PRIMARY LEVEL

POWER FOR EVERYONE EVERYWHERE

SLIDE NOTES

Power for Everyone Everywhere is a hands-on enquiry-based workshop that enables pupils to explore the global issues associated with electricity access and the role that engineering plays in electricity distribution.

UK ENGINEERS WITHOUT BORDERS

Last dated update of this document: 09 September 2019.

This document and the accompanying materials are available to download from: http://www.ewb-uk.org/power-for-everyone-everywhere.

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www.ewb-uk.org

OVERVIEW

Power for Everyone Everywhere is a workshop designed to encourage pupils to explore the challenges associated with access to clean and reliable electricity around the world. Pupils learn about the importance of electricity to people's everyday lives and the role that engineering infrastructure plays in the distribution of electricity. Pupils design, build and test their own model wind turbine as part of this workshop. This workshop builds on the Sustainable Development Goals and the concept of global citizenship.

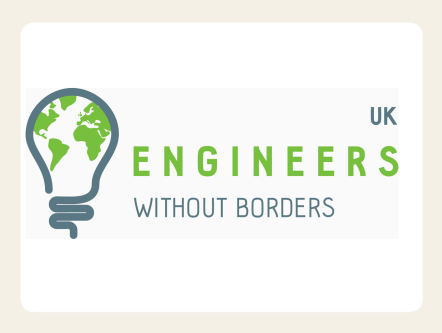
This document is a guide for Engineers Without Borders Ambassadors delivering the presentation. Teachers and youth group leaders can also use it. It should be used in conjunction with the accompanying slides as well as the Facilitator's pack and printouts. Please note that this resource is periodically updated. The date of the last update is on the inside front cover.

If you are not a teacher/youth group leader, please sign up to become an Engineers Without Borders Ambassador to be able to deliver this resource. Find out more and register here on our website. For any queries, please contact Engineers Without Borders UK directly using the email address: outreach@ewb-uk.org.

CONTENTS

INTRODUCTION: HOW WE USE AND RELY ON ELECTRICITY

SLIDE 1: OPENING SLIDE



Display as class enter, if you arrive before them.

SLIDE 2: AMBASSADOR INTRODUCTION

Introduce yourself and anyone else running the session. Each tell the pupils about yourself.
If you are a university student tell the class your:

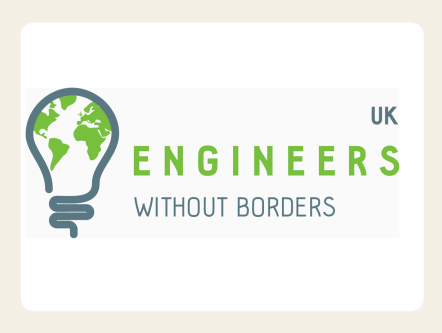
- Name
- University
- Year of study
- Course
- Career plans

If you are not a university student tell the class your:

- Name
- What you studied at university/college
- Profession
- Field of work

Explain that you are delivering a workshop designed by Engineers Without Borders UK. You could also briefly explain how you got involved with Engineers Without Borders UK.

SLIDE 3: WHO ARE ENGINEERS WITHOUT BORDERS UK?

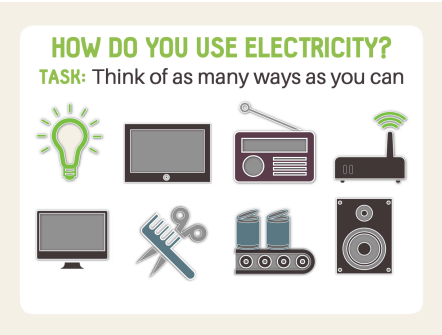


Explain that you are teaching a workshop created by Engineers Without Borders UK.

SLIDE 4: WHO ARE ENGINEERS WITHOUT BORDERS UK?

Introduce Engineers Without Borders UK, a UK based charity engages and galvanises the engineering community to serve all people and our planet better than ever before.

SLIDE 5: HOW DO YOU USE ELECTRICITY?



Starter task

- Ask the class to put their hands up with suggestions or prepare A4/A3 paper on tables/use a flipchart.

