

Power, Energy, Dynamics - Renewable energy power from wind turbines

Year Level:	11/12	Subject:	Physics	Topic:	Power, Energy, Dynamics
Duration:	1 x 50 minute lessons	Australian Curriculum:	<p>Unit 1: Thermal, nuclear and electrical physics - Energy security and sustainability - emerging energy sources</p> <p>Content description codes:</p> <ul style="list-style-type: none"> ● ACSPH037: Electrical circuits enable electrical energy to be transferred efficiently over large distances and transformed into a range of other useful forms of energy including thermal and kinetic energy, and light. ● ACSPH039: Energy is conserved in the energy transfers and transformations that occur in an electrical circuit. ● ACSPH042: Power is the rate at which energy is transformed by a circuit component; power enables quantitative analysis of energy transformations in the circuit. ● ACSPH065: Energy is conserved in isolated systems and is transferred from one object to another when a force is applied over a distance; this causes work to be done and changes to kinetic and/or potential energy of objects. 	Climate Topic(s):	<ul style="list-style-type: none"> ● Renewable energy ● Sustainability

Brief Overview

This lesson plan helps teachers show how the concepts of power, electrical energy and kinetic energy taught across the Australian Physics curriculum can be brought together. It demonstrates the interconnectedness of these concepts in the context of renewable energy, using wind turbines as the primary example. Wind power is a renewable and clean source of energy that can be harnessed to produce electricity and limit greenhouse gas emissions. This lesson helps students apply problem-solving strategies to real-world situations using mathematics.

Learning outcomes

Learning Intention

Students will understand how wind turbines convert kinetic energy from air into electrical energy, and be able to apply mathematical problem-solving strategies to evaluate the efficiency and sustainability of wind power as a renewable energy source.

Success Criteria

- Describe how wind turbines convert kinetic energy from moving air into electrical energy.
- Perform calculations to determine the power output of a wind turbine under varying conditions.
- Evaluate the capacity of wind turbines to generate sufficient electricity to power homes and support energy needs.

Introduced climate science concepts:

- Renewable energy
- The advantages and challenges of producing electricity from a wind turbine
- Computing the energy available from wind

Presumed knowledge:

- **AC9S10U05:** Investigate Newton's laws of motion and quantitatively analyse the relationship between force, mass and acceleration of objects
- **AC9S9U05:** Apply the law of conservation of energy to analyse system efficiency in terms of energy inputs, outputs, transfers and transformations
- **ACSPH065:** Kinetic energy
- **ACSPH039:** Conservation of energy
- **ACSPH037:** Electrical energy and power
- **ACSPH042:** Rate of energy and power

Teaching resources

Tool ID	Type of Tool	Name and web link	Overview	Credits
R1	Teacher resource	Equation questions and answers sheet	This resource contains the formulas, problems and solutions for the lesson.	Monash Climate Change Communications Research Hub
R2	Student resource	Equation questions sheet	This resource contains the lesson's problems for students to solve.	Monash Climate Change Communications Research Hub
R3	Teacher + student resource	How do wind turbines work?	A short video on the various aspects of wind turbines and the science behind the electricity they produce.	Learn Engineering

Lesson activities

	Teacher activities	Student Tasks	Tool ID	Time
ENGAGE	Teacher to ask the class about their knowledge of wind turbines – what do students know about them and how they work?	Students to participate in the opening discussion responding with their ideas and understanding of wind turbines.		5 min
EXPLORE	Teacher to play R3 to the class.	Students watch the R3 video and take notes if they wish.	R3	10 min
EXPLAIN	Work through questions 1-3 from R1 with the class on the board.	Students to solve problems given by the teacher.	R1 / R2	20 min

<p>ELABORATE</p>	<p>Teacher to combine new energy knowledge with application of energy cost in the market.</p> <p>Students can either be given a fixed price (see below a realistic price) or can do independent research to determine the current price.</p> <p>Typical energy rates are 25-40c AUD/kWh.</p>	<p>Students to research the cost of electricity by visiting power-company websites to get rates.</p> <p>Once the price is established, students must determine the revenue generated by a single wind turbine per day (by multiplying <i>electrical energy</i> with the rate they find).</p>	<p>R1 / R2</p>	<p>5 min</p>
<p>EVALUATE</p>	<p>Teacher to ask students to individually complete question 4 from R1.</p> <p>The worksheet can be collected for informal assessment.</p>	<p>Students are to solve question 4 independently.</p>	<p>R1 / R2</p>	<p>10 min</p>