Wonder Project

Power Challenge

Challenge Guide

engineering new zealand te ao rangahau

ENERGISED BY TRANSPOWER

SUPPORTED BY EECA Mercury OMEXOM

Contents

Using the challenge guide

The challenge guide provides all the information you need to run the challenge successfully. Use it alongside the online modules in the student Learning Hub.

It's not important that you pānui this entire document – we know it's pretty huge! We recommend you understand the challenge overview, but otherwise please focus on the parts that are helpful to you. Karawhiua!

Kupu Māori glossary

We use kupu Māori throughout this document because it's a small but important way of encouraging others to do the same, to help keep the language alive.

Ākonga	Student	**Manawanui**	Perseverance, commitment
Auahatanga	Creativity	**Pānui**	Read
Hapori	Community	**Pātai**	Question
Karawhiua	Give it heaps!	**Rōpū**	Team
Kaiako	Teacher	**Whakarongo**	Listen
Kōrero	Speak, conversation	**Whanaungatanga**	Connection, relationships
Kupu	Word	**Whānau**	Family group
Mahi	Work		

STEM skills

Some of the STEM skills ākonga will use throughout the challenge are:

STEM skill	Description
Teamwork	Working with others to achieve an end goal – recognising each other's expertise and strengths, being flexible, and making sure each rōpū member has a job.
Whanaungatanga (connection, relationships)	Fostering belonging and togetherness by forming connections, strengthening relationships and embracing differences.
Communication	Passing on information effectively, whakarongo when others are sharing ideas, understanding instructions, and asking pātai. Bringing different knowledge and experience to the table to improve results.

STEM skill	Description
Open mindedness	Being willing to whakarongo, considering and accepting different ideas, and being open to new experiences and learning about the world around you.
Auahatanga (creativity)	Respecting past knowledge while using inventiveness, creativity and outside the box thinking to collectively find solutions to issues ahead.
Problem solving	Thinking innovatively, being resilient, never giving up and trying lots of ideas to find the best solution.
Manawanui (perseverance, commitment)	Persevering when things don't go as planned, learning from mistakes made, and committing to solving the problem – no matter the journey.
Analysis	Being observant, collecting and interpreting data, detecting patterns, brainstorming ideas, and making decisions based on the results.

Challenge overview

Module	Activity sequence			
Module 1: Power up **85 minutes** **Purpose:** Understand the challenge, the pātai (question) you'll be solving and explore energy forms, energy transformation and transfer, and electricity.	**Powering a brighter future** • Watch: Welcome to the Power Challenge video • Understand the challenge pātai (question) ākonga will solve – I wonder how to power a brighter future?	**Prepare to power up** • Listen to the Ambassador's career story • Unpack your power kit • Start sourcing challenge materials	**Energy** • Watch: Energy transformations video • Display the energy forms poster • Form challenge rōpū • Complete "Activity 1.1: Transforming energy" and test a series of energy transformations	**Illuminating electricity** • Learn about electrical energy and current vs static electricity • Complete "Activity 1.2: Paper circuits" and create an electrical circuit with copper tape
Module 2: Generate **90 minutes** **Purpose:** Learn about electricity's journey and how it's generated from renewable and non-renewable energy sources. Then learn the engineering design process and follow it to imagine a turbine blade design.	**The great journey of electricity** • Display the journey of electricity poster • Learn the first step of electricity's journey – generate • Learn about renewable and non-renewable energy • Watch: The future is bright video • Complete "Activity 2.1: Energy sources relay" and race to categorise energy sources	**Turbine time** • Learn the process ākonga will follow to create their turbine – the engineering design process • Display the engineering design process poster	**Ask** • Unpack the first stage of the engineering design process – ask • Watch: Ask video • Learn about how a turbine works and aerodynamics • Complete "Activity 2.2: Ask" and cement learning on how a turbine works	**Imagine and plan** • Continue with steps 2 and 3 of the engineering design process – imagine and plan • Complete "Activity 2.3: Blade design" and imagine some turbine blade designs, then draw the best one to scale and plan the materials needed to create it
Module 3: Move **90 minutes** **Purpose:** Build on knowledge of electricity's journey by learning about the National Grid. Then create and test a wind turbine prototype.	**Move** • Learn about the National Grid and the second step of electricity's journey – move • Watch: Move – electricity's journey video • Complete: "Activity 3.1: Great grid race" and order the steps of electricity's journey through the National Grid	**Create** • Continue with step 4 of the engineering design process – create • Watch: Create video • Complete "Activity 3.2: Create" and create a turbine prototype	**Test** • Continue with step 5 of the engineering design process – test • Complete "Activity 3.3: Time to test" and perform two tests on the turbine, observing the effect of blade design variables on turbine performance • Analyse test data to determine opportunities to improve the blade design	

Module	Activity sequence			
Module 4: Illuminate **90 minutes** **Purpose:** Explore ways to use energy sustainably before improving turbines using challenge knowledge. Then, connect final turbines to a printed circuit board (the town) to see whose design is most efficient. Use this data to answer the challenge pātai.	**Use** • Learn about being energy smart and the third step of electricity's journey – use • Compete in the energy quiz to recap challenge learning	**Improve** • Continue with step 6 of the engineering design process – improve • Complete "Activity 4.1: Improve" and summarise challenge learnings to determine final improvements to turbines	**It's town time** • Watch: Light up your town video • Complete "Activity 4.2: Light up our town" and connect turbines and a solar panel to the printed circuit board (the town), collecting data on their performance • Analyse data to determine the most efficiently designed turbine, and why	**Powering a brighter future** • Form a conclusion on the challenge pātai – I wonder how to power a brighter future? • Celebrate and reflect on learning • Complete optional activity: Power Challenge competition