Summarise the class's response to your question:

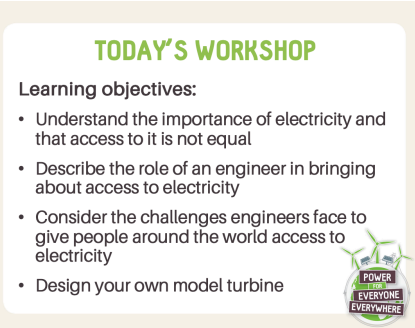
- Electricity is used by us to provide lights in our homes and buildings so we can see after dark; for our computers so we can do our homework and do our jobs; it powers our entertainment, from TVs and radios to powering stage lights and sound at music events; businesses use electricity in a variety of ways, hairdressers for example need it for shavers, hairdryers and styling tools, supermarkets need it for lighting up their aisles and powering their fridges and freezers; power is needed to maintain the internet.

SLIDE 6: INTRODUCTION

Following the starter task:

- Introduce the session as 'Power for Everyone Everywhere'.

SLIDE 7: TODAY'S WORKSHOP

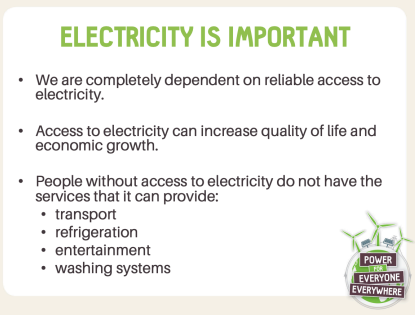


Summarise the overall aim of the workshop: to deepen their understanding of what engineers do and the global challenges that engineers are working to address.

Share the learning objectives of the workshop explaining what they will be doing to meet each one:

- Understand the importance of electricity and that access to it is not equal - to do this the class will be looking at a mind map of what life is like without electricity and explore a case study on wind power in Malawi.
- Describe the role of an engineer in bringing about access to electricity - throughout the workshop the class will be learning the key role engineers play in the different stages of enabling access to electricity.
- Consider the challenges engineers face around the world - the class will explore the challenges engineers face when supplying electricity to everyone everywhere.
- Design your own model turbine - the class will be showing engineering skills in a practical activity to design, build and test out their turbine.

SLIDE 8: ELECTRICITY IS IMPORTANT



Deduce from the starter activity that hopefully the class can see that power is pretty important for human life.

- Access to electricity enables us to do so many things; it's hard to imagine what life would be like without it.
- In many cases it enables us to do things more quickly and with less manual labor than we would otherwise need. As a result, we have more time for other things like education, earning an income and socialising.
- These things include transport, refrigeration (to make food last longer), entertainment and washing systems like washing machines and dish washers.

SLIDE 9: HOWEVER

Explain that despite the fact that electricity helps us in so many ways and is an important part of our lives:

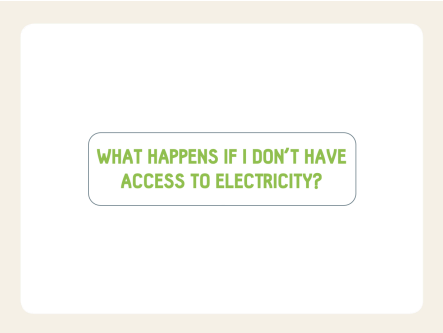
- There are 1 billion people around the world who still lack access to electricity, the equivalent of around 1 in every 8 people.
- This image shows the world at night when all the lights are lit up – highlighting the where people do and don't have access.

Ask pupils if they can identify areas that are the most/lest lit up (take a few responses).

https://www.iea.org/newsroom/news/2018/october/population-without-access-to-electricity-falls-below-1-billion.html
Image:
http://eoimages.gsfc.nasa.gov/images/imagerecords/55000/55167/earth_lights_lrg.jpg

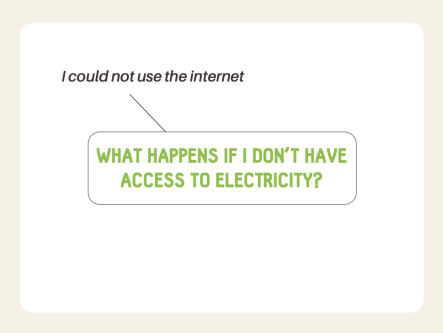
ACCESS ACTIVITY: WHAT IF I DON'T HAVE ACCESS TO ELECTRICITY?

SLIDE 10: WHAT HAPPENS IF I DON'T HAVE ACCESS TO ELECTRICITY?



Ask the class to put their hand up if they've ever experienced a power cut. Ask them to think about what the consequences of the power cut were and what the consequences to their everyday lives would be if they did not have access to electricity. Split the class into pairs or threes and give each group a handout.

SLIDE 11: WHAT HAPPENS IF I DON'T HAVE ACCESS TO ELECTRICITY?

