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| **Sustainable lighting design** |
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| Designing and making a sustainably powered light |
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| **Subject(s):** Design & Technology, Engineering**Approx time:** 70 - 100 minutes |  | **Key words / Topics:** * National Earth Day
* light emitting diodes (LEDs)
* ethical and social issues
* mains electricity
* motors/generators
* renewable energy
* sustainability
* wind power
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| **Stay safe** Whether you are a scientist researching a new medicine or an engineer solving climate change, safety always comes first. An adult must always be around and supervising when doing this activity. You are responsible for: • ensuring that any equipment used for this activity is in good working condition• behaving sensibly and following any safety instructions so as not to hurt or injure yourself or others  Please note that in the absence of any negligence or other breach of duty by us, this activity is carried out at your own risk. It is important to take extra care at the stages marked with this symbol: ⚠ |
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| **Suggested Learning Outcomes**  |  |  |
| * To understand what is meant by, and the need for, renewable energy.
* To be able to design and make a sustainably powered light.
* To understand how wind turbines work.
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| **Introduction** |  |  |
| This is one of a set of resources designed to allow learners to use seasonal themes to support the delivery of key topics within design & technology, maths and science. This resource is based on National Earth Day.Approximately 1 billion people in the world, or 15% of the total population, have no access to mains electricity. How could you power a lamp for children living in these conditions, to enable them to read and study at night?  |
| **Purpose of this activity**In this activity learners will use the theme of National Earth Day to design and make a wind powered reading light. This activity could be used as a main lesson activity to teach about the benefits of using renewable energy and how it can help to solve social problems. It could also be used as part of a wider scheme of learning focussing on sustainability and the 6Rs (rethink, refuse, reduce, reuse, recycle, repair). |
| **Activity** |  | **Teacher notes** |
| **Introduction (10-15 minutes)**Teacher to explain that learners are going to design and make a sustainably powered light for a child who has no access to mains electricity.**How big is 1 billion? (5-10 minutes)**Using the teacher presentation teacher explain that around 1 billion people have no access to mains electricity. Ask learners to discuss how much of the world map they think this covers.**Design brief (10-15 minutes)**Introduce and discuss the design brief with learners:***Situation****People in some developing countries do not have access to mains electricity. This means children have no light for reading and studying at night, which can affect their education.****Design Brief****Your task is to produce a prototype for a reading lamp for children living in places with no access to mains electricity. The lamp must be powered by a renewable energy source, such as the wind.*Discuss the tasks that they will need to complete to meet the requirements of the design brief.* Select the components and parts that you will need from those given by your teacher.
* Produce a labelled sketch of your design.
* Make your design by assembling the components and parts.
* Test your design to check that it works.

Teacher to introduce and hand out resources required for the tasks to learners. Learners to then carry out these steps.**Producing the product (40-55 minutes)**The following steps, as shown in the presentation, can be used as an example to help learners produce their product:* Step 1 - Push both legs of an LED into one end of the block connector. Connect a red wire to the long leg of the LED and a black wire to the short leg of the LED through the other end of the block connector.
* Step 2 - Connect the black wire to the negative leg of the generator. Connect the red wire to the positive leg of the generator.
* Step 3 - Attach the blades to the generator. Test your finished product to check that it works!

