

- 
- **Inspire**
 - **Sustainability**
 - **Engineering a better future**

POWER OUR FUTURE

These resources are part of a set of free STEM and sustainability workshops available to book for primary and secondary classes.

In 'Power our Future' Students will learn about renewable energy and it's role in powering our sustainable future. Then employ their engineering and making skills to design wind turbine blades to generate their own clean power. You will find three different curriculum-linked versions of these resources covering green skills, science and energy, and the engineering design process.

To book these workshops for your class, email engineeringourfuture@uwe.ac.uk



POWER OUR FUTURE

Energy and Physics version
Lesson Plans and Resources .

Other versions of this pack are available
at

curiosityconnections.net

Inspire

Sustainability

Engineering a better future

POWER OUR FUTURE

Inspire Sustainability champions science for children in the West of England with a particular focus on breaking stereotypes and challenging perceptions about STEM careers in order to appeal to under-represented groups in engineering.

Our vision

For every young person in the West of England to have access to inclusive, engaging and inspiring engineering experiences with real-life relatable role models.

Our mission

To support and inspire the next generation of digital engineers. We are working to increase the diversity and number of young people entering engineering careers, to develop a diverse and innovative engineering workforce of the future, and enhance the social and economic progress of our region.



Outreach at UWE's School of Engineering

This session and other STEM and Sustainability focussed workshops can be booked for your class to be held in our outreach classroom in UWE's School of Engineering. We can also hold tours and other experiences for your class that will excite and inspire them with engineering such as flight simulators and VR caves. All of which our student engineers use as part of their learning.

To enquire, email engineeringourfuture@uwe.ac.uk

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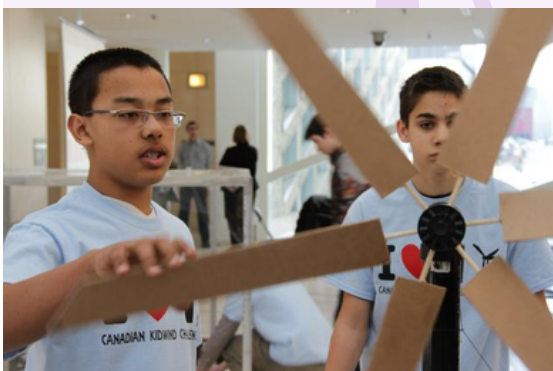
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Curriculum Links

KS2 Design and Technology

- Design
 - use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups
 - generate, develop, model and communicate their ideas through discussion, prototypes, and computer-aided design
- Make
 - select from and use a wider range of materials and components, including construction materials, according to their functional properties and aesthetic qualities
- Evaluate
 - evaluate their ideas and products against their own design criteria and consider the views of others to improve their work
 - understand how key events and individuals in design and technology have helped shape the world

KS2 Geography

- name and locate counties and cities of the United Kingdom, geographical regions and their identifying human and physical characteristics, key topographical features (including hills, mountains, coasts and rivers), and land-use patterns; and understand how some of these aspects have changed over time
- describe and understand key aspects of physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle
- human geography, including: types of settlement and land use, economic activity including trade links, and the distribution of natural resources including energy, food, minerals and water

KS2 Science

- give reasons for the particular uses of everyday materials
- reporting and presenting results from findings
- associate the brightness of a lamp or the volume of a buzzer with the number and voltage used in the circuit - compare and give reasons for variations in how components function, including the brightness of bulbs,
- compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches
- use recognised symbols when representing a simple circuit in a diagram.

KS3 Design and Technology

- Design
 - identify and solve their own design problems and understand how to reformulate problems given to them
 - develop specifications to inform the design of innovative, functional, appealing products that respond to needs in a variety of situations
 - use a variety of approaches to generate creative ideas and avoid stereotypical responses
 - develop and communicate design ideas using computer-based tools and 3D modelling
- Make
 - select from and use a wider, more complex range of materials, components and ingredients, taking into account their properties
- Evaluate
 - analyse the work of past and present professionals and others to develop and broaden their understanding
 - investigate new and emerging technologies
 - test, evaluate and refine their ideas and products against a specification, taking into account the views of intended users and other interested groups
 - understand developments in design and technology, its impact on individuals, society and the environment, and the responsibilities of designers, engineers and technologists
- Technical knowledge
 - understand and use the properties of materials and the performance of structural elements to achieve functioning solutions

KS3 Geography

- human geography relating to: population and urbanisation; international development; economic activity in the primary, secondary, tertiary and quaternary sectors; and the use of natural resources
- understand how human and physical processes interact to influence, and change landscapes, environments and the climate;

KS3 Science

- the properties of metals and non-metals (conductivity)
- Earth as a source of limited resources and the efficacy of recycling
- the production of carbon dioxide by human activity and the impact on climate
- fuels and energy resources
- scientific knowledge required to understand the uses and implications of science, today and for the future
- electric current, measured in amperes, in circuits, series and parallel circuits, currents add where branches meet and current as flow of charge
- potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current

Session Breakdown - Energy

Duration	Activity	Outline
5 minutes	Starter: Where do we get our power from? Display 'Entry Question' slide	Ask the students to show 'energy'. "Where do you get your energy from?" (waving arms, star jumps etc) Energy is what helps us do things, we get our from the food we eat. "What else uses energy in this room?" Our world uses energy to do things too — like light up our homes, cook food, and move cars. Where does that energy come from? We get lots of our energy from burning fuels. Like coal, oil and gas, dug up from the ground. These are called fossil fuels, and once they run out, we cannot replace them! Burning fuels can make us a lot of energy, but there's a problem. Burning things releases a lot of carbon dioxide. This carbon dioxide is forming a heat barrier around the Earth, and causing it to get warmer.
10 minutes 15 of 60	Hand Crank Generator - Energy transfers	Start by introducing the hand crank generator and explain that the children will see how it can generate electricity. Invite a volunteer to demonstrate how turning the crank lights up a bulb, highlighting that they are converting their kinetic (movement) energy into electrical energy. Invite the volunteer to put in different levels of effort. What happens to the voltage and the bulb? Next, connect the generator to a phone or USB device to charge it. KS2: 5-10m Extension task page 6 - Science curriculum links - Students explaining why bulbs get brighter, and draw simple circuit diagram. KS3: 5-10m Extension task page 7 - Discussion points to lead through the climate narrative and define net-zero. Facilitate conversation and encourage an emotional response or debate. .

Session Breakdown - Energy

Duration	Activity	Outline
35 minutes 55 of 60	Blades designing and building time - The Engineering Design Process	- Provide each group with cardboard, scissors, tape, and other materials. - Encourage them to think creatively about the shape, size, and number of blades they want to create. Discuss how different shapes might catch the wind better or worse. - Suggest that they consider the angle of the blades, as this will affect how much wind they catch. One at a time, have each child/group place their turbine in front of the large fan. Turn on the fan to a consistent speed for each test. Record the voltage generated by each child's turbine design and display as a leaderboard. Encourage the children to observe how different designs perform. Ask questions like, "Why do you think this design worked better?" or "What could be improved?" Give children a chance to improve and tweak designs after testing, just as real engineers do. KS2: Encourage students to repeat tests and improvements based on the test results. Also to actively ask others for tips and encourage collaboration. KS3: Encourage students to be precise about their design choices such as blade angle, and mass of blade. Provide other measuring equipment to support this, such as scales, protractors and tracing paper to give more precise design copies.
5 minutes 60 of 60	Wrap up -	Conclude the session with a showcase of the winning designs. Can ask the winning team/student to describe any challenges they had to overcome and how they found the task.

