WESTMILL

WeSET

SUSTAINABLE ENERGY TRUST

Wind energy

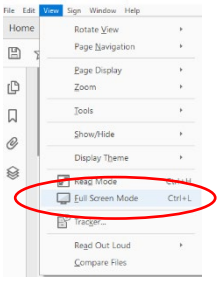
Lesson 4

This guide is designed to accompany and complement:

- Presentation: **Wind energy**
- Single page lesson plan: **Wind energy**
- Worksheet: **Wind energy** (including activities and possible extension tasks or homework)

The guide goes into greater detail than the single page lesson plan and includes suggested resources and elaborates on each slide in the presentation.

Presentation Tips:



- When opening the PDF presentation, you can select how it is displayed. If you wish to **click through** as opposed to scrolling (which gives you more control as you progress and is more like a conventional ppt) it is best to show it in '**full screen mode**' (press 'escape' to exit).

- All associated documents are attached to the presentation. To find these, click on the **paperclip icon** in the left-hand toolbar.

- When viewing the presentation, presenter notes from this delivery guide are also available for reference if you hover the cursor over the small orange callout icon in the top left corner. **Fig.1**

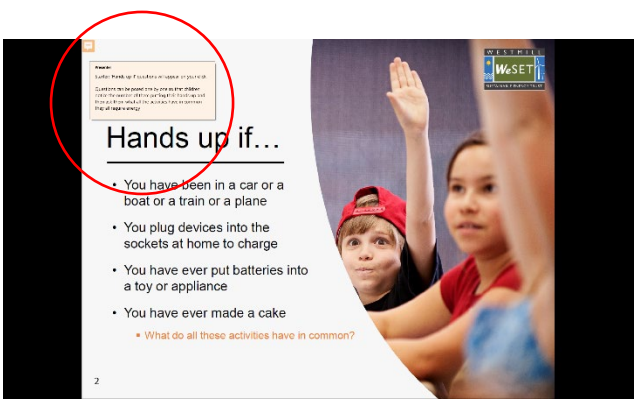


Fig.1

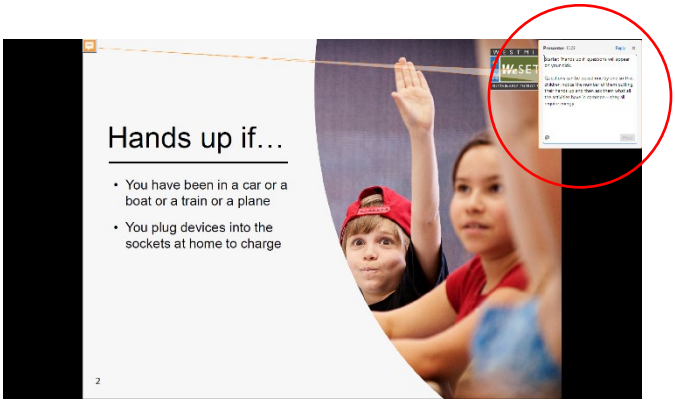


Fig.2

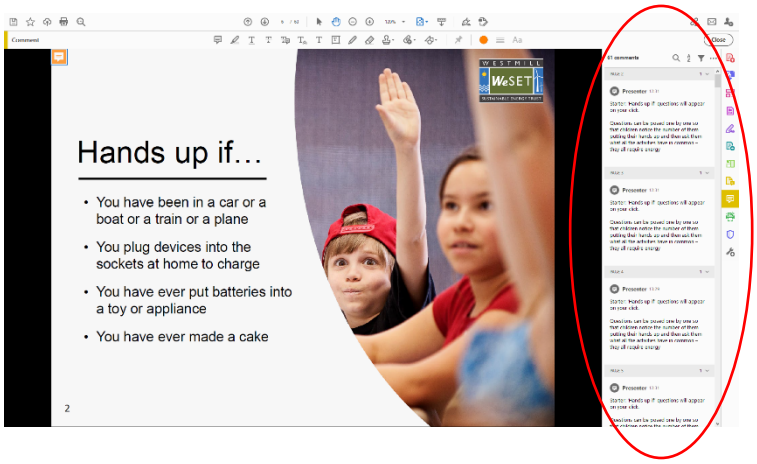


Fig.3

- If you **right click** on that icon it will open a small window showing presenter notes in the top right of the page. **Fig.2** If you right click and scroll down, you can also choose to click '**show comment app**' which opens a panel on the right of the page showing all the presenter notes as you scroll through. **Fig.3**

