→ Challenge:

Investigate the generation of electricity

The generation of electricity, so crucial to life in the 21st century, poses a number of challenges for scientists. Electricity is generated in power stations driven by fossil fuels that can cause pollution, global warming and acid rain. Even with environmental improvements to power stations, fossil fuels will eventually run out and alternative sources of electricity generation will need to be found. Your challenge is to investigate how electricity is generated and present your findings in a round table conference.

→ Contents

Powerhouse Discovery Challenges are inquiry-based units of work that:

- begin and end in your classroom
- involve a structured discovery process with links to the classroom curriculum
- provide a deeper understanding of the Museum's collection
- promote team problem-solving skills, and
- are fun!

→ Teacher information

Before your visit

- Read the challenge to your students.
- Divide your class into groups of four or five students. Each group is a team and should work together to complete the challenge.
- Do the pre-visit activity. This activity is directly related to your challenge and will help your students focus on the issues, preparing them for their museum experience.
- Prepare your group leaders (a teacher, accompanying parent or older student) for the visit to the Powerhouse Museum. Photocopy and give them the challenge trail (pages 7–10) ahead of time. Group leaders are essential to the success of the Powerhouse Discovery Challenges. The more they know, the harder they will work to make your students' museum experience a success.
- Assign a group leader to each team.

At the Powerhouse Museum

- The challenge will take approximately two hours from the time of arrival to the time of departure.
- The challenge trail should only be given to your group leaders. Students may bring along a pad and pencil to jot down their ideas to help complete the challenge.
- On arrival, an education staff member will meet and escort your group to a briefing area, introducing the areas of the Museum that are included in your challenge. They will also remind you of the safety rules and assist with any other details of your visit.
- Apart from this orientation and welcome, staff members will not be available to guide your group through the Museum.
- The exhibitions listed in the challenge can be visited in any order.

After your visit

- Do the post-visit activity. This activity will draw on students' knowledge gained during their exploration of the Museum to complete the challenge.
- Go over the assessment tool which you will use to grade their work.
- Choose an extension activity for your students.
- Return the feedback page to the Powerhouse Museum.

Please note: the websites referred to in this Discovery Challenge were available and suitable at the time of publication. We advise that teachers should check sites before recommending them to students.

Photo by Sue Stafford, Powerhouse Museum

→ Challenge outcomes

Powerhouse Discovery Challenges are structured for teachers to incorporate into their existing curriculum. This challenge has been written with upper primary classes in mind. A variety of learning processes are incorporated into the challenges as well as the 'values and attitudes' outcomes as indicated in the K–6 Science and Technology syllabus. Content outcomes for this challenge and examples of how they might be achieved are included here:

1. Students will learn about static electricity.

   They show this by investigating static electricity using balloons.

2. Students will understand that everything has an electric charge.

   Students will identify static electricity that occurs in their everyday lives.

3. Students will demonstrate knowledge of different ways of making electricity.

   They show this by researching a method of generating electricity and discussing it with other students in a conference setting.

4. Students will learn that a magnet, a wire coil and movement are required to produce electricity.

   Students will manipulate interactives at the Powerhouse Museum to produce electricity.

5. Students will demonstrate an understanding of the impact that electricity has had on society.

   Students will discuss the social impact of electricity while visiting exhibitions at the Powerhouse Museum.

6. Students will demonstrate an understanding of the impact that different forms of electricity generation have on the environment.

   Students will debate with other students about the environmental impact of the generation of electricity during the round table conference.

Michael Mobbs and Heather Armstrong renovated their inner city house using sustainable design principles. The Mobbs family *(pictured)* makes more electricity than their household can use, so their electricity bills are in credit. During the day, 18 solar panels on the roof collect energy from sunlight. Excess energy is pumped into the electricity grid by day and drawn back in the evenings. The Mobbs also treat their own sewerage on site and no water leaves the site either from rainwater or waste water. Find out more in the *EcoLogic* exhibition at the Powerhouse Museum. Photo by Jean-Francois Lanzarone, Powerhouse Museum

