

Overall learning objectives

- Gathering, displaying and using data to support conclusions relating to energy efficiency and arguments about noise pollution.
- Applying ideas about energy transfer and pollution to explore arguments about the use of wind farms and evaluate environmental impact.
- Using ideas to inform discussions about overall power supply systems and judging impact of design on environment and communities.
- Identifying and testing possible solutions to problems by altering key parameters to arrive at optimum design.

Overall learning outcomes

- Designed and tested a small scale turbine to identify optimum features.
- Considered how various people may respond to wind farm developments, and why.
- Explored how to respond to objections and present a positive case.

Curriculum learning objectives

Students should be able to:

Maths

- Identify the mathematical aspects of a situation or problem and choose between representations.
- Calculate accurately, electing mental methods or calculating devices as appropriate.
- Record methods, solutions and conclusions.
- Form convincing arguments based on findings and make general statements.
- Consider the assumptions made and the appropriateness and accuracy of results and conclusions.
- Be aware of the strength of empirical evidence and appreciate the difference between evidence and proof.

Science

- Critically analyse and evaluate evidence from observations and experiments.
- Explore how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.
- Use of scientific methods and techniques to develop and test ideas and explanations.
- Assess risk and work safely in the laboratory, field and workplace.
- Plan and carry out practical and investigative activities, both individually and in groups.
- Use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues.

Technology

- Understand that designing and making has aesthetic, environmental, technical, economic, ethical and social dimensions and impacts on the world.
- Understand that products and systems have an impact on quality of life.
- Explore how products contribute to lifestyle and consumer choices.
- Explore and experiment with ideas, materials, technologies and techniques.

Introduction

This topic is about the use of wind farms to provide sustainable energy for a range of communities in a variety of settings. The selection of a New Zealand context is significant as Maori communities see themselves as being responsible for effective stewardship of the land for future generations.

Learning objectives

- To understand how wind farms can provide a significant source of energy.
- To consider the impact of this on communities.

Learning activities

1. Show the video “Notes from Te Uku”.
2. Ask students to share key points from this.
3. Ask them as well to share personal views as to the value they see wind farms as having.



Outcomes

- To have shared ideas about the value of wind farms.

The Challenge

The purpose of this episode is for students to identify the various factors to consider when designing a small scale wind turbine and how they can investigate the effect they have.

Learning objectives

- To identify factors affecting the design of a wind turbine.
- To consider how these may impact upon each other.

Learning activities

1. Display an image of a large scale wind turbine.
2. Ask students to work in groups and consider the various factors that engineers have had to consider in the design of these.
3. Take feedback and draw out the following factors: they should include
 - a) Location.
 - b) Height.
 - c) Number of blades.
 - d) Length of blades.
 - e) Material.
 - f) Required output.(it is useful to acknowledge that these are often interrelated)
4. Explain that students will be involved in a practical activity that will involve them in investigating a number of these factors on a small scale.



Outcomes

- To have developed a list of factors and identified that there will be a relationship between some of these.

Investigate

This episode involves students investigating various factors to come up with an optimum design, such as number of blades, length and shape of blade and angle.

Additional resources required

- Dynamods and voltmeter

Learning objectives

- To plan and conduct an investigation to identify the optimum design values for a small wind turbine.
- To process data to produce a robust conclusion.

Learning activities

1. Explain that some of the possible factors have had to be constrained for reasons of practicality and prepare to say what these are. Even with a limited range of factors to investigate and values to use there could still be a greater number of combinations than there is time to explore so a tactical decision may have to be made about asking groups to investigate one or two factors each. The advantage of this is that it reinforces the role of working collaboratively and the need for the pooling of data. However, it would be good if each factor was investigated by more than one group so that conclusions can be compared.
2. Ask students to work in groups to investigate variables. Explain that they will be testing the output from their turbines using a voltmeter connected to the generator in the turbine and that the purpose is to find out the ideal combination of factors.
3. Students should plan the range of values that they will be exploring and set up equipment accordingly. They should keep other factors the same so that they can see the effect of changing that one.
4. Ask students to gather data and record it in a suitable format. They should also consider if repeat readings are necessary and act accordingly.
5. They should then process their data and identify a conclusion. This can then be shared to see how it compares with the conclusions from other groups.



Outcomes

- To have planned and carried out an investigation that produces reliable and valid conclusions.

Collaborate

In this episode students will collaborate to share conclusions and identify a combination of effective values for the design of a small scale wind turbine. This use the outcomes from the previous episode (3). With some students it may be worthwhile exploring the validity of this approach (for example the group investigating the optimum number of blades may have been using a different length of blade to that which another group had found to be the best; turbines with that length of blade may work best with a different number of blades).

Learning objectives

- Students will pool their results to produce a composite design solution.
- Students will consider the validity of this process.

Learning activities

- 1. Ask groups of students to share the outcomes from their previous investigations and draw together points to come up with a combined design.**
- 2. Demonstrate this design and investigate how well it works.**
- 3. Ask students to consider how similar this is to large scale designs and ask for ideas to explain any differences.**

Outcomes

- Students will have developed and evaluated a shared overall design.



