

STEAM: Solar-Powered Home Design

Grade Level:	Time Frame:
9th-12th	50 minutes
Standards (ALCOS Science & Mathematics):	
<p>Earth and Human Activity</p> <p>1) Investigate and analyze the use of nonrenewable energy sources (e.g., fossil fuels, nuclear, natural gas) and renewable energy sources (e.g., solar, wind, hydroelectric, geothermal) and propose solutions for their impact on the environment.</p> <p>15) Construct an explanation based on evidence to determine the relationships among management of natural resources, human sustainability, and biodiversity (e.g., resources, waste management, per capita consumption, agricultural efficiency, urban planning).</p> <p>Number and Quantity</p> <p>2. Use units as a way to understand problems and to guide the solution of multi-step problems.</p> <p>33. Design and carry out an investigation to determine whether there appears to be an association between two categorical variables, and write a persuasive argument based on the results of the investigation.</p> <p>Financial Management and Planning</p> <p>2. Use elements of the Mathematical Modeling Cycle to solve real-world problems involving finances.</p>	
Objectives:	

Made Possible By:



<http://alcse.org/education>

Students will use a formula to calculate their annual household energy use and investigate how the type of appliances and amount of use affects the cost of energy.

Students will analyze which household appliances are best for energy efficiency and design a solar-powered home according their argument and findings.

Background Information:

It isn't very often that we think about how much money we are spending when we flip on a light switch, put a piece of bread in the toaster oven, or open the garage door. But what if we heard a cash register "cha-ching" everytime we performed these daily tasks? We are not only spending money on appliances that use energy, we are also using natural resources each time we "plug in." Those who are "plugging in" by utilizing solar panels are using **renewable energy**. We consider solar energy a **sustainable** resource and as this technology becomes more cost-efficient and more popular they have the potential to play an important role in reducing carbon emissions, mitigating current climate change, and leading us to a more sustainable future.

Renewable Energy- energy that comes from resources that are naturally replenished on a human timescale; these include wind, solar, geothermal, biofuel, and hydro.

Sustainable-refers to the concept that renewable energy resources will always be around and never be depleted

Many new appliances have an "Energy Star" label that provides an "Energy Guide" on the amount of energy used and the estimated yearly operating cost. Other appliances also include the amount of **wattage**, or energy used in an hour. The way that we use appliances and the appliances we buy can determine the amounts of money we spend and the amount of energy we use through electricity. If we want to "think sustainably" we can think about ways to make any possible upgrades to our homes and businesses while also considering how to use electricity more efficiently and sensibly.

In this activity, students will investigate their own energy use, the associated costs, and consider ways to live more sustainably!

Materials:

- FOR EACH STUDENT:
 - "Estimating Household Energy" handout OR
 - See "Extend" section below for more details on using technology instead.
 - Calculator
 - "Designing a Solar-Powered Home" handout OR
 - See "Extend" section below for more details on incorporating an art/modeling project.
 - Colored pencils

Engage (5 minutes):

1. **Think about it!** Students will list appliances around the classroom that are using energy (anything that is “plugged in”).
 - a. Teacher could make a list on the board or students could just discuss it out loud.

Explore (25 minutes):

1. **Calculate it!** Students will calculate consumption and cost of their annual household energy use.
 - a. Teacher should provide the utility rate provided here or according to their local power company.
 - i. <https://www.energy.gov/energysaver/estimating-appliance-and-home-electronic-energy-use>
 - b. Students will determine which appliances they use on a daily basis and estimate how much use in hours. They may not use all so some rows will be left blank.
 - c. Students will use the formulas and outline provided to calculate total kWh and cost.
 - d. Students will determine any ways they could reduce their energy use.

Evaluate (20 minutes):

1. **Design it!** Students will use the “Designing a Solar-Powered Home” handout to create a design of an energy-efficient home.
 - a. Students will complete page 1 by calculating the amount of watts they can use in their home. ANSWER=6,250 watts
 - b. Students will use their “Estimating Household Energy” handout to guide their selections of appliances for their design.
 - c. Students will draw a sketch of their design.

Extend

1. Students can use a computer and excel spreadsheet to create the Estimating Your Annual Energy Use table using the appropriate formulas.
2. Students can design a more detailed poster or build a 3-D model of their home design.