→ Pre-visit activity

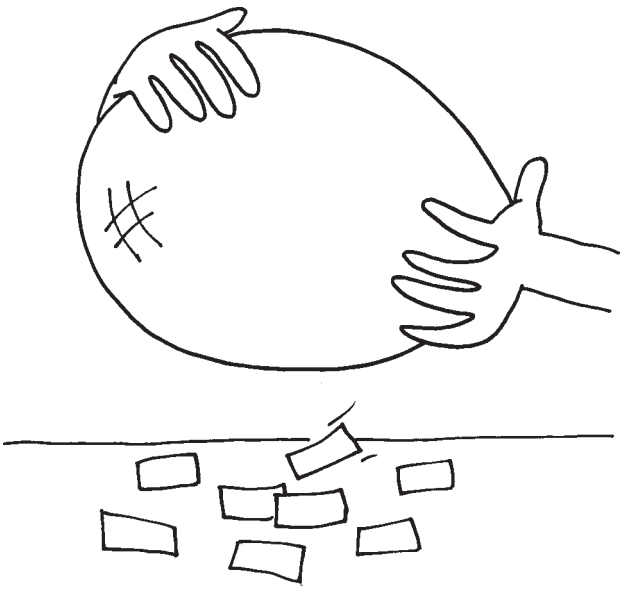
Purpose: in this activity students will investigate different ways of generating electricity.

Teaching strategy

1. Students will explore three different ways of producing electricity: batteries, generators and static electricity caused by rubbing. You may need to do some background research yourself on these subjects. Contact your local high school if you don't have all the necessary equipment. They may also have other equipment you could borrow such as a Wimshurst machine, a Van de Graaff generator and a hand-winding generator.

2. Have the students form teams. Ideally these will be the same teams that they will be in when they visit the Museum.

3. Decide how you want to run the session. Each group of students could investigate one method of generating electricity and then report back to the class. Or each group could investigate each of the activities. Feel free to substitute or add alternative activities.



Generating static electricity by rubbing a balloon.

4. Give clear instructions on how to do each activity, using the instruction sheet on page 6. Set a goal or task for students to complete. Explain all the activities before handing out any equipment.

5. Your role is to assist students to carry out the activities themselves. Prompt them to investigate, ask questions and provide theories. Encourage discussion about how each experiment works and what it shows.

6. Bring students together and have one from each group explain what they've done and discovered. Assist by guiding the explanation and helping students reach a conclusion based on the experiments about the generation of electricity.

7. As a class discuss the results of the activities. What were the three ways of generating electricity? *(static, battery, generator)* Can anyone think of a way to make electricity that you haven't looked at? *(solar)*

8. As a class explore what students know about where electricity comes from, eg power points, wires in the wall, circuit board, power lines, power station, fuel source.

9. Read the challenge to the class.

10. Using the trail (pages 7–10) as a guide, prepare students for the visit to the Powerhouse Museum. Students will investigate electricity generation at the Museum and present what they learn at the conference after their visit. Ask questions about what they expect to see and what questions they might like to have answered by the visit. Also ask students why the Museum is called the Powerhouse Museum. (The fact sheet on page 12 may help.)

→ Activities instruction sheet

Generating static electricity

Equipment
- Unblown balloons
- Small pieces of paper

Instructions
Give the balloons to your students and ask them to use them to produce electricity by blowing them up and rubbing them with their hands. If they get stuck, tell them to try rubbing the balloons against something else.

Discussion
Explain to students that rubbing the balloons causes them to become charged. Ask if anyone knows what we call this type of electricity? (*static electricity*) When you rub a balloon against long hair it causes it to stick up. Where else can you find static electricity? Lightning is a good example. Or when you are zapped by rubbing your feet on the carpet, by a car door or a trampoline. If you have access to a van de Graaff generator or Wimshurst machine introduce it in this discussion.

Lemon juice battery

Equipment
- Two different metal strips (eg zinc and copper)
- Alligator clips
- Containers
- An electricity meter
- Lemon juice and water

Instructions
Set up the lemon juice battery with the two different metal strips connected to the meter, a container full of water and a small container with a small amount of lemon juice in it. (Measure out a small amount into a beaker beforehand.) Ask students to try to produce electricity using these things.