20 minutes to fill? You could look at the case study 'William and the windmill' and show the video clip 'Harnessing the wind' [3m10s] to start a discussion about access to energy and fuel poverty in some parts of the world.		**Slide 20** **Slide 21**

Slide number refer to the **numbers on the slides themselves**	This presentation is designed to allow the presenter/teacher to pitch it as appropriate to higher KS2 or lower KS3 (approximate age range 6 – 12 years). Questions that are on the slides have been differentiated by colour in this guide, with **red** being most challenging. 🏆 Those marked with this icon **may not appear on the slide** and are optional, higher level questions. Points marked with this icon **may not appear on the slide** but can be used as a starting point for a personal investigation activity and for extension where appropriate. **Advisory!** All videos are linked to external players (usually YouTube) these have been chosen to complement and reinforce learning and have been chosen carefully. However, we would **advise that you watch them yourself prior to showing them** to ensure that you hare happy that the content is right for your children or class.	**Suggested resources**	**WeSet resources**
2	Starter: Prompt children to think about the role wind plays in our lives including how we use it for recreation and sport. • **Ask children to make a list of 5 activities that someone could do on a windy day – answers may include but are not limited to sailing, surfing, sail biking, flying kites, kite surfing, wind surfing** Possible answers will appear at the click of the mouse.		PDF presentation, worksheet and lesson plan
3	You might like to read the poem 'Who Has Seen the Wind?' by Christina Rossetti to prompt children to think about the power and impact of this unseen energy. • **What type of energy is wind energy? - Kinetic energy and potential energy** **What words do you associate with the wind? - Short bursts of wind moving at high speeds are known as gusts. Depending on their strength, winds can be known as a breeze, gale, storm or hurricane**	https://www.poetryfoundation.org/poems/43197/who-has-seen-the-wind Who has seen the wind? by Christina Rossetti	

4	It is good to reiterate that wind is a **renewable** resource. For us to harness the wind's energy we must understand and measure variables like wind direction and wind speed. • **When might it be important to know the direction of the wind? – When siting a windmill or turbine, when a pilot is taking off landing, when sailing or wind surfing etc** • **How have we used wind power in the past and how is it still used today? - Windmills were used to create mechanical energy for example to grind cereals to make flour or to pump water. Wind was and is harnessed to propel boats and ships which use sails to catch the wind. Wind turbines are used today to generate electrical energy. As previously discussed, there are also sports and activities that make use of the wind including kite flying, kite boarding, wind surfing, paragliding etc**	Any handheld pin wheel	
5	Introduce the idea of finding wind direction using the cardinal and intercardinal points of the compass, explaining how a weathervane works. • **What directional indicators do you usually find on a weathervane? – The cardinal points north, south, east and west** • **What features of the design of a windsock make it easy for a pilot to spot? – They are large and feature bright orange and white stripes**		
Hand out Worksheet 4 Wind energy			
6	**Task 1** This slide can be used alone or in conjunction with the differentiated worksheet where children can write their answers in the table provided for recorded formative assessment • **Ask children to Look at the compass and identify the cardinal points: North N, South S, East E and West W – once you have gone through this first part - The cardinal points will appear one by one on the click of the mouse STOP at W!** 🏆 **Ask children to see if they can label the intercardinal points midway between each cardinal point: northeast NE, southeast SE, southwest SW, and northwest NW – once you have gone through the task, the intercardinal points will appear one by one on the click of the mouse**	Compasses	Worksheet 4 Wind energy

7	For the scientific measuring of wind speed, cup anemometers are commonly used however, smaller handheld digital anemometers are available, and children will be able to use these on a site visit. • **In sailing and shipping, what unit of measurement is used for wind speed? - Knots**	Digital anemometer if available, if not you will be able to use them when you visit Westmill	
8	You can choose to show the video clip as it will only commence once you have **clicked on the 'play' icon.** The clip runs for [2m09s] and explains how wind direction and speed are measured.	https://www.youtube.com/watch?v=SqbTrbxWT1o&feature=emb_logo [2m09s]	Embedded clip in ppt
9	The wind turbines at Westmill run east to west to make the most of kinetic energy from the prevailing south-west wind. The wind turbines are relatively simple structures with the working parts located at the top behind the blades in a housing called the nacelle. A modern wind turbine should have a lifespan of approximately 20 – 25 years. • **Why is wind energy considered sustainable, renewable energy? – Wind is free and whilst not constant, in the UK, it is a reliable resource** 🏆 **Ask children how they think the turbines are kept in good working order – They may be surprised that they are relatively low maintenance; scheduled maintenance takes place twice a year. Maintenance engineers can access the working parts via a ladder system within the tower if necessary. The turbines at Westmill are monitored by a company called Jacobs in NE England and by Energy4All in Cumbria**		

