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.

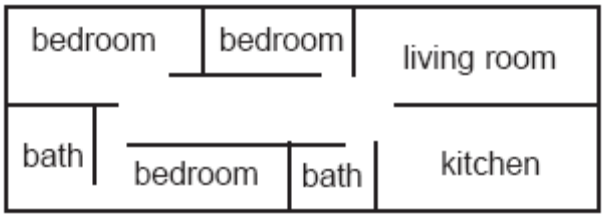
Finally, in Part Five, the teacher will be the "subdivision owner" and "judge" as the groups present their plans. Students will also "judge" each others projects and will need to provide written feedback to each group.

Materials

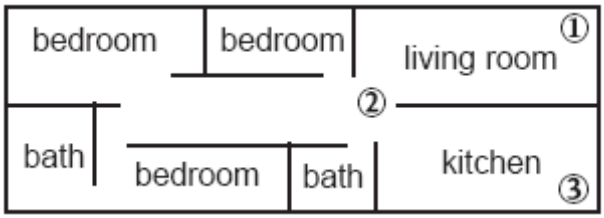
Resources from the Arizona Department of Commerce Energy Office (602-280-1402)
Field trip to APS' STAR (Solar Test and Research) Center at the Ocotillo Power Plant (1500 East University Drive in Tempe). Call 480-350-3137 for a guided tour.
Activity Card 6-1a

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

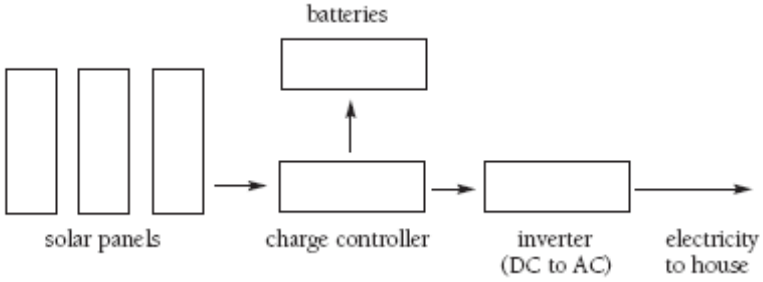
solar cells or battery to alternating current (AC) that is used by most home appliances. A charge controller protects batteries from excessive charge when the modules produce more electricity than the batteries can store. It also protects the battery from releasing electricity if their charge is too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

Solar Villas

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

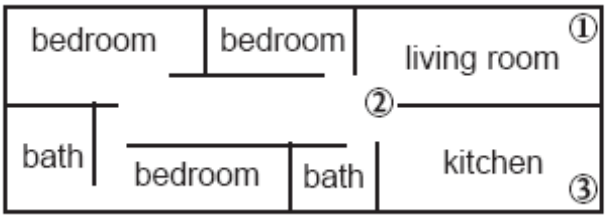
Student's Name: **Date:**

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	

APS Power Posse™

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

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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