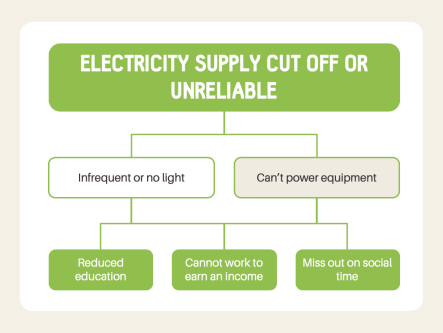


Explain the following:

- In the centre of the sheet is the statement 'What happens when I don't have access to electricity'.
- You'd like them to either think about when they experienced a power cut, or if they haven't, imagine what it would be like if we couldn't access electricity– what couldn't they do?
- Ask them to write down the things they couldn't do as a spider diagram on the sheet, drawing lines out from the starting statement.
- You could start them off by reminding them that we've just talked about all the things we use electricity for.
- Give them a few minutes to fill out the sheet, being sure to wander around and provide encouragement.
- When the time is up, ask the class to feedback what sort of things they wrote down, thanking them for their contributions.

Note: the next few slides are a summary of the impact of lack of electricity access.

SLIDES 12-21: THE IMPACT OF NOT HAVING ACCESS TO ELECTRICITY



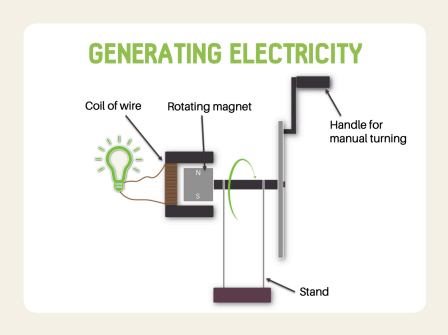
Using the graphic, address the consequences to peoples' lives of not having access to electricity.

- Explain that when your life is affected in this way, you do not have lighting to see after dark.
- Explain that this limits the time available for educational study.
- This may in turn reduce your future chances of employment.
- It may mean that you don't have as much time to work and earn a living, in turn reducing the amount of money you have to buy food and other items.
- It may also mean you have less time to socialise with your friends and family.
- Explain that when your life is affected in this way, you do not have the ability to power electrical equipment.
- This limits educational resources, as pupils have no internet access or use of interactive whiteboards.
- This may in turn reduce your future chances of employment.
- It may mean that you don't have as much time to work and earn a living, in turn reducing the amount of money you have to buy food and other items. You may not be able to use electrical equipment that would make your work easier, more efficient or more profitable. It may also mean you have less time to socialise with your friends and family.
- For those 1 billion people who lack access at all, these impacts are a daily reality. But even when people have access there are still many issues and challenges associated with access to clean reliable electricity, and the potential impacts of lacking access remain true for everyone.

- Explain that you are going to tell them about four examples from around the world highlighting the local challenges people are facing regarding access to clean reliable electricity and what they are doing to overcome these challenges.

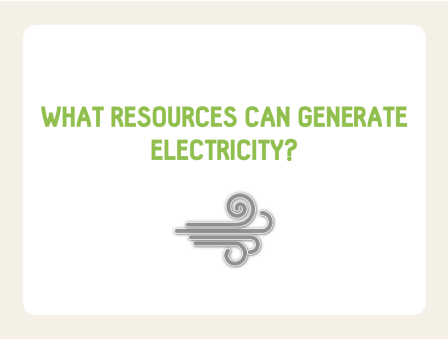
THE ROLE OF ENGINEERING: GENERATING ELECTRICITY AND POWER RESOURCES

SLIDE 22: GENERATING ELECTRICITY



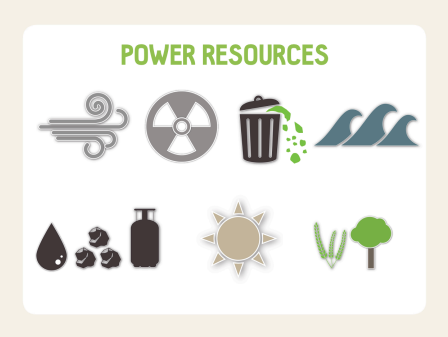
- Explain to the class that the first thing they need to understand is that electricity needs to be generated – it can't be found in nature.
- Ask the class if they have studied the generation of electricity, possibly in a power station. If they can get them to name key parts (turbine and generator).
- If the class has not yet covered this in science lessons, don't worry, use this simple explanation and assure them that they will learn about it some other time.
- The basic principle is that if a magnet moves near a wire an electrical charge is induced.
- Most of the time, the movement we use is a rotational movement. The magnet can be rotated close to a coil of wire, if we were doing this by hand it might look something like this hand operated torch – as you move the handle the magnet moves around near the coil, generating electricity and powering the light inside the torch.
- We don't want to be sitting around all day moving magnets over wires. Therefore, you need a power resource to provide the rotational movement.
- **Note:** Explain this slowly as the pupils may have trouble understanding.

