

# Dorset Community Energy Solar Energy Resource Teaching Pack



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# Introduction

## About this resource

The purpose of this resource is to help teachers in Primary schools deliver curriculum learning about renewable energy production using solar photovoltaics. The resource will be of particular benefit to schools with their own rooftop photovoltaic (PV) system, but it is hoped that schools with an interest in learning about sustainability will also find the resources useful.

The equipment and suggested activities are designed to be flexible. We have aimed to provide basic information about how solar PV works and provide some background to electric circuits for those less confident teaching about electricity.

We have given an overview of possible curriculum links on page XXX, but this is not exhaustive. Once you understand the basic principles, with a little imagination you will probably see many opportunities to bring learning about solar and other renewables into Primary curriculum. We hope you will use the suggested activities as a starting point and adapt and extend them to meet the needs of your class.

Besides making the school's solar energy production tangible to children, teaching about solar energy offers links to Eco-Schools topics, Rights Respecting Schools and Global Learning.

## About Dorset Community Energy

Dorset Community Energy (DCE) is a not-for-profit Community Benefit Society which facilitates community ownership of renewable energy production. DCE was formed in 2013 and has installed community owned photovoltaic installations across community buildings and schools in Dorset. With 100 shareholders, DCE installations now provide 403kW of solar capacity.

To find out more about DCE, visit [www.dorsetcommunityenergy.org.uk](http://www.dorsetcommunityenergy.org.uk).

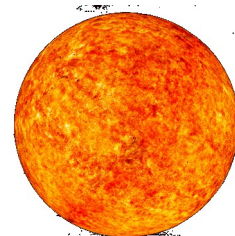
This resource has been produced by Dorset Community Energy and Dorset County Council.



# Background Information

## About solar energy

Our sun is a giant, hot ball of gases, reaching temperatures of around 15 million degrees Celsius at its core. Inside its core, hydrogen atoms combine to form helium in a process called **nuclear fusion**. This process creates a huge amount of energy which is emitted into space.



Energy (light) from the sun scatters out in all directions, and a tiny proportion of it strikes the earth. The sun is 92 million miles from the Earth. Travelling at the speed of light, energy from the sun hits the Earth *8 minutes and 20 seconds* after leaving the surface of the sun.



**ACTIVITY:** Read the full story of how light travels from the sun to Earth in 'There and Not Back Again: A photon's Tale' (page xx)

Solar energy striking the Earth directly or indirectly provides the world with nearly all its energy:

- Solar energy drives the process of **photosynthesis** in green plants. This is the process by which plants make their own food from carbon dioxide and water. Because of this, plants are at the start of most food chains.
- The **fossil fuels** we use today are made from stored plant biomass – the result of sun-powered growth millions of years ago.
- The convection currents that make wind are driven by heat energy from the sun.
- Waves and tides, which can be harnessed to make electricity, are also driven by the force of the sun and moon.

## Renewable

Solar is considered a source of **renewable energy** because the fusion reactions inside the sun are expected to continue for millions of years to come. It is also a 'clean' technology in that it doesn't make any **greenhouse gases** which contribute to **climate change**.

*(See page 19 for links to climate change teaching materials).*

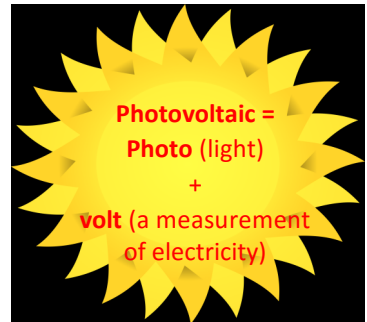




# Background Information

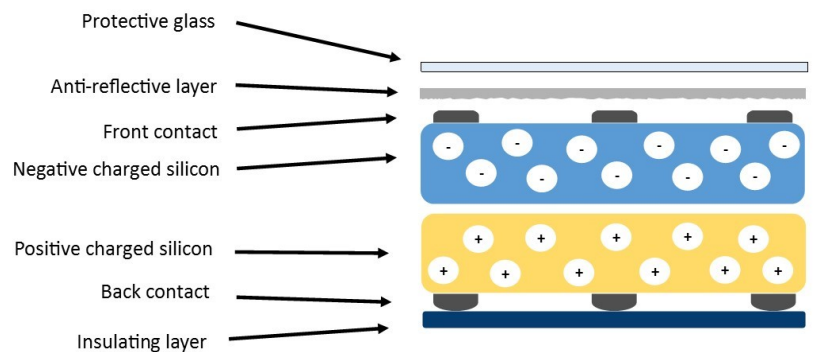
## Making Electricity in Photovoltaic Cells

Photovoltaic (PV) systems use solar energy to make electricity. Electricity is created when the sun's energy 'excites' the electrons inside a PV cell, making an electrical current flow.



