has distracting noises or movements.
Uses Complete Sentences	Always (99-100% of time) speaks in complete sentences.	Mostly (80-98%) speaks in complete sentences.	Sometimes (70-80%) speaks in complete sentences.	Rarely speaks in complete sentences.
Speaks Clearly	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.	Speaks clearly and distinctly most (94-85%) of the time. Mispronounces no more than one word.	Often mumbles or can not be understood OR mispronounces more than one word

Presentation Evaluation

Sixth Grade
Activity: 1 Part 5
Activity Card: 6-1h

Student's Name: **Date:**

This sheet will be used for the evaluation of each group's presentation. A final bid total will determine which house gets voted as the model home that the subdivision owner will choose to build. The vote will be based on a combination of points earned as evaluated by the teacher and overall rating from students and teacher.

Introduction Pts. Earned_____

- ☐ name of the architect design company
- ☐ the names of the company members
- ☐ general information about solar homes and electricity
- ☐ the effect solar homes have on the environment
- ☐ creativity

Poster of Floor Plan/Total Daily Load Chart Pts. Earned_____

- ☐ drawing of the solar home's floor plan
- ☐ drawing of the Total Daily Load Chart
- ☐ detail including furniture, appliances, outdoor plants, etc.
- ☐ explanation of each room of the floor plan
- ☐ explanation of number of electrical outlets and switches in each room
- ☐ description of the features of your home
- ☐ poster is neat and colorful

Chart of Solar Home Electric System Cost Pts. Earned _____

- ☐ drawing of cost chart
- ☐ readability and neatness of chart
- ☐ explanation of calculations for number of panels and batteries
- ☐ reasonable cost for the house
- ☐ report of ways that solar electricity could be more affordable

Closing Address Pts. Earned_____

- ☐ summary of solar home design strong points
- ☐ overall creativity
- ☐ overall organization
- ☐ overall accuracy of information

Total Pts. Earned_____

Overall Rating

- ☐ circle a number one through five that represents how well this house met the criteria of the subdivision owner

1 2 3 4 5

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Solar Home Rubric

Sixth Grade
Activity: 1 Part 5
Activity Card: 6-1i

Student's Name: **Date:**

Oral Presentation Rubric : Solar Home design

CATEGORY	4	3	2	1
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Preparedness	Student is completely prepared and has obviously rehearsed.	Student seems pretty prepared but might have needed a couple more rehearsals.	The student is somewhat prepared, but it is clear that rehearsal was lacking.	Student does not seem at all prepared to present.
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes 1-2 words that might be new to most of the audience, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (5 or more) words or phrases that are not understood by the audience.
Listens to Other Presentations	Listens intently. Does not make distracting noises or movements.	Listens intently but has one distracting noise or movement.	Sometimes does not appear to be listening but is not distracting.	Sometimes does not appear to be listening and has distracting noises or movements.
Uses Complete Sentences	Always (99-100% of time) speaks in complete sentences.	Mostly (80-98%) speaks in complete sentences.	Sometimes (70-80%) speaks in complete sentences.	Rarely speaks in complete sentences.
Speaks Clearly	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.	Speaks clearly and distinctly most (94-85%) of the time. Mispronounces no more than one word.	Often mumbles or can not be understood OR mispronounces more than one word

Presentation Cards

Sixth Grade
Activity: 1 Part 5
Activity Card: 6-1j

Student's Name: **Date:**

Presentation Bidding Card

(make comments for each part below)

Name of Company:
Introduction:
Poster/Chart:
Cost Chart:
Closing:
Overall Bid Rating:

1 = did not meet set criteria
2 = barely met set criteria
3 = average presentation
4 = superb presentation
5 = excellent presentation - should be selected for model

==========

Presentation Bidding Card

(make comments for each part below)

Name of Company:
Introduction:
Poster/Chart:
Cost Chart:
Closing:
Overall Bid Rating:

1 = did not meet set criteria
2 = barely met set criteria
3 = average presentation
4 = superb presentation
5 = excellent presentation - should be selected for model

Energy Transformation and Source Bingo

Sixth Grade
Activity: 10
Time: 1-2 Class Periods

General Description
Students will review energy terms associated with energy transformation and energy sources

Objectives
Students will demonstrate their mastery of energy terms

Arizona State Standards
SC06 S5C3 PO1 Identify various ways in which electrical energy is generated using renewable and nonrenewable resources (e.g., wind, dams, fossil fuels, nuclear reactions).

Teacher Information
Students should have completed a variety of energy activities before playing this game. It can be adapted for any vocabulary words that have been studied.

Materials
Bingo markers such as elbow macaroni or bingo game chips
List of energy vocabulary words and definitions that the class has studied
Energy Bingo Card (Activity Card 6-10)

Procedures/Exploration
1. Divide the students in groups of four. Assign each member in the group a number one through four.
2. Tell students they are going to play a game to help them review energy terms.
3. Read the definition of an energy term and then say "energize together". The four students in each group should discuss what term they think belongs with the definition that was read. Each student needs to agree and know the word. Allow approximately 30 seconds. Call for students' attention.
4. Choose a number from one to four. For example, say, "All the number threes stand up. Each person assigned a number three should stand. This should be one person in each group.
5. Choose a group to respond. The person standing will report the group's answer. If the answer is correct, go on to the next definition. If the answer is incorrect, choose another group to respond. Points for each group may be kept if desired.
6. After the terms and definitions have been reviewed in this way, proceed with Review Bingo.
7. Write the energy terms on the board. Hand out blank Energy Bingo Card, Activity Card 6-10, and have students put the terms in a random order on their cards.
8. Hand out bingo markers. The center spot can be designated a free space.
9. Tell students that you will read definitions of the terms that are listed on the board. As you read the definition, they should cover the term that matches on their bingo card. When they have five spaces covered, they should say, "Energy Bingo!"
10. Keep track of terms used for each game.

Energy Bingo Card

Sixth Grade
Activity: 10
Activity Card: 6-10

		FREE SPACE		

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Geothermal Sites in Arizona

Sixth Grade
Activity: 2
Time: 1 Class Period

General Description
Students will plot the locations of the geothermal hot spots in the state of Arizona and identify which location would be best to begin development.

Objectives
Students will plot geographical point on an Arizona map identifying geothermal locations.
Students will identify the most ideal location for development of the geothermal resources and justify their answer.

Arizona State Standards
SC06 S5C3 PO1 Identify various way in which electrical energy is generated using renewable and non renewable resources (e.g., wind, dams, fossil fuels, nuclear reactions)
SC06 S2C2 PO2 Describe how scientific knowledge is subject to change as new information and or technology challenges prevailing theories
SC06 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends

M06 S2C1 PO2 Construct a histogram, line graph, scatter plot, or stem-and-leaf plot with appropriate labels and title from organized data
M06 S2C1 PO4 Answer questions based on simple displays of data including double bar graphs, tally charts, frequency tables, circle graphs, and line graphs
M06 S4C4 PO1 Determine the appropriate measure of accuracy within a system for a given Contextual situation
M06 S4C4 PO2 Determine the appropriate tool needed to measure to the needed accuracy

Teacher Information
Geothermal energy is energy obtained from the heat in the earth's crust. The heat is caused by the underlying mantle which is essentially molten volcanic rock of extremely high temperatures. The heat is everywhere under the earth's crust, but it is most useful in places where it is at or near the earth's surface. Geothermal energy can be classified based on how it is extracted. The three basic sources from which it is extracted are: steam only, hot rocks, or hot water/steam combination. The forms of geothermal energy that can be used to produce electricity are the steam only systems and the hot water/steam combination systems. Geothermal energy can also be used for heating, hot water, industrial applications such as distilling, sterilizing, evaporating, etc.

