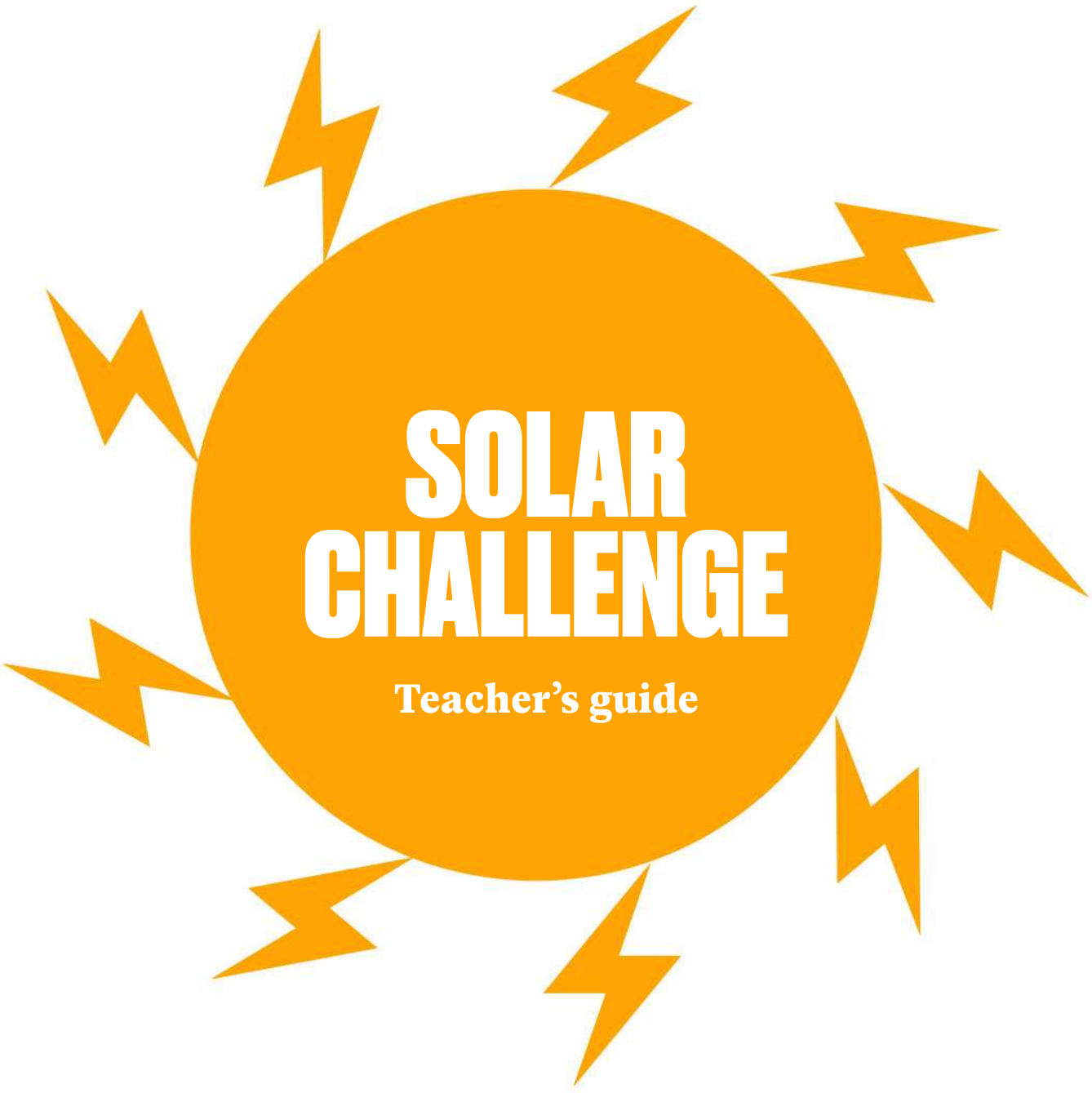

SOLAR CHALLENGE

Teacher's guide

CREST AWARDS

THE GLOBAL GOALS For Sustainable Development

practicalaction.org/schools/solar-challenge

Practical ACTION

The Solar Challenge is an exciting STEM challenge for pupils aged 8-14 years. It enables them to investigate how the generation of electricity using solar cells can transform the lives of people living without access to mains electricity.

