Solar Heating - – water and buildings

Go to the solar water heating display in the middle of the site, near wind and water power.

Inside the display there is a sink on the right and a large tank to the right of it. This tank is only heated from the three panels above it on the roof (to the right of the roof). The smaller tank at the front has been cut open to show how the hot water from the panel passes through the tank in a copper pipe.
How hot is the water from the tap in the sink? You might need to run the tap for a bit to get rid of the cold water in the pipe.

The temperature is affected by a number of factors:

what time of day is it?

what time of year is it?

how sunny has it been today?

how sunny was it yesterday?

how many visitors do you think have come round today and used some of the hot water?

Given all these factors is the water hotter or colder than you'd expect?

(When it is quite sunny the water heated by the sun has to be mixed with some cold water so that it does not burn visitors' fingers).
The system has a pump – why?

What do the electronic controls do?

Outside, the panel with the kettle has a thermometer attached. What is the temperature?

To the left of that panel there are four small panels with thermometers above (under flaps that lift up). What are the temperatures?

Metal (white) metal (black) insulated behind glazed & insulated

Look at the panel which has a cut-away corner to show what it is like inside. Make a sketch of this one showing all the parts. To label them you may find these words useful -
insulation, reflecting, glass, clear plastic, black surface, water pipes, angle.

Materials used in the solar water heating systems

Why have the following materials been used in this display –

Copper pipe inside the tank

Foam on the outside of the tank

Metal panel inside the panel with the kettle attached

Glass on the front of the panel

Rockwool in the panel made from an old radiator

On average in Britain houses could get 50% of their hot water from the sun (not central heating but showers, washing up etc).
Is there a suitable place on your home to put solar water heating panels? If so, where and why?

Passive solar heating of buildings

Go to the Self-build house and look at the conservatory. Which direction does it face?

This helps to heat the house at certain times. How do you think it does this?

Go into the shop and look at the big windows in the roof. They face South. What will happen when the sun is out?

The earth wall stores heat. When will this be particularly useful?

Solar Electricity

Solar cells – Photovoltaics - PVs

Go to the main display of solar electricity (check on your map to see where it is).
Remember electricity is measured in Watts (W) and 1000W is called a kilowatt (kW).
Solar cells are called photovoltaic cells (PVs for short).
What do they actually do?

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All the solar cells around here are facing the same way.
Which direction do you think they are facing?

Why do they face this way?

Look around at the sky. What sort of weather is it?

How well would you expect the solar cells to work in these light conditions?

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Look for the Solar Pump. This has 5 panels of solar cells. They produce electricity and that runs the pump. In a real situation it would probably be used in a dry area to pump water up from underground for people to use. Here it is just pumping water round and round to show how it works.
Is it pumping water at the moment?

Would you expect it to be, given the weather, time of day and time of year?

If the pump is working, put the clouds over the panels.
What happens?

Why?

What happens if you only put some of the clouds over the panels?

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Find the case with the butterfly model in it.
Where is the solar electricity cell that should make the butterfly move?

Pull down the handle on the right of the display and observe what happens in the case. Explain what's happening (or not).

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Look at the display panels with information about solar electricity. Look for the picture of a house in Oxford which has solar cells on its roof.

How much did those solar cells cost?

That house in Oxford also uses solar energy in other ways. What other ways?

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Look up at the roofs of the buildings around you. One of them is covered with solar cells. These solar cells can produce 13kW of electricity.
13kW is the maximum that they will produce. Sometimes they will produce less than this and sometimes they will produce nothing.
When do you think they will produce the most? (what season of the year and what time of day).

When do you think they will produce nothing?

How many laptop computers could you power with 13kW? (A laptop uses less than 50 watts of power.)

Behind the restaurant there is a control room with a large window. Inside there you will see a computer screen which gives all sorts of information about the solar roof. At the bottom of the screen in the middle there is a little box labelled "overall output power (kW)". If, for example, it says 6.50 then the roof is producing half of what it could do.
What is it producing right now?