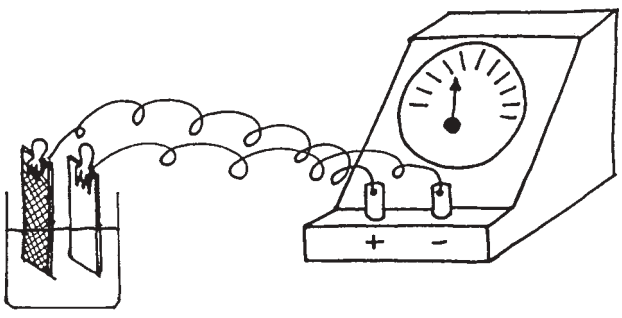
Discussion
Ask students how lemon juice and two different metals could produce electricity? (*There is a chemical reaction between the juice and the metals that makes electricity.*) Explain that this is similar to batteries we all use at home. Inside the battery there is a special liquid that reacts with metals to make electricity. Don't try to pull apart a battery to look because the liquid inside it is poisonous. This is another way to make electricity — using chemical reactions.

Basic generator

Equipment
- Magnet
- Coil of copper wire (eg looped speaker wire)
- Alligator clips
- Meter

Instructions
Attach the copper wire to the meter to see if there is any electricity in the wire. If the meter on the needle moves it means there is electricity in the wire. Ask students to use the magnet and the coil together to try to produce electricity.

Discussion
Ask students how they made electricity using the magnet and the coil. (*The key ingredient is movement.*) Ask students if it matters which thing moves. (*No, you can move the magnet, coil or both.*) Did students discover how to move them to make the most electricity? Moving a big magnet or coil is how most of the electricity we use is made. What is used to make them move? (*steam, water or wind*) What do we call these machines? (*generators*) If you have access to a hand generator demonstrate it here.



A lemon juice battery.

FOR GROUP LEADERS

→ Challenge trail:

Investigate the generation of electricity

The generation of electricity, so crucial to life in the 21st century, poses a number of challenges for scientists. Electricity is generated in power stations driven by fossil fuels that can cause pollution, global warming and acid rain. Even with environmental improvements to power stations, fossil fuels will eventually run out and alternative sources of electricity generation will need to be found. Your challenge is to investigate how electricity is generated and present your findings in a round table conference.

Tips for the group leader

(a teacher, accompanying parent or student)

1. Know your group. Help them get excited about their visit.

2. Study the map of the exhibitions you will visit.

3. **Where to go** gives you brief directions on the location of your next exhibition stop. If you get lost, please ask a gallery officer for directions.

4. **All about** is designed to familiarise the group leader with the exhibitions they are about to visit.

5. **To say or do** gives the group leader ways to introduce the topic to the group. Explain the focus, activity or discussion point at each stop. Remember Powerhouse Discovery Challenge trails are guides not rules. If the students are restless or no longer interested, move to another part of the exhibition.

6. At each stop give your group time to look around the exhibition, listen to the audiovisual(s) and/or play the interactive(s).

7. Gather your group to talk, reflect or do an activity according to the stop.

8. Rest, debrief and allow time for each student to go back to his or her own exhibition highlight.

9. Have fun! The Powerhouse is a place of discovery. Be an adventurer with your group.

→ Challenge guide

Stop 1

■ Where to go

EcoLogic: creating a sustainable future exhibition, level 2. We recommend entering via the south end of the Turbine Hall and going around in an anticlockwise direction.

■ All about

EcoLogic looks at environmental problems facing Australia and the world. It also presents a positive picture of an ecologically sustainable future through case studies and real life stories of people and developments that are changing the way we live, manufacture, work and travel.

■ To say or do

Encourage your team to explore the different sections of this exhibition with a focus on the following sections.

a. The showcase containing the wind turbine looks at alternative energy sources. Ask students if they are familiar with any of the energy sources shown? Are some better than others?
b. While passing through the 'house' area notice the energy efficient products on display. How do these products help us save electricity?
c. The exhibition is all about sustainability. How is sustainability important to electricity generation?

The Freeplay wind-up radio needs no coal-fired electricity. It is powered by either arm muscles or the sun. When you wind the handle it tightens a spring inside the radio that stores enough energy to play for 45 minutes. Photo by Sue Stafford, Powerhouse Museum

Stop 2

■ Where to go

Experimentations, level 2. You can enter this exhibition via the northern end of the Turbine Hall.

■ All about

Experimentations is a fascinating interactive exhibition that investigates how things work and why things happen. It's about looking at the world in a whole new way, asking questions, observing carefully and measuring. It's about experimenting! Focus on the electricity and magnetism sections in the back left-hand corner of the exhibition, but feel free to explore the other exhibits if time permits.