Entry Question Slide

The following can be displayed as the students enter the room.

Our world needs **power!**



Where does the **energy** we need come from?

5 minutes - Can start with asking the children to show 'energy'. Where do you get your energy from? (waving arms, star jumps etc) Energy is what helps us do things, we get our from the food we eat! What else uses energy in this room?

Our world uses energy to do things too — like light up our homes, cook food, and move cars. Where does that energy come from?

We get lots of our energy from burning fuels. Like coal, oil and gas, dug up from the ground. These are called fossil fuels, and once they run out, we cannot replace them!

Burning fuels can make us a lot of energy, but there's a problem. Burning things releases a lot of carbon dioxide.

This carbon dioxide is forming a heat barrier around the Earth, and causing it to get warmer.

Generating electrical energy



What type of energy are you putting in?

What happens when you put more power in?

What are other ways that you could make a generator spin?

Start by introducing the hand crank generator and explain that the children will see how it can generate electricity.

Invite a volunteer to demonstrate how turning the crank lights up an LED bulb, highlighting that they are converting their kinetic (movement) energy into electrical energy.

Invite the volunteer to put in different levels of effort. What happens to the voltage and the bulb?

Next, connect the generator to a phone or USB device and let the children try cranking to charge it, emphasizing the effort required to power everyday devices.

Conclude by discussing how this illustrates the basics of energy generation and the importance of conserving electricity.

KS2 Extension Task Slide

Describe what energy is:

When you turn the hand crank, the bulb lights up.

Explain why the bulb gets brighter when you turn the crank faster.

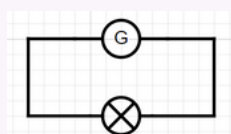
Use the following symbols to draw a circuit diagram to represent the generator lighting up a bulb.

generator =  bulb = 

Answers:

Energy is the ability to do work - such as move, or heat something.
It cannot be created, or destroyed, only converted from one form to another.
Energy can be stored, for example in a stretched rubber band or a battery.

When the hand crank spins, the energy of movement (kinetic) is being converted to electrical energy in the generator. The electrical energy is then converted to light energy (and a little heat too) in the bulb.

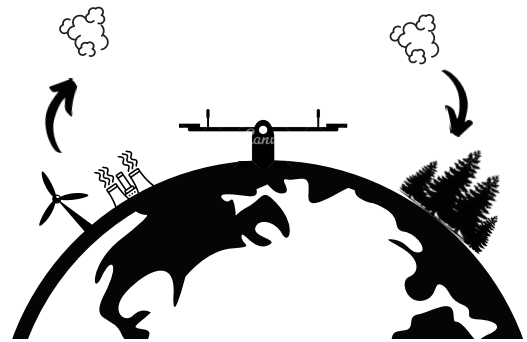
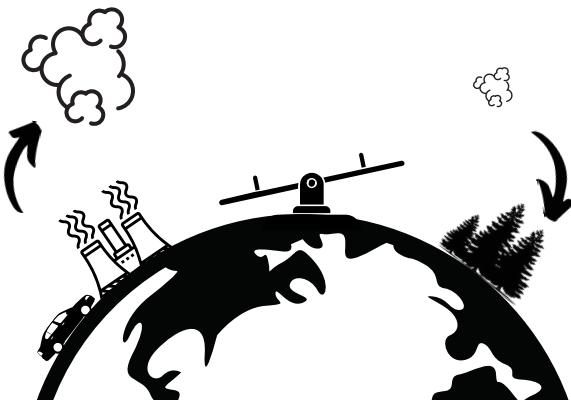


KS3 Extension - Net Zero and the Energy Transition

Discussion points and questions to lead KS3 students through the climate narrative and thinking about current challenges with energy generation and consumption.

Look at these images, what are the differences?

What do you think the images represent?



Define the term 'net-zero'.

Describe some things we can do to help achieve net-zero.

How do these images make you feel?



Building a wind turbine



Time to be a wind turbine **engineer!**

...design** some wind turbine blades that will power your wind turbine and generate the most electricity!**

How many **blades?**

What **shape?**

What **material?**

What **angle?**

Engineers **test and then **improve** their designs.**

Can you top our leaderboard?

Building a wind turbine - Facilitator Instructions

Materials:

- scrap craft materials such as cardboard, paper, recyclable plastics, fabrics, etc
- wooden dowels
- paper tape, glue etc
- safety scissors
- decorations / felt pens etc
- Wind Turbine kits
- Large fans
- multimeters

There are wooden dowels that can be used to build the blades on to, these may be slightly too small for the turbine mount so it's easiest to wrap a piece of tape around the dowel to increase it's diameter. This makes them fit more securely onto the turbine.

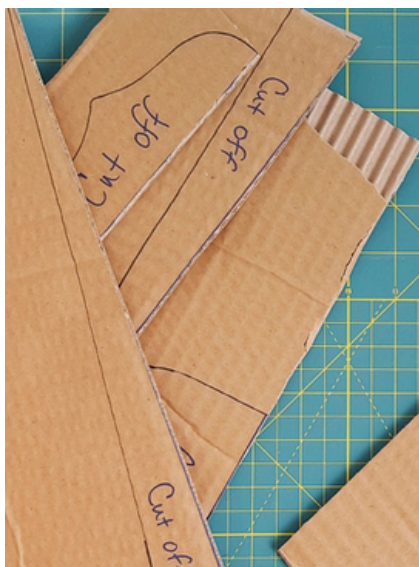
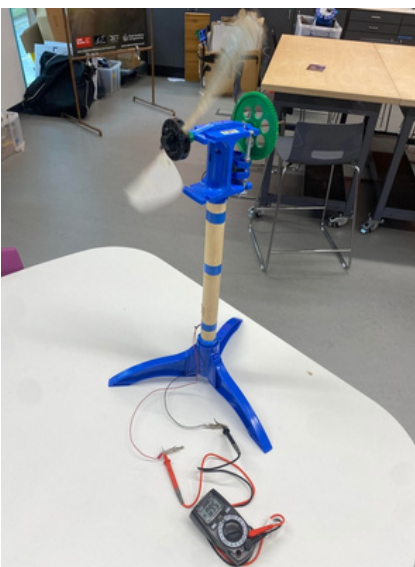
There is a digital multimeter that can display how much voltage the turbine is producing. Connect it to the turbine using the crocodile clips and wires. Then switch it to V 20 to display voltage.

This can then be used to have a competition to see whose blade design can generate the most power. (Just make sure that the fan is a set distance away from the turbine!)

Record each person's result on a leaderboard, then challenge them to improve their designs.

It's beneficial to have lots of engineering discussions with the students, such as: angle of blades, size, shape, number of blades, material, weight etc...

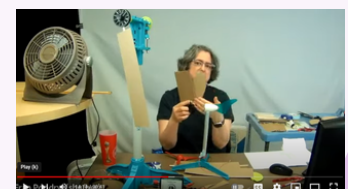
There is always lots of room for tinkering, testing, and improving, just like real engineers do!



There is also a video showing how to use the equipment and how to think about wind turbine design with students.