Curriculum links

Achievement objectives

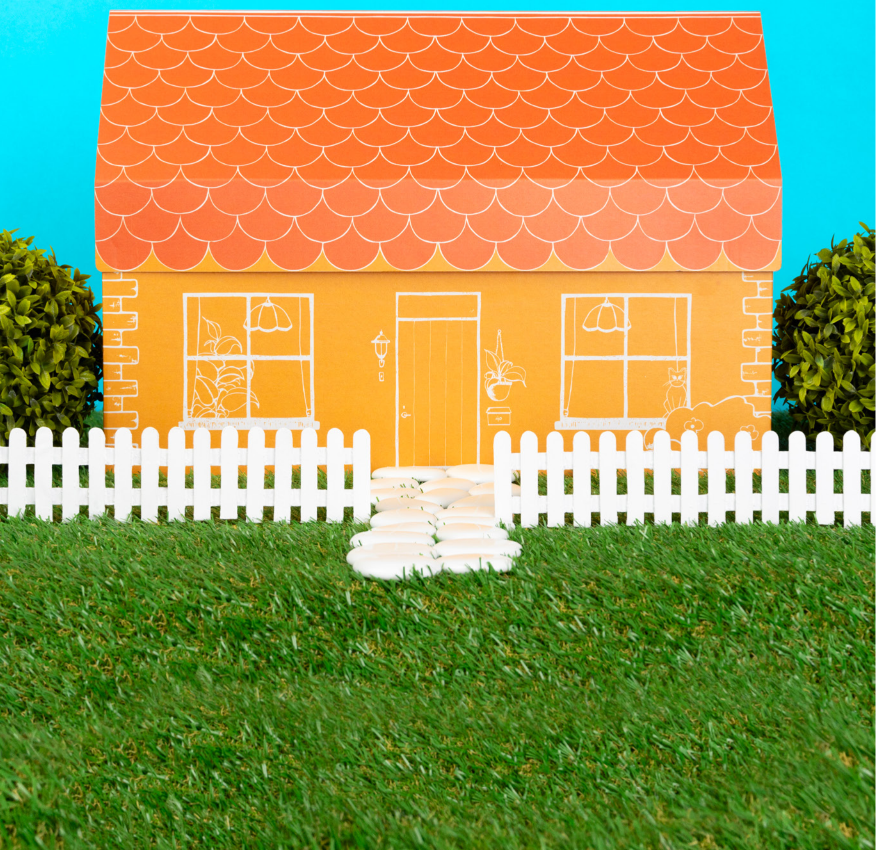
Kaiako can make wider curriculum links to other achievement objectives depending on ākonga level and individual learning programmes.

Strand	Ākonga will	Curriculum level/phase
Science: Nature of science	Ask pātai, explore simple models, and carry out appropriate investigations to develop simple explanations around how energy is generated and used.	Level 4
Science: Planet Earth and beyond	Develop an understanding of how Earth's resources make up our sources of energy and how this relates to sustainability.	Level 4
Science: Physical world	Explore different sources of energy, forms of energy and energy transformations including the transformation of different energy sources into electrical energy.	Level 4
Technology: Technological knowledge	Use functional modelling to create a prototype that converts wind energy into electrical energy. Explore the relationship between aerodynamic features and energy efficiency through blade design.	Level 4
Mathematics and Statistics: Geometry; shapes and spatial reasoning	Explore modelling using a range of 2D and 3D geometric shapes. Gather, analyse and draw conclusions from wind turbine performance data.	Phase 3 (Year 7-8)

Your resources

To complete the Power Challenge, you'll be using the items in your power kit, alongside some items you'll need to source as a school.

Wonder Project kits are designed to be reused. Please keep it on hand for next year, or pass on to another kaiako so we can reach as many schools as possible.



Power kit items

Layer one:

- 8 x dowels *turbine tower*

Layer two:

Box: Paper circuits

- 8 x coin batteries
- 1 x roll of copper tape
- 20 x LEDs

Box: Our town

- 2 x printed circuit boards *(PCB)*
- 2 x solar panels

Layer three

Box: Turbine

- 8 x motors
- 8 x motor brackets
- 10 x hubs
- 1 x pack of popsicle sticks
- 8 x wingnut and screws

Box: Turbine and power cards

- 1 x set of power cards
- 8 x turbine bases

Need help sourcing something? We're here to help with a library of resources you can borrow. Get in touch with what you need at **hello@wonderproject.nz**

Schools to supply

- Technology *for the ambassador's PowerPoint presentation*

Turbine testing and use

- 30cm ruler
- 2 x fans *a 40cm desk fan will work best*
- 2 x light sources *a strong torch or desk lamp*

Energy and electricity learning

- 30cm ruler *1 per rōpū*
- Balloons *1 per rōpū*
- Pencil *1 per rōpū*
- Containers *2 per rōpū*

Turbine creation

- Recyclable materials for turbine blades *cardboard or ice cream containers*
- Decorations and colourful pens/pencils
- Hot glue gun or other adhesives *eg, super glue, polyurethane glue*
- Scissors

Lesson plans

Module 1:
Power up

85 minutes (approximate)

Purpose

Ākonga will understand the challenge, the pātai (question) they'll be solving and explore energy forms, energy transformation and transfer, and electricity.