The challenge is based around Practical Action's work in Gwanda, Zimbabwe. The Solar challenge can be used to deliver parts of the science, design and technology, and maths curriculum in regular lessons, in an enrichment day, in a STEM/science club or as part of a primary to secondary transition activity. Pupils can also gain a CREST Award through taking part in the challenge.

The teacher's guide is accompanied by a PowerPoint (PPT) presentation, pupil activity sheets, a poster and certificates. They can all be downloaded for free from: practicalaction.org/schools/solar-challenge.

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Learning objectives

Through engaging in the solar challenge, pupils will:

- understand what solar cells are and how they can be used
- solve problems and find solutions to challenges using solar cells
- explore how the use of solar cells can change people's lives.

Curriculum links

STEM subjects provide great opportunities for teachers to include authentic global contexts and global learning. To see where the Solar Challenge supports the delivery of the formal science curriculum for England, Northern Ireland, Scotland and Wales please go to: practicalaction.org/schools/science-curriculum.

Within the D&T curriculum pupils will gain technical skills and knowledge.

Overview of Solar challenge

Outline	Teaching material	Timing (min)
Introduction to the context	**PPT slides 1–3**	10 mins
Starter activities		
a. Making a National Grid	**PPT slides 4–7** **Pupil activity sheets (one set per class)** - *Making a National Grid: place cards* - *Making a National Grid: power stations*	20 min
b. Solar energy	**PPT slides 8–13** **Pupil activity sheets (one per pupil)** - *Building circuits to explore the use of solar cells*	60 min
c. Sustainable Development Goals	**PPT slide 14–15** **Pupil activity sheets** - *Sustainable Development Goals (one per pair)* - *Global Goals display materials (one set per class)* *practicalaction.org/schools/global-goals-dispaly-materials*	25 min
Main activity – Making decisions about solar power	**PPT slides 16–23** **Pupil activity sheets (one per group)** - *Community case studies* - *What does the community in Gwanda need electricity for?* - *How much electricity do appliances use?* - *Appliance energy cards* - *Village map (print A3)* - *Power to the people! (printed or Excel spreadsheet)* - *Units of electricity*	60 min
Feedback	**PPT slide 24** **Pupil activity sheet (one per pupil)** - *Team feedback*	20 min
Solar solutions	**PPT slides 25–26**	5 min
Celebrating success	**PPT slides 27–28**	5 min

Introduction to the context

Use PPT slides 1–4 to get pupils thinking about electricity and its uses.

NB. Some of the pupil activity sheets have been differentiated for primary and secondary aged pupils. Depending on the ability range of your pupils, you might choose to select activity sheets from both age groups.

Use PPT slide 2 to encourage pupils to think about their own use of electrical appliances. You might choose to extend the chart on the PPT slide on a whiteboard to develop a list of the different appliances pupils think of. Then, encourage them to consider whether the appliances are powered by battery or mains electricity.

Some pupils may suggest that certain appliances can use both (e.g., a laptop computer). Acknowledge this as a valid point but encourage them to distinguish between something charged from the mains as opposed to something that uses batteries that are already charged. Discuss rechargeable batteries too.

Use PPT slide 3 to introduce how electricity is produced in the UK. If time permits, encourage the pupils to identify the overhead National Grid cable lines around the school and community. Note that they may need some guidance on this – not all overhead wires are part of the National Grid. Some pictures of grid lines with pylons will help.

Extension/homework activity

Ask pupils to find out about how and where electricity is generated in their local region.

Starter activities

We recommend that you work through the starter activities to help pupils understand the context of the challenge.

a. Making a National Grid

Now pupils have identified how important energy is, this activity supported by PPT slides 4–7, helps them understand that whilst in most parts of the world a national grid transports electrical power across the whole country, sometimes people living in rural areas do not get electricity. This raises the issues of fairness and equal access to energy.