<https://www.youtube.com/watch?v=ozdE8NvKYr8>

(Credit: Vernier Science Education, Kid Wind)



Wind Turbine Design - Facilitator Prompts

Below are some prompts and questions that facilitators can use in the activity to support the children with their design.

KS2: Aim to encourage the children to begin with a simple design, and perform a first test early. They can then be encouraged to refine their design from the outcome of the test.

"How do you think the shape of the blades will affect how much energy the turbine can generate?"

"How many blades do you think will work best? Why?"

"What shapes can you experiment with to see if they catch more wind?"

"What can you measure to know if your design is successful?"

"What did you learn from testing your blades? What worked well, and what didn't?"

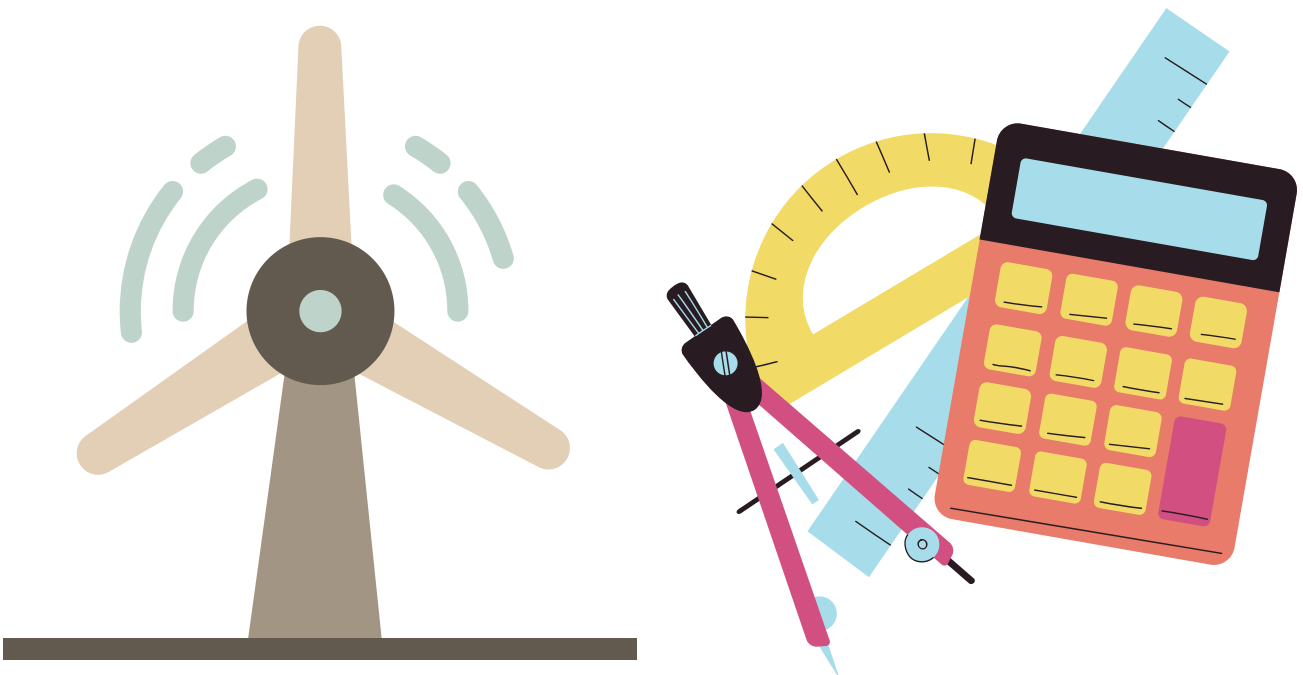
KS3: Aim to encourage the children to focus more on precision of their design, perhaps thinking about how the weight of the blades affects their performance. Facilitating them to separate variables and test them individually. For additional challenge, consider creating a results table or graph of one isolated variable against voltage generated.

"How could you balance strength and weight in your blade design to maximize performance?"

"How could you adjust the angle of your blades to be the most effective?"

"Could you create a table or graph to find the most effective angle for your blades?"

"How could you test to see if longer blades are more effective?"



Wind Turbine Design - KS2 Literacy Extension



Below are some literacy prompts and tasks that can be used or adapted to include literacy into the lesson. Or, to provide an extension task.

1. Write the correct keywords into the blank spaces.

To power our lives, we need _____. Currently, lots of our energy comes from burning _____. This is a problem because it produces _____, which is causing the climate to _____ up. Instead, we can _____ energy using _____ turbines, which are _____. In this workshop, we _____ some turbine _____ and showed how they can generate energy from wind.

blades / generate / energy / pollution / fossil fuels / renewable / heat / designed / wind

2. Talking about your blade designs:

a. **Describe your blade design.** (How many blades did you use? What shape are they? What materials did you use?)

b. *"One thing that went well in my design was..."*

c. *"One thing that didn't go so well in my design was..."*

d. Explain what you might do differently if you had another go.

Inspiring you to inspire others

Engineers make the future





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Green Skills version
Lesson Plans and Resources .

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**UWE
Bristol**

University
of the
West of
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p 8-9 - Facilitator Prompts and Literacy Extension

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- potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current

Session Breakdown - Green Skills version

Duration	Activity	Outline
10 minutes	Starter: Discussing green skills - Students consider green skills and how they can be used to tackle the climate.	Begin by establishing the energy challenge and check understanding of the problem with fossil fuel use. Then introduce the skills and ask students to decide which they think is the most important to help solve it and why. KS2: Ask to stand and walk to either side of room to vote on wither skill, then ask a volunteer to explain why they think this skill was more important. KS3: Assign groups a single skill to argue for, or a pair of skills to decide on as a table. This helps to make it clear that each skill has a place in the story, by facilitating a discussion that gives merit to each skill and explores examples of how each can be used to help. Facilitate a mini-debate on each table.
10 minutes 15 of 60	Green Skill Charades	IHave groups of students play charades with the card skills. Each student in the group takes in turns to choose a skill, and silently act it out for the others in the group to guess. Below are the 8 skills to print and cut out for each group. They can be folded over and placed in a hat to draw from, or alternatively they can simply choose which they'd like to perform This would help them to recognise how each skill could be applied and helps them to recognise it when they see it demonstrated in the future.

Session Breakdown - Green Skills Version

Duration	Activity	Outline
30 minutes 50 of 60	Blades designing and building time - The Engineering Design Process	- Provide each group with cardboard, scissors, tape, and other materials. - Encourage them to think creatively about the shape, size, and number of blades they want to create. Discuss how different shapes might catch the wind better or worse. - Suggest that they consider the angle of the blades, as this will affect how much wind they catch. One at a time, have each child/group place their turbine in front of the large fan. Turn on the fan to a consistent speed for each test. Record the voltage generated by each child's turbine design and display as a leaderboard. Encourage the children to observe how different designs perform. Ask questions like, "Why do you think this design worked better?" or "What could be improved?" Give children a chance to improve and tweak designs after testing, just as real engineers do. KS2: Encourage students to repeat tests and improvements based on the test results. Also to actively ask others for tips and encourage collaboration. KS3: Encourage students to be precise about their design choices such as blade angle, and mass of blade. Provide other measuring equipment to support this, such as scales and tracing paper to give more precise design copies.
10 minutes 60 of 60	Wrap up - Design Showcase and Literacy Extension	Conclude the session with a showcase of the winning designs. Can ask the winning team/student to describe any challenges they had to overcome and which skills they think they used the most in the challenge. KS2 - The Literacy task (page 9) can be used to bring the task back to the skills discussed earlier and asks students to consider which green skill they thought most valuable during the task.