Materials
Activity Card 6-2a
List of Coordinates, Activity Card 6-2b

Suggested Contacts

Free Geothermal Energy Booklet
U.S. Department of Energy
P.O. Box 62
Oak Ridge, TN 37830

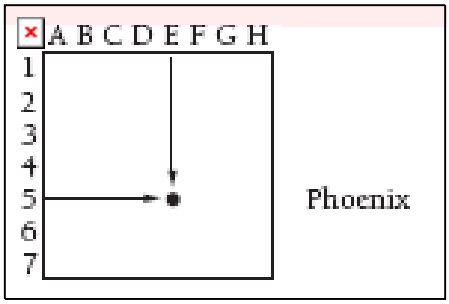
Arizona Department of Commerce Energy Office
Phone 602-771-1194 or 1-800-352-5499

For more information write to:
U.S. Department of Energy
East Mesa Geothermal Test Facility
Holtville, California 92250

Procedures/Exploration

1. Define geothermal energy. Discuss geothermal energy as a way to produce electricity using the heat from the earth's interior. Discuss the limitations of geothermal energy which are location and availability.
2. Define coordinates as a set of numbers used to specify a location on a map or grid.
3. Demonstrate how to plot points on a map by drawing a sketch of the state of Arizona on the chalkboard or overhead. Draw a few letters in a row across the top and a few numbers in a column down the side (see example below). The location of a point on a map can be found by using coordinates. Using the straight edge of a piece of paper or a ruler, show students that a plot point is found where the numbers and letters cross.

   For example: Phoenix (E, 5)



4. Hand out Geothermal Sites in Arizona Activity Card 6-2a, a piece of paper or ruler, and the map of Arizona, Activity Card 6-2b.
5. Have the students plot the coordinates either individually, with a partner, or as a directed group activity as you read the list of coordinates from Activity Card 6-2b to the class.
6. Make an overhead of the map of Arizona. Have students take turns plotting the points at the end of the class on the overhead to check their work.
7. Have students' research geothermal energy and describe the pros and cons of this energy source. Have students discuss how the location of geothermal sites affects the availability.

Geothermal Sites in Arizona

Sixth Grade
Activity: 2
Activity Card: 6-2a

Student's Name: **Date:**

As you read the following list of Geothermal Hot Water Sites in Arizona, plot the coordinates on the map on Activity Card 6-2b. You might work up a symbol representing Geothermal Sites, or just write the numbers on the map. Select the best location to begin using geothermal energy. Base your decision on distance to nearest population, temperature, and quantity.

• Power Ranch: Subsurface temperature. 180°C. Two wells drilled to a two-mile depth well bottom hole temperatures of 163°C and 184°C. Discharge from well estimated at 4,700 gallons per minute from below one mile. **Coordinates:** (R, 27)

•Verde Hot Springs: Surface temperature 36°C. Subsurface temperature 150° C. Several springs. **Coordinates:** (S, 21)

•Castle Hot Springs: Surface temperature 50°C. Subsurface temperature 110°C. Two springs. **Coordinates:** (0, 22)

•North of Clifton: Surface temperature 59°C. Subsurface temperature 140°C. Two springs. **Coordinates:** (FF, 28)

•Clifton Hot Springs: Surface temperature 75°C. Subsurface temperature 110°C. Two springs. **Coordinates:** (GG, 28)

•Eagle Creek Springs: Surface temperature 36°C. Subsurface temperature 115°C. **Coordinates:** (EE, 29)

•Gillard Hot Springs: Surface temperature 82°C. Subsurface temperature 140°C. Five springs. **Coordinates:** (DD, 30)

•Mt. Graham: Surface temperature 42°C. Subsurface temperature 110°C. One hot mineral well. **Coordinates:** (BB, 31)

•Exxon Yuma - Yuma County: Bottom hole in a Basalt 138°C. **Coordinates:** (B, 32)

•Exxon State - Pinal Country: Bottom hole in gneiss 110°C. **Coordinates:** (T, 31)

•Exxon State - Pima County: Bottom hole in granite 146°C. **Coordinates:** (X, 37)

•Plateau Drill hole: Bottom hole temperature 46°C. **Coordinates:** (EE, 4)

•Plateau Drill hole: Bottom hole temperature 57°C. **Coordinates:** (FF, 3)

•Plateau Drill hole: Bottom hole temperature 34°C. **Coordinates:** (DD, 18)

•Plateau Drill hole: Bottom hole temperature 69°C. **Coordinates:** (DD, 16)

Geothermal Sites in Arizona

Sixth Grade
Activity: 2
Activity Card: 6-2b

Student's Name: **Date:**

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Energy Books

Sixth Grade
Activity: 3
Time: 3-5 Class Periods

General Description

Students will research an energy topic and then create a book to share what they learned with classmates and other students.

Objectives

Students will research information about a specific energy source, renewable or non-renewable, consolidating that information into an easily read book to be presented to fourth graders at their school.

Arizona State Standards

SC06 S5C3 PO1 Identify various way in which electrical energy is generated using renewable and non renewable resources (e.g., wind, dams, fossil fuels, nuclear reactions)

SC06 S2C2 PO2 Describe how scientific knowledge is subject to change as new information and or technology challenges prevailing theories

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)

W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic

W06 S3C2 PO2 Write a summary based on the information gathered that include(s):

a. topic sentence
b. supporting details
c. relevant information

W06 S3C3 PO1 Write a variety of functional texts (e.g., directions, recipes, procedures, rubrics, labels, posters, graphs/tables)

W06 S3C4 PO1 Write persuasive text (e.g., essay, paragraph, written communications) that:

a. establishes and develops a controlling idea
b. supports arguments with detailed evidence
c. includes persuasive techniques
d. excludes irrelevant information

LS E1 Prepare and deliver an organized speech and effectively convey the message through verbal and nonverbal communications with a specific audience

Teacher Information

Creating a book is an effective way for students to summarize what they have learned about a particular topic. Educating and entertaining an audience of peers or younger students will give purpose to the book and provide a meaningful writing experience.

In order to have enough resources for your students you can contact the following different locations to receive free materials:

Arizona Department of Commerce Energy Office
Phone (602) 280-1402 or 1-800-352-5499
Especially "Bright Ideas" series and "Just Conserve It" series

Arizona Public Service Company
Phone (602) 250-2291
Especially "Ways to Save Energy"

Materials

Activity Card 6-3a
Activity Card 6-3b

Procedures/Exploration

1. Ask students the purpose of books. Make a list of their answers on the board. Make sure that students include the points that books inform and entertain the reader. Discuss the different formats of books such as pop-up books, wordless books, picture books with few words, storybooks, textbooks, etc. Provide examples if possible.
2. Tell students that creating books is not only a way to entertain and inform readers but it is also a good indicator of what the author knows about a particular topic. Tell students they will write a book about an energy topic of their choice. The students can choose a topic from the
3. Energy Book Idea List, Activity Card 6-3a or suggest their own. The books will be shared with the rest of the class or with younger students if possible.
4. Hand out the APS booklet "The Energy Kids." Tell the students that this is an example of an information book. They can choose to do their book in this type of format or a storybook format (puzzles and games are optional in the information format).
5. Suggested writing steps include:
    - gathering information about their topic
    - creating a main character such as a light bulb or kilowatt
    - planning a storyline or focus for the book
    - writing the book
    - illustrating and coloring the book
    - making a book cover
6. Have students choose a topic from the Energy Book Idea List, Activity Card 6-3a or create their own idea and begin research using energy brochures, energy books from the library, encyclopedias, magazines, etc.
7. Give the students the rubric, Activity Card 6-3b, which will be used to grade their task.
8. The students may work alone or with a partner. Use Six Trait Writing during this task.
9. Provide time for the students to read their book to the class or to another class.