Resources

From your Power kit:

- Coin batteries
- Roll of copper tape
- LEDs

School to supply:

- Technology *for the ambassador's PowerPoint presentation*
- Balloons
- Pencil
- Ruler

Print or share online:

- Activity 1.1: Transforming energy (1 per rōpū)
- Activity 1.2: Paper circuits (1 per rōpū)
- Poster: Forms of energy (A3, 1 per class)

Module outcomes

- Learn the challenge pātai (question) they'll be solving – I wonder how to power a brighter future?
- Understand the role of STEM in powering our hapori (communities)
- Form a rōpū and understand the importance of roles and responsibilities
- Learn about energy forms and energy transformation and transfer
- Explore electrical energy and use learnings to create a basic circuit

Preparation

Pre-module checklist

Kaiako

- [ ] Completed teacher training
- [ ] Pānui Module 1 of the Student Hub
- [ ] Checked the power kit has arrived or that your existing kit has all its resources
- [ ] Pānui the health and safety guidance
- [ ] Completed the teacher pre challenge survey
- [ ] Asked ākonga to complete the student pre challenge survey
- [ ] Asked ākonga to take home the whānau information sheet
- [ ] Joined Wonder Project Facebook group

Ambassadors

- [ ] Completed ambassador training
- [ ] Pānui Module 1 of the Student Hub
- [ ] Ordered free Wonder Project t-shirt to wear on visits
- [ ] Pānui the health and safety guidance
- [ ] Prepared your career presentation
- [ ] Joined Wonder Project Facebook group

Module 1 lesson plan

Use this plan to support you as you work through Module 1 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

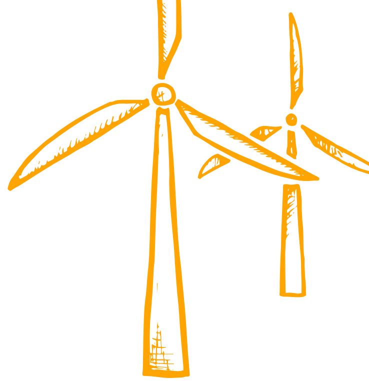
Timing	Activity	Teaching sequence	Ambassador role
	Pre challenge surveys		
	Student and teacher pre challenge surveys	All kaiako and ākonga should complete their pre challenge survey before the challenge. They're an important tool for us to improve the programme each year and continue our funding to keep the Wonder Project free for schools.	
Block A 20 minutes	**Powering a brighter future**		
	Video: Welcome to the Power Challenge	Watch video that introduces the Power Challenge – to design and build a wind turbine to power a mini town. Understand the challenge pātai (question) ākonga will solve – I wonder how to power a brighter future?	Support ākonga to understand how STEM relates to power. **Ask pātai:** *What do you already know about power? How can you use STEM skills to answer the challenge pātai?*
	Prepare to power up		
	Meet your support crew	Establish the kaiako and ambassador as the support crew. Then, the ambassador will share their career story. If you don't have an ambassador, watch Andrew Renton's career story video, our Wonder Project virtual ambassador.	Introduce yourself to the class and share your career story presentation (5 mins). Use the tips provided in the video telling your story.
	Unpack your power kit	Get ākonga to help unpack the kit.	Explain how each item might be used.
	Smile for the camera	Start to think about what parts of the challenge ākonga would like to capture for their Power Challenge competition entry (see Activity 4.3). **Pātai to consider:** *What story do you want to tell? How? What messages do you want to include?*	
Block B 25 minutes	**Energy**		
	Video: Energy transformation and transfer	Watch video that explains energy and energy forms, before exploring energy transformation and transfer with relevant examples. Print and display the forms of energy poster.	After the video, lead a Q&A session on energy forms, energy transformation and energy transfer. Give examples. Eg, when you clap, you transform kinetic energy into sound energy.

Timing	Activity	Teaching sequence	Ambassador role
	Energy (cont)		
Block B 25 minutes	**Activity 1.1: Transforming energy**	Get ākonga into their challenge rōpū of 3–6 and work through the energy transformation tests.	Explain the example at the beginning of the activity sheet. Then, support ākonga to complete the activity.
	Illuminating electricity		
Block C 40 minutes	**Illuminating electricity**	Discover why electrical energy is important and learn the difference between current and static electricity.	Explain electrical energy in simple terms and provide examples. Eg, electricity is energy that helps power our hapori (communities). When it gathers in one place, it's called static electricity. When it moves, it's called current electricity.
	Activity 1.2: Paper circuits	Create a paper circuit that successfully lights up an LED to test the basics of current electricity.	Introduce the activity by explaining what an electrical circuit is, and the three main things required to construct one: • Energy source • Conductive path • A load Eg, an electrical circuit is a closed path that allows electric current to flow, transforming electrical energy to light energy.