SLIDE 23: WHAT RESOURCES CAN GENERATE ELECTRICITY?



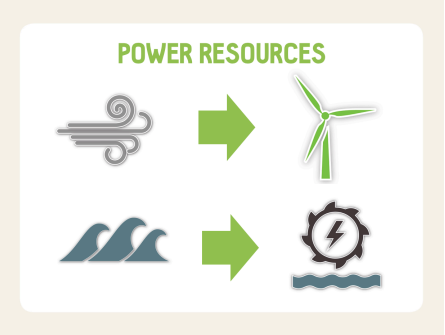
Explain that there are many other power resources that can generate electricity. Ask the class to come up with suggestions of power resources, such as the one shown on the slide (wind) which can be used to generate electricity from kinetic energy.

SLIDE 24: POWER RESOURCES



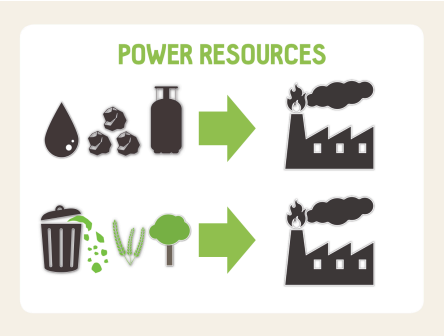
Ask the class to put their hands up to name the power resources they can see on the board, that have not been previously suggested.

SLIDE 25: POWER RESOURCES



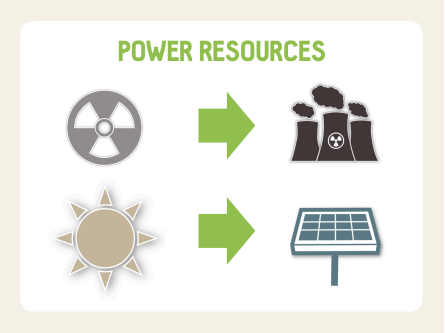
Things that themselves can move/push the generator around, like the wind and moving water for example in a river or a waterfall or in the sea. Here you can see that these resources are harnessed using turbines, as the wind or water flows through the turbine, the blades are specially shaped to capture this flow motion and turn it into a rotational movement.

SLIDE 26: POWER RESOURCES



Things that generate heat which makes steam. The pressure of the steam is then used to push the generator around. These things can be harnessed by burning things like coal, oil, gas, our rubbish, and wood.

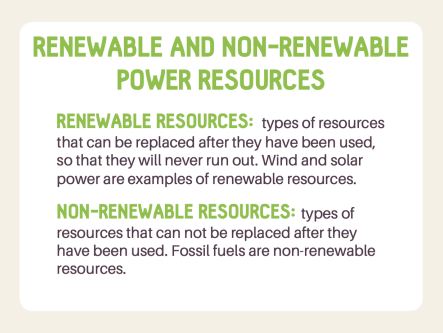
SLIDE 27: POWER RESOURCES



Nuclear radiation can also be used to generate heat to make steam, which is used to push the generator around.
Explain to the class that there is another valuable resource that generates electricity, but in a different way to moving wire and magnets.

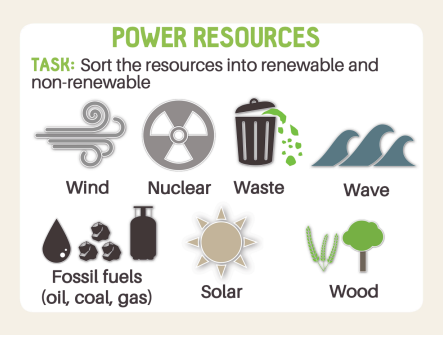
- Solar panels can be made of a special material that generates electricity when it is exposed to sunlight. This type of solar panel is called photovoltaic. So, the sun is another valuable resource that can be used to generate electricity.
- (The other type of solar panels are thermal, and they get very hot and are used to heat water for people to use in their homes.)

SLIDE 28: RENEWABLE AND NON-RENEWABLE POWER RESOURCES



Now tell the class that you are moving onto ways we can classify different types of power resources.
Ask if the class knows the difference between renewable and non-renewable power resources. If they have already learned about this in school, then you can cover this slide with a quick recap. if not then make sure you explain the difference between the types of power resources and ask the class to give additional examples of each.