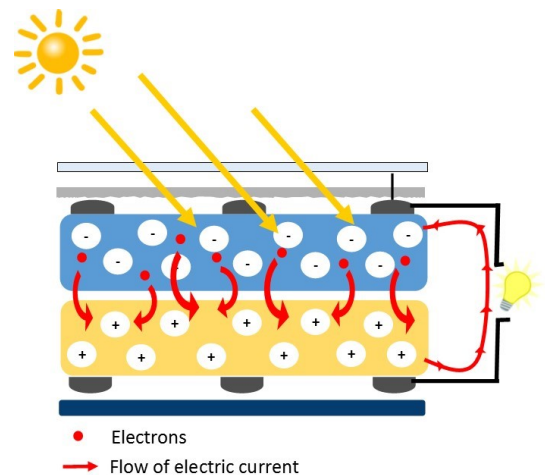
## Construction of a PV cell

At the heart of the solar cell are two layers of silicone (a **semiconductor**). One layer is **negatively charged** and full of electrons. The other is **positive charged** and lacking in electrons.



## How electricity is made

When sunlight strikes a PV cell, some the energy is absorbed. This energy 'excites' the **electrons** in the negative layer and gives them enough energy to move. The electrons begin to flow from the negative layer to the positive. When electrons start to move along in the same direction, you have **electricity**. Put two metal contacts on either side of the silicon sandwich and you get an **electric current** flowing through a **circuit**.



ACTIVITIES: Electron Chain Game p. X  
Photon Bombardment Game p. X

## When do they work?

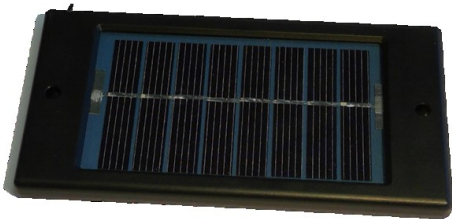
PV works at any time when the sun is shining, but more electricity is produced in more intense sunlight. PV cells are also most efficient when sunlight hits them at 90°.



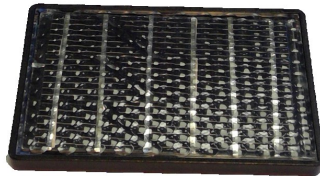
# Using the PV Kit

## What's in the Box

Large Solar Panels



Small solar panels



9V battery



Motors



Large: 1.5—9V  
Small: 1.5—6V

Halogen light bulbs



Buzzers



3-6V

Crocodile leads



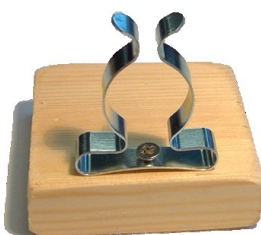
Propellers



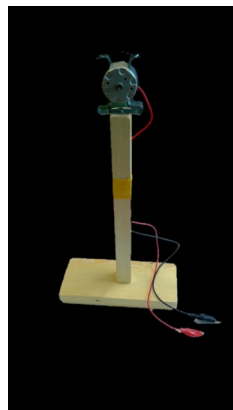
Multimeter



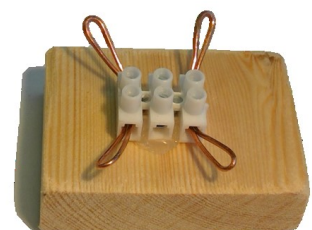
Motor clips



Wooden motor stands



Voltage junction



# Activities

## Notes on Making Solar Circuits

All the activities outlined here are best done outside on a sunny day! You will find the output of the solar panels and what they will power is very variable, depending on the amount of shade or cloud cover.

Alternatively, these activities can be done in the classroom using the 50 Watt lamp provided as a light source (but make sure children understand the lamp is representing the sun).

### SAFETY

*The circuits made with the components provided have very low energy and are harmless to children. However please be aware of the following risks and control measures associated with using the solar kit.*

Risk	Control measure
<b>Burns.</b> Lamps and solar cells can get very hot.	Children should hold panels by rims and move lights using handles.
<b>Splinters.</b> Wooden equipment may cause splintering.	Check wooden items before using. Brief children to handle wooden items carefully.
<b>Trips.</b> Cables of electric lamps may cause trips.	Position electric lamps carefully. Brief children to stay sat at their tables.

Children should be reminded that touching electrical wires in domestic appliances is highly dangerous. Children should not touch or experiment with electrical circuits outside of school and correct supervision.





# Using the PV Kit

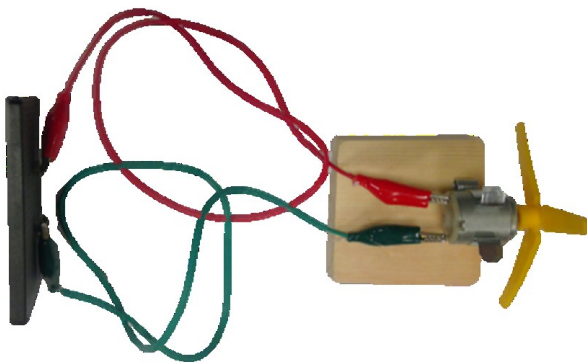
## A simple solar circuit

Your circuit needs 3 things:

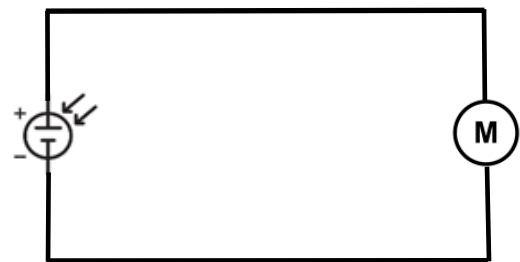
- A power source – solar cell or battery
- Something to transmit the power – wires or leads
- A component to use the power (do 'work') – a light bulb, buzzer or motor

The solar cell is like a battery, providing power for the circuit when it is illuminated. Use the crocodile leads to connect the metallic contacts on solar cells to the terminals on the components.