Skills for the Future:

We need to **stop using fossil fuels** for our energy.

We **need a new way** of producing the energy we need.

Look at these **skills**. Which do you think is the most important to help with this problem?



Begin by establishing the energy challenge and check understanding of the problem with fossil fuel use.

Then introduce the skills and ask students to decide which they think is the most important to help solve it and why.

KS2: Ask to stand and walk to either side of room to vote on which skill, then ask a volunteer to explain why they think this skill was more important.

KS3: Assign groups a single skill to argue for, or a pair of skills to decide on as a table. This helps to make it clear that each skill has a place in the story, by facilitating a discussion that gives merit to each skill and explores examples of how each can be used to help. Facilitate a mini-debate on each table.

<https://www.skillsbuilder.org/>

Green Skill Charades



In your table groups, take in turns to pick a random green skill.

You then have 10 seconds to act out the skill for the others to guess.

Have groups of students play charades with the card skills. Each student in the group takes in turns to choose a skill, and silently act it out for the others in the group to guess. Below are the 8 skills to print and cut out for each group. They can be folded over and placed in a hat to draw from, or alternatively they can simply choose which they'd like to perform.

This would help them to recognise how each skill could be applied and helps them to recognise it when they see it demonstrated in the future.



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...design** some wind turbine blades that will power your wind turbine and generate the most electricity!**

How many **blades?**

What **shape?**

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What **angle?**

Engineers **test and then **improve** their designs.**

Can you top our leaderboard?

Building a wind turbine

Materials:

- scrap craft materials such as cardboard, paper, recyclable plastics, fabrics, etc
- wooden dowels
- paper tape, glue etc
- safety scissors
- decorations / felt pens etc
- Wind Turbine kits
- Large fans
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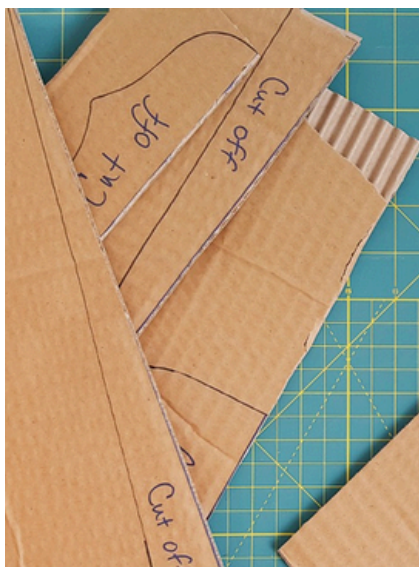
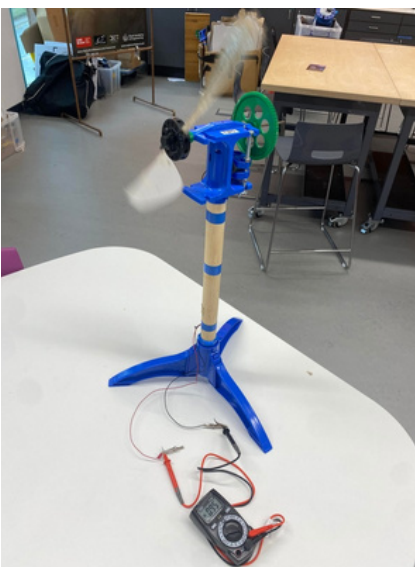
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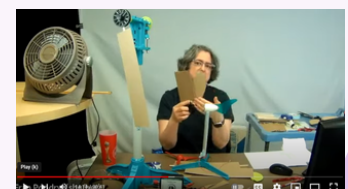
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(Credit: Vernier Science Education, Kid Wind)



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Below are some prompts and questions that facilitators can use in the activity to support the children with their design.

KS2: Aim to encourage the children to begin with a simple design, and perform a first test early. They can then be encouraged to refine their design from the outcome of the test.

"How do you think the shape of the blades will affect how much energy the turbine can generate?"

"How many blades do you think will work best? Why?"

"What shapes can you experiment with to see if they catch more wind?"

"What can you measure to know if your design is successful?"

"What did you learn from testing your blades? What worked well, and what didn't?"

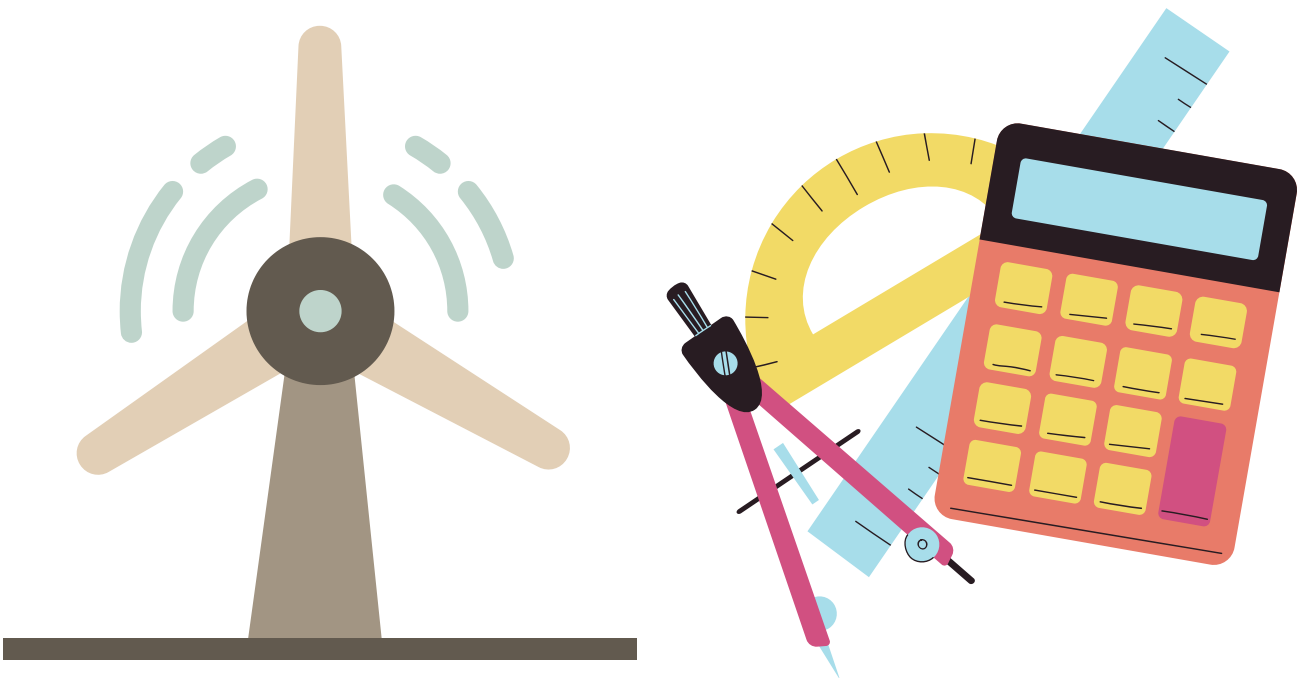
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"How could you balance strength and weight in your blade design to maximize performance?"