SLIDE 29: POWER RESOURCES

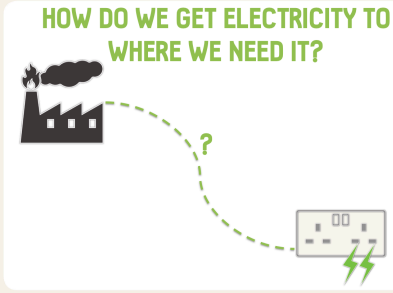


Give the class a few minutes to decide in pairs or small groups how they would group the resources. Take feedback from pupils on each resource and discuss their answer.

Renewable- can be used again or replaced quickly
Wind, wave, solar, wood-if replanted
Non-Renewable- will run out one day/ not quickly replaced
Fossil fuels, wood- if not replanted, nuclear, rubbish

THE ROLE OF ENGINEERING: EXPLORING ACCESS

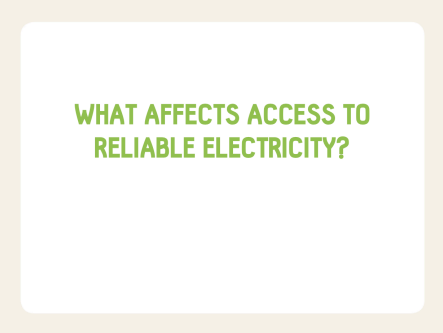
SLIDE 30: HOW DO WE GET ELECTRICITY TO WHERE WE NEED IT?



Explain that not only do we need to generate electricity, we need to get it to where you want to use it as quite often electricity is generated a long way from where people want to use it.

This is often done by connecting people to the electricity source via cables. In the UK, we have a huge network of cables to do this known as the 'national grid'.

SLIDE 31: WHAT AFFECTS ACCESS TO RELIABLE ELECTRICITY?



Explain that we have looked at how engineering brings clean, reliable electricity to you to use. However, it is not always an easy exercise and that is what makes it a challenge. Explain that we are now going to do a small activity to reflect on this question and explore what factors affect access to clean, reliable electricity.

SLIDE 31: OPTIONAL ACTIVITY

Optional Activity

- Ask for between 5 volunteers from the class.
- Give each of these volunteers one of the population cards highlighting to the rest of the class the different size populations.
- Ask the volunteers to spread out in the space you have identified for the activity, holding up their population cards.
- Ask for another volunteer, give them the card showing the wind farm, ask them to stand somewhere in the space you have identified for the activity.
- Ask for another volunteer, give them the card showing the coal-fired power station, ask them to stand somewhere in the space you have identified for the activity.
- Ask for one last volunteer, tell them they are the engineer. Give them the ball of string – you should keep hold of the scissors.
- Ask the rest of the class to gather around one of the volunteers with a population card of their choice (depending on the space available you might not want to do this), but it's important that they are engaged.

Engineer's role

- Ask the engineer to give one end of the ball of string to the person that is the wind farm. Ask them to start unravelling the ball of string and connect up with a few of the people who represent different populations but, importantly, not all of them.
- Whilst they are doing this, explain that the string represents the cable bringing the electricity from the power resource to the people at each location, explain that the two power resources are the only power resources available.
- When the engineer is finished, cut the string and then ask them to do the same thing again but this time starting with the coal-fired power station, tell them that they can connect some populations to both power resources, but some should only be connected to one. Tell them they need at least one population that is not connected at all.
- Cut the string off when the connections are finished.

Highlighting challenges of getting access in the first place

- Ask the class why they think that population group has not been connected to the power resource by a cable.
- You could physically move the population group so that they are visibly far away from everyone else, this will help you to highlight that they may not be connected because it's too difficult due to the terrain or distance. It could be too expensive, and the money isn't available, it could be that there currently aren't enough materials or skilled people available to put the cables in place.

- **Highlighting challenges of keeping access to electricity: Technical failure**
- Explain that even once you have access to electricity, there are factors that could mean this access is affected.
- Cut the string so that some of the connected population groups are no longer connected and explain that this represents a technical break down of the system.
- Ask the affected population groups to identify themselves. Explain that technical failure/breakdown of the electricity distribution system could mean that you no longer have access to electricity. This could be due to not maintaining the system, or something breaking the cable affecting the reliability of the system.

SLIDE 32: WHAT AFFECTS ACCESS TO RELIABLE ELECTRICITY?

WHAT AFFECTS ACCESS TO RELIABLE ELECTRICITY?