Remember: Ask ākonga to start collecting the resources and recyclable materials they will use for their turbines!

Module 2: Generate

90 minutes (approximate)



Purpose

Ākonga will learn about electricity's journey and how it's generated from renewable and non-renewable energy sources. Then, they'll learn the engineering design process and follow it to imagine a turbine blade design.

Resources

School to supply:

Containers
2 per rōpū

Classroom resources
including scissors, rulers and string

Print or share online:

- Activity 2.1: Energy sources relay (1 per rōpū)
- Activity 2.2: Ask (1 per rōpū)
- Activity 2.3: Blade design (1 per rōpū)
- Poster: Journey of electricity (A3, 1 per class)
- Poster: Engineering design process (A3, 1 per class)

Module outcomes

- Learn the journey of electricity
- Learn about electricity generation and renewable and non-renewable energy
- Learn the process they'll follow to complete the challenge – the engineering design process
- Explore the first, second and third stages of the engineering design process – ask, imagine and plan
- Learn the basics of how a wind turbine works, including aerodynamics, to inform prototype design
- Imagine and plan wind turbine blade designs

Preparation

Pre-module checklist

- ○ Collected your resources
- ○ Pānui Module 2 of the Student Hub

Module 2 lesson plan

Use this plan to support you as you work through Module 2 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 45 minutes	**The great journey of electricity**		
	The great journey of electricity	Learn the three steps that electricity travels to reach our hapori – generate, move and use. Print and display the journey of electricity poster. **Pātai to consider:** *Where do you think electricity comes from? How do you think electricity gets to your home?*	Support discussion by explaining how STEM superstars support electricity's journey.
	Generate	Learn that the first step in electricity's journey is generate – where electricity is generated from an energy source that can be renewable or non-renewable.	**Ask pātai:** *Do you know the difference between renewable and non-renewable energy? What are the positives/negatives of using each type of energy? Why?*
	Video: The future is bright	Watch video on the importance of renewable energy, and how STEM superstars are helping us use more of it. **Pātai to consider:** *Why do you think STEM is important to help us achieve our renewable energy goals? How can we achieve the goal of generating all our electricity from renewable energy?*	Bring in a piece of equipment, or show some pictures, that relate to renewable energy. Do a show and tell with ākonga. Eg, part of a pylon, part of a turbine, images of a substation near the school, etc.
	Activity 2.1: Energy sources relay	Cement learning on renewable and non-renewable energy sources while getting ākonga moving outside.	Support ākonga to set up the activity.
Block B 45 minutes	**Turbine time**		
	Engineering design process	Introduce ākonga to the process that they'll use to create their turbines. Print and display the engineering design process poster.	**Ask pātai:** *What is important about the ask/imagine/plan/create/test/improve stage? Why might it be helpful to go back and forth between each stage?*
	Ask		
	Video: Ask	Watch video, that explores the first stage of the engineering design process, 'ask', and how a turbine works.	Support ākonga to understand how asking pātai at the start of a project can help with the problem-solving process. Give examples of when you might have done this at mahi.

Timing	Activity	Teaching sequence	Ambassador role
Block B 45 minutes	**Ask (cont)**		
	I wonder how a turbine works?	Consider turbine blade design variables and aerodynamics and how they impact a turbine's performance.	Lead kōrero on the blade design variables ākonga could consider. Eg, how efficiently blades spin depends on materials, shape, size and number of blades.
	Activity 2.2: Ask	Cement learning on how a turbine works by answering pātai on turbine parts, electricity generation and aerodynamics.	Support ākonga to complete the activity.
	Imagine and plan		
	Imagine and plan	Explore the second and third stages of the engineering design process – 'imagine' and 'plan'. Have a class kōrero on possible blade shapes. **Pātai to consider:** *What do we need to think about when we imagine turbine blades?*	Support kōrero with simple explanations: • Flat blades are easy to make but have a higher drag force • Tapered blades are stronger and lighter than straight blades • Airfoil shapes will increase speed and efficiency while reducing drag • Card is simple to use while plastic is sturdier, etc.
	Activity 2.3: Blade design	Imagine a range of 2D and 3D turbine blade design ideas in rōpū. Then, choose the best one, draw it to scale, explain why the design will be efficient and plan the recyclable materials needed to construct it.	Pick some blade designs to share with the class and get rōpū to name their shape based on its attributes (eg triangle, airfoil, prism), share their design reasoning and how their shape generates lift and reduces drag. **Ask pātai:** *Why have you chosen to add this design feature to your blades? How will this feature help your turbine generate more electricity?*

Remember: Bring in materials to construct your turbine prototypes in Module 3. You'll also need two desk fans.

Module 3:
Move

90 minutes (approximate)

Purpose

Ākonga will build on knowledge of electricity's journey by learning about the National Grid. Then create and test a wind turbine prototype.