"How could you adjust the angle of your blades to be the most effective?"

"Could you create a table or graph to find the most effective angle for your blades?"

"How could you test to see if longer blades are more effective."



Wind Turbine Design - KS2 Literacy Extension



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1. Write the correct keywords into the blank spaces.

To power our lives, we need _____. Currently, lots of our energy comes from burning _____. This is a problem because it produces _____, which is causing the climate to _____ up. Instead, we can _____ energy using _____ turbines, which are _____. In this workshop, we _____ some turbine _____ and showed how they can generate energy from wind.

blades / generate / energy / pollution / fossil fuels / renewable / heat / designed / wind

2. Talking about your blade designs and the green skills required:

a. **Describe your blade design.** (How many blades did you use? What shape are they? What materials did you use?)

b. Which green skill do you think you needed the most when designing your blades?

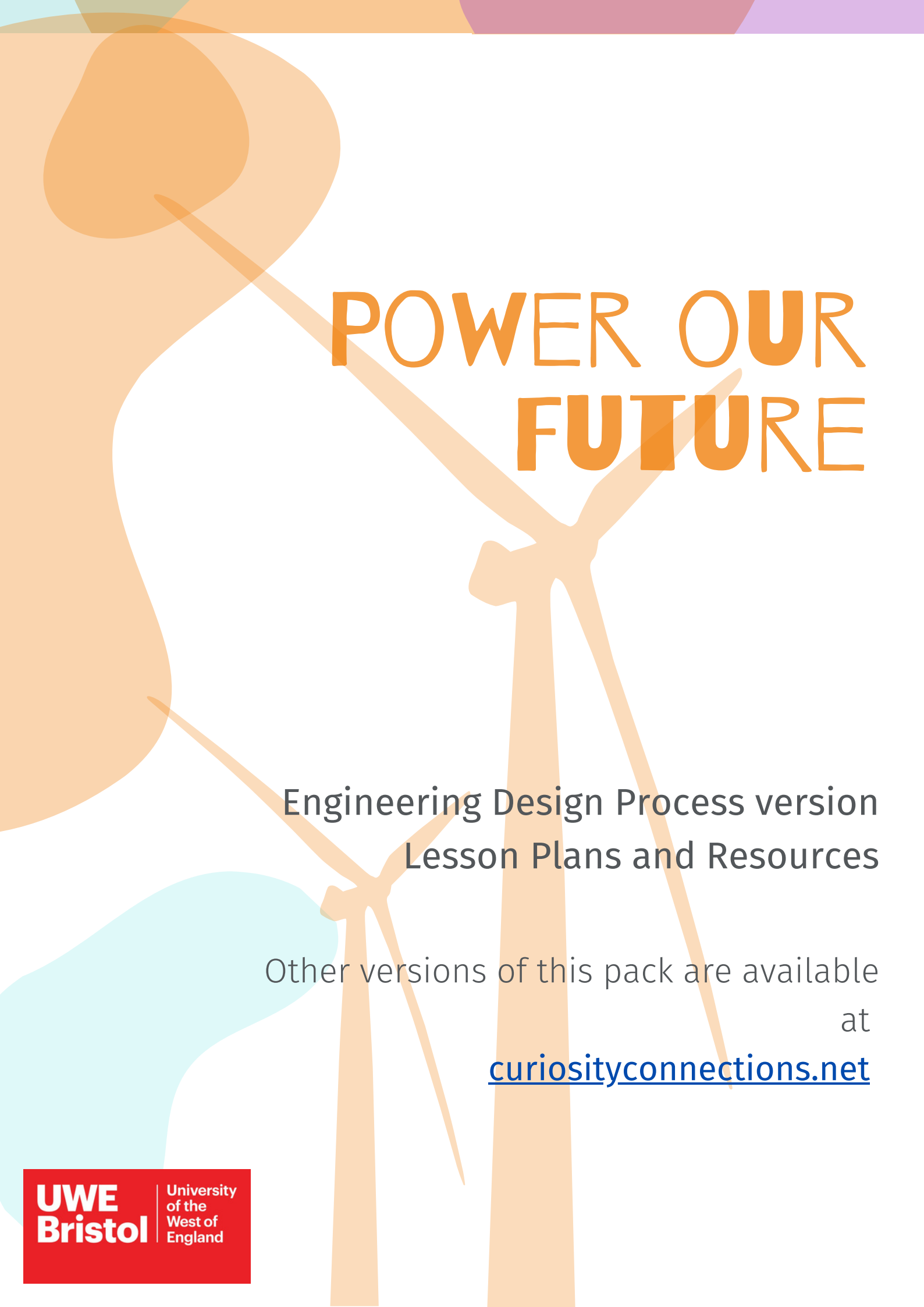
c. Explain how you used this skill.

d. Explain what you might do differently if you had another go.

Inspiring you to inspire others

Engineers make the future





POWER OUR FUTURE

Engineering Design Process version
Lesson Plans and Resources

Other versions of this pack are available
at
curiosityconnections.net

**UWE
Bristol**

University
of the
West of
England

● **Inspire** ● **Sustainability** ● **Engineering a better future**

POWER OUR FUTURE

Inspire Sustainability champions science for children in the West of England with a particular focus on breaking stereotypes and challenging perceptions about STEM careers in order to appeal to under-represented groups in engineering.

Our vision

For every young person in the West of England to have access to inclusive, engaging and inspiring engineering experiences with real-life relatable role models.

Our mission

To support and inspire the next generation of digital engineers. We are working to increase the diversity and number of young people entering engineering careers, to develop a diverse and innovative engineering workforce of the future, and enhance the social and economic progress of our region.



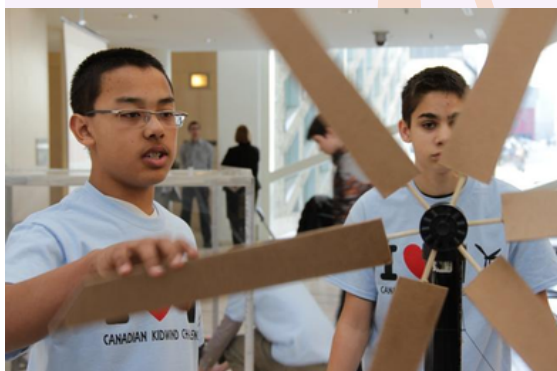
Outreach at UWE's School of Engineering

This session and other STEM and Sustainability focussed workshops can be booked for your class to be held in our outreach classroom in UWE's School of Engineering. We can also hold tours and other experiences for your class that will excite and inspire them with engineering such as flight simulators and VR caves. All of which our student engineers use as part of their learning.