■ To say or do

a. Find the 'Magnets make a current' showcase. See if your team can locate the magnets and coils in these electricity-making devices. Delzenne's Circle works with the help of a natural magnet. What is it? *(Earth's magnetic field)* Find the dynamo on the bicycle, how does it work?
b. Find the 'Spin an electric motor' experiment. Can your team make the coil turn with the magnets? Ask them if they know what makes the lights come on? *(The electricity generated by the movement of the coil between the magnets.)*
c. Check out the 'Make electricity to run a train' experiment. What makes the electricity? *(The changing magnetic field in the coil makes electricity flow.)*
d. Have the team try out the fire engine. See who can get the radio, wipers, lights and sirens to go on. Ask the students how they think their pedalling power is being changed into electrical energy? *(The pedals turn a coil in a magnetic field, making an electric current.)*
e. Look at the other showcases and interactives. Discuss the other ways you can make electricity? (*Solar cells, batteries)*

Stop 3

■ Where to go

The steam revolution exhibition at the northern end of level 3. After entering the exhibition, take the students in a clockwise direction.

■ All about

The steam revolution traces developments in steam technology, from scientific experiments of the 1600s to the power stations of today. It features early electrical devices and lights and offers an insight into people's reactions to electricity in Sydney.

■ To say or do

As you enter the exhibition stop at the photographs on the wall and mention to the students that over 250 years ago people had to rely on human, animal, wind and water power to do work. This all changed when we began to harness the power of steam.

a. Walking in a clockwise direction explore the different steam engines and what they were used for. Make your way slowly past the merry-go-round to the section called 'Designed for speed'. What were the steam engines in this section used for? *(To turn the generator so that electricity can be produced)*

b. Find the Parsons steam turbine in 'The city electric' section. Explain that in a steam turbine (the left half), steam turns the blades. The turbine then turns the generator (the right half) which produces the electricity. Steam turbines are used to generate around 90 per cent of Australia's electricity.

c. Find the 'City lights' section (look for the light bulbs). When electricity was introduced in Sydney in the 1890s, people soon had electric lighting. Spin the generator and light up the Imperial Arcade, one of the first buildings in Sydney to get electric lighting. While in this section discuss with students how people's lives were changed with the spread of electricity.

Stop 4

■ Where to go

Go to the *'… never done'* exhibition on level 3. If you are coming from *The steam revolution* or up the stairs from level 2, you can get there through *What's in store? Shopping in Australia 1880–1930*.

■ All about

By visiting the bush hut and the 1920s suburban kitchen in this exhibition students will see what lifestyles were like during the late 1800s and early 1900s. Lifestyles changed after the 1920s as electrical appliances gained popularity.