A simple circuit with one component would look like this:



Circuit diagram:



### Tips

- Always connect negative to positive contacts (see *Box 1*).
- For best results, use the small motors with the small solar panels and large motors with large panels.
- Make sure there is an unbroken chain of conduction for electricity to flow – check that the lead is intact and that crocodile clips and metal contacts are properly connected.
- For the best results, position your solar cells at 90° to the sun's rays or light source. This will allow the most light to be collected by the solar cell and will produce the most electricity.

#### Box 1.

The contact points on the solar cells are marked + and – for positive and negative (figure 1). Some components also have positive and negative terminals marked (figure 2). In most circuits, electricity will only flow when positive terminal on the power source is connected to the negative terminal on the component and vice versa.

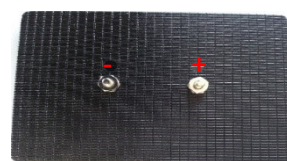


Fig 1.



Fig 2.



# Using the PV Kit

## Measuring the power in a circuit

*Children may be able to think of ways of judging how much energy the solar panel is making.  
E.g. they may notice that a propeller spins very fast then the solar cell is in full sun and slower in the shade.*

*You can also use the multimeter to measure how much power (voltage) is in the circuit.  
To use the multimeter:*

**SECTION BY PETE!**



# Activities

## Activity 1: Current Flow Circle Game

**Purpose:** For children to understand that it is sunshine making electrons move around that creates electricity in a solar panel. Best suited to Key Stage 1.

**Materials:**

- Balls or bean bags – 2 or 3 per 10 children
- Large pictures of the sun, moon and clouds – children could draw or paint these
- A hand bell, tambourine, squeaky toy or anything that makes a noise.




### How to play

#### Set up and explanation

- Choose 3 children to be the sun, moon and clouds. Give them a picture each to hold.
- All the other children are 'atoms' and sit in a circle.
- Pass out the balls/bean bags so that every 4<sup>th</sup> or 5<sup>th</sup> child is holding one.
- Choose one child in the circle to be the 'bell' and give them the bell to hold.
- Explain that the bell is an electric bell and it needs electricity to be able to ring. The bean bags are 'electrons' and to make the electricity we have to make them move. However they can only move when the sun is shining!

#### Making electrons move

Teach children to perform the following actions in response to your call:

- Call out  'sunshine' → 'Sun' holds up their picture. → Children start passing 'electrons' around the circle. Whenever the child who is the 'bell' receives an 'electron', they should ring their bell once before passing the bean bag along.
- Call out  'it time' → 'Moon' holds up their picture. → Children hold their bean bags still.
- Call out  'cloudy' → The 'cloud' stands next to the 'sun' with their picture. → Children pass their 'electrons' *slowly* round the circle. The 'bell' can ring when they receive an 'electron'.

If you want to make it competitive, children who do the wrong movement can be 'out'. As children drop out you will need to slowly take away bean bags.

#### Plenary

Discuss with children: When did they hear the bell ring? When did it stop? When did it ring the most?

*When the children were passing their 'electrons', they were making electricity which made the bell ring. The more sun there was, the more electricity was made and the more the bell rang.*

*It is the same with the school solar panels. When the sun shines they make electricity that the school can use. If the day is cloudy, the panels still make electricity but they make less than on bright sunny days.*



# Activities

## Activity 2: Photon Bombardment Game

**A run-around game, best played outdoors! Best suited to Key Stage 2.**

**Purpose:** For children to visualise how photons (light) cause electrons to flow and create electricity in a solar panel.

**Materials:**

- Chalk
- Sticky labels or coloured bibs
- Something that makes a noise – tambourine, squeaky toy, hand bell, battery-powered doorbell.
- A yellow ball or picture of the sun
- The solar panel model will help you explain the concept

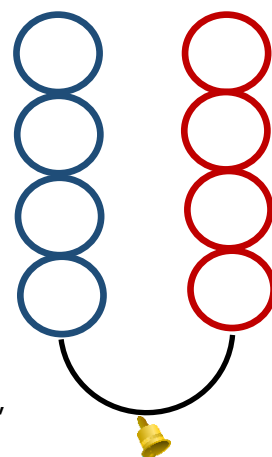
### Prior knowledge:

Make sure the children understand that electricity is a flow of electrons. See the [glossary page xx](#) for other key words.