To enquire, email engineeringourfuture@uwe.ac.uk

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Curriculum Links

KS2 Design and Technology

- Design
 - use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups
 - generate, develop, model and communicate their ideas through discussion, prototypes, and computer-aided design
- Make
 - select from and use a wider range of materials and components, including construction materials, according to their functional properties and aesthetic qualities
- Evaluate
 - evaluate their ideas and products against their own design criteria and consider the views of others to improve their work
 - understand how key events and individuals in design and technology have helped shape the world

KS2 Geography

- name and locate counties and cities of the United Kingdom, geographical regions and their identifying human and physical characteristics, key topographical features (including hills, mountains, coasts and rivers), and land-use patterns; and understand how some of these aspects have changed over time
- describe and understand key aspects of physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle
- human geography, including: types of settlement and land use, economic activity including trade links, and the distribution of natural resources including energy, food, minerals and water

KS2 Science

- give reasons for the particular uses of everyday materials
- reporting and presenting results from findings
- associate the brightness of a lamp or the volume of a buzzer with the number and voltage used in the circuit - compare and give reasons for variations in how components function, including the brightness of bulbs,
- compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches
- use recognised symbols when representing a simple circuit in a diagram.

KS3 Design and Technology

- Design
 - identify and solve their own design problems and understand how to reformulate problems given to them
 - develop specifications to inform the design of innovative, functional, appealing products that respond to needs in a variety of situations
 - use a variety of approaches to generate creative ideas and avoid stereotypical responses
 - develop and communicate design ideas using computer-based tools and 3D modelling
- Make
 - select from and use a wider, more complex range of materials, components and ingredients, taking into account their properties
- Evaluate
 - analyse the work of past and present professionals and others to develop and broaden their understanding
 - investigate new and emerging technologies
 - test, evaluate and refine their ideas and products against a specification, taking into account the views of intended users and other interested groups
 - understand developments in design and technology, its impact on individuals, society and the environment, and the responsibilities of designers, engineers and technologists
- Technical knowledge
 - understand and use the properties of materials and the performance of structural elements to achieve functioning solutions

KS3 Geography

- human geography relating to: population and urbanisation; international development; economic activity in the primary, secondary, tertiary and quaternary sectors; and the use of natural resources
- understand how human and physical processes interact to influence, and change landscapes, environments and the climate;

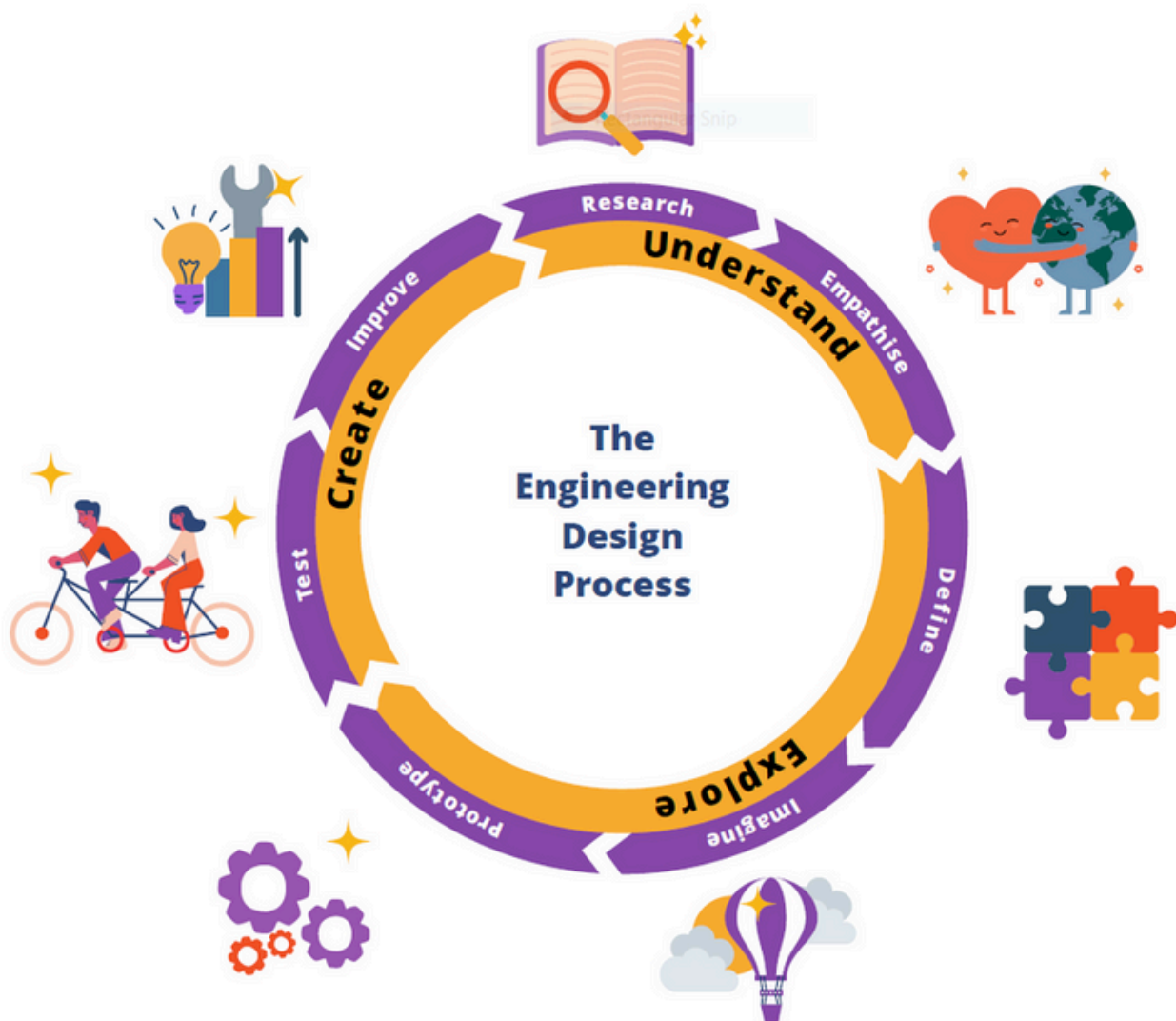
KS3 Science

- the properties of metals and non-metals (conductivity)
- Earth as a source of limited resources and the efficacy of recycling
- the production of carbon dioxide by human activity and the impact on climate
- fuels and energy resources
- scientific knowledge required to understand the uses and implications of science, today and for the future
- electric current, measured in amperes, in circuits, series and parallel circuits, currents add where branches meet and current as flow of charge
- potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current

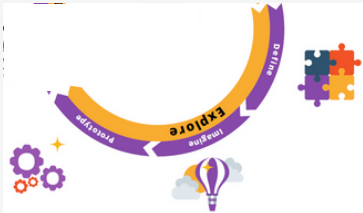
The Engineering Design Process

The Engineering Design Process follows the principle that in order to design effective solutions, we must **Understand** the problem (discover what problems people have, and empathise with their situation), **Explore** potential solutions (define and ideate), and then **Implement** a solution, by creating, testing and improving a product.

This session aims to break the process into three clear and accessible stages, relating them to solving the energy generation challenge. Leading to students designing and building creative wind turbine blades and learning about the need for sustainable energy generation.