■ To say or do

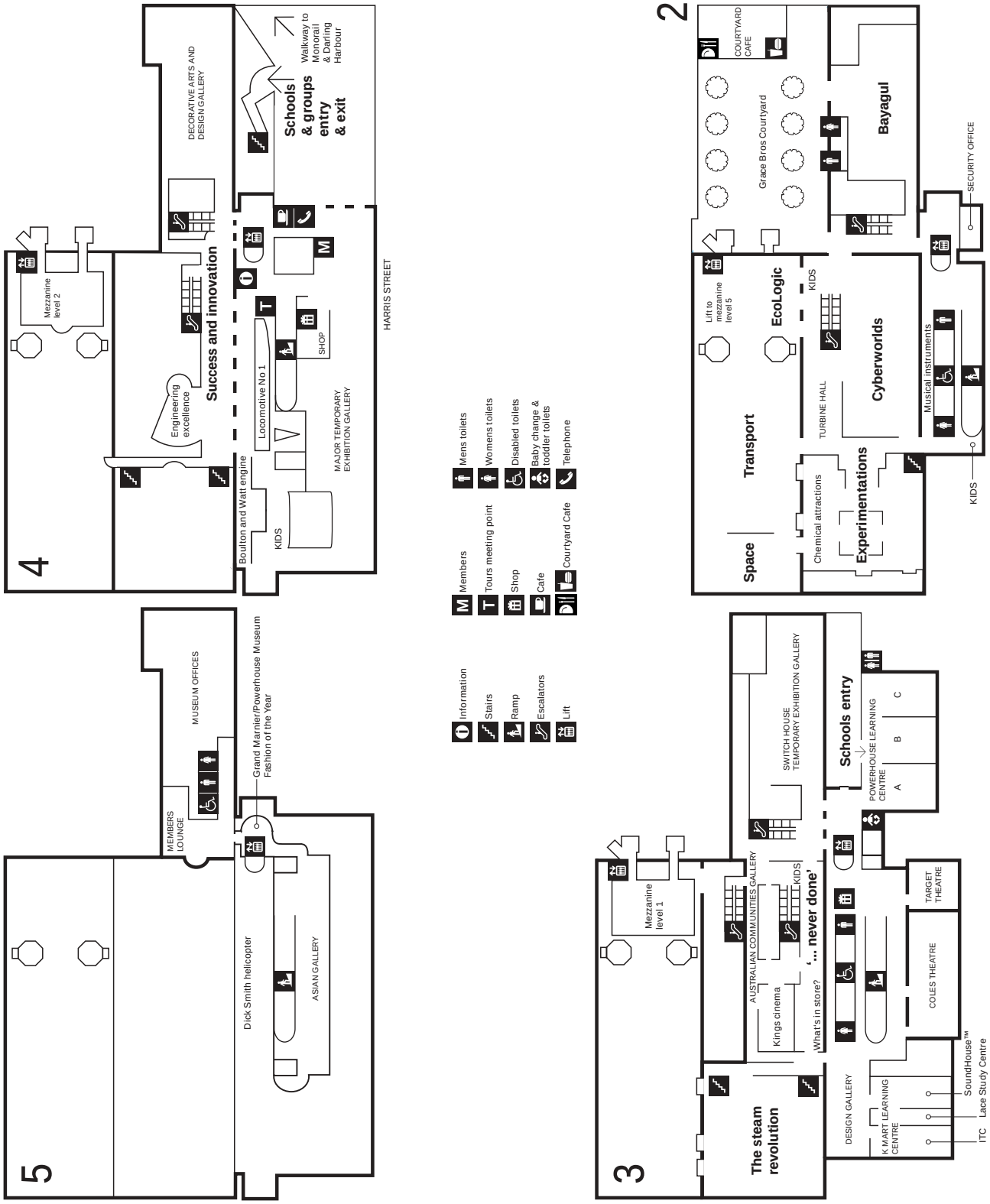
a. While in the bush hut, ask students to identify what things are now powered by electricity. How did the Coolgardie safe keep food cold? *(The hessian sides of the food safe were kept wet. As water evaporated it cooled the air inside the safe.)*

b. In the 1800s people often went to bed at sunset. Ask students if they know why? *(Work could not be done in the home at night without a source of light such as candles or lamps.)* Find the range of lamps in the cabinet with the wallaby hanging in it. Ask students to think about what it would be like to live in a hut lit by a kerosene lamp.

c. Walk through to the 1920s kitchen. How similar or different is it to your kitchen today? Go over to the display opposite the kitchen and look at the advertisements on the TV set. Wait for the Mr Ice Man advertisement and ask students in what ways the ad claims that ice is better than an electric fridge? *(Claims that it is more economical and won't break down.)*

d. Next to the TV are electrical appliances that became popular from the 1920s on. Explore the rest of *'… never done'* and discuss how electricity in the home has influenced the quality of life.

Map


2
COURTYARD CAFE
Grace Bros Courtyard
Bayagul
Lift to mezzanine level 5
EcoLogic
KIDS
Transport
TURBINE HALL
Cyberworlds
Musical instruments
SECURITY OFFICE
Space
Chemical attractions
Experimentations
KIDS
4
Mezzanine level 2
DECORATIVE ARTS AND DESIGN GALLERY
Schools & groups entry & exit
Walkway to Monorail & Darling Harbour
Success and innovation
Engineering excellence
Locomotive No 1
SHOP
M
T
HARRIS STREET
MAJOR TEMPORARY EXHIBITION GALLERY
Boulton and Watt engine
KIDS
Information
Stairs
Ramp
Escalators
Lift
Members
Tours meeting point
Shop
Cafe
Courtyard Cafe
Mens toilets
Womens toilets
Disabled toilets
Baby change & toddler toilets
Telephone
5
MUSEUM OFFICES
MEMBERS LOUNGE
Grand Marnier/Powerhouse Museum Fashion of the Year
Dick Smith helicopter
ASIAN GALLERY
3
Mezzanine level 1
SWITCH HOUSE TEMPORARY EXHIBITION GALLERY
Schools entry
POWERHOUSE LEARNING CENTRE
A
B
C
AUSTRALIAN COMMUNITIES GALLERY
Kings cinema
What's in store?
KIDS
'... never done'
TARGET THEATRE
COLES THEATRE
The steam revolution
DESIGN GALLERY
K MART LEARNING CENTRE
SoundHouse™
ITC
Lace Study Centre

→ Post-visit activity

Purpose: students will investigate a form of electricity generation and participate in a round table conference.