- **Location** - distance and difficulty to connect
- **Money** - available money, materials and skills
- **Reliability** – electricity distribution system and amount of electricity available

- Thank the volunteers that participated in the activity and invite everyone to sit back in their seats.
- Use this slide to summarise the key factors that affect access to clean, reliable electricity by referring to the bullets on the slide.
- Conclude the activity by highlighting how difficult it is to get access to clean, reliable electricity and therefore we need engineers to give everyone everywhere access to electricity.

SLIDE 33: WIMBE, MALAWI – CASE STUDY

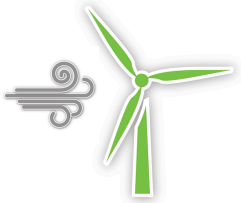
WIMBE, MALAWI

- Use this case study to tell the story of William Kamkwamba and the challenges for children across the world.
- This is an example about the electricity challenges facing people in Wimbe, in Malawi, Southeastern Africa.
- The country's central electricity grid has not reached the village so the residents are unable to power electrical devices such as lighting meaning that when it gets dark, they cannot see to read, socialise or make a living.
- 14-year-old William Kamkwamba was not able to go to school but managed to study sometimes in the local library and found out about harnessing the wind for electricity.
- He decided to build a wind turbine and as a result successfully powered electrical devices in his family home.
- He also managed to bring light into six other homes nearby through solar power and has since gone onto develop other technologies [1].

[1] http://williamkamkwamba.typepad.com/about.html
Image: http://www.theforesightinitiative.com/innovationandprogress/

SLIDE 34: HOW A WIND TURBINE WORKS

HOW A WIND TURBINE WORKS



Explain that we are now going to look at one renewable power resource, wind, and how we use it to generate electricity using a wind turbine.

- Refer to the diagram on the slide to highlight that as the wind blows it flows over the blades of the wind turbine.
- The blades are shaped so that when the wind hits the blade, the blade experiences a force which causes the blade to move.
- As an example, ask the class to think of what happens when you put your hand out of the window in a moving car. As you change the angle that your hand meets the wind, the force on your hand changes and it gets pushed away.
- Because the turbine blades are fixed at one end to the wind turbine, the resultant movement of the turbine blades is in a circle.
- The bigger the turbine blade, the more surface area there is for the wind to push a force on, so you end up with more power. To deal with this greater power the turbine blades need to be much stronger otherwise they will break.
- However, the downside of being both bigger and stronger often means that the blades are heavier. The blades then require stronger wind to get moving – which isn't always available.
- So, when you're designing a wind turbine you have to make a compromise between the blades being big enough to make the most power from the wind, but not so big that if the wind is weaker for most of the time the wind turbine can't move at all.

BUILD ACTIVITY: BUILD A WIND TURBINE

SLIDE 35: BUILDING A WIND TURBINE

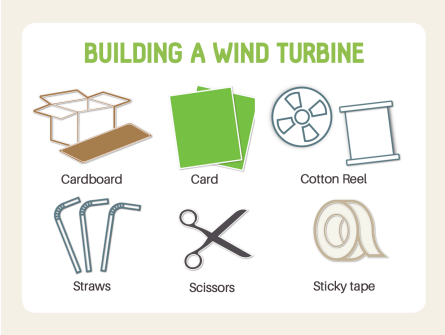
Use this slide to explain the activity to the class. Tell them, that in groups, they will be designing and making the blades and can use the images of different turbines as inspiration. You will need to decide how to define the groups, this could be in their tables. Explain to the pupils that you will be testing their turbines afterwards to see which of them spins.

- Each group should have a worksheet to fill in.
- They should first design the turbine and fill out their worksheet in their groups, then build it when everyone has finished their sketch. **Don't hand out the building materials until the designs are finished!** This highlights the importance of planning.
- If you are behind schedule, give a strict time limit for planning to ensure adequate building time.
- During the plan and build task highlight the engineer skills pupils are displaying- planning, creativity, problem solving, team work, evaluative.

Signal to the class the end of planning time and start of building time.

- Each group should have enough of the materials to make their turbine.
- Ask them to bring their turbines to a table at the front when they are finished, to be tested when everyone is ready.
- Remind the pupils of the principle of how the turbines spin, however, encourage them to work out their designs on their own.
- **Note:** The cotton reel will have the blades attached to it so should be in the center of their design and the central cotton reel hole should be clear/free from obstruction.