Resources

From your Power kit:

- Power cards
- Turbine bases
- Wooden dowels
- Motor brackets
- Motors
- Hubs
- Popsicle sticks
- Wingnut and screws
- 2 x printed circuit boards *(PCB)*

School to supply:

- Recyclable materials for turbine blades *cardboard or ice cream containers*
- Decorations
- Hot glue gun or other adhesives *eg, super glue, polyurethane glue*
- 2 x fans *40cm desk fan will work best*
- Scissors
- 30cm ruler
- Classroom resources *including pens and scissors*

Print or share online:

- Activity 3.1: Great grid race (1 per rōpū)
- Activity 3.2: Create (1 per rōpū)
- Activity 3.3: Time to test (1 per rōpū)

Module outcomes

- Learn the components of the National Grid and how they're connected
- Explore the fourth and fifth steps of the engineering design process – create and test
- Create a wind turbine prototype, using challenge knowledge to inform design
- Set and reflect on a conjecture on how turbine blade design variables will impact performance
- Evaluate and test turbine fitness of purpose and energy output
- Analyse test data to gain insights into how to improve turbine blade design

Preparation

Pre-module checklist

- ◯ Collected materials for turbine blades
- ◯ Sourced a 40cm desk fan
- ◯ Familiarised yourself with the PCB
- ◯ Pānui Module 3 of the Student Hub

Module 3 lesson plan

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Use this plan to support you as you work through Module 3 of the student online Learning Hub.

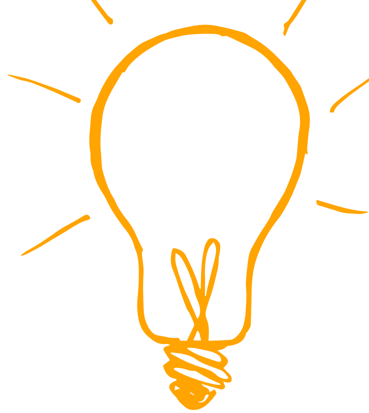
Timing	Activity	Teaching sequence	Ambassador role
Block A 15 minutes	**Move**		
	Video: Move – electricity's journey	Watch video that covers the second step in electricity's journey, move. Learn more about the National Grid and how it connects electricity generated at power stations, to the places that need it.	**Ask pātai:** *What do you think the National Grid is? Why is it important?*
	Activity 3.1: Great grid race	In rōpū, recreate the journey electricity travels to get to homes by putting the power cards in the right order.	Support ākonga to complete the activity.
Block B 45 minutes	**Create**		
	Create	Explore the third step of the engineering design process 'create'. Understand that after engineers have imagined some solutions to their problem, they create a prototype or model that helps them test their ideas.	**Ask pātai:** *Why do you think it's helpful to test ideas with a prototype?*
	Video: Create	Watch instructional video that outlines how to put together the wind turbine. After the video, have a kōrero on blade pitch. **Pātai to consider:** *Why do you think the slots on the hub are angled?*	Explain that the turbine blade angle (pitch) has a big effect on the performance and energy output of the wind turbine. Refer to the key concepts document for more information.
	Activity 3.2: Create	Using their blade design from activity 2.3, create a turbine prototype in rōpū.	Support ākonga to complete the activity. **Ask pātai:** *How can geometry and measurement help with blade construction and improve aerodynamics?*
Block C 30 minutes	**Test**		
	Test	Explore the fifth stage of the engineering design process – test. Understand that after they've created their prototypes, engineers will perform a series of tests to determine whether their solution works, and if there are any ways it could be improved.	Explain the importance of iterating and improving as a STEM professional. **Ask pātai:** *Why do you think it's important to test your prototypes?*

Timing	Activity	Teaching sequence	Ambassador role
	Test (cont)		
Block C 30 minutes	**Activity 3.3: Time to test**	Set a conjecture on how the turbine's blade design will impact its performance. Then, perform two simple tests and collect performance data. After testing, analyse data, compare results to the conjecture, and consider improvements.	Encourage ākonga to embrace the STEM skill of manawanui (perseverance) if their turbines aren't working efficiently and support them to find potential improvements.

Remember: Bring in materials to improve your turbine prototypes in Module 4. You'll also need two desk fans and two lamps/strong torches.

Module 4:
Illuminate

90 minutes (approximate)



Purpose

Ākonga will explore ways to use energy sustainably before improving turbines using challenge knowledge. Then, they'll connect final turbines to a printed circuit board (the town) to see whose design is most efficient. They'll use this data to answer the challenge pātai.

Resources

From your power kit:

- Wind turbine prototypes
- 2 x printed circuit board *(PCB)*
- 2 x solar panels
- 2 x coin batteries
- Leftover copper tape
- 4 x LEDs
- Power kit *Outer house box only*

School to supply:

- Recyclable materials for turbine blades *cardboard or ice cream containers*
- 2 x fans *a 40cm desk fan will work best*
- 2 x light sources *a strong torch or desk lamp*
- Classroom resources *including pens, scissors and rulers*

Print or share online:

- Activity 4.1: Improve (1 per rōpū)
- Activity 4.2: Light up our town (1 per rōpū)
- Activity 4.3: Power Challenge competition (1 per class)

Module outcomes

- Learn ways to use energy more efficiently
- Explore the sixth and final step of the engineering design process – improve
- Make final improvements to turbine prototypes, using challenge learnings and data
- Set and reflect on a conjecture on how turbine improvements will impact performance
- Connect final turbines to the printed circuit board (PCB), collecting data on performance with, and without, an added solar panel
- Analyse data to determine who created the best turbine, and why
- Form a conclusion on the challenge pātai (question)