When you calculate the amount of solar energy we get falling on the cells over the course of a year, you would expect to get the equivalent of 10% of what they would produce if they were generating their maximum all the time,

How much did this roof cost?

What other ways do we use here at CAT to produce electricity?

Wind Power

Take a walk round the Centre.....follow the arrows. On your way count how many windmills you can see. Notice whether they are turning or not. Notice the number of blades and the different shapes and sizes of blades.

What three jobs can windmills do? Think of how they were used in the past and an area short of water and and a place with no electricity.

When it generates electricity a windmill is often called a wind turbine or aerogenerator.
Near the restaurant there are steps which lead up the bank to a platform where you can see a 600kW wind turbine. This belongs to the Centre but the electricity goes into the grid. In a very windy position a wind turbine that size would produce enough electricity for 500 homes.

Now go to the wind power display.
From the middle of the wind power display you can see the wind turbine up on the hill which produces a lot of the Centre's electricity. This is a 15kW turbine, called a Polenko. Is it turning?

Look at the top of a full-size windmill (the nacelle) which has been cut open to show the parts inside and labelled. With the help of this and the signs in the display, draw and label diagram which shows you how a windmill to generate electricity works.

Try the windseat. Can it lift you up today?
This is an old wind machine which was moved from where it was originally used. What was it designed to do?

Look at the blades of this machine and compare them with the ones which generate electricity. Describe the differences.

To generate electricity the rotor needs to turn fast. To do mechanical work (to move something heavy) they need a strong turning force (torque). How do you think the numbers and shape of the blades relates to this?

How would you describe the wind today – very strong, strong, weak, none?

If it's blowing at all, which direction is it coming from?

We have put lots of windmills down here so that people can see them properly and touch them. Look again at the windmills that are turning. Some of them will probably be turning around, changing their direction all the time. This isn't very good for producing power. Why is it happening?

Look for some which are facing the same way all the time.
What can learn from this about where you should (or should not) put windmills?

Look at the smaller machines down in the display. There is one with 3 white blades down on your level. On the tail it says it is an Aerogen 5. Think about the stages of energy transfer that would happen when the wind blows (if it wasn't tied to the railing so that it can't spin round and hurt anyone).
Explain step by step what would happen.
The wind blows……

…….electricity travels through the wires to be used in houses and offices.

Why does the wind turbine have a tail? What does it do?

Could we get much of our electricity from windpower in Britain?

What sort of places could we put them? Where will the strongest winds be?

Is it fairly cheap or expensive to make electricity with the wind?

After about 25 years a big windmill will be worn out and will have to be taken down. What do you think would be left on the site after it has gone?

How much more energy do we get out of them in their lifetime, compared with the energy used to build them and look after them?

What do you feel about windmills? Would you like to see more of them in Britain? Why?

WATER POWER

Go to the **POWER HOUSE** (near the lake).
Make notes and sketches of the large turbine inside. Describe the flow of water from the source (a reservoir up the hill) down to the river in the bottom of the valley.

If the turbine is running today, find out how many kilowatts it is generating.

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In the Power house you will also find the model to show how a Pelton wheel works.
Turn on the water jet so that it makes the model Pelton wheel spin.
Make a sketch of it. Note exactly where the water hits the wheel.

Is it the weight of water or the force of the water that is making the wheel spin?

You can feel the force of the wheel turning in its shaft. Hold it and see if you can stop it.

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Here at CAT over half our electricity comes from water power but in Britain about 2% of electricity comes from water power. Find a picture of the type of large water power system that produces electricity. In Britain these big systems are very efficient, the power is cheap and they produce very few problems, but huge water power systems in other places often cause all sorts of problems. List the problems you can find information about.

Go through the wind display to the **WAVE POWER** machine.
Make some electricity, without wetting yourself and your friends too much.
Describe how the machine uses the energy in the waves to make electricity.

In what sort of place would you find an actual wave power system?

What makes waves happen in the sea?