Before starting the activity, write the name of two local villages/small towns and the nearest city on the blank cards and, if possible, include the population size.

Hand out the place cards and three power station cards to different pupils. Ask the pupils to spread themselves around the room and to hold up their cards. Now give each pupil **not** holding a card a piece of string and explain that they will act as electricity pylons, with string for their power cables.

Demonstrate that each pupil needs to hold the ends of the string in their hands and all the strings must touch each other for the electricity to flow from one pylon to the next. The aim is for them all to connect the towns and villages to at least one power station, thus representing the National Grid.

Prompt questions

- Why is it a good idea, wherever possible, to have more than one connection between a town or a village and the National Grid?
- What might happen if one region needs more electricity than the local power station can produce?

Stress that in the UK we are lucky as most people have a secure electrical supply. Ask the pupils if they think that everyone in the world has access to electricity. Tell them that in many parts of the world, particularly where people are living in rural locations, many do not have access to mains electricity. To simulate this, remove the cables that connect to the towns or villages with a population of less than 10,000 people. Ask the pupils prompt questions such as those shown below:

Prompt questions

- How would you manage without electricity?
- Is it fair that some parts of a country get electricity and others do not?
- What other ways could your village/town generate its own electricity?

PPT slide 7 shows some examples of the most common methods of generating electricity when mains access is limited and/or people want to generate electricity from renewable energy sources, including solar energy. You may like to show pupils our renewable energy poster. Email schools@practicalaction.org.uk to request a free copy, or download one from practicalaction.org/schools/posters.

Resources

Pupil activity sheets
- *Making a National Grid: place cards (one set per class)*
- *Making a National Grid: power stations (3 per class)*

Equipment
- *1 piece of string per pupil, approximately 0.5m long*

b. Solar energy

PPT slides 8–12 explore the use of solar cells and introduce some investigative activities that involve making electrical circuits using batteries and solar cells. There are three activity sheets that can support pupils as they conduct these investigations.

1) Getting the power
There are different versions of the *Power to the people!* activity sheet for upper primary and lower secondary and/or pupils of different abilities. The purpose of this activity is to get pupils building and testing circuits, and then exploring how batteries can be replaced by solar cells. It uses equipment that is often available in schools, though the solar cells may need to be acquired. The activity culminates in pupils being asked to compare and contrast batteries and solar cells; this lays foundations for later work on evaluating the practicality of solar-powered appliances.

Note that solar cells need charging before they are used. This is best done using a desk lamp and a 60W light bulb.

Using solar cells also highlights the significantly different requirements of bulbs, motors and buzzers. The latter will often work with one solar cell, whereas bulbs and motors may need two or three solar cells in series.

These aspects are, of course, key aspects of the learning. The purpose is for pupils to understand that the light needs to be strong and constant to power some devices so working out the number and position of the solar cells is important.

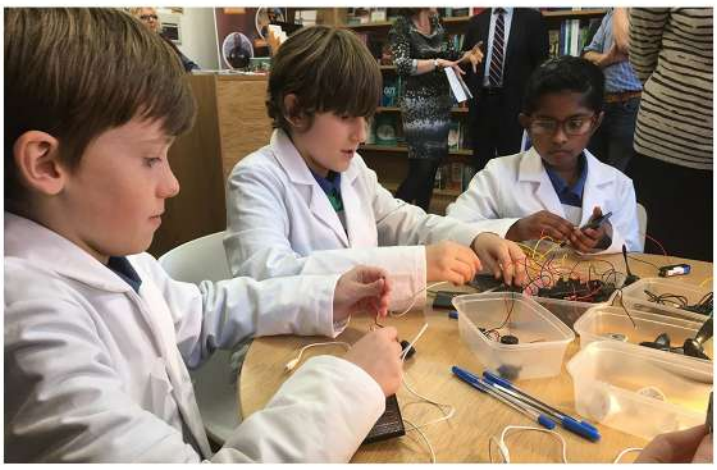
2) How much light?
This sheet is designed to challenge pupils to investigate how solar cells respond to different levels of light. The investigation can be set up in different ways, depending on the age and ability of the pupils and the equipment available.

