Wonder Project

Power Challenge

Key concepts

engineering new zealand te ao rangahau

ENERGISED BY TRANSPOWER

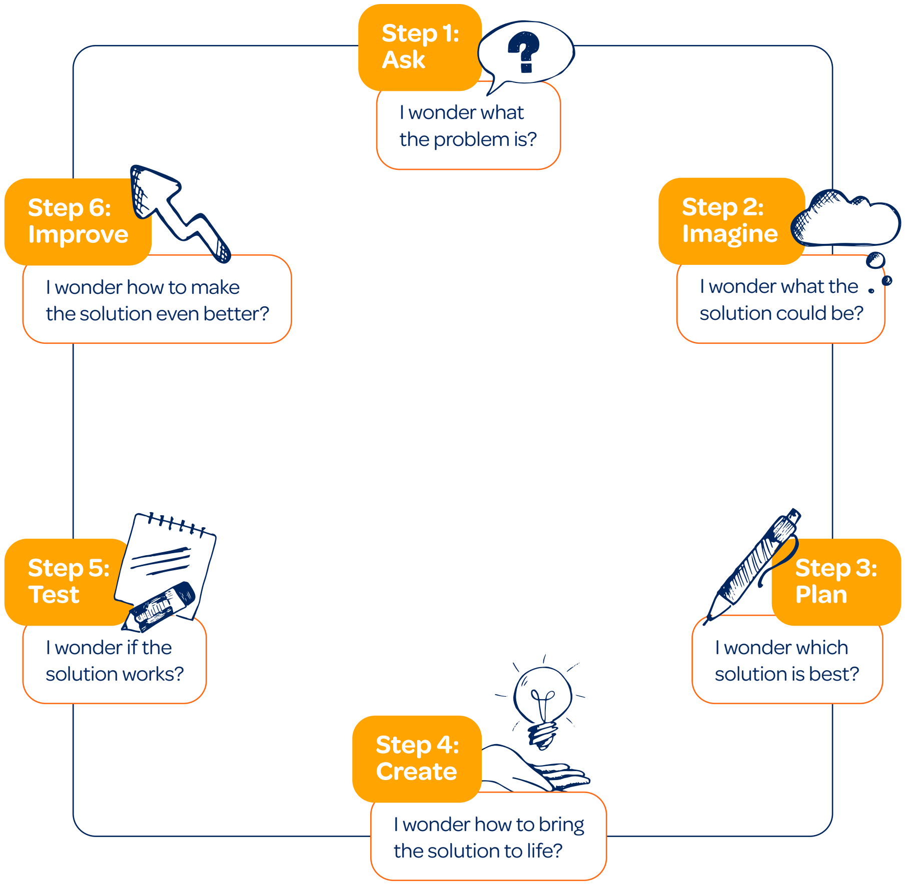
SUPPORTED BY EECA Mercury OMEXOM

Contents

Engineering design process

The engineering design process is a series of simple steps that STEM superstars use to solve problems and make ideas work.

Engineers go back and forth between the steps until they find the best solution.
This is called iterative thinking.



Step 1: Ask	Engineers ask pātai (questions) to help them understand the problem they're trying to solve.
Step 2: Imagine	Engineers imagine some possible solutions to the problem they defined in the 'ask' step.
Step 3: Plan	Engineers plan which solution to progress, and how to progress it.
Step 4: Create	Engineers bring their solution to life.
Step 5: Test	Engineers test their solution to see whether it works, and if there are any ways it can be improved.
Step 6: Improve	Engineers use all the knowledge gained throughout the engineering design process to improve their mahi.

Energy

Energy is the ability to do work.
Simply put, energy makes things happen.

Forms of energy

Energy comes in many different forms. The forms you'll explore in the Power Challenge include:

Gravitational potential	Energy that's stored because of an object's height above the Earth.
Elastic potential	Energy stored in something elastic when it's stretched or compressed.
Kinetic	The energy of motion.
Electrical	Energy that helps power our hapori.
Light	Energy that helps us see the things around us.
Thermal	Energy responsible for something's temperature.
Sound	Energy that we can hear.
Rotational energy	Energy that occurs due to an object's rotation.
Wind energy	A renewable energy source that harnesses the kinetic energy of wind to generate electricity.

Energy transformation and transfer

Ākonga video: Energy transformation and transfer

Energy can't be created or destroyed, only transformed from one form into another, or transferred from one place to another.

Energy transformation	Energy transfer
When one form of energy is transformed into another form	**When energy moves from one place to another, or from one object to another**
Eg, a wind turbine works by transforming wind energy, into electrical energy.	Eg, energy is moved from wind turbines where it's generated, to the places where it's used, through our National Grid.

Electricity

Electricity is energy that helps power our hapori.

Current vs static electricity

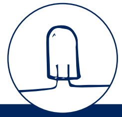
Static electricity	Electricity that's gathered in one place. It's responsible for static shocks, used to print things and helps form lightning!
Current electricity	Electricity that moves from one place to another. It's responsible for powering our homes.

