The FUTURES Channel®

MOVIE GUIDE

MOVIES NUMBER

1022-24

Off the Grid PARTS 1, 2 & 3

The Movies:

Part 1: Culture Shock—Most people in the world don't have access to electricity. *(Movie length: 3:28)*

Part 2: The Solar Solution—For people in remote locations without access to a power grid, solar panels can provide a a solution to their energy problems. *(Movie length: 5:20)*

Part 3: Delivering Energy—Engineers from Sandia Laboratories install a solar panel in a small roadside store in Honduras. *(Movie length: 3:21)*

Featured: Beth Richards, engineer, Sandia Laboratories; Miguel Contreras, research scientist, National Renewable Energy Laboratory.

Background:

The latter half of the nineteenth century was an incredibly productive period for physicists and engineers working in the field of electricity. By the year 1900, geniuses such as Nikola Tesla and Charles Steinmetz had worked out just about all of the technology needed to generate electrical power, transport it over great distances, and deliver it into homes.

However, know-how doesn't always lead to implementation, and the construction of a power grid requires a high level of initial investment. Even in the U.S., it took a special federal government project in the 1930's and 40's to take electricity into rural areas. For much of the developing world, this has yet to happen. That may not be all bad, however. Those nations now have an opportunity to leapfrog over developed countries—and keep their skylines free of power lines—with the 21st century power production technology known as photovoltaics.

Curriculum Connections:

Measurement (energy) 1

a. Choose an appliance or light in your home.

b. With the help of an adult, determine how many watts your chosen item uses. This number can usually be found somewhere on the appliance or light bulb. **Caution:** Make certain that the appliance or light is not on and is not still hot from recent use.

c. Estimate the number of hours (or fraction of an hour) that it is turned on in one day. Based on your estimate, determine the number of watt-hours of energy that it uses in a 30-day month. How many kilowatt-hours is that?

d. (Optional) Look at your family's electrical bill for a previous month. What percent of the total electricity used that month was used by the item you chose?

Measurement (energy), Percents 2

Isabel owns a leather business in Honduras that requires 500 watt-hours of electricity a day. She has enough solar panels to produce the required energy. However, she does not have enough of any single type of battery to store the energy. (Note: *Capacity* means how much energy the battery can hold.)

Battery Capacity	Efficiency	Cost
300 watt-hours	50%	$55.00
250 watt-hours	60%	$50.00
200 watt-hours	60%	$40.00
150 watt-hours	75%	$45.00
100 watt-hours	75%	$35.00
90 watt-hours	80%	$25.00

From the batteries listed in the table, select a set of four that together would produce *at least* the energy required for the leather business. The local supplier can obtain no more than two of any type of battery. Your challenge is to provide the energy needed for the *least* amount of money.

Measurement (energy), Percents 3

1. Please complete the table. Then, using an efficiency rate of 65% for the batteries, determine the total amount of energy that will need to be put <u>into</u> the batteries to supply the total watt-hours you calculated.

Appliance	Watt Rating: (watts)	Time Used (per day)	Watt-hours Needed
Toaster	120 W	5 min	
Radio	15 W	2 h	
Lights	75 W	2.75 h	
		Total Watt-hours Needed Per Day:	

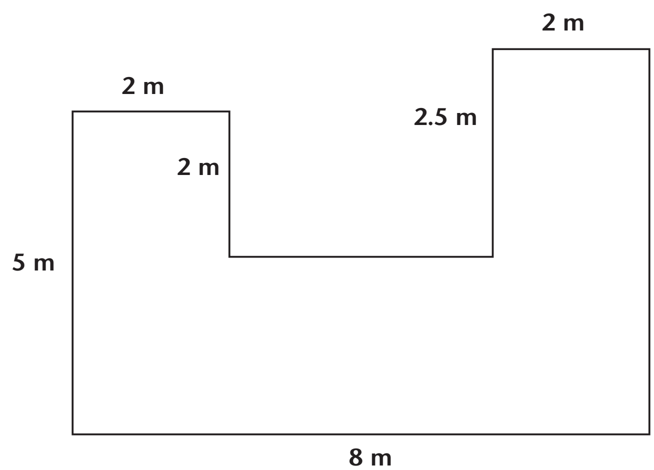
To: Consultants
From: Beth Richards/Sandia National Laboratories
Subject: Determining supplies

I will be traveling to Costa Rica in July to train the people who will be setting up a number of solar-powered electrical systems in remote areas.