Energy Book Idea List

Sixth Grade
Activity: 3
Activity Card: 6-3a

Student's Name: **Date:**

Sunspot Builds a Solar House
Mr. Shade Landscapes his Yard
Bright Bulb Saves Electricity
Gus Builds a Windmill
Ms. Current Explores New Energy Sources
- *...Learns About Energy Conservation*
- *...Carpools to Work*
- *...Leaves Electrical Appliances On*
- *...Uses His Bike Instead of a Car*
- *...Takes a Trip to the Star Center*
- *...Fixes Dinner*
- *...Makes an Electric Car*
- *...Finds a Geothermal Area*
- *...Builds a Dam*
- *...Visits Hoover Dam*
- *...Mines for Coal*
- *...Takes a Bus Instead of a Car*
- *...Uses Biomass Energy*
- *...Practices Electrical Safety*

The Pink Panther Insulates his Home
Robbie Reads his Meter
Frankie Cooks Hot Dogs with the Sun

Energy Book Rubric

Sixth Grade
Activity: 3
Activity Card: 6-3b

Student's Name: **Date:**

Energy Book Rubric

CATEGORY	4	3	2	1
Writing Process	Student devotes a lot of time and effort to the writing process (prewriting, drafting, reviewing, and editing). Works hard to make the story wonderful.	Student devotes sufficient time and effort to the writing process (prewriting, drafting, reviewing, and editing). Works and gets the job done.	Student devotes some time and effort to the writing process but was not very thorough. Does enough to get by.	Student devotes little time and effort to the writing process. Doesn't seem to care.
Creativity	The story contains many creative details and/or descriptions that contribute to the reader's enjoyment. The author has really used his imagination.	The story contains a few creative details and/or descriptions that contribute to the reader's enjoyment. The author has used his imagination.	The story contains a few creative details and/or descriptions, but they distract from the story. The author has tried to use his imagination.	There is little evidence of creativity in the story. The author does not seem to have used much imagination.
Requirements	All of the written requirements (# of pages, # of graphics, type of graphics, etc.) were met.	Almost all (about 90%) the written requirements were met.	Most (about 75%) of the written requirements were met, but several were not.	Many requirements were not met.
Characters	The main characters are named and clearly described in text as well as pictures. Most readers could describe the characters accurately.	The main characters are named and described. Most readers would have some idea of what the characters looked like.	The main characters are named. The reader knows very little about the characters.	It is hard to tell who the main characters are.
Neatness	The final draft of the story is readable, clean, neat and attractive. It is free of erasures and crossed-out words. It looks like the author took great pride in it.	The final draft of the story is readable, neat and attractive. It may have one or two erasures, but they are not distracting. It looks like the author took some pride in it.	The final draft of the story is readable and some of the pages are attractive. It looks like parts of it might have been done in a hurry.	The final draft is not neat or attractive. It looks like the student just wanted to get it done and didn't care what it looked like.
Spelling and Punctuation	There are no spelling or punctuation errors in the final draft. Character and place names that the author invented are spelled consistently throughout.	There is one spelling or punctuation error in the final draft.	There are 2-3 spelling and punctuation errors in the final draft.	The final draft has more than 3 spelling and punctuation errors.
Accuracy of Facts	All facts presented in the story are accurate.	Almost all facts presented in the story are accurate.	Most facts presented in the story are accurate (at least 70%).	There are several factual errors in the story.

"Take it to the Mayor" Game

Sixth Grade
Activity: 4
Time: 1-2 Class Periods

General Description
Students will play an energy game increasing their understanding and knowledge of conservation. In the process of playing this game, students will be able use their knowledge of conservation to propose a solution to an energy need.

Objectives
Students will increase their understanding of conservation and apply that understanding to a new situation.

Arizona State Standards
SC06 S3C2 PO1 Propose viable methods of responding to an identified need or problem
SC06 S3C2 PO2 Compare possible solutions to best address an identified need or problem

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)
W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W06 S3C4 PO1 Write persuasive text (e.g., essay, paragraph, written communications) that:
- a. establishes and develops a controlling idea
- b. supports arguments with detailed evidence
- c. includes persuasive techniques
- d. excludes irrelevant information

Teacher Information
There are many ways to conserve energy. This game will introduce a variety of actions that either conserve or waste energy. Giving students the opportunity to study a variety of brochures and pamphlets on energy conservation will enhance the effectiveness of this activity.

Materials
Activity Card 6-4a - put together to make a game board
Activity Cards 6-4b (Council Cards), 6-4c (Mayor Cards), 6-4d (Car Inspection Cards). Copy two sided, cut so there are two sets
Energy conservation pamphlets and brochures
Dice (1 per board)
Game markers (game pieces from Monopoly or another similar game)

Energy conservation materials can be provided by:

Arizona Department of Commerce Energy Office
(602) 771-1194 or 1-800-352-5499
Especially “Bright Ideas” series and “Just Conserve It” series

APS
Phone (602) 250-2291
Especially “Ways to Save Energy”

Procedures/Exploration

1. Tell students they will play an energy conservation game that will give them the opportunity to identify conservation versus waste. They will play the game twice. Between the two games they will be given the opportunity to do research to make new pieces for the game and better decisions during the second game.
2. The game can be played by two to four players for each board. Make sure you explain the rules to the students, modeling one round:
   - Each student rolls the die and the highest number goes first.
   - In turn, each player rolls the die and moves their marker the number of spaces indicated on the die.
   - If a player lands on a space with a plus or minus number, that number is recorded on a score sheet.
   - If a player lands on a space that says "Draw a Mayor card", the player draws and records that number on the score sheet.
   - If the mayor card says to "Draw a City Council card", the player draws a card and records that number on the score sheet.
   - If a player lands on a car inspection space, he draws a card and records the number on the score sheet.
3. Have the students keep a record of their points and the reasons for those points.
4. The winner of the game is the person with the highest total number at the end.
5. After the game has been played, have the students’ research and analyze why the numbers were positive and negative for the actions in the game.
6. Provide research materials and time in order for student to create new actions to replace those on the game. Encourage them to create both positive and negative spaces and cards.
7. Students could play the game again using their revised spaces and cards. This would also be a good activity to have students share with lower grade level students.
8. As a final wrap up have the students write a persuasive essay on why they made the decisions they made.