Circuits

A circuit is a path for electricity to move from one location to another. Every electrical circuit is made up of three basic things: an energy source, a conductive path and a load.

In a simple circuit, the battery pushes charged particles called **electrons** away from its negative terminal and pulls them towards the positive terminal. This movement of electrons is called electrical **current**.

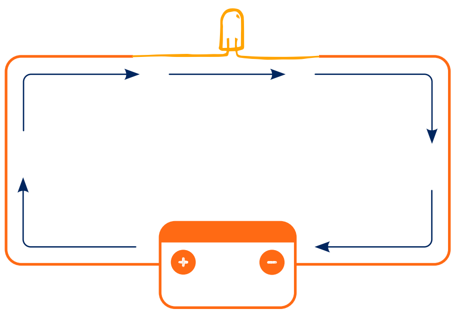
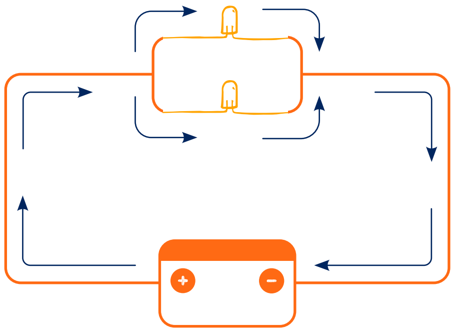
Electricity travels in closed circuits. A closed circuit provides a continuous path for a current to flow, with no interruptions. When you turn on a light by flipping a switch, you close a circuit.

 Energy source	 Conductive path	 Load
Provides electricity. Eg, a battery	A path for the electricity to flow. Eg, copper tape	Uses the electrical energy. Eg, an LED.

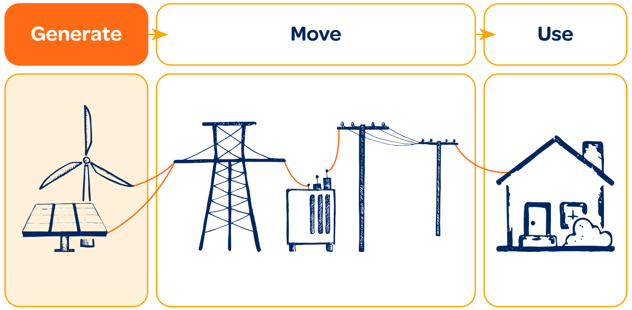
Series vs parallel circuits (optional extra)

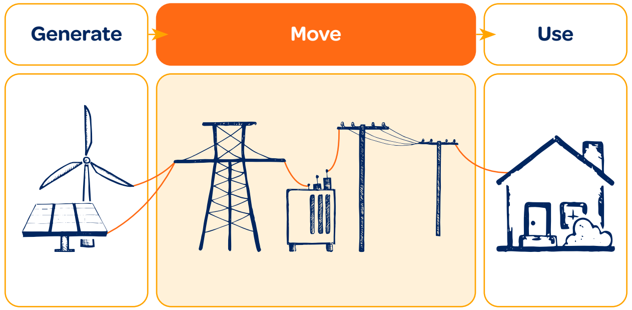
This information is only required if your class chooses to complete the optional light up your kit activity.

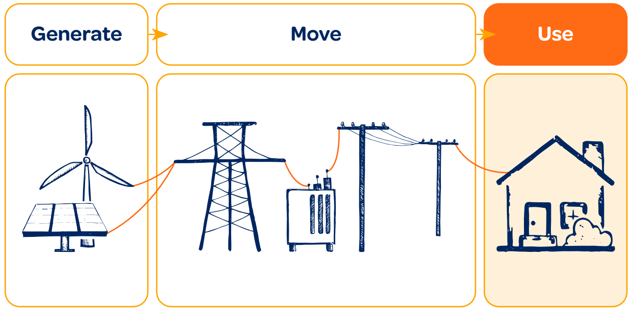
In Activity 1.2, rōpū created series circuits. The differences between series circuits and parallel circuits are outlined in the comparison chart below:

	Series circuit	Parallel circuit
Introduction	A circuit made up of components (eg LEDs, batteries) connected in a single path.	A circuit made up of components (eg LEDs, batteries) connected in parallel along multiple paths.
Current	The same amount of current flows through all components within the circuit. And, there's only one pathway for electricity to flow.	The current flowing through each component combines to form the current flow through the energy source (the battery).
Voltage	The voltage of the battery is the sum of all voltage of the components in a circuit.	The voltage of every component of the circuit is the same.
Functionality	Components are not functional if any of the other components are damaged because it disrupts the flow of current.	Components are functional even if any of the other components are damaged.
Examples	• Freezers • Refrigerators • Lamps • Bulbs	• Outlets in our home • Wiring in toys • Washing machine • Microwave
Circuits		

The great journey of electricity







Generate

Ākonga video: The future is bright

In the generate phase of electricity's journey, electricity is generated from an energy source.