Show children the model solar panel and explain that it is made of 2 layers of silicone, a negative layer with lots of electrons and a positive layer without electrons. (see page [XX](#)).

### Preparation:

- Draw 2 parallel lines of circles on the yard in chalk (see diagram, right). Ideally use a different colour for each line. Make the number of circles in each line approximately  $\frac{1}{3}$  of the number of children playing the game. (i.e. for a class of 30 children, make each line 10 circles long). ***These represent silicon atoms in the 2 silicon layers in the solar panel.***
- Draw a loop connecting one line to the other. ***This is the wire that conducts electric current around the circuit.***
- Position your noise-making item on the loop (you might want to put it on a chair on the outside of the loop). ***This will represent the 'work' done by the electric current.***
- Put the ball or picture of the sun around 15 metres away from the 'solar panel' you have drawn. ***This represents the sun.***



### Explanation:

- Choose 10 children to be electrons. Mark them with bibs or stickers and ask them to stand in the circles on one side of the line, forming the negative silicon layer.
- Explain that the 'electrons' are stuck in their atoms (the circles) in the solar panel and can't move. In order to move and make electricity they need more energy.
- The rest of the children are 'photons'. Photons are tiny particles of light that are made in the sun, travel through space and hit the Earth. Get the 'photons' to line up around 15 metres away from the 'solar panel'.
- Explain that when it's their turn, each photon will have to travel ***incredibly fast*** and with ***lots of energy*** from the sun to the solar panel.

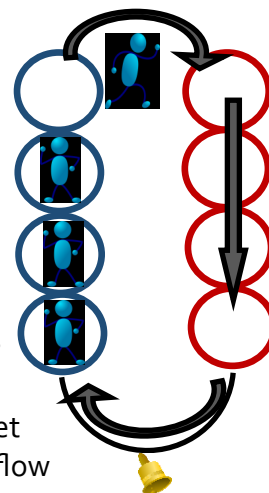


# Activities

## Activity 2: Photon Bombardment Game (continued)

### Playing the game

- The first 'photon' in the line runs towards the 'solar panel' and tags the first 'electron' in the line. (th one furthest away from the bell). That electron gets excited, jumps to the opposite empty circle then runs down the line of circles and along the 'wire', ringing the bell as they go past.
- All the other electrons move up to fill the free 'atom'.
- As soon as the first 'photon' tags an electron, the next 'photon' in the line starts running towards the 'solar panel' and tags the next electron. The electron gets excited and starts to 'flow', following the route of the previous electron.
- Continue sending photons to the solar panel to tag electrons. As children get the hang of it, speed up the flow of photons and see if you can get a steady flow of electrons running round the circuit and ringing the bell.



### Extension:

- Make some children 'clouds'. Ask them to stand in the way of the photon stream and try to catch photons before they hit the solar panel (as if playing bulldogs).

### Plenary

- What did the game teach us about how electricity is made in a solar panel?
- What did the electrons need in order to move and make electricity?
- What happened to the flow of current when the 'clouds' were there?
- What does the bell represent? What items in your house or school could it be? (computer, phone charger etc).

*This game is a good model for how photons excite electrons in a solar panel, creating a flow of electric current that can be used to do work. It is made possible by the properties of the two silicone layers which allow electrons to flow from negative to positive when provided with extra energy from sunlight.*

### Glossary

<b>Photon</b>	A particle of light	<b>Atom</b>	The basic building blocks of all materials.
<b>Electron</b>	A very small negatively charged particle inside an atom.	<b>Silicon</b>	The main material in solar panels, made up of individual silicon atoms.
<b>Electricity</b>	The energy caused by the movement of elec-	<b>Current</b>	The flow of electricity through a wire or



# Activities

## Activity 3: Exploring simple solar circuits

- Purpose:** For children to construct a simple circuit.  
For children to observe that electricity is created when the solar panel is exposed to light.
- Working scientifically:** Opportunities for making predictions, observing phenomena, measuring & recording.
- Materials:** *Per pair of children:*
- 1 solar panel
  - 2 crocodile leads
  - 1 component (buzzer or motor with propeller attached)
- Multimeter

### Activity

In pairs, ask children to make a simple circuit that will operate a motor & propeller or buzzer (see page 8). Test circuits outside or under a lamp.

Use the exploring questions below to encourage children to make and test predictions.

### Exploring Questions

**How can you tell whether the solar panel is making a lot or a little electricity?**

*When the panel is making a lot of electricity the component will work harder. Children will observe differences in the speed of the propeller turning or loudness of the buzzer and can explain this in terms of how much electricity is being made.*

**How can you vary how much electricity your solar panel is making? Can you explain why the amount of electricity changes?**

*The more light hits the solar panel the more electricity it will make. Children can vary the amount of light reaching the solar panel by shading all or part of the panel, or if using a lamp, varying the distance between the panel and the light source.*

### Plenary

When we see solar panels on a roof you don't see smoke, steam or anything moving, so it's hard to tell that they're making electricity!