Preparation

Pre-module checklist

- ◯ Collected materials to improve turbines
- ◯ Sourced 2 40cm desk fans and 2 desk lamps/strong torches
- ◯ Re-familiarised yourself with the PCB
- ◯ Pānui Module 4 of the Student Hub

Post-module checklist

Complete/share post-challenge surveys

- ◯ Teacher survey
- ◯ Student survey
- ◯ Ambassador survey

Module 4 lesson plan

Use this plan to support you as you work through Module 4 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 15 minutes	**Use**		
	Use	Learn that the final step in electricity's journey is 'use'. Understand why it's important to be energy smart.	**Ask pātai:** *What do you use electricity for? Why is it important to be conscious of how you use electricity? How can we reduce our electricity use?*
	Energy quiz	Recap and test challenge learning to date in a fun, online quiz.	Lead the quiz as the quizmaster.
Block B 45 minutes	**Improve**		
	Improve	Explore the sixth and final step of the engineering design process – 'improve'. Understand that after engineers have created and tested their ideas, they use the data from their testing to make improvements.	Explain a time that you've improved on an idea at mahi. **Ask pātai:** *Why do you think it's helpful to test and improve your ideas? How will you improve your turbines?*
	Activity 4.1: Improve	Reflect on learnings and data from the challenge. Then, consider and carry out improvements to turbines before the final challenge.	Help ākonga understand their data. **Ask pātai:** *Why do you think your turbine performed this way? Can you find any patterns between turbine performance and blade design features?*
	It's town time!		
	Video: Light up our town	Watch video that covers the final challenge – to use renewable energy solutions to light up a mini town.	Discuss the important part that each element of the mini town plays in maintaining a thriving hapori.
	Activity 4.2: Light up our town	Set a conjecture on how turbine improvements will impact performance before testing them in front of a fan, and with an added solar panel. Collect data on the results. Then, review data collected, do a final analysis, and form a conclusion on the challenge pātai.	Ensure that each rōpū uses the same light source on their solar panel, and that the distance between their light source and solar panel is consistent.
	Whānau showcase	Invite whānau to visit the classroom so ākonga can show off their turbines. You could also film the turbines and share with whānau virtually.	Set up the turbines with the PCB to demonstrate their performance.

Timing	Activity	Teaching sequence	Ambassador role
Block C 30 minutes	**Not ready to turn the lights off?**		
	Optional extra activity: Light up your kit!	Learn the difference between parallel circuits and series circuits. Then find a way to light up the lights on the outside of the power kit by creating a parallel circuit. A solution to this activity can be found on page 28.	Frontload the activity by discussing parallel circuits with ākonga and how they're different from series circuits. Refer to the key concepts document for more information.
	I wonder how to tell our story?		
	Activity 4.3: Power Challenge competition	Plan and create a creative video or poster that captures the Power Challenge experience to be in to win a prize.	
	Post challenge surveys		
	Post challenge surveys	All kaiako, ākonga and ambassadors should complete their post challenge survey. They're an important tool for us to improve the programme each year and continue our funding to keep the Wonder Project free for schools. We supply kaiako with the survey data from their school to show the impact the Power Challenge has had on ākonga perceptions towards STEM, and how much they've learned.	

Activity notes

Activity 1.1: Transforming energy

Here you'll find support notes and answers for relevant activities. If there's anything else you need help with, please get in touch at hello@wonderproject.nz

Answers:

Test 1: Flicking a ruler

Kinetic energy → Sound energy (flicked ruler)

Test 2: Rubbing hands together

Kinetic energy → Thermal energy + Sound energy (hands rubbing)

Test 3: Turning lights off and on

Electrical energy (Lights off) → Light energy + Thermal energy + (Lights on)

Test 4: Dropping a pencil

Gravitational potential energy (pencil held above the floor)

→ Kinetic energy (pencil dropping)

→ Sound energy (pencil hitting the floor)

Test 5: Blowing up and releasing a balloon

Elastic potential energy (Blown up balloon)

→ Kinetic energy + Sound energy (Released balloon)

Activity 1.2: Paper circuits

Troubleshooting circuits

If LEDs don't light up, start by checking the following:

Does the circuit flow from negative to positive?

To achieve an electrical current, a circuit needs to flow from negative to positive. The two things that impact this flow are the **battery** and the **LED.**

- The **battery** has a positive side and a negative side. The positive side is labelled with a + symbol. Make sure the battery is placed on the circuit with the negative side facing down.
- The **LED** also has a positive leg, and a negative leg. The positive leg is longer than the negative leg. Make sure ākonga have connected the positive leg of their LED to the positive side of the circuit, and the negative leg of their LED to the negative side of the circuit.

Is the circuit broken?

- When ākonga create corners with their copper tape, make sure they bend it, instead of cutting it. This is because the sticky part on the bottom of the tape is not conductive. So, it will break the circuit.

Have they covered the LED icon with tape?