Energy sources can be either renewable, or non-renewable:

Renewable energy	Made from resources that are naturally replenished. For example, we get solar power from the sun which is renewable because we can't use up all the sun's sunlight.
Non-renewable energy	Made from resources that will run out or won't be replenished for a very long time. Coal, oil and natural gas are all non-renewable.

Move – the National Grid

Ākonga video: Move – electricity's journey

In Aotearoa, we rely on a power system to move electricity that's generated, to the hapori that use it. It's called the National Grid.

- The National Grid is responsible for moving electrical energy all over the country.
- It's made up of over 12,000km of transmission lines and more than 170 substations.
- Check out Transpower's live data for current statistics on our power system.

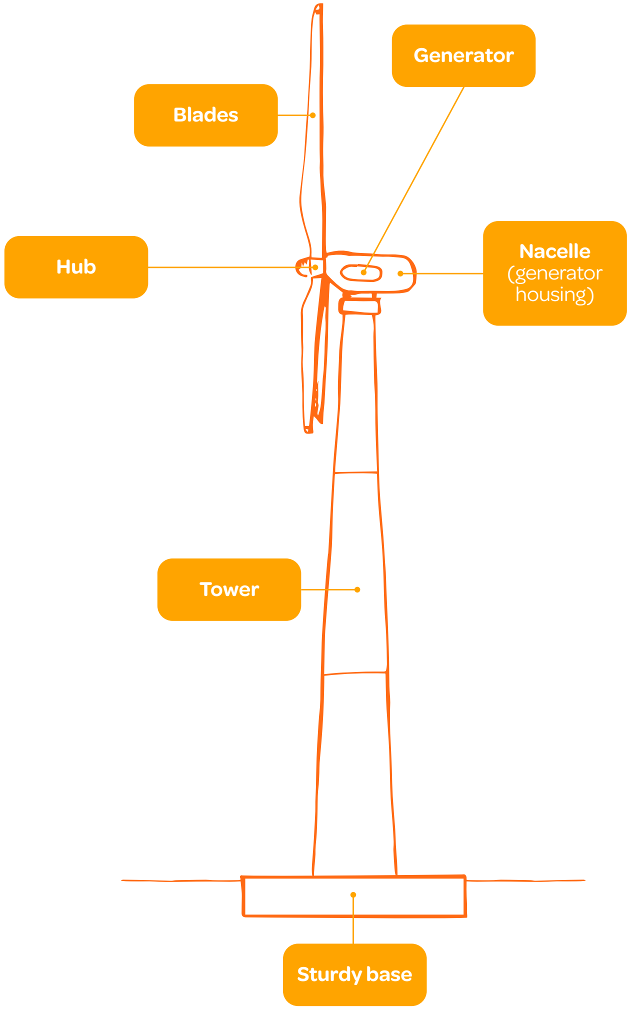
Use

To ensure we have enough electricity in the future for our growing population, and increasing reliance on electricity, we'll need to make more of it and reduce the amount we use.

Encourage ākonga to reflect on ways to become energy smart:

- Turn off unnecessary lights
- Take shorter showers
- Turn off the water when brushing teeth
- Use energy saving light bulbs

Wind turbines



How do they work?

Ākonga video: Ask

Wind turbines generate electricity by transforming wind energy into electrical energy:

- When wind energy moves over the turbine blades, it transforms into rotational energy. This makes the blades spin.
- The blades are connected to a generator inside the turbine nacelle. So, when the blades spin, they turn a magnetic rotor inside the generator.
- The spinning of the magnets inside the coils of the generator creates electricity. So, the rotational energy is transformed into electrical energy.
- The electricity travels down a cable, down the turbine tower, into the ground, and to the nearest substation.

Aerodynamics

Aerodynamics is the study of how air moves around an object. The better the aerodynamic design of a turbine, the more electrical energy will be generated.

- There are two important aerodynamic forces for turbines:
  - Drag is the friction of the blades against the air as they rotate. Drag works against the rotation of the blades, causing them to slow down. Aerodynamic blades are designed to reduce the amount of drag acting on a turbine's blades, so they can spin quickly.
  - Lift helps pull the blades upwards – maximising the rotational force of the blades.
- Turbine blades are designed using airfoils – a streamlined shape that improves their aerodynamic performance by increasing lift and reducing drag.
- They also have "winglets" on their tips, similar to those used on aeroplane wings, to support aerodynamic efficiency.

Blade pitch

- Turbine blades are all attached to the hub at a slight angle. This is called the blade pitch and helps by increasing the aerodynamic efficiency of a wind turbine.
- There is a specific pitch angle for any given wind speed to optimize the output of the turbine.
- Turbines have a smart system that adjusts the blade pitch depending on the wind speed. This ensures that the turbine is getting the most out of the wind.