"Take it to the Mayor" Game Board

Sixth Grade
Activity: 4
Activity Card: 6-4a

1 Start	**16** You took a hot bath rather than a shower. -6	**17** You cut down the tree on the west side of your house. -5	**18** You left the classroom door open. -4
2 You left the bathroom light on all day. -5	**15** You wrote your congressman asking for solar support. +3		**19** Your family bought a jacket for the water heater. +3
3 You recycle at home. +5	**14** You and a friend went shopping together. +3		**20** You waited till after dark to water your outside plants +3
4 You drove 65 mph on the freeway. -3	**13** You have a plan for car pooling. take it to the Mayor. Draw a Mayor card		**21** You burned your old newspapers instead of recycling. -3
5 You had your car inspected. Draw an inspection card.	**12** You left your air conditioner turned on at 78° when you went on summer vacation. -6		**22** You had your car inspected. Draw an inspection card.
6 You inflated your tires to proper pressure. +3	**11** You made a solar cooker. +4		**23** You left the TV on when you went out to play. -3
7 You left water dripping in the shower. -4	**10** You rode your bike to the ball game instead of riding in the car. +5		**24** You have a plan for park grass that uses less water. Take it to the Mayor. Draw a Mayor card.
8 You have an idea for a bike club. Take it to the Mayor. Draw a Mayor card.	**9** You let irrigation overflow into the street. -5		**25** You helped your mom do laundry after 9 p.m. +4

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3 You had your car inspected. Draw an inspection card.	**34** You ran the dishwasher without a full load. -5	**35** You left all the lights turned on in the house when you left. -4	**50** **END** Give yourself one point for each player behind you.
32 You didn't clean the dryer's lint filter after drying your clothes. -6		**36** Your family installed a solar water heater. +6	**49** You left the TV on again. Go back to 23 and lose 3 points. -3
31 Your family had a cook-out. Saved heating up the house +4		**37** You rode your bike to school this morning. +2	**48** You left the water running while you brushed your teeth. -5
30 You reminded dad to get a tune-up on his car +6		**38** You started a "Save Energy" program at school. +5	**47** You had your car inspected. Draw an inspection card.
29 You had your car inspected. Draw an inspection card.		**39** You wore a sweater rather than complaining about the thermostat set at 68º in the winter. +4	**46** You suggested weather stripping for a business. Take it to the Mayor. Draw a Mayor card.
28 You left the fireplace damper open with no fire. -3		**40** You heated the oven to warm rolls and forgot to turn it off until after dinner. -6	**45** You ran the washing machine half full so you could wear your favorite shirt. -3
27 You planted trees around your house. +3		**41** You had your car inspected. Draw an inspection card.	**44** You used an electric can opener instead of doing it yourself -3
26 Your club wants to install a bike path. Take it to the Mayor. Draw a Mayor card.		**42** You have an idea on irrigation that will get more land watered. Take it to the Mayor. Draw a Mayor card	**43** You installed low-flow shower heads in your bathroom shower. +2

City Council Cards

Sixth Grade
Activity: 4
Activity Card: 6-4b

City Council Card APS Power Posse™	City Council Card APS Power Posse™
City Council Card APS Power Posse™	City Council Card APS Power Posse™
City Council Card APS Power Posse™	City Council Card APS Power Posse™
City Council Card APS Power Posse™	City Council Card APS Power Posse™
City Council Card APS Power Posse™	City Council Card APS Power Posse™

Not worth Phoenix tax dollars. No way. -2	Motion carried!!!! +7
Since the major businesses will be footing the bill, we approve. +4	A 1.5 % city tax increase? No!!!! -3
This sounds too rich for our town. No!!!! -3	Not worth considering. -1
This sounds like a nice asset to our community. Yes!!!! +5	Super idea!!!! +10
Our town needs that type of progressive thinking. Yes!! +3	No money this year. Come back again. -1

Mayor Cards

Sixth Grade
Activity: 4
Activity Card: 6-4c

Mayor Card APS Power Posse™	Mayor Card APS Power Posse™
Mayor Card APS Power Posse™	Mayor Card APS Power Posse™
Mayor Card APS Power Posse™	Mayor Card APS Power Posse™
Mayor Card APS Power Posse™	Mayor Card APS Power Posse™

That's a good idea. We will pass it on to the City Council. (Draw a City Council card) +1	Mayor likes the idea but thinks Council will disapprove. -3
Super idea! Take it to the City Council. (Draw a City Council card) +2	It's a good idea but the people living farthest from town won't like it. No!!!! -4
Mayor likes the idea. Pass it on to the City Council. (Draw a City Council card) +2	Mayor agrees! Take it to the City Council. (Draw a City Council card) +1
Businesses in Phoenix would be against such an idea. No!! -2	Try again after the election. -1

Car Inspection Cards

Sixth Grade
Activity: 4
Activity Card: 6-4d

Car inspection card APS Power Posse™	Car inspection card APS Power Posse™
Car inspection card APS Power Posse™	Car inspection card APS Power Posse™
Car inspection card APS Power Posse™	Car inspection card APS Power Posse™
Car inspection card APS Power Posse™	Car inspection card APS Power Posse™
Car inspection card APS Power Posse™	Car inspection card APS Power Posse™

In your car you had weather stripping for your windows. +5	In your car you had a new oil filter for your car. +3
In your car you had individually wrapped candies. -1	In your car you had low wattage light bulbs for low light areas. +3
In your car you had fried chicken TV dinners for the whole family. -3	In your car you had a new filter for your air conditioner. +3
In your car you had sunscreens for your windows +5	In your car you had new spark plugs for your car. +3
In your car you had a list of things you need from other nearby stores in order to save gas. +5	In your car you had an outdoor loudspeaker for your car. -4

Heat Conductors

Sixth Grade
Activity: 5
Time: 1 Class Period

General Description
Students will investigate what it means for a material to conduct thermal energy.

Objectives
Students will invest what the term conduction means in terms of thermal energy.
Students will describe how heat energy can be transferred by conduction.

Arizona State Standards
SC06 S5C3 PO4 Explain how thermal energy (heat energy) can be transferred by:

- conduction
- convection
- radiation

SC06 S1C1 PO2 Formulate questions based on observations that lead to the development of a hypothesis
SC06 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC06 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs
SC06 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC06 S1C4 PO1 Choose an appropriate graphic representation for collected data:

- line graph
- double bar graph
- stem and leaf plot
- histogram

M06 S2C1 PO1 Formulate questions to collect data in contextual situations
M06 S2C1 PO2 Construct a histogram, line graph, scatter plot, or stem-and-leaf plot with appropriate labels and title from organized data
M06 S2C1 PO4 Answer questions based on simple displays of data including double bar graphs, tally charts, frequency tables, circle graphs, and line graphs
M06 S4C4 PO1 Determine the appropriate measure of accuracy within a system for a given Contextual situation
M06 S4C4PO 2 Determine the appropriate tool needed to measure to the needed accuracy.

Teacher Information
Conduction is the transfer of thermal energy from one substance to another through direct contact. Conduction can also occur within a substance such as a piece of metal or glass.

Materials

Hot water
Metal spoons
Wooden spoons
Plastic spoons
Glass rod
Shallow pans to hold hot water

Procedures/Exploration

1. Divide the students into groups.
2. Explain to the students that they will be gathering some data that they will need to graph. Have the students brainstorm how they will keep track of the data.
3. Have the students create the table they will be using to keep track of the data.
4. Explain to the students what they will be doing; testing the conductivity of heat through a material.
5. Make predictions about which spoon will conduct heat the best.
6. Pour about one inch of heated water into the pan.
7. Place a thermometer in the water and attach one with tape to the end of the spoon or rod.
8. Record the temperature of the water and the end of the spoon at the start.
9. Record the temperature of both the water and object every 30 seconds for two minutes.
10. Repeat steps 8 and 9 for all the different objects.
11. Graph the results.
12. In their groups have the students discuss what they discovered.
13. Have the students share whole their results.
14. Provide students with the opportunity to develop their own definition of conduction and illustrate it in their science notebooks.
15. Ask students if they think the same would find similar results if they used ice water instead; would the same materials conduct the temperature at the same rate?

Hot Dogs and Sun Tea

Sixth Grade
Activity: 6
Time: 2-3 Class Periods

General Description
Students will investigate the use of solar energy as heat to prepare food and drinks. They will build a solar cooker for hot dogs and make sun tea.

Objectives
Students will construct a solar cooker to help reduce the use of electricity.