Look at the sign. Where is there a full size wave power system in Britain which provides electricity for people to use?

Does that one work in a similar way to our model here?

What other types of wave power machine are shown here?

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There is another type of water power which we could use in Britain – tidal power.
What makes the tides come and go?

Where would tidal systems be put?

Buildings and materials

Walk all round the Centre looking at buildings.
Various different materials have been used over the years to build them.

For the structure of walls they include slate blocks quarried on this site, wood, bricks, straw, earth
Roofs use Welsh slates, wood, grass and metal
Insulation in walls and roofs is wool, warmcell (shredded up newspapers), straw, (and fibreglass and foam in older buildings).

Look at these buildings and write down the materials that have been used in each:

The shop and information centre

The restaurant

The theatre

The top railway station

The self-build house

Here when we choose materials to build with we think about a number of things:

They should be made as near to here as possible so that we don't use too much energy transporting them
They should use as little energy as possible to make (embodied energy)
They should not be unhealthy for the builders or for the people who use the buildings
They should be renewable – not made from something that will run out.

Some of the buildings are 25 years old and ideas about what materials we should use have changed in that time.

Why do you think we have used the following materials?

Wool

Straw

Wood

Earth

Slate

Two of the buildings on the site have been designed so that solar energy can come in through windows to heat the building up (this is called passive solar heating).
Which buildings are they?

Draw a sketch of one of them to show how it does this.

ENERGY CONSERVATION

Go to the building with the Shop and Information Centre. This building has been designed to keep heat in and stop it from escaping quickly.
Look at the windows. What type of windows are they and why have they been used?

In the Information Centre you will find a little “window” which lets you see inside the wall.
What is the wall filled with?

This is insulation in the wall. How does insulation work?

Why do you think this material has been used at CAT?

Go to the **SELF-BUILD DISPLAY**, next to the wind/sun phone box and look at the type of insulation that is displayed there.
What is it made from?

Now go into **THE WHOLE HOME** display inside the house nearby.
What is special about the way this house has been built?

Explain how you could insulate your home. Use drawings to help you.

Where might you find draughts in your house?

How can you save electricity at home? What electrical gadgets are left on when they don’t need to be?

What electrical gadgets could we live without quite comfortably?

How can you save energy when you are cooking?

What other ways can you save energy in the kitchen?

Name *six* quick things you can do in your home to save energy.

Then think about your school.

How could you save energy in transport? How could you reduce your family's use of the car?

ORGANIC GROWING

Go to the polytunnel and then through the **MOLE-HOLE** (slowly enough to really appreciate it) to the start of the garden.
The problems gardeners have to deal with are dealing with the weeds and pests which eat the plants and feeding the soil.

What micro-organisms do you see displayed in the molehole and at what magnification?

What useful jobs do these creatures do?

What happens to these creatures when pesticides are used?

What do the words ‘organic growing’ mean to you?

Give an example of a food chain, starting with a plant and ending with a mammal.

Have a look at the **PEST CONTROL** display.
What predators are useful to a gardener? (not just the ones we show here)

Have a look at the **COMPOST BINS** in the display. Choose one and make notes and sketches so that you could make one at home or school.

All the things in the compost bins will rot. Lots of different organic material is being made into compost. Make a list of at least *six* different types of things you can recycle into compost.

When people do not have compost bins what happens to these things? Where do they end up?

What are the advantages of putting all this organic material into compost heaps?

We compost the sewage but we keep it separate from the other compost and we never put it on the lettuces. Why do you think that is?

What usually happens to sewage in Britain? Where does it end up?

On these few acres at CAT there is a huge variety of species of insects, birds, small mammals and plants. Why do you think there is so much biodiversity here?

What are the dangers for the future if we carry on chemical farming?

What would the advantages be in growing some food organically in your back garden?

In The Whole Home display “Garden flows” shows how a garden could be used for different functions. What different uses can you see?

How could you redesign your garden to produce food, encourage wildlife and be a pleasant place to relax?