This activity shows how solar panels create energy that can make gadgets work, and the amount of electricity depends on how much sun there is. We can use the electrical energy made by solar panels to power electrical gadgets of all kinds.

#### Experiment!

Make paper clouds of different sizes.  
Shade the solar panels with the different clouds in turn.





- Can children observe a change in the flow of electricity with different sized clouds?
- Using the multimeter, can children measure and record the voltage in the circuit under different shading conditions?

# Activities

## Activity 3: Suggested extension tasks

### 1. Circuit diagrams

Can children draw their circuits as a circuit diagram using the symbols below:

Solar panel	Wire	Motor	Buzzer
			

For additional teaching resources about circuit diagrams visit :

[www.stem.org.uk/elibrary/resource/26916](http://www.stem.org.uk/elibrary/resource/26916)

### 2. Solar inventions

Can children design a useful invention using the circuits they've created?

Children should bear in mind that the inventions will only work when it is sunny!

Where or when would their invention be most useful?

#### ⇒ Global learning links

*In this activity you could consider how solar energy can help people in parts of the world without grid electricity.*

*Visit <http://practicalaction.org/solar-powered-water-pumps-for-inspiration>*



### 3. Series circuits

Children can experiment adding a second component to the circuit by connecting them in series. In series circuits the components are connected in the same circuit loop.

- **Do the small solar panels provide enough power to make both components work? What about the large ones?**

*Even in bright sunlight, the small panels can't make enough energy to power more than one component, but the larger solar panels do.*

- **What happens if they replace the solar cell with a battery?**

Compared to a battery, the solar panels produce very little energy. This is why you see solar panels in large groups—you need a lot to produce a worthwhile amount of electricity.

# Activities

## Activity 4: Light Bulb Challenge

**Purpose:** Children learn to combine the output of solar panels by connecting them in series. Children learn that solar panels are

**Working scientifically:** Opportunities for making predictions, observing phenomena, measuring & recording.

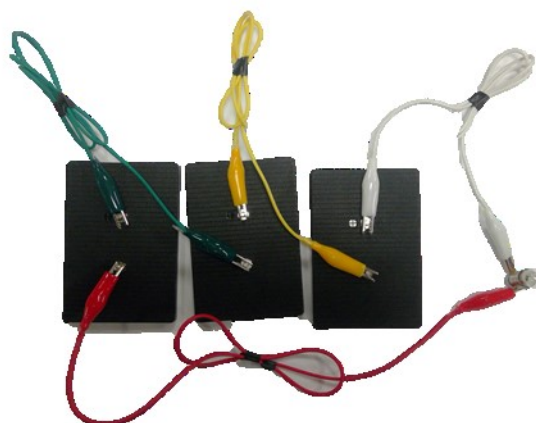
**Materials:** *Per pair or group:*

- 5 or 6 small solar panels
- 10 crocodile leads
- 1 1.5V light bulb

### Background

When two solar panels are connected in **series**, their power is combined. So two 0.45 volt panel connected in series will give a maximum power in the circuit of 0.9 volts.

To make a series, connect the positive contact of the first panel to the negative contact of the next panel with a crocodile lead. Close the circuit by connecting the + from one panel and the – from the other panel to the terminals on the component (see photo).



### Activity:

Ask children to make a simple circuit connecting one solar panel to a 1.5V halogen light bulb. Does the bulb light up?

Help children to add solar cells one by one to the circuit in series. After each one, check whether the bulb lights up.

How many of the small solar panels did they need to make the bulb light up?

➡ **Discussion** Rooftop solar installations are usually big (though they are actually lots of smaller panels connected together). Because each panel only makes a small amount of electricity, to make enough energy to power our appliances, we need a large area of solar panels.



# Activities

## Activity 4: Suggested extension task

### Debating the Pros and Cons of Solar

After experimenting with some solar-powered circuits, children will realise that the output of solar panels is very variable, depending on the amount of sunlight available. You also need a quite large area of solar panels to produce enough electricity to power useful appliances such as light bulbs and computers, or to charge a phone.

The pros and cons of solar versus other sources of energy is a fruitful topic for children to debate. Compare the following facts about solar farms and coal-fired power stations:



Chapel Lane solar farm near Parley is the biggest solar energy farm, or 'solar array' in the UK.

**Land 'footprint':** 380 acres

**Electricity output:** 70 Megawatts per year



West Burton power station in Lincolnshire is an average-sized coal-fired power station.

**Land 'footprint':** 410 acres

**Electricity output:** 2000 Megawatts per year

### Activity: Do we need solar energy in the UK?

**Purpose:** Children research and evaluate different methods of generating electricity.  
Children distinguish between facts and opinions.  
Children construct verbal arguments to support their point of view.