Sample teaching strategy

1. Since each team may have explored different exhibits at the Powerhouse Museum, we suggest the teams share their information and ideas for completing the challenge.

2. In consultation with your students decide on a topic for the conference. A sample topic might be: 'Making electricity: alternatives for the future — a conference to examine the pros and cons of various means of generating electricity in the future, including fossil fuels, nuclear reactors, and tidal, hydro, wind and solar power'.

3. Either as individuals or in the teams that visited the Museum ask students to select and research a method of making electricity. Have them prepare a case for its use in the future. Students can compile their research reports in a conference proceedings booklet or they could produce posters and display them during the conference.

4. Invite students to take on the roles of representatives from various groups including conservationists, mining companies, the 'Global Warming Party', electricity generation companies, fuel companies, the 'Anti-Nuclear Alliance', politicians, members of the public and journalists.

5. Set up the conference table with all the students facing each other in a circle with a label to show which interest group they represent.

6. Direct questions to conference delegates, field questions and comments, encourage students to contribute, and ensure that all members have an opportunity to speak.

7. The conference could also take the form of a debate with students arguing for or against a particular form of electricity generation.

8. Another alternative is for the students to set up their investigation as a 'trade show' and invite other members of the school to visit the displays.

→ History of the Powerhouse Museum building

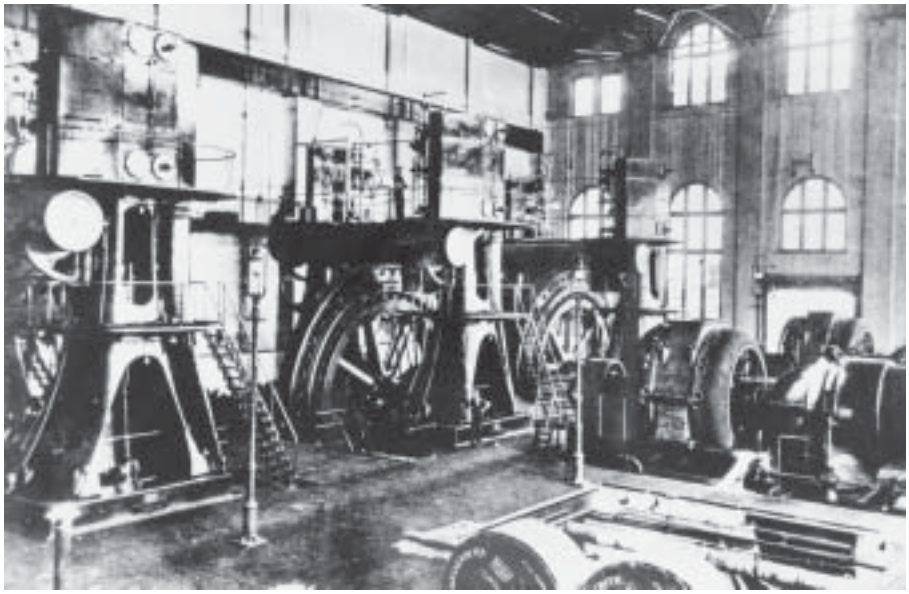
The Powerhouse Museum is built in and around the shell of the old Ultimo power station, constructed in 1899–1902 to provide power for Sydney's new electric tram system.

When you visit the Powerhouse you walk through the old boiler house with its enormous pair of smokestacks, the turbine and engine houses, where the electricity was generated, and the switch house (built in 1927), where the electricity was switched through to various parts of the city.

After 50 years of operation the changing transport needs of the city sounded the death knell for this energetic giant, as buses took over from trams. In 1963 the Ultimo power station was closed. Ten years later it was a derelict, vandalised hulk.

In the 1980s the building was renovated and the Museum opened in March 1988. All that remains of the power station is the shell and the gantry and cranes that your students will see in *The steam revolution* exhibition.

The old Ultimo power station.



The turbine house in the Ultimo power station.