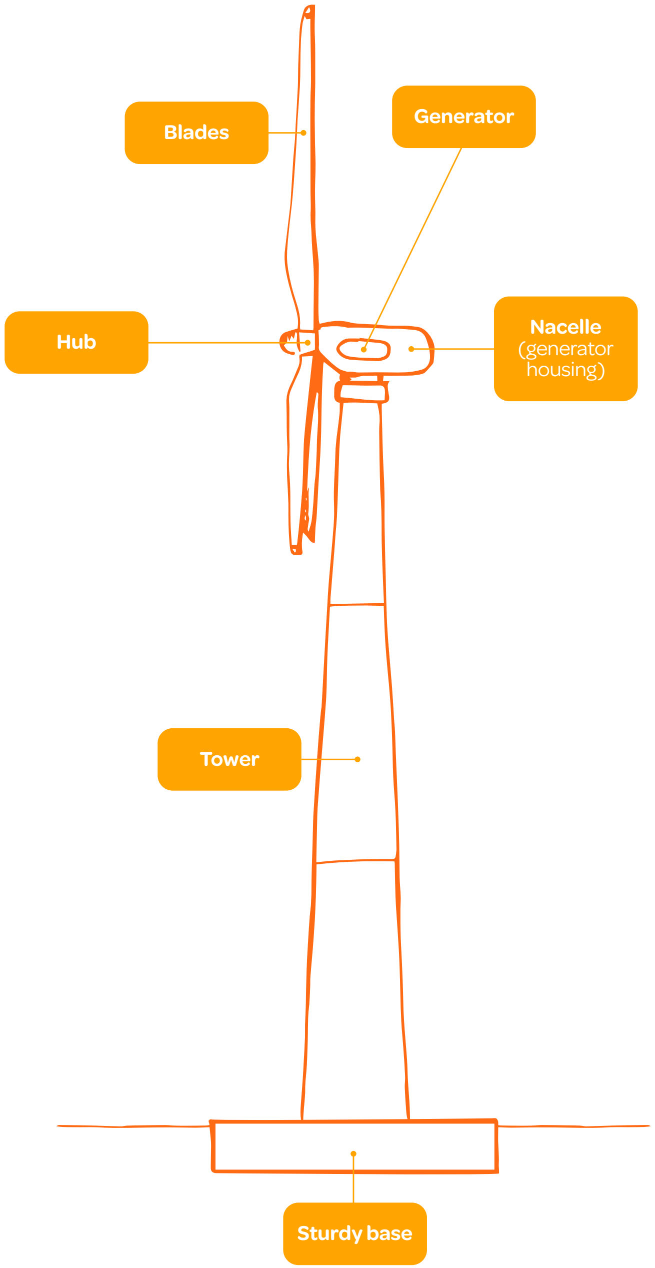
Ākonga need to leave a gap in the tape where they'll place their LED – so two or more pieces of tape are required.

Other possible issues

Make sure that none of the components are damaged.

Activity 2.2: Ask

Answers:



I wonder how a turbine generates electricity?

When [wind energy] moves over the turbine [blades], it transforms into [rotational energy]. This makes the blades spin.

The blades are connected to the turbine's [generator]. So, when the blades spin, the [generator] spins.

This transforms the [rotational energy] into [electrical energy].

I wonder how aerodynamics affects turbines?

Aerodynamics is: the study of how air moves around an object.

It affects turbines by: determining how effectively the blades spin, and therefore how much electricity the turbine generates.

Some blade design variables that impact aerodynamics are: blade materials, size, shape and number.

Activity 3.1: Great grid race

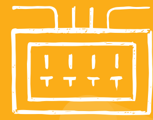
Answers:

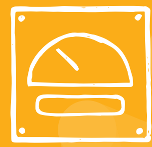
1

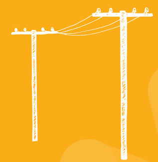
Toaster

2

Power outlet

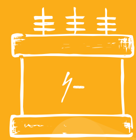
3

Fuse board

4

Meter box

5

Distribution network

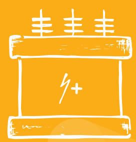
6

Substation

7

Step-down transformer

8

Pylons and transmission lines

9

Step-up transformer

10

Power station

11

Wind

Activity 3.2:
Create

Turbine creation tips

Base and tower	• The dowel (turbine tower) should fit securely into the turbine base. If it's wobbly, secure it in place with hot glue.
Hub	• The hub has 12 slots to allow for many different blade configurations. • Once each turbine blade is inside the slot, secure it in place with some blu-tack or tape. This will give ākonga freedom to swap out their blades later in the challenge.
Blades	• **Materials:** The most efficient materials to use include cardboard, corflute, or plastic ice cream containers. • **Size:** Each blade on the turbine should also be the same size to ensure it's balanced. A medium-sized blade (around 15cm) is generally most efficient. • **Shape:** Ākonga could also experiment with curving their blades or creating an airfoil shape to replicate a real turbine. • **Number:** Generally, a turbine with 3 to 4 blades should work efficiently. Blades should also be placed evenly across the hub for balance. We recommend ākonga start with less blades, then scale up – it's much easier to add more blades than to remove blades.

Connecting the hub to the motor

The hole in the middle of the hub fits onto the motor pin. You might find that it's a tight squeeze to put them together. We suggest that ākonga twist the hub onto the pin with a bit of force. Once you've put the hub and the motor together once, it should get easier each time.

Other ways to attach the hub and the motor include:

- Pressing it hard and securing it with a bit of hot glue.
- Tap it (not hit it!) with a hammer-type object.