References:

<https://www.energy.gov/energysaver/estimating-appliance-and-home-electronic-energy-use>
<https://us.sunpower.com/solar-resources/how-many-solar-panels-do-you-need-panel-size-and-output-factors>

Name:----- Date:-----

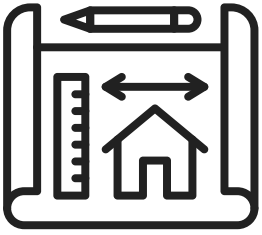
DESIGNING A SOLAR-POWERED HOME

CONGRATULATIONS!

You just won a FREE SOLAR-POWERED HOME!

There are just a few small details before you can claim your prize.

1. You only get a total of 25 solar panels that can each generate 250 watts per day.
2. You have to design the home and decide all of the appliances you'll need.



How many watts of energy will you be able to use per day?

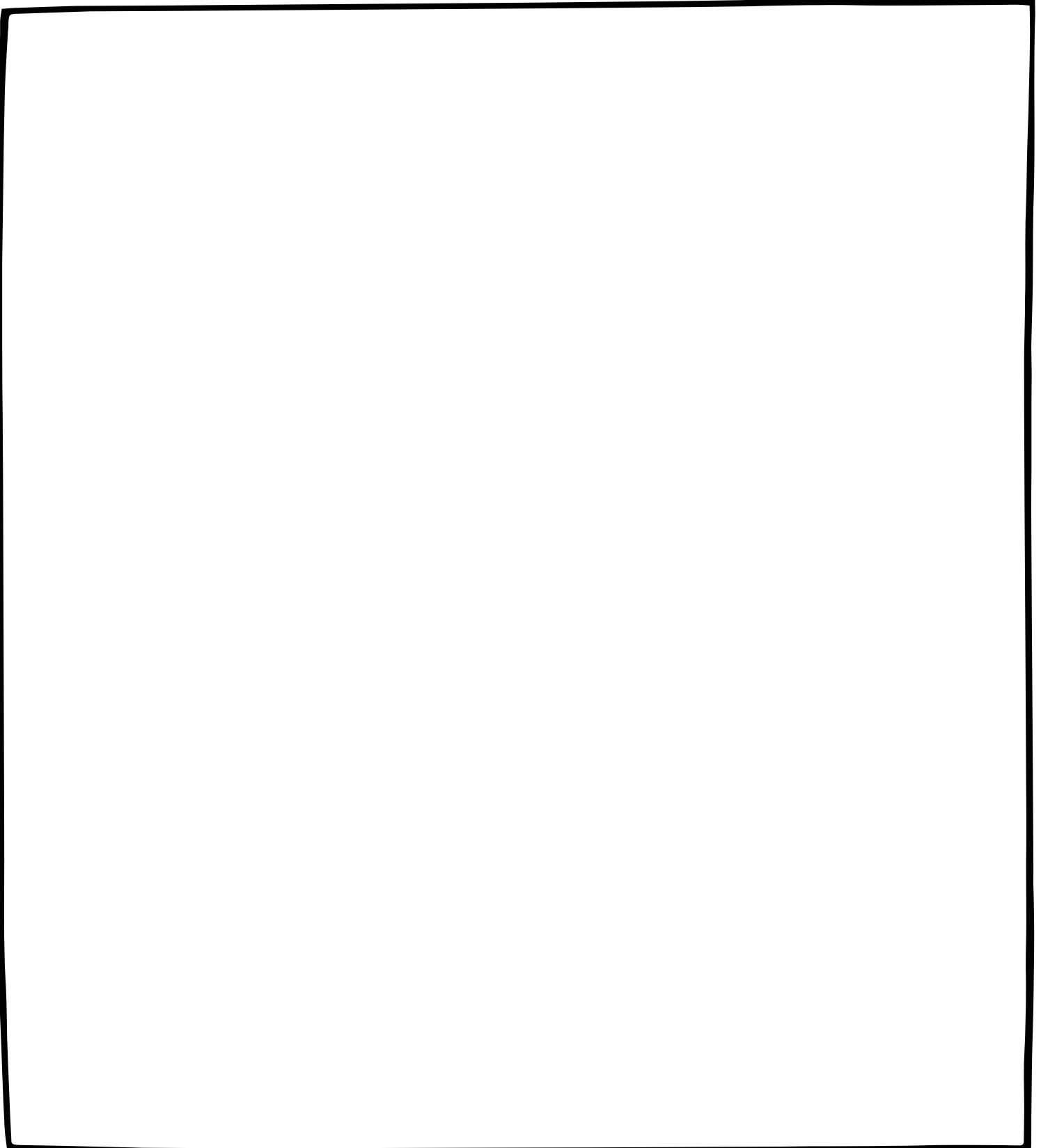
What appliances will you choose? Make a list below and make sure to calculate the total amount of wattage to make sure you don't exceed your limit.