Arizona State Standards
SC06 S3C2 PO3 Design and construct a solution to an identified need or problem using simple classroom materials.
SC06 S2C2 PO2 Describe how scientific knowledge is subject to change as new information and or technology challenges prevailing theories.

Teacher Information
When parallel light rays, as seen from the sun, fall on a concave mirror, foil on the inside of an oatmeal box, the reflected light rays come together at a place called the focal point. The focal point is a concentrated point of the sun's thermal, heat, energy. A foil-lined oatmeal box does not make just one focal point but a line of focal points. In order for the hot dog to cook, it must lie along this line. The students should be shown how the focal point is determined. Use half of an oatmeal box to determine this. Point out that the focal point is not a spot on the box. Even though they cannot see this line of points, they can feel the heat generated by the focal line with their hands. See Activity Card 6-6a.

Safety Note: Make sure the students use unpainted coat hangers as some paints could be poisonous. Caution students not to look directly into the solar cooker as the intense sun could damage their eyes.

Materials
Activity Card 6-6b
Round oatmeal box
Cardboard card (no longer than the oatmeal box)
Aluminum foil
Tape
Unpainted coat hangers
Nuts and bolts
Hot dogs

Sun tea
Water
Tea bags
Glass jar with lid
Sun

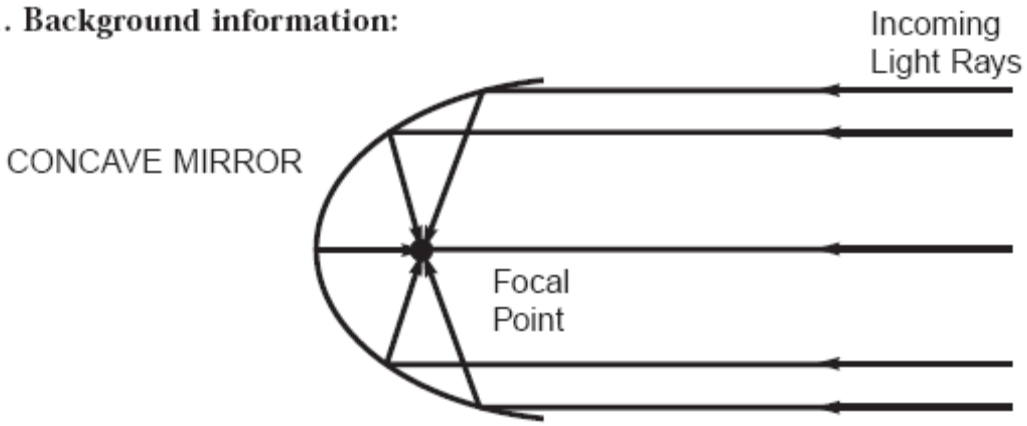
Procedures/Exploration

1. Discuss and model the steps for building the solar cooker as shown on Activity Card 6-6b before beginning project.
2. Discuss the steps for making sun tea as described on Activity Card 6-6b.
3. Allow students time to construct the solar cookers.
4. Pick a sunny day and cook the hot dogs and make the sun tea.
5. Discuss other ways to use the heat generated by solar energy. Students could research current uses of solar energy and give reports to the class.

Teacher Information

Sixth Grade
Activity: 6
Activity Card: 6-6a

1. Background information:



When parallel light rays (as from the sun) fall on a concave mirror (foil on the inside of an oatmeal box), the reflected light rays come together at a place called the focal point. A foil-lined oatmeal box does not make just one focal point but a line of focal points. In order for the hot dog to cook, it must lie along this line.

2. Directions:
The children must be shown how the focal point is determined. Use half of an oatmeal box to demonstrate this. Point out that the focal point is not a spot on the box. Even though they can not see this line of point, they can feel the heat generated by the focal line with their hands.

After the children have located their focal line, have them make their hole in their boxes and run the coat hanger through this line using the diagram as a guide.

Nuts and bolts are not necessary to hold the coat hanger in place.

3. Safety note:
Make sure the students use unpainted coat hangers because paint can poison.
Do not look directly into your solar cooker. If you do, it may damage your eyes.

Glossary
Focal point: the point to which light is focused by using a concave mirror or convex lens.
Parallel: side-by-side but the same distance apart.
Concave mirror: mirror which curves inward at its center.

Hot Dogs and Sun Tea

Materials

For solar cooker:

- Round oatmeal box
- Cardboard box that is longer than the oatmeal box
- Unpainted coat hanger
- Foil
- Tape
- Nuts and bolts
- Hot dogs

For sun tea:

- Water
- Tea bags
- Glass jar with lid
- Sun

Directions

For solar cooker:

1. Cut the oatmeal box in half lengthwise and line the inside with foil. This means both the curved surface and the ends will be lined.
2. Cut off one side of the cardboard box (as shown in the picture) so the oatmeal box will turn freely.
3. Straighten your coat hanger and bend a handle in one end.
4. To find the focal point, hold the oatmeal box so the sun shines into it. Give it a minute to warm up. Using your hand, (DON'T TOUCH THE FOIL) find the warmest spot in front of the foil. Mark this spot with your pencil on the side of the oatmeal box. This is the focal point. Your coat hanger must run along the focal points. See the picture and wait for the teacher's help before going on.

For sun tea:

1. Fill the glass container with water.
2. Put the tea bags in the water (leave the tags on the bags hanging outside the jar).
3. Put the lid on the container and place the container in the sun where it will not be knocked over. Leave the jar in the sun for two to six hours, depending on how strong you prefer your tea.

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Work and Energy

Sixth Grade
Activity: 7
Time: 1 Class Period

General Description
Kinetic energy and potential energy will be introduced using balloons, a wind-up clock and a battery-operated toy.

Objectives
Students will demonstrate knowledge the difference between potential and kinetic energy.

Arizona State Standards
SC06 S5C3 PO2 Identify several ways in which energy may be stored
SC06 S1C2 PO1 Demonstrate safe behavior and appropriate procedures
SC06 S3C2 PO3 Design and construct a solution to an identified need or problem using simple classroom materials

W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic.

Teacher Information
Energy of motion is known as kinetic energy. Energy that is stored is known as potential energy. The class activities will show how energy can be stored and then used to do work. In the scientific sense, work is done whenever energy is used.

Materials
Wind up clock
Battery powered clock
Rubber bands
Batteries
Sting
Straws
Balloons (one per student)
Other materials to help students design toys (students could bring things from home)

Procedures/Exploration
1. Write the words “kinetic” and “potential” on the board. As a demonstration model, bring in a wind-up clock and a battery – powered clock
2. Have the students move around the room until they begin to feel tired.
3. Ask them the following questions: How do you feel? Why do you feel warm when you have been running? Discuss the kind of energy that was used.
4. Have each student blow up a balloon (storing energy). Ask if this energy can be used to do work. The students will hold on to the balloon and let the air blow out onto a scrap of paper. Is that evidence of work? Why or Why not?

5. Explain how the wind-up clock and battery toys are examples of stored energy that can do work.
6. Students will summarize potential and kinetic energy and give examples.
7. Students will design models using energy from the balloon's air, winding rubber bands or batteries to run a toy, i.e.: toy boat, toy jet on a string with straw, toy car or truck, etc

Reference: Dunn, Susan , and Rob Larson . Design Technology: Children's Engineering . Bristal PA: The Falmer Publishing , 1990.
Eichelberger, Barbara , Connie Larsen, Constructions For Children: Projects in Design Technology. Palo Alto CA: Dale Seymore Public, 1993.