Learners to carry out the design and make activity. The teacher presentation could be left on the whiteboard as a supporting guide as they do this. **Plenary (5 minutes)**Peer assessment of selected examples – what are their good features? What could be improved? |  | **How big is 1 billion?**A blank copy of the world map could be handed out and learners could colour in how much of the globe they think represents 1 billion people, or where people are more likely to not have access to mains electricity.**Design brief and tasks**Discuss the situation and design brief with learners.Learners should be given a range of relevant components to select from, such as motors/generators, hi-bright LEDs and/or lamps, block connectors, wires/cables, parts to make turbine blades etc. (see resources section of lesson plan). To extend the activity learners could be given a budget for their finished product; each part could be allocated a cost and released in a ‘shop’ approach.CAD software could be used to produce the sketches, or they could be drawn by hand, depending on the resources and time available.**Example solution**Slides 6-9 show how a simple prototype could be assembled. This could be used to support lower ability learners who struggle to develop their own more individual designs.Instead of a block connector the wires could be soldered to the LED legs if soldering equipment is available. Wires should be cut to an appropriate size either by the learners, or by teachers in advance. Many modern hi-bright LEDs do not require a protective resistor, but some do. This must be checked before assembling the prototype.Wires can be soldered to the legs of the generator or wrapped around the legs, with insulation tape used to secure them. Blades could be pre-produced in advance by the teacher (for example, using laser cutter or 3D printer), or kits can be purchased from online suppliers such as Amazon or Rapid Electronics. The LED should light up when the blades rotate. |
| **Differentiation** |  |  |
| **Basic** |  | **Extension** |
| * Learners could produce the simple solution involving an LED, generator and turbine blades shown in the presentation.
* Pre-cut wires to size and provide a wiring and/or circuit diagram to aid with assembly.
 |  | * Improve the design of the circuit by adding additional LEDs and a power switch.
* Allocate budgets to learners for their design and part costs, releasing parts in a ‘shop’ situation.
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| **Resources** |  | **Required files** icon-docicon-pdficon-ppt |
| * Hi-bright light emitting diodes (LEDs).
* Block connectors with two pin connections at either end, or solder and soldering equipment.
* Insulation tape.
* Red and black wires or crocodile clips.
* A low power DC generator/motor (a motor working in reverse acts as a generator).
* Pre-made or purchased turbine blades to attach to the generator.
 |  | icon-ppt Sustainable lighting design presentationicon-doc Sustainable lighting design map handout |
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| **Additional websites** |  |  |
| * **The earth day website:** earthday.org
* **YouTube – Earth Day for kids:** https://www.youtube.com/watch?v=yl3zgcL0Tv8
* **LUTW website:** Official website of the Light up the World Foundation, a charity that provides lighting solutions to people with no access to mains electricity. <https://lutw.org/>
* **BBC Bitesize – Renewable energy:** Video and revision notes explaining sustainability and the uses, advantages and disadvantages of different renewable energy sources. <https://www.bbc.co.uk/bitesize/guides/zf8ck2p/revision/3>
* **Association for Renewable Energy website:** Website for a not-for-profit organisation that champions the development and use of renewable energy solutions. <https://www.r-e-a.net/>
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| **Related activities (to build a full lesson)** |  |  |
| **Starters** (Options) * Watch the earth day for kids clip on you tube: <https://www.youtube.com/watch?v=yl3zgcL0Tv8> and discuss the purpose of National Earth Day.
* How big is 1 billion? Discuss how many people do not have access to mains electricity. Learners could colour how much of the world they think this covers using the map handout.
* Discuss the advantages and disadvantages of different types of renewable energy sources such as wind, solar, biomass and hydro power.
 | **Extension** (Options)* Improve the design of the circuit by adding additional LEDs and a power switch.
* Allocate budgets to learners for their design and part costs, releasing parts in a ‘shop’ situation.

**Plenary*** Self/peer assessment of completed prototypes.
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| **The Engineering Context** film |
| * Engineers have a social and moral responsibility to consider the effects of the environment when solving design problems.
* The renewable energy sector is one of the biggest growing industries within engineering, so an understanding of ways to produce greener energy is essential for anyone looking to become an electrical or electronic engineer.
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| **Curriculum links** |
| **England: National Curriculum**Design & Technology * KS3 1a, d, e, 2a, b, 3c, d

**GCSE D&T**AQA D&T* 3.1.1, 3.1.2, 3.1.4, 3.2.1, 3.2.3, 3.3.2, 3.3.4, 3.3.5, 3.3.6, 3.3.7

Edexcel D&T* 1.1.3c, 1.1.4c, 1.2.2d, 1.3.1, 1.3.2, 1.3.3, 1.6.3c, 1.17.1, 5.2.3b, d, 5.3.5a,

Eduqas D&T* Core: 1, 2, 3, 5
* Electronic systems: 1, 2, 6

OCR D&T* 1.1a, 1.2a i, 2.1a i, iv, vi, 2.2a, 3.1a, 3.2, 3.3a, 4.1a, 5.2c, 6.4b i, 7.2a ii, 8.1
 | **Northern Ireland Curriculum**Technology & Design* KS3 Developing pupils as contributors to society: Explore technical inventions and designs that have met a social need cost-effectively. Design cost effective and appropriate solutions to meet the specific needs of diverse local and global groups
* KS3 Developing pupils as contributors to the economy and the environment: Pursue design solutions using environmentally friendly materials and energy sources
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| **Scotland: Curriculum for Excellence**Technologies* TCH 306a TCH 3-07a, TCH 3-09a, TCH 3-12a
 | **Wales: National Curriculum** Design and Technology* KS3 Skills: Designing 1, 4, 6, 8
* KS3 Skills: Making 1, 2
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| **England: GCSE Engineering*** 3.1.3, 3.2.5, 3.3.2, 3.3.3
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| **Assessment opportunities** |
| * Informal teacher assessment of practical skills through observation of learners.
* Formal teacher assessment of completed prototypes.
* Self/peer assessment of completed prototypes.
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