Session Breakdown - Engineering Design Process

Duration	Activity	Outline
5 minutes 5 of 60	Starter: Introducing the Engineering Design Process “Understand” energy generation, and the challenge for net-zero. 	Asking the children to show ‘energy’. “Where do you get your energy from?” (waving arms, star jumps etc) Energy is what helps us do things, we get our from the food we eat. “What else uses energy in this room?” Our world uses energy to do things too — like light up our homes, cook food, and move cars. Where does that energy come from? Lead a discussion into the challenge with fossil fuels and the need to embrace alternatives. “This is the first step on the Engineering Design Process, to solve a problem, it is important to know exactly what the problem is and what causes it!
10 minutes 15 of 60	Exploring solutions - Introduce the hand crank, and it concept of kinetic energy to electrical power. Task to design and draw creative ways of spinning a generator. “Imagining” different solutions. 	Introduce the class to the hand crank, and invite a volunteer to spin and generate power. Reenforce that the kinetic (movement) energy is being converted to electrical energy. By finding ways to spin the generator, we can harness electrical energy. 5 minutes with the turbine prototype sheet, and felt pens or pencils to draw a creative way of spinning a turbine generator. “The next step of the Engineering Design Process is to explore solutions to the problem. We can imagine creative ways of harnessing movement energy without needing to burn fossil fuels to spin turbines.”

Session Breakdown - Engineering Design Process

Duration	Activity	Outline
35 minutes 55 of 60	• “Create” - Blades designing and building time Design, build, test and improve your wind turbine blade designs. Engineered to spin the generator effectively without using fossil fuels. 	Design and build turbine blades to spin the generator. • Provide each group with cardboard, scissors, tape, and other materials. • Encourage them to think creatively about the shape, size, and number of blades they want to create. Discuss how different shapes might catch the wind better or worse. • Suggest that they consider the angle of the blades, as this will affect how much wind they catch. One at a time, have each child/group place their turbine in front of the large fan. Turn on the fan to a consistent speed for each test. Record the voltage generated by each child’s turbine design and display as a leaderboard. Encourage the children to observe how different designs perform. Ask questions like, "Why do you think this design worked better?" or "What could be improved?" Give children a chance to improve and tweak designs after testing, just as real engineers do. “The final stage of the EDP is to test and improve your designs. If you do, you could top the engineering leaderboard!”
5 minutes 60 of 60	• Wrap up -	Conclude the session with a showcase of the winning designs. Can ask the winning team/student to describe any challenges they had to overcome and which skills they think they used the most in the challenge. Re-emphasise the importance that a strength in any of the skills is useful.

Entry Question

The following can be displayed as the students enter the room.



Our world needs **power!**



Where does the **energy** we need come from?

Start with asking the children to show 'energy'. "Where do you get your energy from?" (waving arms, star jumps etc) Energy is what helps us do things, we get our from the food we eat.

"What else uses energy in this room?"

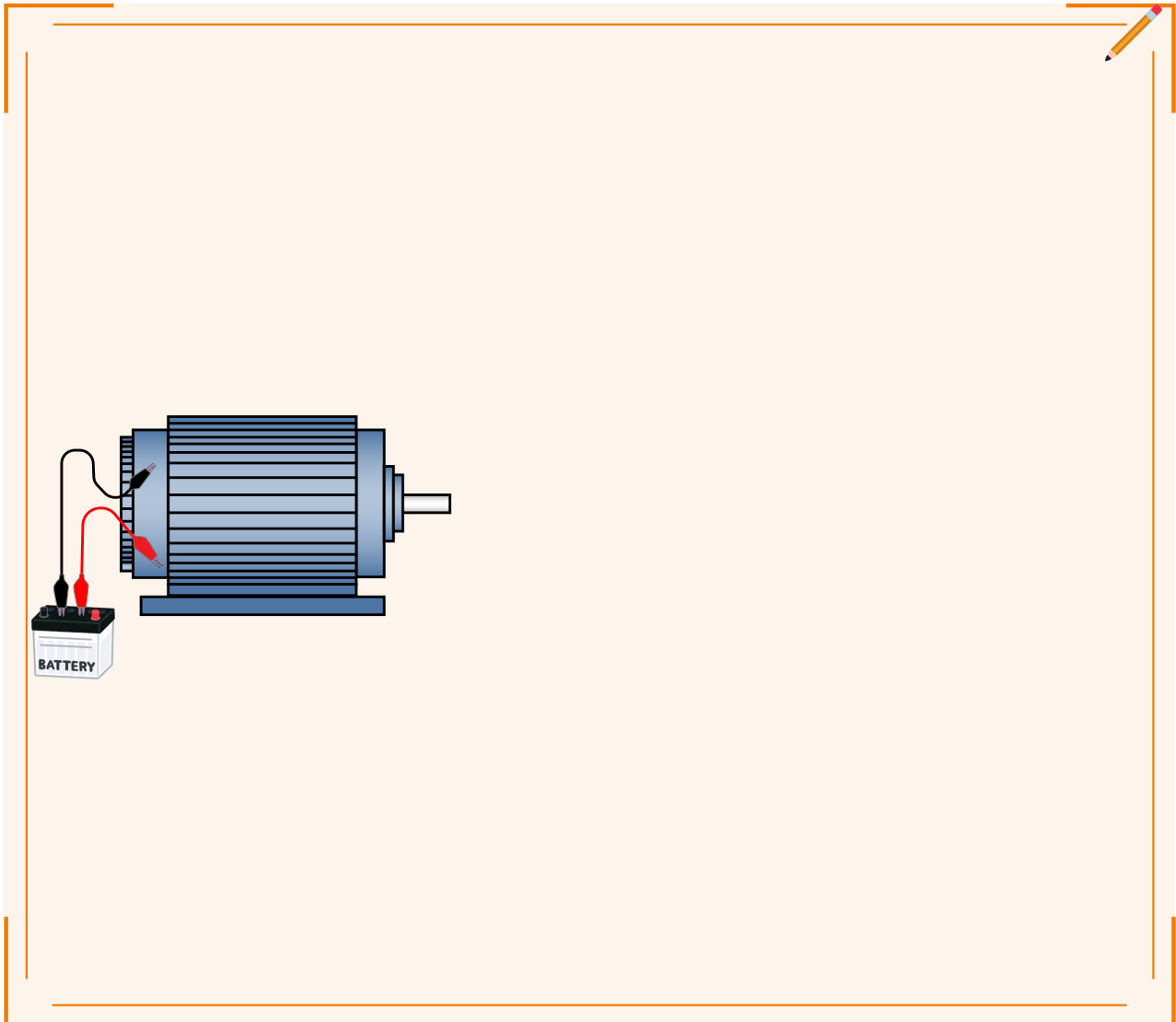
Our world uses energy to do things too — like light up our homes, cook food, and move cars. Where does that energy come from?

Lead a discussion into the challenge with fossil fuels and the need to embrace alternatives.

"This is the first step on the Engineering Design Process, to solve a problem, it is important to know exactly what the problem is and what causes it!"

Sketch a creative way to spin this generator

This turns kinetic (movement) energy into electrical energy.



Describe your idea:

Building a wind turbine



Time to be a wind turbine **engineer!**

...**design** some wind turbine blades that will power your wind turbine and generate the most electricity!

How many **blades**?

What **shape**?

What **material**?

What **angle**?



Engineers **test** and then **improve** their designs.

Can you top our leaderboard?

Building a wind turbine

Materials:

- scrap craft materials such as cardboard, paper, recyclable plastics, fabrics, etc
- wooden dowels
- paper tape, glue etc
- safety scissors
- decorations / felt pens etc
- Wind Turbine kits
- Large fans
- multimeters

There are wooden dowels that can be used to build the blades on to, these may be slightly too small for the turbine mount so it's easiest to wrap a piece of tape around the dowel to increase it's diameter. This makes them fit more securely onto the turbine.