→ Extension activities

Ask students to:

- Look for stories about electricity in newspapers and popular science journals. Put them up on a current affairs notice board.
- Borrow a van de Graaff generator or Wimshurst machine from a local high school to further explore the concept of static electricity with your students.
- Write to your local electricity authority for information on the generation and distribution of electricity in your area.
- Investigate lightning and safety in thunderstorms. Find out about lightning rods and how they work.
- Examine electricity bills and specifications for electrical appliances to consider the cost of electricity and how it is calculated.
- Observe how a generator operates. Research and trial the range of ways of turning a generator, eg human action, moving water, wind, air and steam.
- Find out more about the Mobbs family's sustainable house, which has a solar electricity generator. For details about a class visit to the house, contact (02) 9310 2930 or visit www.sustainablehouse.com.au
- Investigate ways in which your classroom or the school can reduce their electricity usage. Draft guidelines for the implementation of any ideas.
- Visit a power station such as Delta Electricity's Mount Piper Power Station located 25 km west of Lithgow on the western edge of the Blue Mountains. The Mount Piper Energy Expo is situated on the grounds and is full of information on electricity generation. Call (02) 6354 8155 for more information.

Mt Piper Power Station.

→ Assessment tool

A Likert scale can be used by the teacher as an evaluation of the Discovery Challenges program or by students as a self-assessment tool. Teams can use this to evaluate themselves or other teams. Below are some suggestions for creating your own Likert scale.

A sample Likert scale might look like this:

Name: Date:

Challenge name:

Who is assessing? (circle one) Student Team Teacher

1. Criterion: Quality and accuracy of information gathered at PHM

Quickly put together | Shows some thought | Accurate & detailed

2. Criterion: Completed challenge project

Incomplete | Meets criteria | Exceeds criteria

3. Criterion: Creativity

Lacks originality | Shows some thinking | Museum-worthy

Comments:

1. At the top of your scale include a place for name, date and challenge name.
2. Also include a 'Who is assessing?' line with choices to circle.
3. Establish criteria for assessment. The three criteria shown here are some examples. Objective statements may also be used for evaluation, such as, 'Students demonstrated the ability to…'
4. Decide on a scale. Scores are placed on the scale by marking an 'X' where the score falls. You can use a verbal scale like the ones shown left, or a variety of others. Some additional scales might be:

   1__2__3__4__5
   A__B__C__D__F
   Wow__Okay__Needs Work

5. Leave room for comments at the bottom of the page.

Grading Scale:

6. Include a scale if grades are used.

4.5 – 5 = A 3.8 – 4.4 = B 2.8 – 3.7 = C 2 – 2.7 = D below 2 = not yet

This is one scale that works with the 1————2————3————4————5 scale.

You would add the total points and divide by the number of criteria for final number grade.

→ Feedback form

Your feedback will help us modify and improve the Discovery Challenges program. Please complete this evaluation with your students and return it to the address below or fax to (02) 9217 0441. When we receive your completed form we will send you a free family pass to the Museum.

School name:

Teacher in charge:

School phone:

School address:

Year level(s):

Total group size:

Day and date of visit:

Name of challenge:

Did you do the pre-visit activity?	Yes ☐	No ☐
Was the pre-visit activity useful?	Yes ☐	No ☐
Were the 'Where to go' directions helpful?	Yes ☐	No ☐
Was the 'All about' information helpful?	Yes ☐	No ☐
Were the 'To say or do' questions relevant?	Yes ☐	No ☐
Did your group do the post-visit activity?	Yes ☐	No ☐
Did the challenge trail assist in completing the post-visit activity?	Yes ☐	No ☐
Did you attempt an extension activity?	Yes ☐	No ☐
Would you like to do a challenge again in the future?	Yes ☐	No ☐

How did you incorporate the challenge into your curriculum?

Comments:

Thank you for taking the time to fill out this form!

Please return to: Powerhouse Discovery Challenge Program
Education & Visitor Services
Powerhouse Museum
PO Box K346
Haymarket NSW 1238

discovery challenges

The Electricity Discovery Challenge
is sponsored by

Delta electricity

For other challenges visit:
http://www.phm.gov.au/education/challenges.html

For more information about Powerhouse Discovery Challenges or to make a booking, contact:
Education and Visitor Services, Powerhouse Museum
Telephone: (02) 9217 0222
Fax: (02) 9217 0441
Email: edserv@phm.gov.au
Post: PO Box K346, Haymarket, NSW 1238

Get regular updates about Museum programs delivered directly to your computer by joining our listserv. Email: edserv@phm.gov.au

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