SLIDE 36: BUILDING A WIND TURBINE

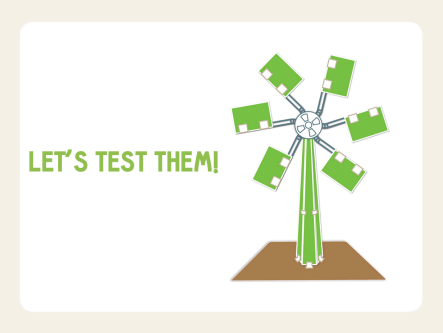


Use this slide to show the class the materials that they have available. Display this slide during the planning stage.

- Each group should have enough a cotton reel each; this will be used to connect the wind turbine blades to our wind turbine tower for the test at the end of the activity. The cotton reel should be in the center of their design and the central cotton reel hole should be clear/free from obstruction.
- Each group should have some cardboard, card, straws, sticky tape and scissors. Tell them they need to be extremely careful with the scissors so that they don't hurt themselves.
- Explain to the pupils that you will be testing their wind turbines afterwards using a hair dryer.
- Tell them they have 10-15 minutes to complete the planning and building and invite them to bring up their completed worksheets and wind turbines to the front desk when ready.

Remind the pupils of the turbine blade principle, to be at the right angle and big enough to capture the power of the wind, but not so heavy that they are too heavy for the wind to move the turbine.

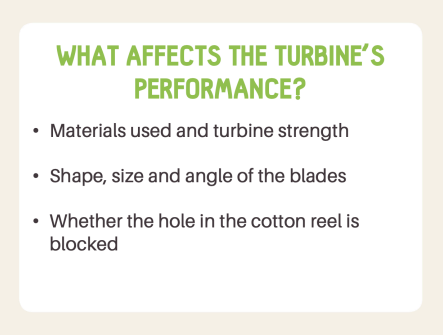
SLIDE 37: LET'S TEST THEM!



When the time is up, get testing!

- One at a time, attach each group's wind turbine blades to the wind turbine tower, by placing the cotton reel onto the rod/pencil.
- Point the hair dryer at the turbine blades and turn it on to see if the turbine blades will move. Start gently then increase the power if need be. Do this for all the wind turbines to compare their performances.
- As you're going, if any are particularly good, or particularly bad, ask the pupils why they think this might be. Is this because the turbine blades aren't strong enough/big enough? Is it because of the angle at which the wind from the hair dryer hits the blades?
- Manage pupils' expectations about the performance of their blades by informing them that in the real world, wind turbine blades take a very long time to design and get right, with months of testing and redesigning until a final design is decided upon.

SLIDE 38: WHAT AFFECTS THE TURBINE'S PERFORMANCE?



You should have discussed some of these things whilst testing the wind turbines but use this slide to summarise the factors that affect the turbine's performance and conclude the activity.

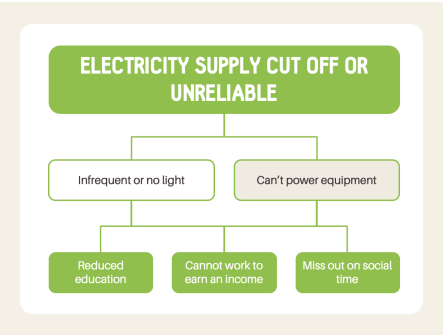
- The surface area of the turbine blades
- The angle of the turbine blades
- The sturdiness of the turbine blades
- The weight of the turbine blades

Highlight that these might be things you would reconsider if you were to do the activity again to improve the turbine's performance and optimise the design.

After testing instruct the group to evaluate their turbine's performance on the worksheet if they have not done so already.

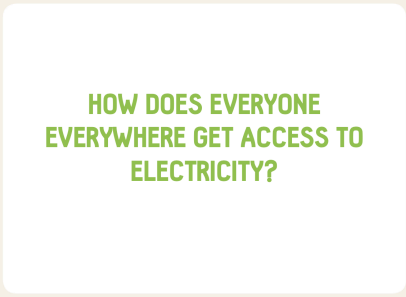
WHAT YOU CAN DO AND LOOKING AFTER ELECTRICITY

SLIDE 39: REITERATING THE IMPORTANCE OF ELECTRICITY



- Use this slide to do a quick recap on how important electricity is to us, and what can happen when we lack access to clean, reliable electricity.
- We should all be careful to conserve electricity as best we can – e.g. we should not be wasteful with it.

SLIDE 40: HOW DOES EVERYONE EVERYWHERE GET ACCESS TO ELECTRICITY?