10	Names of the numbered part names will appear at the click of the mouse Wind turbines are actually quite simple structures consisting of: 1. concrete foundations – **these need to be deep and wide enough to anchor the turbine in high winds** 2. transformer – **the turbine produces AC current. Higher voltages lose less energy during transmission so the transformer in the wind turbine is there to increase the voltage for transmission** 3. tower containing… – **the tower is a hollow metal structure made from sheet steel sections that are bolted together** 4. cables and access ladders – **the cables convey the electricity to the transformer and the access ladder allows maintenance engineers access to the nacelle** 5. yaw system - **this system is situated between the wind turbine, nacelle and tower. It ensures that the wind turbine is producing maximum output by pivoting the nacelle so that the rotor hub is facing into the wind** 6. casing called the Nacelle – **which houses all the working parts and protects them from the weather, it also contains a controller which starts and stops the turbine, depending on conditions** 7. generator – **which converts rotational mechanical energy into AC electricity** 8. wind vane and anemometer – **these measure the wind speed and direction** 9. driveshaft and gearbox (if fitted) – **the shaft is driven by the rotation of the blades and turns the gears which speeds up the RPM (revolutions per minute)** 10. brake system – **this ensures that, should the wind speed get too high, the turbine can be switched off** 11. rotor blades x 3 – **the pitch or angle of the rotor blades can be adjusted, depending on loading and desired speed. A failsafe is in place (pitch is controlled in the rotor hub) so if windspeed goes over 50mph the blades 'feather' (turn their edges into the wind) and the pitch is adjusted to reduce load and stop the turbine rotor from turning** 12. rotor hub – **this contains the pitch control system** 13. protective nosecone – **like an aeroplane, the nosecone streamlines the turbine making it more aerodynamic and also protects the rotor hub**		

11	As you go through each point on this slide, a click of the mouse will locate the relevant part on the image. • **How do you think the shape of the blades affects the efficiency of the turbine? – A flat rectangular blade is not the most efficient shape therefore most turbine blades are wider near the axis around which they turn at the top (nacelle) narrowing towards the tip. They are also set at an angle against the wind which is greater at the top near the nacelle and shallower near the tip. These factors create a more efficient, aerodynamic form** In December 2019 a new record was set when UK wind farms generated more than **16 GWh (gigawatt) of electricity in one day** supplying **43.7% of the nation's electricity needs!** 🏆 **Ask children what they think happens to the blades if the wind speed goes above about 50mph (above which operation is not deemed safe) – There is a failsafe and so the turbines automatically shut down. When this happens, the blades feather so that they present the least resistance to the wind**		
12	You can choose to show the video clip as it will only commence once you have **clicked on the 'play' icon.** The clip runs for [1m07s] and explains simply how a wind turbine works.	https://www.youtube.com/watch?v=gwBZTrnXsvA&feature=emb_logo [1m07s]	
13	**Task 2** This slide can be used alone or in conjunction with the differentiated worksheet for recorded formative assessment An example has been given to help children understand the activity • **Ask children to match the descriptions on the post-its with the relevant parts and pictures shown below – arrows will appear one by one on the click of the mouse**		Worksheet 4 Wind energy

14	The UK is investing in offshore wind. At time of writing, we currently have 33 offshore wind farms with a further 5 under construction. **The good news is that numbers are rising!** In 2018 wind accounted for 18% of UK energy consumption and **this percentage will rise when 2019/2020 numbers are out!** • **What are the benefits of installing wind farms offshore? - Winds at sea are stronger and more consistent. There is nothing at sea to 'block' the wind. Larger wind farms can be built with less aesthetic impact so there tends to be less objection in planning** 🏆 **What does the word 'aesthetics' mean? – it refers to the way something looks, if something has aesthetic appeal, it looks good/attractive/appealing**		
15	The possible concerns listed will be discussed in the following 2 slides. 🖋 **Do you have any worries about wind turbines? – It is good to discuss children's concerns if there are any. There is some sensationalist and negative information online much of which is not fact based and so it is easy to hear false propaganda**		
16	Turbines are harmful to animals especially birds - **RSPB is supportive of wind farms as long as they are not placed in the birds' migration paths. They believe the risk of climate change is greater to birds. At Westmill there have been a few bird strikes, but all structures, including houses cause casualties. Skylarks and lapwings nest and successfully breed on the site.** Turbines are noisy – **Turbines are far less noisy than some people think. When visiting Westmill you find they cannot usually be heard from the road and it is only when you are halfway up the track, about 150m from turbine 2 you may hear the faint swoosh of the blades. Listen to the sound recordings on the virtual tour or use your experience of being on the wind farm and your recordings to establish an answer for yourself.** • **Do think you can hear conversation when standing under a running wind turbine? - Even when standing under a turbine it is easy to hear someone talk without them raising their voice**		