Varying the light could be done by altering the distance to the light source. Another variation on this could be to find out whether the angle of the solar cell in relation to the direction of light makes a difference (especially if the light is primarily coming from one direction).

Measuring the electricity produced could be done by seeing how bright the bulbs are/how loud the buzzer is/how fast the motor turns. A quantitative measure would involve using a voltmeter (or multimeter on a voltage range) though this is more likely to be an option in a secondary school.

3) Turning up the power
This sheet explores what happens when more power is used in a circuit. This fits well with the KS2 programme of study (England) for Year 6, for example, in which pupils are expected to identify patterns in the behaviour of different circuits. Pupils should learn that, just as extra batteries provide more power, so do extra solar cells.

To explore this it is likely that groups of pupils will need to share the use of solar cells or that this part of the activity will need to be demonstrated. PPT slide 13 clarifies the difference between solar cells which produce electricity and solar panels which are used to heat up water.



Resources

Equipment

- *AA batteries (16)*
- *battery holders (16)*
- *light bulbs 1.5V (24)*
- *bulb holders (24)*
- *round buzzers (8)*
- *electric motors 1.5 to 4.5v (8)*
- *blades for motors (8)*
- *crocodile leads (32)*
- *solar cells 0.45V (8)*

A complete solar kit with all these materials has been compiled for us by TTS and is available to purchase from tts-group.co.uk.

TE10025 – Practical Action Solar Kit

Extension/homework activity

Set pupils the task to find out more about life in Zimbabwe. In particular how people light their homes, cook, etc. in areas without access to mains electricity.

c. Sustainable Development Goals

Now pupils are aware that access to electricity is a global problem, it is useful for them to be aware that lots of people and organisations are working to find solutions.

Use PPT slides 14–15 to introduce the Sustainable Development Goals (SDGs) also known as the Global Goals. Do this by explaining that in 2015 the United Nations identified a number of problems faced by people and communities around the world. They then came up came up with 17 SDGs which they agreed to work towards to help solve world poverty by 2030.

SDG 7 Affordable and clean energy is the most relevant goal for this challenge.

Hand out copies of the *Sustainable Development Goals* sheet to help aid understanding of what the Global Goals are. Ask pupils which ones might be linked to some of the problems faced by people around the world who do not have access to energy.

Now carry out our Global Goals string activity. This helps pupils see the interconnections between the goals.

1. Hand out all the symbols to start with, then enough of the images for each pupil to have something to hold. For younger pupils, or to simplify the activity, you may wish to cut the targets off the bottom of the symbols.

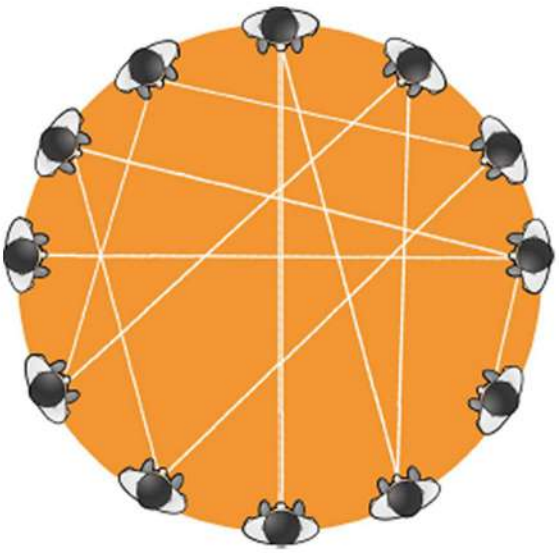
2. Ask the pupils holding images to 'pair up' with the correct Global Goal.

3. Ask pupils to stand in a circle facing inwards and showing their Global Goal symbols and images.

4. Hand one end of the string to the pupil holding Global Goal 2 and ask the pair which of the other goals they think 'Zero hunger' may link to, and why. An example may be a link to health and well-being because people who don't have enough to eat cannot be healthy. Ask them to keep hold of the end and pass (or throw!) the ball of string to the pupils holding that Global Goal and image.