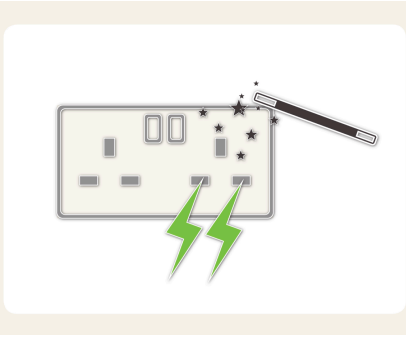


Conclude the first part of the session by summarising the key points culminating in this question.

- Highlight that electricity is important to human life. But, unfortunately not everyone has equal access to this vital resource.
- All around the world, people are addressing this issue and recently there has been a commitment made amongst global leaders to ensure access to clean affordable energy for everyone, everywhere by 2030 through the Sustainable Development Goals.

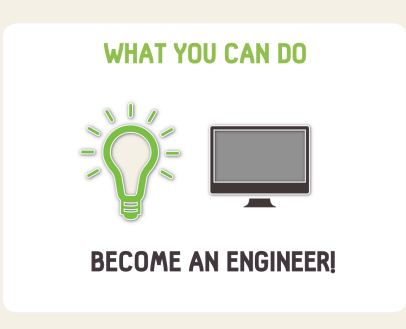
So, we have to ask the question – how can this happen? How does everyone, everywhere get access to clean affordable energy, in particular electricity?

SLIDE 41: THE MAGIC OF ENGINEERING



- Through the magic of engineering, everyone everywhere will one day have access to affordable, reliable, sustainable and modern energy.
- But, what can you do to help this happen?

SLIDE 42: WHAT YOU CAN DO



Use this slide to explain to the class that here are some ideas for how you can individually conserve electricity.

- This means doing things like turning off the lights when you're not using them, turning off equipment like TVs, computers and not leaving them on stand-by – ask the pupils for more suggestions of how they can conserve electricity.
- Explain that whilst you might think doing these things won't make a lot of difference, in fact when you consider the total population, for example the UK population is 68 million people, and imagine if everyone did these things, we'd save a huge amount of electricity.
- As we have seen, it is also important to use less fossil fuels, and so they should try to use green electricity when they can.

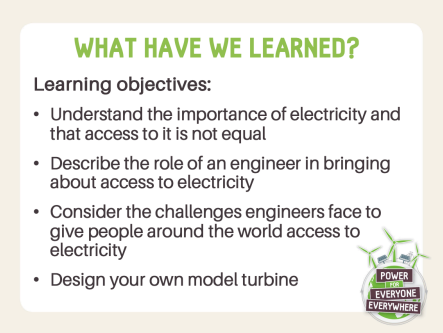
Explain that these are examples of things pupils can do in their everyday lives, but also you hope that the workshop has inspired them to consider how they could play a major role in tackling issues to do with electricity access, by becoming engineers themselves!

Engineers:

- Generate electricity.
- Transport electricity to where it is needed.
- Innovate new technologies to improve the efficiency of generating renewable electricity.
- Make processes less energy intensive, to conserve electricity.

REFLECTIONS ON LEARNING

SLIDE 43: WHAT HAVE WE LEARNED?



Summarise the overall aim of the workshop: to deepen their understanding of what engineers do and the global challenges that engineers are working to address.
To test the knowledge of the class, ask each table, or even more pupils, a question about a topic covered in the workshop, such as:

- What is something we use electricity for
- What are the consequences if you do not have access to electricity
- Give an example of a power resource
- Give an example of a way we generate electricity from a power resource
- What might stop someone having access to electricity
- Give an example of a renewable/non-renewable power resource
- How can we conserve electricity by changing our habits etc.

Pupil feedback is vital to measure the success of the workshop.
Hand out sticky notes and encourage the pupils to fill them out with:
Score of 1-10 for how much they enjoyed the workshop
Something that they enjoyed about the workshop
Something that they did not enjoy about the workshop
Something new that they have learned from the workshop
Take a photograph of the sticky notes, or take them with you, so that you have a record of how well the workshop was received.

SLIDE 44: THANK YOU!

- Thank the class for listening and participating in the workshop.
- Thank the teacher for having you.
- Highlight to the class that if they've enjoyed the process we've gone through today that they might like to find out more about engineering and what engineers do. There are lots of other things that engineers do, not just giving people access to electricity.

SLIDE 45: QUESTIONS?

- Encourage the pupils to ask you about any relevant topic. When talking about your university experience, remember to make it clear that you can only speak for yourself and other people have different answers to you. All ambassadors should answer the questions, to get a better range of answers.
- Clear up, don't leave a mess, and safe travels home!