**Resources:** Internet access for children.  
Download and print the Energy Trumps cards from <http://learning.cat.org.uk/en/resources>

In teams or individually, ask children to pick an energy technology (e.g. coal, wind, gas, solar, nuclear, tidal power or shale gas) and research it's advantages and drawbacks. Fact-finding should include information about:



# Activities

- The cost of building a plant
- \* Cost of the electricity
- \* CO<sub>2</sub> produced
- \* Other pollution
- \* Effects on wildlife
- \* Amount of land needed

Children should also consider subjective factors such as visual impact.

Once the children are armed with facts you can hold a debate. Make up your own question or choose one from below. Ask children to pick a side and use what they know to put forward arguments to support their chosen position.

## **Suggested debate questions:**

**'Solar is the best way for the UK to make it's energy'**

**'There's no point having solar panels in the UK because it's not sunny enough'**

**'We should not spoil the British countryside by covering it with big solar farms'**

**'We should keep using coal-fired power stations because they are so reliable'**

**'We don't need solar power, we just need to use our electricity more efficiently'**



# Activities

## Activity 3: Moving Art

**Purpose:** Children employ the solar-powered movement to create spinning art works.

**Materials:**

- Paper plates or circles or card
- Coloured pens, pencils, paints stickers and collage materials.
- Velcro or Blu-tac
- Wooden motor stand with motor connected to a solar panel

### Solar Swirls

Ask children to decorate paper plates or cardboard discs. They should think about designing a pattern that will look interesting when it spins slowly and fast.

Attach completed plates to a propeller using Velcro or Blu-tac. Expose the solar cell to sunlight or lamplight and watch the patterns spin!



### Newton Wheels

Isaac Newton was the first to discover that visible light is made of seven different colours – Red, Orange, Yellow, Green, Blue, Indigo and Violet.

Divide a paper plate into 7 sections and colour each one with a different colour. If the propeller can be made to spin fast enough, children should see the colours blend into white.

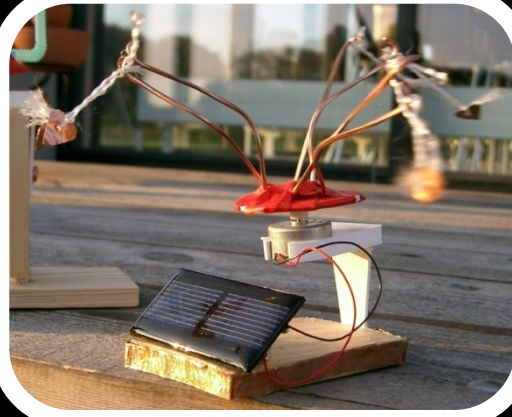
Children can experiment with different sizes and positions of solar cells to create a fast enough propeller spin.



# Activities

## Carousels

Experiment with horizontally-spinning movement. Use materials you find around school (e.g. Lego, straws, natural materials, recycled materials) to mount a solar panel and create sun-powered spinning models and carousels.





# Activities

## Activity 4: Wacky Races

**Purpose:** Children design and build a boat which can be propelled by a solar-powered circuit.

- Materials:**
- Simple solar circuit (solar panel connected to motor & propeller) per group
  - Selection of D & T materials e.g. balsa wood, dowel, MDF, cotton reels, plastic sheet or recycled items (plastic bottles, cartons, polystyrene, lollipop sticks).
  - Glue (including hot glue) and tape

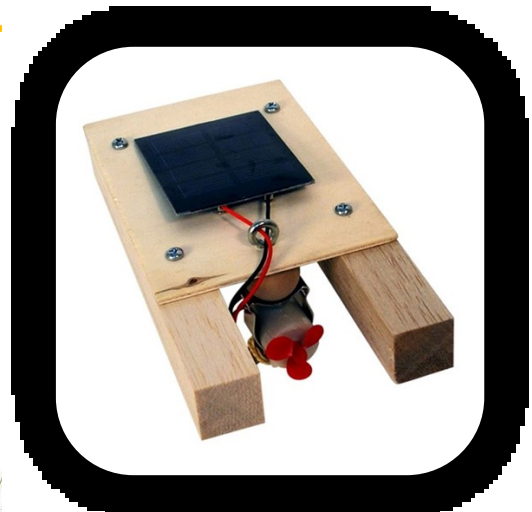
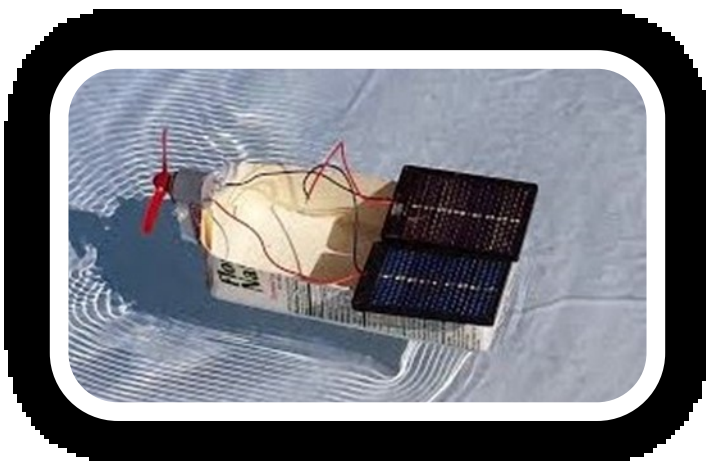
### Activity

Challenge children in groups to design a floating raft or boat that can be propelled by a solar circuit. You could up the ante by requiring the vessel to be able to carry a load! Children could consider:

- Where on the raft the propeller should go
- How to make the vessel is balanced and streamlined.