5. Ask the same question of this pair of pupils, and again ask them to keep hold of the string but pass the ball to the pair who have a Global Goal they think links to theirs, and explain why.

6. Continue until you have a spider web effect.



7. Ask the pupil holding Global Goal 7 (Affordable and clean energy) to pull on their string. When other pupils find their string moves explain that this is because everything is interconnected; when you make progress on one Global Goal it affects the others.

Resources

Pupil activity sheets
- *Sustainable Development Goals (one per pair)*
- *Global Goals display materials (one set per class)* *practicalaction.org/schools/global-goals-display-materials*

Equipment
- *String*

Main activity – Making decisions about solar power

Divide the class into small teams of up to 4 pupils. Introduce the challenge using PPT slides 16–23 and the pupil activity sheets listed in the resources section.

Essentially, the pupils are tasked with deciding how to use 10 solar cells to best meet the needs of the community based in a village in Gwanda. They need to combine their research findings about the needs of the community with information about how much electricity different appliances use and how long those appliances need to be on for in one day in order to work out how best to use the limited number of solar cells that are available.

Pupils can use either the *Power to the People!* activity sheet or Excel spreadsheet to calculate and record their decisions on the choice and number of appliances. The spreadsheets can be found here: old.practicalaction.org/power-primary and old.practicalaction.org/power-secondary.

Once they have decided how best to use the units, pupils can plot where they would install the solar cells on the *Village map*. You might want to have a discussion about where solar cells are best positioned and in which direction they should face.

Prompt questions

It might be interesting to ask the pupils, if there was more funding available for solar cells, what further uses for the community would they suggest?

Feedback

We suggest that pupils present their model to the rest of the class reflecting on how well they worked together, problems they solved, etc. (this will be necessary if you are planning for your pupils to gain a CREST Discovery award).

Pupils are asked to comment on:
Teamwork – Did they assign roles well and work together as a team?
Research – Did they use their research to make recommendations for the best use of the solar cells.
Developing and finalising ideas – Did they develop ideas that met the needs of the community?
Village map and/or model – How clearly did they annotate the map or model?
Presentation – How well did the team communicate about their Solar challenge?

Resources

Pupil activity sheet
- *Team feedback (one per pupil)*

Solar solutions

Use PPT slides 25–26 to share the story of how solar cells have transformed the lives of people living in another area of Zimbabwe.

Tell the pupils that the real community in Gwanda decided to use their entire allocation of solar cells to install a solar irrigation system. They felt this would bring about the greatest benefit to all of the community, as families would be able to grow enough food to feed themselves and prevent malnutrition especially amongst children. Any additional foods could be sold at markets bringing additional income for women.

Celebrating success

CREST Awards

Taking part in the Solar challenge is a great way for pupils to gain a CREST Award. The challenge is aligned to the Discovery Award, but can be used towards achieving a Superstar Award or as the starting point for a Bronze, Silver or Gold Award.

The CREST Discovery Award is generally undertaken by 9–14 year olds. It can be acheived in 3–5 hours. CREST Bronze, Silver and Gold Awards are designed for pupils aged 11–18.

For more information on CREST Awards go to: crestawards.org

For further ideas for Bronze, Silver and Gold projects linked to global issues go to: practicalaction.org/schools/global-project-ideas

Big Bang Competition

Pupils aged 11–18 and in full time education/ training who have taken part in a STEM challenge can enter their work into the National Big Bang Competition.

Prizes include industry/scientific site visits, and a chance to represent the UK at international contests. Being a part of the competition is an inspiring and valuable experience for all young people involved.

To find out more go to: competition.thebigbangfair.co.uk

Great Science Share for Schools

Having taken part in the challenge, pupils are encouraged to join in the annual Great Science Share for Schools campaign. It's their chance to share their project with new audiences in or beyond their own schools. To find out more and register your school to take part visit: greatscienceshare.org

British Science Week

The Solar challenge would be a great activity for your class or year group to do during British Science week in March each year. To find out more go to: britishscienceweek.org.

To find out if your school is eligible for a grant go to: britishscienceweek.org/about-us/grants