Energy Transformation and Hydroelectric Power

Sixth Grade
Activity: 8
Time: 1-2 Class Periods

General Description

Students will explore the difference between kinetic and potential energy. Students will also discover how a hydroelectric dam works to change potential energy into electrical energy. They will identify the locations of hydroelectric dams in Arizona.

Objectives

Students will explore potential and kinetic energy.
Students will explain and provide examples of how potential energy is use to make things move.
Students will compare how energy can be transformed: mechanical to electrical.
Students will identify the locations of hydroelectric dams in Arizona.

Arizona State Standards

SC06 S5C3 PO1 Identify various ways in which electrical energy is generated using renewable and non-renewable resources (e.g., wind, dams, fossil fuels, nuclear reactions)
SC06 S5C3 PO2 Identify several ways in which energy may be stored
SC06 S5C3 PO3 Compare the following ways in which energy may be transformed:

- mechanical to electrical
- electrical to thermal

W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic

Teacher Information

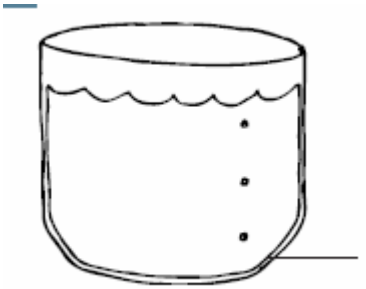
Potential energy is energy that is stored in an object or substance. Typically this stored energy is as a result of gravity. When an object is moved in the opposite direction of gravity or the force acting on the object potential energy is built up. For example, when a ball is lifted off the floor, energy from the muscles in the hand that lifted it plus the force of gravity energy is transferred to the ball. The ball has the "potential" to fall and transform its potential energy into kinetic energy (the energy of motion). The farther something is lifted off the ground (in the opposite direction of gravitational force), the more potential energy it will have. This principle is used in dams to generate electricity. The potential energy of the water behind the dam is used when the water is released and changed into kinetic energy as it falls. Water pressure plays a significant role in determining where and how to release the water. The release of water is most effective near the bottom of the dam because of the greater amount of water pressure/ gravitation force from above.

Materials

Activity Cards 6-8a,6-8b, 6-8c, 6-8d, 6-8e, 6-8f, 6-8g
Plastic two-liter soda bottle with the top cut off
Small picture hanging nails
Rubber bands
Meter sticks
Ramp-made out of scrap wood
Small toy cars (i.e. Matchbox)

Set up Directions

Punch three holes in a vertical line with small nails: one near the top, one near the middle, and one near the bottom. See picture to the right. Leave the nails in the bottle and fill with water. (If the bottle leaks too much either tape the holes or use volunteers to cover the holes with their fingers.)



Procedures/Exploration

1. Discuss potential of kinetic energy with the students. Give the students a rubber band (be sure to have safety rules in place) and have the students barely stretch the rubber band, ask them how far they think it will go, and then let go.
2. Have them measure how far it traveled.
3. Ask them what they have to do to make the rubber band go the furthest. Have them investigate if their idea is correct. They should use the meter stick to measure how far the rubber band went.
4. Provide time for the students to share their ideas/discoveries.
5. Give the students a toy car and a wooden ramp.
6. Have them explore how they will use the ramp to make the car go the furthest.
7. Teacher Note: the higher the ramp the further the car should travel.
8. Ask them to explain how height/opposite force caused the car/rubber band to move. Have the students explain the difference between potential and kinetic energy.
9. Hand out the Hydroelectric Information sheet (Activity Card 6-8a). Read the information and discuss the vocabulary words.
10. Show the students the two-liter bottle of water with the push pins. Ask the students to predict what will happen if all three nails are removed at the same time. Ask if they think there will be a difference in the amount of flow or the force of the flow from each hole. Remove nails. (Students should see that the bottom hole produces a stronger, longer stream of water due to the increased water pressure.)
11. Have students record their predictions, observations and hypotheses as to why this occurred on the Hydroelectric Data sheet (Activity Card 6-8b).
12. Discuss the implications this has for the construction of dams. See Turning on the Switch Teacher Information Sheet (Activity Card 6-8c) (The lower the water is released from the dam, the more forceful the water is - due to the pressure of the water.)

On the Turning on the Switch sheet (Activity Card 6-8d), have the students color the steps in producing electricity from falling water.

13. Hand out the map of Arizona Dam Sites (Activity Card 6-8e and 6-8g) and have students label the correct names using the chart. Activity Card 6-8f has the answers.
14. Discuss the importance of hydroelectric power with the students. Have them brainstorm a list of pros and cons for electricity generated by hydroelectric power plants.

Hydroelectric Information

Sixth Grade
Activity: 8
Activity Card: 6-8a

Making electricity from falling water is called hydroelectric generation. The Salt River Project has dams at six reservoirs: four have generating facilities. In these hydroelectric units, water is released from the reservoir through a tube called a penstock. At the bottom of the dam, in the powerhouse, this water is forced past a series of bladed wheel-like structures attached to a shaft. These are called turbines.

The pressure of the water rushing past the blades turns the shaft very rapidly, which turns the rotor on the other end of the shaft inside the generator. The generator is made up of a shaft with a huge coil of wire that spins within a magnetic field. This generates electricity. The generator changes mechanical energy into electrical energy, making electricity. Before the electricity is sent to homes, the transformer changes the electricity to the appropriate voltage for it to travel long distances. Before it can be use by homes, schools and other buildings different transformers change the voltage again to 120/240 Volts.

Hydroelectric generation is one of the most inexpensive methods of making electricity because it does not consume natural resources. It is also environmentally clean because no waste is produced. However, there are virtually no new sites in the Southwest that are economically or environmentally feasible for new hydroelectric generating sites. SRP and other Western utilities must rely on more expensive fuels for most power generation.

Glossary

Potential energy- stored energy in an object or substance such as water behind a dam or a car at the top of a roller coaster.

Kinetic energy- energy of an object or substance that is moving.

Turbine- a bladed, wheel-like machine which is made up of a spinning shaft of wire rotating within a magnetic field.

Generator- a device that converts mechanical energy into electrical energy.

Transformer- a device used to change the voltage of an electric current.

Hydroelectric Data

Sixth Grade
Activity: 8
Activity Card: 6-8b

Water Flow Demonstration

1. Observe a two-liter bottle with three vertical holes punched in it. The holes should be covered or plugged with small nails. Predict what will happen when the bottle is filled with water and the holes are uncovered at the same time.

2. Observe the water that flows out of the holes. What happened?

3. What do you think caused this to happen?

4. What implications does this have for the construction of a dam?

Turning on the Switch Teacher Information

Sixth Grade
Activity: 8
Activity Card: 6-8c

1. Explain to the students that other power plants may have other primary energy sources.
2. Distribute Activity Card 6-8d. Have the students point to the building. Questions:
   What is this building called? (power plant, hydroelectric plant)
   What is the purpose of this plant? (produces electricity)
   Where is the electricity sent? (to cities, towns, businesses and homes)
   How is the electricity sent to these places? (through wires)
3. Answers:
   - Color the area from the filter to the turbine blue
   - Color the area that extends from the turbine out of the plant in the form of waste red.
   - Color the turbine orange.
   - Color the generator brown.
   - Color the transformer black.