Evaluate

This episode explores the scaling up of designs to large scale usage. It needs to be accepted that whereas one design solution may work well at a classroom level, the large school solution may look different. As well as factors such as measuring the output, there will also need to be consideration of factors such as the environmental impact.

Learning objectives

- To consider how different stakeholders may have different perspectives on wind farm developments.
- To appreciate arguments for and against.
- To understand how there may sometimes be a conflict between local and national interests.

Learning activities

- 1. Show students images of various wind farm installations and ask for their reactions to the size, scale and environmental impact. Encourage them to consider why some people will be in support of this power provision and others against it.**
- 2. Show student support sheet 5 and explain that they are going to role play a situation in which a planning proposal is being considered. Each of them will have to take the role of someone who has an interest in the development. Say that these roles include:**
 - a) Farmer, on whose land the wind farm is being constructed and who will benefit from rental whilst still being able to farm the land.
 - b) Holiday park owner, who is worried that it will spoil the view across the valley.
 - c) Local resident, who is worried about the noise they will make.
 - d) Environmental campaigner, who is keen that more renewable forms of energy are used.
 - e) Councillor, who wants to make sure that the scheme only goes ahead if it has local support.
- 3. Organise students into five groups and allocate each group a role. Distribute role briefing sheets and allow time for discussion so that students can internalise their roles.**
- 4. Then re-group the students into mixed groups (don't worry if the groups aren't exactly balanced) and ask them to debate whether or not the scheme should go ahead.**
- 5. Take feedback from each group on how the discussion went, what the key points were and what the decision was.**
- 6. Then tell the groups that the government has just announced that it is intending to overrule local decision-making on this issue as it has set itself a target of at least 25% of all energy being generated from renewable sources by the end of the decade and it can only achieve this if all of these proposals go through. Ask the groups to discuss their responses to this development.**
- 7. Finally, draw together key points about the principle arguments for and against. Explore the idea that sometimes people may be in favour of such developments generally but not want them where they live; ask for ideas about what should happen then.**

Outcomes

- To have expressed ideas for and against wind farm developments.
- To have developed ideas about how conflicting ideas may be resolved.



Conclusions

During this episode students plan questionnaire to gauge public support for wind farms, gathering and processing data about the opinions that people may form.

Learning objectives

- To consider how to ascertain attitudes towards energy provision in general and wind farms in particular.
- To design questionnaires to produce useful data.
- To draw conclusions from evidence of attitudes.

Learning activities

1. Explain that this activity is designed to enable students to explore attitudes towards wind farms and how attitudes can be gathered and measured.
2. Explain that the survey is one that the class will design, carry out and gather responses to. Say that the survey will explore three areas:
 - a) Attitudes towards wind farms in general.
 - b) Attitudes towards a wind farm in the respondent's locality.
 - c) Attitudes towards energy provision generally.
3. Explain that students will be gathering the responses and processing them to draw conclusions about attitudes overall. Students will work in groups to develop different sections. Explain that thought needs to be given to how to design the questionnaire so that the responses can be processed relatively easily. Show how a question can be framed as a statement and the respondent asked for the extent of their agreement or disagreement with this on a numbered scale; this supports numerical processing of data. However, other questions may need a choice of answers not on a continuum (e.g. which type of power station are you happiest to rely upon?) and others may need a free response.
4. Ask the students to work in groups and allocate each group one of the three areas. Ask them to develop two or three questions.
5. Then ask the groups working on the same area to combine their efforts and come up with a shared response. Set a maximum on the number of questions, say, four.
6. Then gather the sections in. Ask the students if the order matters – will people think differently about wind farms in general if that's the first question or if they've thought about the alternatives before being asked about that. Students might suggest having similar (but not identical) general questions both at the start and at the end.
7. Say that students should use this with friends, family and neighbours. You might like to explore though whether students think that this will give a representative cross section.
8. Ask students subsequently to process the data and draw conclusions. They should try to identify a handful of key points that have emerged about attitudes and whether they are surprised by these.

Outcomes

- To have expressed ideas for and against wind farm developments.
- To have developed ideas about how conflicting ideas may be resolved.

Solution

This episode is designed to draw together key points about the role that wind farms might play, how people react to them and how a positive case can be developed.

Learning objectives

- To draw together key points about the effectiveness of wind farms and attitudes towards them.
- To design and present a presentation designed to win support.

Learning activities

1. Ask students to identify features of wind farms that should be used when designing energy provision overall. Ask students to recall the key points about people's views towards wind farms.
2. Explain that they are to work in groups to design three minute presentations to present the case for developing wind farms in the area. Say that each presentation should have no more than six slides, no more than 20 words on a slide and should be persuasive, countering objections and winning people over.
3. Ask each group to make their presentation. The rest of the class are to complete feedback slips as to how persuasive a case was presented, identifying two features that were effective and one that could be developed further.



Outcomes

- To have presented a case for wind farms, including Any points and responses to objections.
- To have provided quality feedback to other students.