17	They are ugly - **This is subjective. In surveys, more people like the appearance of wind turbines than dislike them. They can be viewed as elegant symbols of a sustainable future! What about pylons? This can be a good point for discussion.** • **When we talk about energy, what do you think is meant by the term 'payback'? - The Energy Payback Time or EPBT is time it takes for the turbine to generate the same amount of energy it took to produce the system (which is called embodied energy)** They use more energy to build than they generate - **Our energy payback was under 1 year; our turbines generated more energy in their first year of operation than was used to manufacture the equipment and in construction.**		
18	You can choose to show the video clip as it will only commence once you have **clicked on the 'play' icon.** The clip runs for [3m50s] and shows the delivery and construction of the turbines at the Westmill site.	https://www.youtube.com/watch?v=NkCODYfo_dQ [3m50s]	
19	Each of the new mega-turbines planned for the world's biggest offshore windfarm at Dogger Bank in the North Sea will reach 220 metres high and generate enough electricity for 16,000 homes. • **What makes the UK particularly well placed to harness wind power? – The UK is said to have the best 'wind resource' in other words is the windiest place in Europe, this means we have not necessarily the strongest but the most frequent wind, ideal for wind farms. The west coast is ideal as the winds arrive unimpeded from the Atlantic. However, in many areas the sea is too deep to locate turbines. For this reason, offshore wind turbines are also located in suitable parts of the east coast**		
20	William Kamkawamba's story serves as an excellent case study looking at the difference innovation and a single wind turbine can make to an off-grid village. His story was made into a feature film, 'The Boy Who Harnessed the Wind' in 2019 written, directed by and starring Chiwetel Ejiofor and based on the memoir The Boy Who Harnessed the Wind by William Kamkwamba and Bryan Mealer. **In what ways do you think wind power could impact a village that previously had no access to electricity? – It could improve quality of life, safety (powering electric lighting) access to water (powering pumps and irrigation systems), food storage (powering fridges) etc**		

21	You can choose to show the video clip as it will only commence once you have **clicked on the 'play' icon.** The clip runs for [3m10s] and tells the inspiring story of innovator William Kamkwamba's decision to harness the wind to bring power and prosperity to his village.	https://www.youtube.com/watch?v=BzIgyDAMupw&feature=emb_logo [3m10s]	
22	**Task 3** This slide can be used alone or in conjunction with the differentiated worksheet for recorded formative assessment. This can be done in pairs or larger teams. 🏆 **Ask children to design and make a horizontal wind turbine to create the power to raise a paper cup off the floor.** The turbine will be powered by 'wind' from a fan/hairdryer. You can decide the parameters you wish to set in terms of materials, but these may include: String ~ plasticine ~ cardboard toilet rolls ~ cardboard ~ tape ~ pencils ~ wooden dowel **It helps if they attach their turbine to the desk as per the example in worksheet answers which includes instructions for a simple jig.** The video clip is very useful showing a rage of possible outcomes.	https://www.youtube.com/watch?v=ZGmMkMkQ_gc String, plasticine, cardboard toilet rolls, cardboard, tape, pencils, wooden dowel, paper cups and a hairdryer or desk fan	Worksheet 4 Wind energy
23	**Plenary Quiz** - What have you learnt? This can be done as a quick-fire hands up quiz or pupils can be given time to write down their own answers for formative assessment. • **Is wind energy renewable or non-renewable energy? - Renewable** • **Can you name two devices used to show wind direction? – Windsock, weathervane** • **An anemometer is used to measure what? – Wind speed** • **On a wind turbine, what is the casing which houses all the working parts called? - Nacelle** • **What term do we use to describe the time it takes for a turbine to generate the same amount of energy it took to manufacture and construct it? - Payback** • **What term is used for wind turbines located at sea? - Offshore**		

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