Glossary

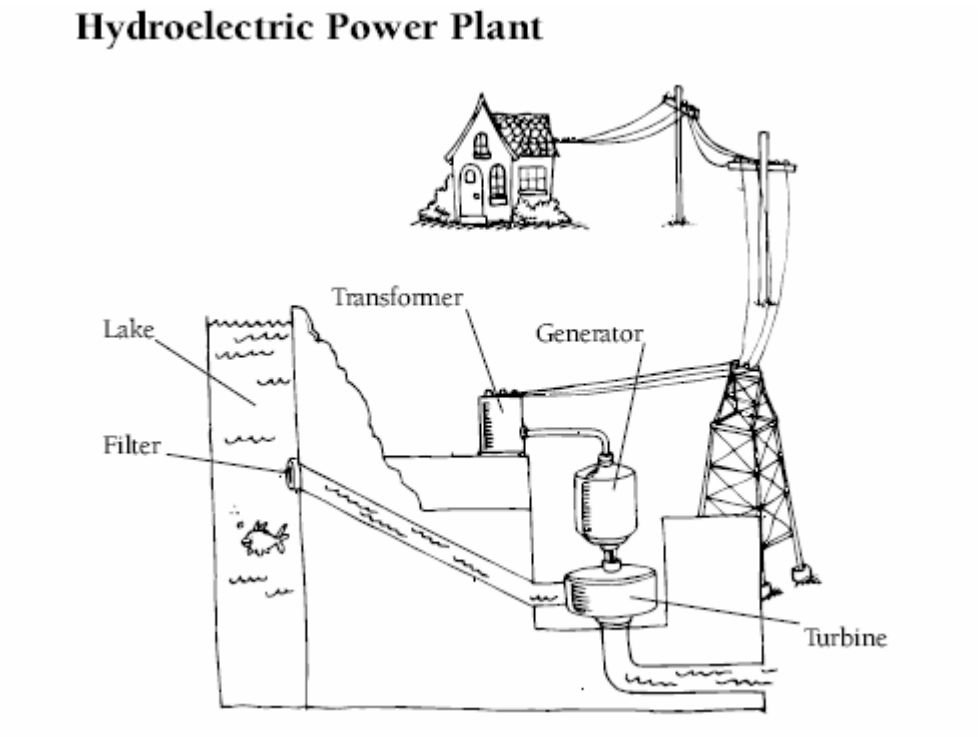
Turbine – a bladed, wheel-like machine which is made up of a spinning shaft of wire rotating within a magnetic field.

Generator – a device that converts mechanical energy into electrical energy.

Transformer – a device used to change the voltage of an electric current.

Turning on the Switch

Sixth Grade
Activity: 8
Activity Card: 6-8d



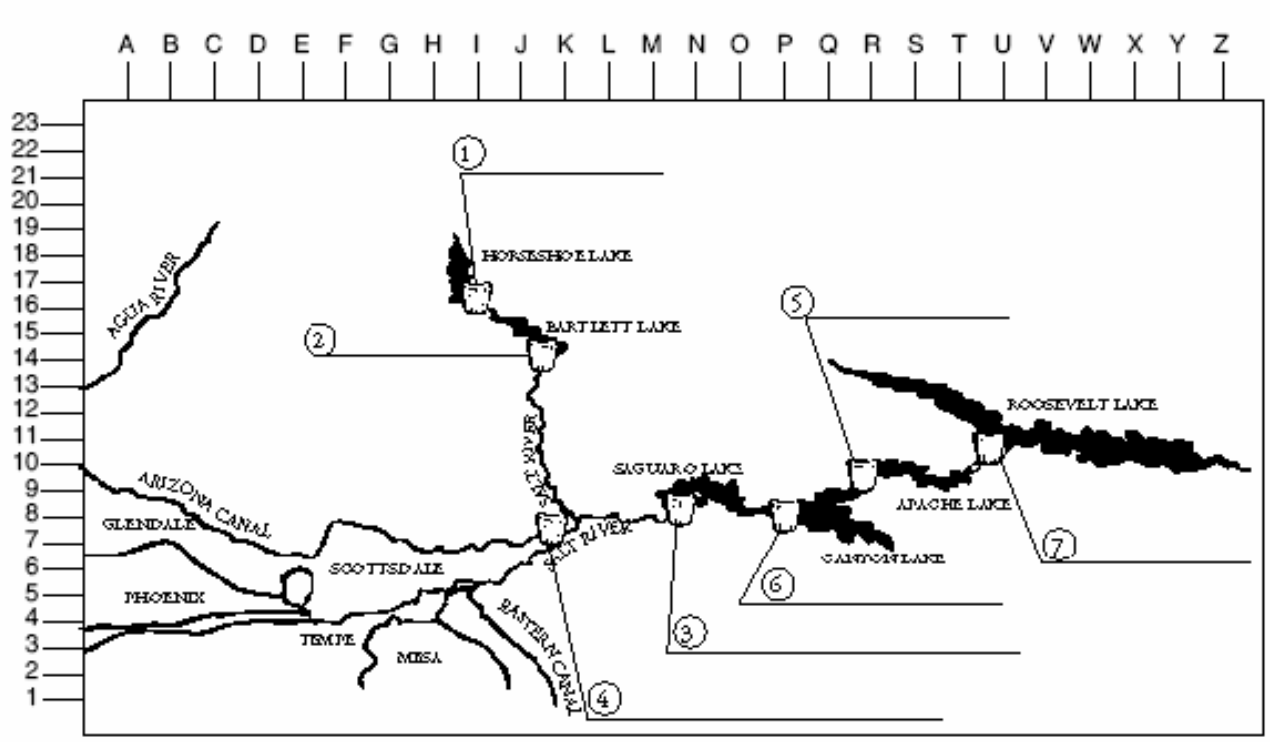
Directions

1. Show how the lake water flows to the turbine by coloring the water blue.
2. Trace the flow of water from the turbine out of the plant by coloring it red.
3. Color the device orange that uses the movement of water to generate mechanical energy.
4. Color the device brown that changes mechanical energy into electrical energy.
5. Color the device black that changes the voltage of the electricity, making it safer for our homes.

Arizona Dam Sites

Sixth Grade
Activity: 8
Activity Card: 6-8e

Directions
Using the descriptions of the dams on Activity Card 6-27, locate and write in the names of the dams on the map below.



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Arizona Dam Sites Teacher Information

Sixth Grade
Activity: 8
Activity Card: 6-8f

Answer Key

1. Horseshoe Dam (I-17)
2. Bartlett Dam (K-14)
3. Stewart Mountain Dam (N-9)
4. Granite Reef Division (K-8)
5. Horse Mesa Dam (R-10)
6. Mormon Flat Dam (P-8)
7. Theodore Roosevelt Dam(U-11)

Arizona Dams Site Information

Sixth Grade
Activity: 8
Activity Card: 6-8g

Verde River Dams

U-11 Theodore Roosevelt Dam - The first dam built to supply a dependable water source to the Valley was the Theodore Roosevelt Dam, completed in 1911. It has a generating capacity of 36,000 kilowatts (kw). Roosevelt Lake, which is formed by Roosevelt Dam, at the conflux of the Salt River and Tonto Creek, has a capacity of 1,381,580 acre-feet of water and a shoreline of 88.35 miles. (An acre-foot of water is enough water to cover an acre one foot deep or 325,850 gallons. The abbreviation is af.) The dam was named for the President of the United States Theodore Roosevelt.

R-10 Horse Mesa Dam - Completed in 1927, Horse Mesa Dam has the generating capacity of 130,800 kw. Apache Lake, which is formed by Horse Mesa, has a capacity of 245,138 af of water. Horse Mesa Dam was named because it was built near a mesa allegedly used for hiding stolen horses.