Test out (or race) designs on a pond or paddling pool on a sunny day.

**Caution!** Prolonged full submersion in water will damage the solar panels. If the panels and components get wet, please dry them carefully with paper towel and lay them out somewhere warm to dry thoroughly.





# Links

## Solar Energy in the News

<b>Solar Impulse:</b> Solar airplane flies around the world.	<a href="http://www.solarimpulse.com/adventure">www.solarimpulse.com/adventure</a>
<b>Al Jazeera:</b> World's largest solar power plant in India	<a href="http://tinyurl.com/huxjgxl">http://tinyurl.com/huxjgxl</a>
<b>The Guardian:</b> Renewable energy in Morocco	<a href="http://tinyurl.com/gtpkojz">http://tinyurl.com/gtpkojz</a>
<b>Mashable:</b> Solar power in the developing world	<a href="http://tinyurl.com/h7o8kcv">http://tinyurl.com/h7o8kcv</a>
<b>New Internationalist:</b> Could the Sahara power the	<a href="http://tinyurl.com/zhxvcxg">http://tinyurl.com/zhxvcxg</a>

## Key Stage 1 & 2 Teaching Materials

<b>Centre for Alternative Technology</b> Energy Trumps Cards	<a href="http://learning.cat.org.uk/en/resources">http://learning.cat.org.uk/en/resources</a>
<b>West Mill SET</b> Solar Insulators	<a href="http://www.weset.org/worksheets/ws-66.pdf">www.weset.org/worksheets/ws-66.pdf</a>
<b>West Mill SET</b> Thermal Collectors	<a href="http://www.weset.org/worksheets/ws-65.pdf">www.weset.org/worksheets/ws-65.pdf</a>
<b>West Mill SET</b> Solar Conductors	<a href="http://www.weset.org/worksheets/ws-67.pdf">www.weset.org/worksheets/ws-67.pdf</a>
<b>BBC Bitesize</b> Electricity in rural Zambia	<a href="http://www.bbc.co.uk/education/clips/zmynvcw">www.bbc.co.uk/education/clips/zmynvcw</a>
<b>West Mill SET</b> Sun Web of Life	<a href="http://www.weset.org/worksheets/ws-62.pdf">www.weset.org/worksheets/ws-62.pdf</a>
<b>Ashden Schools</b> Investigating Energy Technologies	<a href="http://www.ashden.org/schools/activities">www.ashden.org/schools/activities</a>
<b>Solar Aid</b> Light the Way	<a href="http://www.solar-aid.org/sunnyschools">www.solar-aid.org/sunnyschools</a>
<b>Solar Aid</b> Sunny Schools resource and activity packs	<a href="http://www.solar-aid.org/sunnyschools">www.solar-aid.org/sunnyschools</a>
<b>Solar for Schools</b> Phased teaching resources	<a href="http://www.solarforschools.co.uk/resources">www.solarforschools.co.uk/resources</a>
<b>Met Office</b> Climate Change teaching resources	<a href="http://www.metlink.org/climate/climate-change-schools-project">www.metlink.org/climate/climate-change-schools-project</a>
<b>Friends of the Earth</b> Run on Sun Education Pack	<a href="http://tinyurl.com/hkmsu2w">http://tinyurl.com/hkmsu2w</a>

## Video

<b>BBC Bitesize</b> Electricity in rural Zambia	<a href="http://www.bbc.co.uk/education/clips/zmynvcw">www.bbc.co.uk/education/clips/zmynvcw</a>
<b>TED Ed</b> How do solar panels work?	<a href="http://www.youtube.com/watch?v=xKxrkht7CpY">www.youtube.com/watch?v=xKxrkht7CpY</a>



# Appendix 1:

## There and Not Back Again: A Photon's Tale

The story of how particles of light cross space and activate your solar panels, told from the perspective of one of those light particles, Phil the Photon.

### Uses:

- Linking to project work on Space and the Solar System
- Developing scientific vocabulary and concepts
- Stimulus for Art or Drama activities

Hi, I'm a photon, and my name's Philip. Philip the photon, that's me. This is my story, a story of how I was made, and how I bumped into your solar panel and made you some electricity.

We **photons** are tiny little particles, so small that the most powerful microscopes have no hope of seeing us unless we aim right for them. We make up light. All the light that you can see. I'm a normal photon. I am yellow.

I was made in the middle of the Sun a long, long time ago. It's hot, the middle of the sun. Very hot. The heat would break the best thermometer you humans can build. But I was there, so I know how hot it was, and I'll tell you.....It was **fifteen million degrees**. That is more than one hundred thousand times hotter than a kettle!