Using your PCB

Activities 3.3, 4.2

Prepare to power up

- Split the class into two, keeping rōpū members together.
- Set up two activity stations, each with a PCB and a fan. Add a light source for activity 4.2.
  - The fan speed, size and distance will have a big impact on the results. We recommend a 40cm desk fan for the best results.
  - We recommend a torch or a desk lamp for the light source.

What to expect

The number of lights ākonga turn on will depend on their turbine blade design. If they've designed an efficient turbine, they should achieve:

- Turbine alone: 4–5 LEDs.
- Turbine and solar panel: 8–9 LEDs.

Troubleshooting tips

- If the blades don't spin:
  - Make sure the centre of the fan matches up with the centre of the wind turbine. You may need to raise your fan with some books, or a container.
  - Check they've been inserted into the hub properly. If not, secure with blu-tack. You can use hot glue for activity 4.2.
- If the town doesn't light up:
  - Check the hub is securely attached to the motor pin. If it's too loose, the motor won't spin when the blades spin and no lights will turn on.

Activity 4.1: Improve

Example answers

What we've learned about energy transformation:	What we've learned about aerodynamics:	What we've learned about blade design variables:	What we've learned from testing our turbines:
Turbines transform wind energy into electrical energy when the blades spin. When the wind moves over the blades, they spin, which spins the generator in the turbine's nacelle. The faster the blades spin, the more electricity is generated.	Aerodynamic blades are designed to increase the lift force and reduce the drag force.	The most aerodynamic shape for our blades is an airfoil.	Turbines with 4 blades achieved more lights than turbines with 2 blades.
We can use this information to improve our turbine by:	**We can use this information to improve our turbine by:**	**We can use this information to improve our turbine by:**	**We can use this information to improve our turbine by:**
Distributing the turbine's weight better by evenly spacing the blades. This will make them spin faster and generate more electricity.	Using lighter, but sturdy material to reduce the drag force.	Swapping our flat blades for 3D airfoil blades.	Adding 2 more blades to our turbine.

Activity extensions

Turbine testing scenarios

Scenario one – Slip slop slap and wrap

It's a blistering hot day and the winds have almost slowed to a stop! Place the fan 1 metre away from the turbine and maintain the distance between the solar panel and light source. Record how many LEDs light up.

Scenario two – Winds galore

Hold onto your hats – it sure is windy! Remove the solar panel and set up the fan as close to the turbine as possible. Record how many LEDs light up.

If you're in a windy area, you could try setting up your turbine outside.

Scenario three – A calm, cold day

The sun's tucked behind the clouds and the winds are mellow. Use natural light from the windows on your solar panel and set the fan up 1 metre away from the turbine. Record how many LEDs light up.

Light up your kit

Referencing the principles and troubleshooting options in Activity 1.2, you can attempt to light up all lights on the outside of the power kit through a parallel circuit.

There are four lights on the outside of the kit – we recommend placing your LEDs on top of these lights.

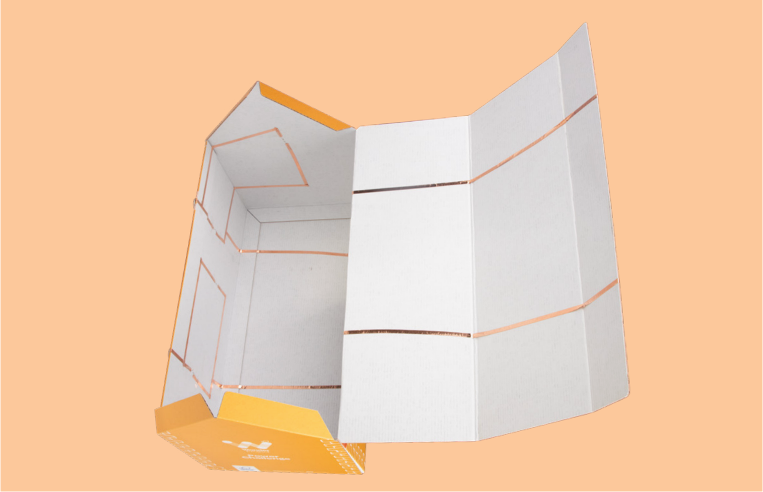
You should use one battery per two LEDs.

Ensure that the copper tape is placed carefully so you don't break your circuit.

This image is an example of how to create a successful parallel circuit. Encourage ākonga to find a solution themselves without referencing this image.

Resources

- Power kit *Outer house box only*
- LEDs
- Scissors
- Copper tape
- Coin batteries
- Tape



Challenge conclusion

Example answer

I wonder how to power a brighter future?

- A brighter future has a sustainable, clean electricity supply to meet the growing needs of our hapori. This can be achieved through New Zealand's goal of becoming 100% renewable by 2035.
- To achieve this goal, we need to use STEM to investigate ways to make more effective renewable energy solutions. For example:
  - Designing aerodynamic turbine blades – considering their material, shape, size and number to get more energy out of the wind.
  - Building more renewable energy power stations that don't impact the land, or its inhabitants.
  - Considering ways to store renewable energy. For example, storing energy generated through wind turbines and solar panels so we have electricity to use when it's not windy, or sunny.
  - Researching and innovating to find new or improved renewable energy solutions. Eg, super geothermal energy.
  - Upgrading the National Grid to connect places that generate lots of renewable energy, to places that use a lot of energy.