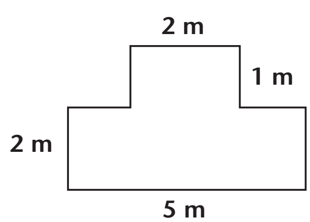
A. Please fill in the following table to ensure that our crews have proper supplies to complete the work. Remember that all the solar panels currently in our warehouse are 1 m long by 0.5 m wide with a peak power rating of 50 watts.

Building Number:	**Roof Size**	**Area of Roof**	**Peak Power Needed (watts)**	**Number of Panels Needed**	**Area of Panels Needed**	**Will needed panels fit on roof?** (circle correct answer)
2035	20 m x 10 m		1500 W			Yes No
#3904	5 m x 8 m		350 W			Yes No
#7745	4 m x 3.75 m		2400 W			Yes No

B. Here is a drawing of the roof of a community center in San Jose, which is the capital of Costa Rica. The manager of the center wants to get as much power as possible from solar panels on the roof. If we could cover the entire roof with standard panels, what is the maximum peak power we could get?



C. Because buildings have different shapes and dimensions, it is often necessary to arrange panels into different geometric shapes to produce a given peak power. Please design several arrangements that would produce a total peak power of 1200 watts. Remember that our standard panels are 1 m long by 0.5 m wide. Here is one example:

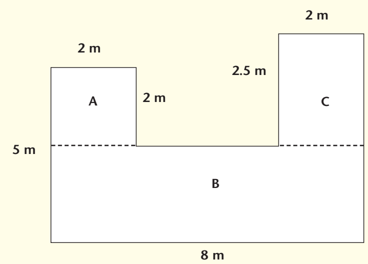


Teaching Guidelines: Determining Supplies
Math Topic: Measurement (area, energy)

A. The area of each roof is the product of its dimensions. To get the number of panels needed, divide the peak power needed by the peak power of one panel (50 watts). Since each panel is 1 m x 0.5 m, which equals 0.5 square meters, the area of the panels is the number of panels multiplied by 0.5.

Building Number:	Roof Size	Area of Roof (m^2)	Peak Power Needed (watts)	Number of Panels Needed	Area of Panels Needed (m^2)	Will needed panels fit on roof? (circle correct answer)
#2035	20 m x 10 m	*200*	1500 W	*30*	*15*	Yes No
#3904	5 m x 8 m	*40*	350 W	*7*	*3.5*	Yes No
#7745	4 m x 3.75 m	*15*	2400 W	*48*	*24*	Yes No
		Total number of panels needed for shipping		*85*		

B. The area of rectangle A is 2 m x 2 m = 4 square meters. Rectangle B has a length of 3 m (5 m – 2 m), a width of 8 m, and an area of 24 square meters. The area of rectangle C is 2.5 x 2 = 5 square meters. The total area is 33 square meters, which gives a peak power of 3300 watts (33 square meters divided by 0.5 = 66 panels, multiplied by 50 watts per panel).



The students may divide the roof into a different set of rectangles such as (2 m x 5 m) + (3 m x 4 m) + (5.5 m x 2 m). What is important is for students to recognize that—no matter how they divide the roof—the total area remains the same.

C. Answers will vary, but all the figures should have a total area of 12 square meters. 1200 watts of power divided by 50 watts per panel means that the equivalent of twenty-four 50-watt panels are required. Each panel is 1.0 m by 0.5 m, or 0.5 square meters in area, so the total area required is 24 x 0.5 = 12 square meters.

Students will probably first explore the variety of different simple rectangles that have an area of 12 square meters, starting with whole number solutions (3 m x 4 m; 2 m x 6 m, 1 m x 12 m). This can lead to a discussion of factoring and how it relates to solving this problem.

If you enjoyed this Futures Channel Movie, you will probably also like these:

Electricity from the Wind, #1010	The natural force of the wind is harnessed by mathematics and physics to generate clean electricity.
Making Sparks Series, #1019–1021	Sunlight can be converted directly into electricity with a device made of one of Earth's most plentiful elements.
Solar Powered Cars, #1001	Using the energy it takes to run a hair dryer, this solar-powered car travels 200 miles at speeds of 50 to 65 mph.