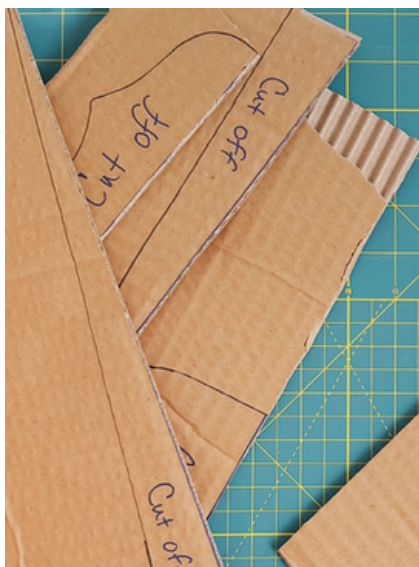
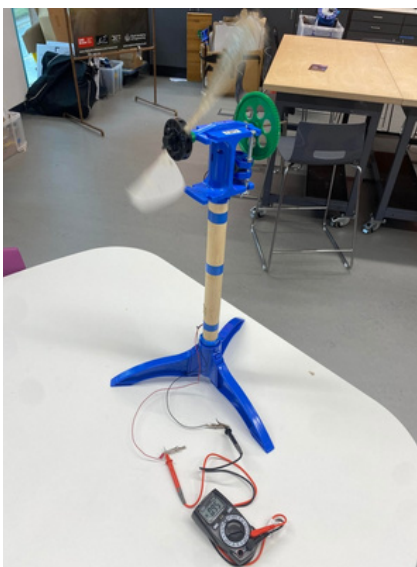
There is a digital multimeter that can display how much voltage the turbine is producing. Connect it to the turbine using the crocodile clips and wires. Then switch it to V 20 to display voltage.

This can then be used to have a competition to see whose blade design can generate the most power. (Just make sure that the fan is a set distance away from the turbine!)

Record each person's result on a leaderboard, then challenge them to improve their designs.

It's beneficial to have lots of engineering discussions with the students, such as: angle of blades, size, shape, number of blades, material, weight etc...

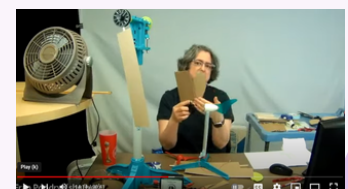
There is always lots of room for tinkering, testing, and improving, just like real engineers do!



There is also a video showing how to use the equipment and how to think about wind turbine design with students.

<https://www.youtube.com/watch?v=ozdE8NvKYr8>

(Credit: Vernier Science Education, Kid Wind)



Wind Turbine Design - Facilitator Prompts

Below are some prompts and questions that facilitators can use in the activity to support the children with their design.

KS2: Aim to encourage the children to begin with a simple design, and perform a first test early. They can then be encouraged to refine their design from the outcome of the test.

"How do you think the shape of the blades will affect how much energy the turbine can generate?"

"How many blades do you think will work best? Why?"

"What shapes can you experiment with to see if they catch more wind?"

"What can you measure to know if your design is successful?"

"What did you learn from testing your blades? What worked well, and what didn't?"

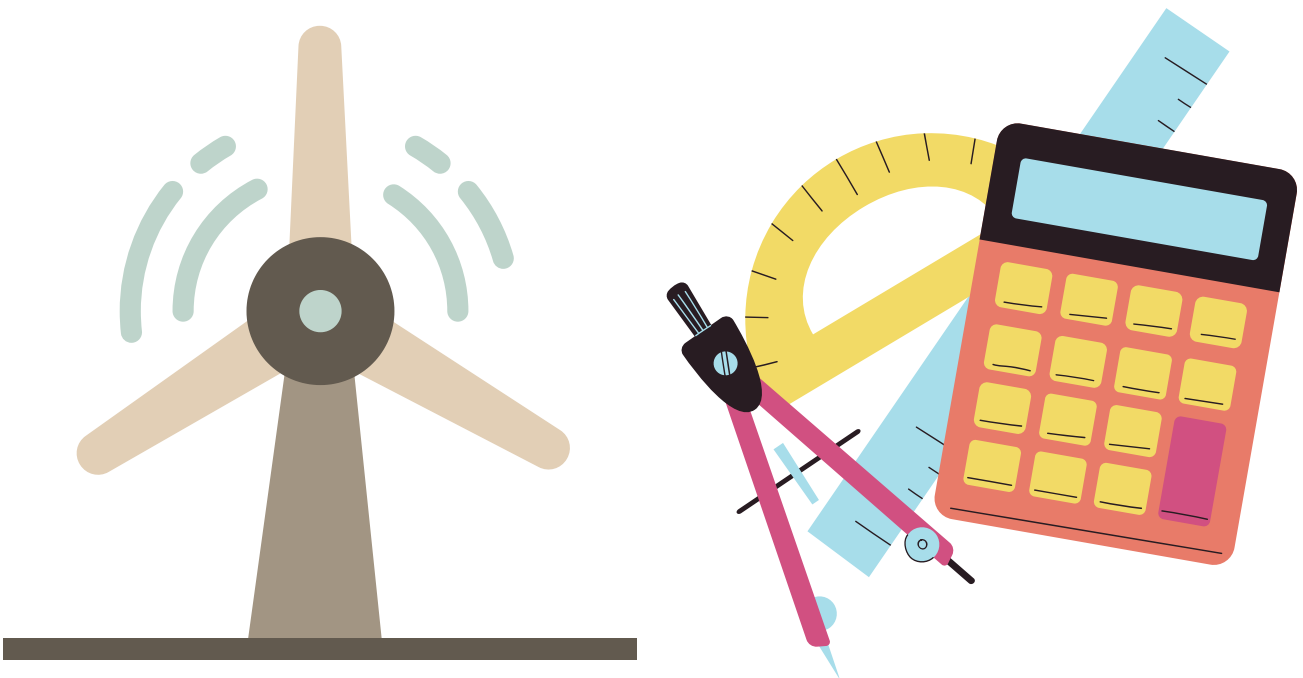
KS3: Aim to encourage the children to focus more on precision of their design, perhaps thinking about how the weight of the blades affects their performance. Facilitating them to separate variables and test them individually. For additional challenge, consider creating a results table or graph of one isolated variable against voltage generated.

"How could you balance strength and weight in your blade design to maximize performance?"

"How could you adjust the angle of your blades to be the most effective?"

"Could you create a table or graph to find the most effective angle for your blades?"

"How could you test to see if longer blades are more effective."



Wind Turbine Design - KS2 Literacy Extension



Below are some literacy prompts and tasks that can be used or adapted to include literacy into the lesson. Or, to provide an extension task.

1. Write the correct keywords into the blank spaces.

To power our lives, we need _____. Currently, lots of our energy comes from burning _____. This is a problem because it produces _____, which is causing the climate to _____ up. Instead, we can _____ energy using _____ turbines, which are _____. In this workshop, we _____ some turbine _____ and showed how they can generate energy from wind.

blades / generate / energy / pollution / fossil fuels / renewable / heat / designed / wind

2. Talking about your blade designs:

a. **Describe your blade design.** (How many blades did you use? What shape are they? What materials did you use?)

b. *"One thing that went well in my design was..."*

c. *"One thing that didn't go so well in my design was..."*

d. Explain what you might do differently if you had another go.

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