I was made when two tiny bits of the Sun bashed into each other and stuck together. Bits of the sun colliding and sticking together like this happens all the time in the sun. Actually, it happens  $1 \times 10^{38}$  times per second. That number is a one with 38 zeros after it!

Making me made so much energy that as soon as I was born I whizzed off from my parents (they were called Harry the **Hydrogen** and Penny the **Proton**). But I didn't get very far before I bashed into another little bit of the sun. Smash! I hit one of my dad's brothers, Henry the Hydrogen. I'd only managed to go a few millimetres. We bounced off each other, and I headed off in a different direction. This is ok, I thought, seeing that things were a slightly different

colour in the direction that I was heading. But then, bash! I hit another of my uncles. This time, it was Horace. I bounced off again, and headed off in a different direction. Then I hit another one. Then another. It is really crowded in the middle of the sun!

I carried on bouncing like this, getting further and further from my mum and dad, for ages. In fact, I carried on doing it for 100,000 of your Earth years. That is a very long time - longer than 100 science lessons! The first 20,000 years or so were really fun. I love bouncing around, seeing all my uncles. But after a while it got a bit boring. So I was really happy when, after 100,000 years, things changed. I had got so far out from my parents in the centre of the sun that things had cooled down and were feeling a bit less crowded. It was only 20 million degrees, and I had to think about putting on a jumper.

With all that bouncing and jiggling around I had worked my way towards the surface of the Sun, which was surprisingly.....bubbly! All around me was like a pot of boiling water, bubbles rising and popping vigorously. I was so absorbed watching the fiery eruptions that I forgot to pay attention to myself, and before I knew it I had the strange sensation of floating upwards. I had been caught in a giant bubble. This one was hot and big enough to fit your whole planet Earth in! The bubble roared and rose, floating away from the fiery sea below. We rose for days until, without warning, the bubble popped and I was thrown out in to space.



# Activities

Something you should know: we photons like to go in straight lines, and FAST! We go at 671 million miles per hour. It is faster than Lewis Hamilton in his car. It is faster than the fastest jet plane or space rocket. In fact, we photons are the fastest things in the universe!

So I headed off in a nice fast straight line. As I rushed away from the Sun I realised I was flying past a huge fiery arch. It looked like a rainbow, but it was orange. Its feet were in the sun but it projected into space for hundreds of thousands of miles. Apparently you humans call them **Coronal loops**. I think they might be important.

Waving goodbye to the sun, I looked at where I was going. It looked black, with lots of sparkling little lights. Cool! I can go really fast for a really long way! Sadly, after only **8 minutes**, something got in the way. It was a lovely green and blue ball with wispy white things over its surface. Just before hitting it, I realised that it was your planet, Earth.

It was so pretty that I almost didn't notice passing through two areas that made me tingle. Apparently, you humans call them the **Van Allen belts**, and they help protect you from harmful radiation from space. Handy!

At this point, I was getting closer and closer to your planet, and looking forward to seeing what it was like. But bash! I hit something else. This time, it was Neville the **Nitrogen**. He and a load of his friends hang around in a thin layer around your planet. Apparently, you call them the atmosphere, and he has a loads of friends called Orville, Oliver and Olly, all **oxygen**s. Dashing past Neville and his friends I hurtled through a layer of **ozone**, which protects you from radiation from space, and found myself heading straight down towards the surface of Earth.

As your planet came more clearly into view, I saw I was heading towards a green bit, rather than a blue bit. It was an island, I realised, surrounded by blue and with some lovely crinkly bits.

Gazing at the green bits getting closer and closer, I was wondering where on Earth I was when OUCH! I hit your solar panel. 671 million miles an hour to being still, in under a second.

What had happened was that I had got to your solar panel and hit Sally. Sally is a **silicon** atom. She was made in the middle of another star, not the sun. Sally and millions of her silicon friends all stand in rows and columns and make up your solar panel. Sally was so excited to see me that she threw her arms out to catch me. Sadly, she had forgotten that she was holding her **electrons** (electrons are tiny little balls that carry electricity). She caught me, and gathered up all but one of the electrons.

As I hugged Sally, I looked around. All around us, other photons were hitting Sally's silicon friends. Each time they did, the silicons dropped an electron. And the electrons were all rolling in one direction. As more and more photons crashed into the solar panel, more electrons joined this flow. With all those electricity-carrying electrons rolling along, an **electric current** started to flow. I don't understand how your clever humans do it, but apparently you can use these currents to do all sorts of clever things, like turning on light bulbs, cooking dinners, and powering computer games. Isn't that amazing?

I was born 100,000 years ago in the middle of a star, and now I can help you see, eat, and find Pokemon. All because Sally was so excited to see me, and I hit her fast enough to make her drop one of her balls. I hope you enjoy them all! I am staying with Sally for now. Who knows, one day she may get excited enough to throw me off, and I'll go zooming somewhere else. Bye!

By Philip the Photon

**AKA Dr Derek Moss**

**Dorset Community Energy Director and Astrophysicist**



# Activities