P-8 Mormon Flat Dam - Completed in 1925, Mormon Flat Dam's generating capacity is 60,200 kw. Canyon Lake, which is formed by Mormon Flat Dam, has a capacity or 57,852 af of water. Mormon Flat Dam was named for a small Mormon community once located at the site.

N-9 Stewart Mountain Dam - This dam was completed in 1930. It has a generating capacity of 12,500 kw. Saguaro Lake, which is formed by Stewart Mountain Dam, has a capacity or 69,765 af of water. The dam was named for nearby Stewart Mountain, landmark of the old Stewart Ranch.

Salt River Dams

K-14 Bartlett Dam - Like Horseshoe Dam, Bartlett Dam has no generating capacity. Bartlett Dam was completed in 1939. Bartlett Lake has a capacity of 178,477 af of water.

I-17 Horseshoe Dam - Has no generating capacity. The dam was completed in 1946. Horseshoe Lake has a capacity of 2,800 af of water.

K-8 Granite Reef Diversion Dam - The purpose of the Granite Reef Diversion Dam is to divert water from the river into the canals north and south of the river for delivery to water users within the Project. No water is stored, and no power is generated at Granite Reef Dam. There are no recreational facilities. Constructed in 1908. The dam is only 29 feet high and is 1,000 feet long.

Energy Source Posters

Sixth Grade
Activity: 9
Time: 4-5 Class Periods

General Description

Students will research primary energy sources to discover and gather a variety of information to use in creating a poster to present to the class
Students will work in groups and determine the pros and cons of each energy source: coal, petroleum, gas, nuclear, falling water (hydroelectric), sunlight, wind, geothermal and biomass. The group will select one to promote and encourage people to use.

Objectives

Students will research an energy source, create a poster of the information they learned, and then share it with the class.

Arizona State Standards

SC06 S5C3 PO1 Identify various ways in which electrical energy is generated using renewable and nonrenewable resources (e.g., wind, dams, fossil fuels, nuclear reactions)

W06 S1C1 PO1 Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources)
W06 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W06 S3C3 PO1 Write a variety of functional texts (e.g., directions, recipes, procedures, labels, posters, graphs/tables)

Teacher Information

Electricity is usually considered to be a secondary source of energy. To generate electricity, a primary source of energy is needed. There are a variety of primary sources that can be used to generate electricity. Each has advantages and disadvantages associated with it. Scientists are continually trying to find ways to improve using existing renewable and nonrenewable sources to alleviate the disadvantages.

Materials

Books, encyclopedias, Internet, and pamphlets for each energy source to be researched
Poster paper
Butcher paper
Markers
Colored pencils
Activity Card 6-9a

Procedures/Exploration

1. Tell students that electricity is usually considered to be a secondary source of energy. To generate electricity consistently requires a primary energy source. These sources are coal, petroleum, gas, nuclear, falling water (hydroelectric), sunlight, wind, geothermal and biomass. Discuss renewable and nonrenewable primary sources. Discuss some advantages and disadvantages of some of the sources based on the students' prior knowledge. Have the students share what these sources are.
2. Tell students they will become experts on a particular source. They will work in small groups to create a poster of information to share with the class.
3. Hand out the Poster Research Notes sheet (Activity Card 6-9a). Discuss the poster requirements with the students.
4. Assign groups based on the kind of information available for student use. Possible topics for groups include the following:

coal	sunlight
petroleum	wind
gas	geothermal
nuclear	biomass
hydroelectric	

5. Discuss research techniques and group work expectations. If desired, have the class create a list of rules and expectations on butcher paper to be displayed throughout the researching period.
6. Allow students time to work on their posters. It may be helpful to go over positive research techniques that were demonstrated by particular groups at the end of each class period.
7. Students should present their poster to the class to share their information. Discuss with the students some of the advantages and disadvantages that were presented on each of the energy sources.
8. Have the students write a reflection paper that explains which energy source they would choose for generating electricity and why.

**Teacher Note: Use Rubric (Activity Card 6-9b) to grade posters and reflection papers.

Poster Research Notes

Sixth Grade
Activity: 9
Activity Card: 6-9a

Create a poster which describes a particular energy source. Use this sheet to help you keep your research notes organized for your poster. The poster should answer the following questions:

What is the energy source? (definition)

How is the energy source used to generate electricity?

Where is the energy source found in the United States?

How is the energy source transported?

What are the advantages of using the energy source?

What are the disadvantages of using the energy source?

APS Power Posse™

Poster and Reflection Rubrics

Sixth Grade
Activity: 9
Activity Card: 6-9b

Student's Name: **Date:**

Making a Poster: Energy Sources

CATEGORY	4	3	2	1
Graphics - Originality	Several of the graphics used on the poster reflect a exceptional degree of student creativity in their creation and/or display.	One or two of the graphics used on the poster reflect student creativity in their creation and/or display.	The graphics are made by the student, but are based on the designs or ideas of others.	No graphics made by the student are included.
Graphics - Relevance	All graphics are related to the topic and make it easier to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most make it easier to understand. All borrowed graphics have a source citation.	All graphics relate to the topic. Most borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.
Use of Class Time	Used time well during each class period. Focused on getting the project done. Never distracted others.	Used time well during each class period. Usually focused on getting the project done and never distracted others.	Used some of the time well during each class period. There was some focus on getting the project done but occasionally distracted others.	Did not use class time to focus on the project OR often distracted others.
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Several required elements were missing.
Knowledge Gained	Student can accurately answer all questions related to facts in the poster and processes used to create the poster.	Student can accurately answer most questions related to facts in the poster and processes used to create the poster.	Student can accurately answer about 75% of questions related to facts in the poster and processes used to create the poster.	Student appears to have insufficient knowledge about the facts or processes used in the poster.
Content - Accuracy	At least 7 accurate facts are displayed on the poster.	5-6 accurate facts are displayed on the poster.	3-4 accurate facts are displayed on the poster.	Less than 3 accurate facts are displayed on the poster.

Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.
Mechanics	Capitalization and punctuation are correct throughout the poster.	There is 1 error in capitalization or punctuation.	There are 2 errors in capitalization or punctuation.	There are more than 2 errors in capitalization or punctuation.
Grammar	There are no grammatical mistakes on the poster.	There is 1 grammatical mistake on the poster.	There are 2 grammatical mistakes on the poster.	There are more than 2 grammatical mistakes on the poster.

Reflections Rubric

CATEGORY	**4**	**3**	**2**	**1**
Introduction (Organization)	The introduction is inviting, states the main topic and previews the structure of the paper.	The introduction clearly states the main topic and previews the structure of the paper, but is not particularly inviting to the reader.	The introduction states the main topic, but does not adequately preview the structure of the paper nor is it particularly inviting to the reader.	There is no clear introduction of the main topic or structure of the paper.
Grammar & Spelling (Conventions)	Writer makes no errors in grammar or spelling that distract the reader from the content.	Writer makes 1-2 errors in grammar or spelling that distract the reader from the content.	Writer makes 3-4 errors in grammar or spelling that distract the reader from the content.	Writer makes more than 4 errors in grammar or spelling that distract the reader from the content.
Accuracy of Facts (Content)	All supportive facts are reported accurately.	Almost all supportive facts are reported accurately.	Most supportive facts are reported accurately.	NO facts are reported OR most are inaccurately reported.
Support for Topic (Content)	Relevant, telling, quality details give the reader important information that goes beyond the obvious or predictable.	Supporting details and information are relevant, but one key issue or portion of the storyline is unsupported.	Supporting details and information are relevant, but several key issues or portions of the storyline are unsupported.	Supporting details and information are typically unclear or not related to the topic.