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SCHOOLGEN ACTIVITIES LEVELS 5-6

WHAT CAN SOLAR PANELS RUN?

Teacher-led Activity

This activity enables students to understand the relationship between energy and power. Students will:

- find out the power ratings of various appliances around their school and the energy output for a given month for a Schoolgen school's solar panels.
- select an appliance and calculate how long they could run it continuously from the total monthly energy output of the Schoolgen solar panels
- quantify how much energy can be saved by simple energy efficiency measures.

WHAT CAN SOLAR PANELS RUN?

POWER IS THE RATE AT WHICH AN APPLIANCE USES ENERGY

One Watt is one Joule of energy per second.

1W = 1 J/s

So, for example, a light bulb rated at 100 Watts (100 Watt light bulb) uses 100 Joules of energy per second.

The Joule and the Watt are very small amounts of energy and power. Many appliances use energy at rates of thousands of joules per second, or thousands of Watts. We therefore need bigger units:

One kiloJoule (kJ) is 1000 Joules, and one kiloWatt (kW) is 1000 Watts.

An electric heater rated at 2kW therefore uses energy at a rate of 2000W or 2000 Joules per second (J/s or $J.s^{-1}$).

And bigger units still:

One MegaJoule (MJ) is one million Joules, and one MegaWatt (MW) is a million Watts.

So, what is a kiloWatt-hour (kW.h)? The Joule and the Watt are examples of the standard international units agreed upon and used by all scientists. The kW.h is a non-standard, but nonetheless convenient, unit of energy and is used by many power companies. It is the amount of energy used in one hour by an appliance drawing energy at a rate of 1kW.

Since 1kW = 1000J/s, and 1hour = 3600s, then 1kW.h = 1000(J/s) x 3600(s) = 3600000J (or 3.6MJ)

So 1kW.h = 3.6MJ = 3600000J

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PRACTICE EXERCISE

How many Joules of energy does a 60W light bulb use in

1 second? __________

1 minute? __________

1 hour? __________

Convert your last answer (energy used in 1 hour) to kW.h

Your answer should be 0.060 kW.h: since 60W = 0.060kW, so running it for 1 hour uses 0.06 kW.hr

In doing this exercise you should have found that:

$$Power = \frac{EnergyUsed}{TimeTaken}$$

and

$$EnergyUsed = Power \times TimeTaken$$

You should also realise that in using these equations, you need to use the right set of units.

Either › Energy in (kilo)Joules, Power in (kilo)Watts, time in seconds

Or › Energy in (kilo)Watt.h, Power in (kilo)Watts, time in hours

WHAT YOU NEED TO DO

Fill in the table below by finding out the power ratings of various appliances around your school. Choose two others of your own choice.

APPLIANCE	POWER RATING (WATT)	ENERGY USED PER SECOND (JOULES)	ENERGY USED PER HOUR (JOULES)	ENERGY USED PER HOUR (kW.h)
Ordinary light bulb				
Energy efficient light bulb				
Computer				
Fridge				
Classroom heater				

WHAT CAN SOLAR PANELS RUN?

STUDENT WORKSHEET

Find the energy output for a given month for a school's solar panels. This will probably be in kW.h.

Month: ____________________

Monthly energy output: ______________ kW.h = ________________ MJ (multiply by 3.6)

= _________________ J (multiply MJ by 1,000,000)

How many hours are there in the month for which you have data? ___________________

Divide your total energy by this number to get the average power output this month. ________ W

Use the average power output to work out how many ordinary 100W light bulbs you could run continuously from the electricity generated by your solar panels this month (if electricity was available as and when needed).

____

____

____

If you used the electrical energy output directly when the panels are working at maximum output (2kW), how many 100W bulbs could you run at that time?

____

____

____

Now, take the total amount of energy produced by the Schoolgen solar panels in the month, and work out for how long you could run:

a single ordinary 100W light bulb ____

an energy efficient 20W light bulb ____

For help with these calculations, refer to the Example for Students sheet

WHAT CAN SOLAR PANELS RUN?

EXAMPLE FOR STUDENTS

WORK OUT HOW MANY BULBS YOU CAN RUN CONTINUOUSLY

Suppose a school's Schoolgen solar panels created 300kW.h of energy (probably optimistic!!) this month

= 300 x 3.6 MJ = 1080MJ = 1080000000J

Number of hours in a (30 day) month = 24 x 30 = 720 h
So, average power output = 300 (KW.h)/720 (h) = 0.417 kW = 417 W
and a light bulb at your home uses energy at a rate of 100W
So you could run:

417/100 = 4 x 100W light bulbs continuously, or

417/20 = 20 x 20W energy efficient light bulbs continuously.

WORK OUT HOW LONG YOU CAN RUN A SINGLE BULB FOR

Total energy generated in month = 300 kW.h
A single ordinary light bulb uses energy at 100W = 0.1 kW
So, time for a single light bulb to use 300 kW.h = 300 KW.h/0.1 (W) = 3000 hours
= 125 days ≅ 4 months

This example shows why power companies like to use kW.h. If you were to do the calculations using Joules for energy and seconds for time, you would get exactly the same answers (try it), but you would be handling very large numbers - you just need to work out the number of seconds in a month to see this.

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ENERGY EFFICIENCY ACTIONS WORKSHEET (EXTENSION)

Look around your school, what could you do to reduce your use of energy? For example, turning off computers when not in use and switching off lights in empty classrooms.

This exercise draws on what you have learned about the energy used by various appliances. Take an energy efficient action, and calculate how much you can reduce your school's energy use by. A worked example is provided below.

1. Choose one energy efficient action.
   [Switching off lights in empty classrooms]

2. Find out how many hours the lights in a classroom are left on each day.
   [10 hours a day, 5 days a week]

3. Find out how many hours the classroom is empty but the lights are left on.
   [4 hours a day, 5 days a week]

4. What is the energy used? (This example assumes the classroom has 10 x 40 W fluorescent tubes.)
   [10 x 40W light tube: 10 x40W x 10 hours x 5 days = 20000 W.h = 20 kW.h]

5. What is the energy used if the lights are turned off when the classroom is empty?
   [Now on for only 6 hours per day, ie 12 kW.h for a 5 day week]

6. By turning off the classroom lights, how much have you reduced the school's energy use by?
   [8 kW.h per week (assumes switched off all weekend)]

7. Compare this with the average monthly energy output for the solar panels.
   [4 weeks per month: monthly savings = 4 x 8 = 32 kW.h = approx 1/10 of the previous estimate of 300 kW.h for monthly output]