Are there any ways you could design your home to make it more energy efficient?

Name:----- Date:-----

DESIGNING A SOLAR-POWERED HOME

Instructions: Use the space below to sketch a design of your solar-powered home. You will need to draw or note each of your selected appliances. Also, add any other special details that could make your home more energy efficient. Don't forget to add your 25 solar panels!



Name: _____ Date: _____ Class: _____

Estimating Your Annual Household Energy Consumption and Cost

Appliance	Energy Consumed in 1 Hour (watts)	Watts to Kilowatts Conversion	Hours Used Per Day	Total Amount of Energy (Kilowatt Hours) Used Per Day	Energy Cost Per Day Utility Rate=\$__.____
Air Conditioner	x=1000W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Air Fryer	x=1500W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Bluetooth Music Player (small)	x=8W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Ceiling Fan	x=75W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Clothes Dryer (electric)	x=3,500W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Clothes Washer	x=800W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Coffee Maker	x=1,250W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Curling Iron	x=30W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Computer (Desktop)	x=300W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____
Computer (Laptop)	x=100W	$x \div 1,000 = \underline{\hspace{2cm}}$	X _____ hour(s)	= _____ kWh	X \$__.____=\$_____

Name: _____ Date: _____ Class: _____

Estimating Your Annual Household Energy Consumption and Cost

Dishwasher	x=1,250	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Food Blender	x=350W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Game Console	x=150W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Gaming PC	x=400W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Garage Door Opener	x=300W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Hair Dryer	x=1,500W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Heater	x=1,100W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Light Bulbs (LED)	x=8W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Microwave Oven	x=1750W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Oven (electric)	x=1500W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$
Phone Charger	x=5W	$x \div 1,000 = \underline{\hspace{2cm}}$	X $\underline{\hspace{2cm}}$ hour(s)	= $\underline{\hspace{2cm}}$ kWh	X \$ $\underline{\hspace{1cm}}.\underline{\hspace{1cm}}$ = \$ $\underline{\hspace{2cm}}$

Name: _____ Date: _____ Class: _____

Estimating Your Annual Household Energy Consumption and Cost

Playstation/Xbox	x=100W	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Refrigerator	x=725	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Stereo	x=400	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Stove (electric)	x=2,000	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
TV (32 inch LCD)	x=50W	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
TV (50 inch LCD)	x=150W	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
TV (82 inch LED)	x=250W	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Toaster	x=1,100	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Treadmill	x=500W	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Vacuum Cleaner	x=1,200	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____
Water Heater (estimate how long you use HOT water)	x=5,000	x ÷ 1,000= _____	X _____ hour(s)	= _____ kWh	X \$ ____ = \$ _____

Name: _____ Date: _____ Class: _____

Estimating Your Annual Household Energy Consumption and Cost

Water Pump (estimate how long you use water)	x=650	$x \div 1,000 =$ _____	X _____ hour(s)	= _____ kWh	X \$ ____ . ____ = \$ _____
Other	x= _____	$x \div 1,000 =$ _____	X _____ hour(s)	= _____ kWh	X \$ ____ . ____ = \$ _____
Other	x= _____	$x \div 1,000 =$ _____	X _____ hour(s)	= _____ kWh	X \$ ____ . ____ = \$ _____
Other	x= _____	$x \div 1,000 =$ _____	X _____ hour(s)	= _____ kWh	X \$ ____ . ____ = \$ _____
1. What appliances used the highest amount of energy and had the highest costs per year? 2. Are there any changes or improvement you could make to lower the energy use and cost for any of the appliances?				Total amount of energy used per day=	Total cost of energy per day=
				= _____ kWh	= \$ _____
				Total amount of energy used per year=	Total cost of energy per year=
				= _____ kWh	= \$ _____