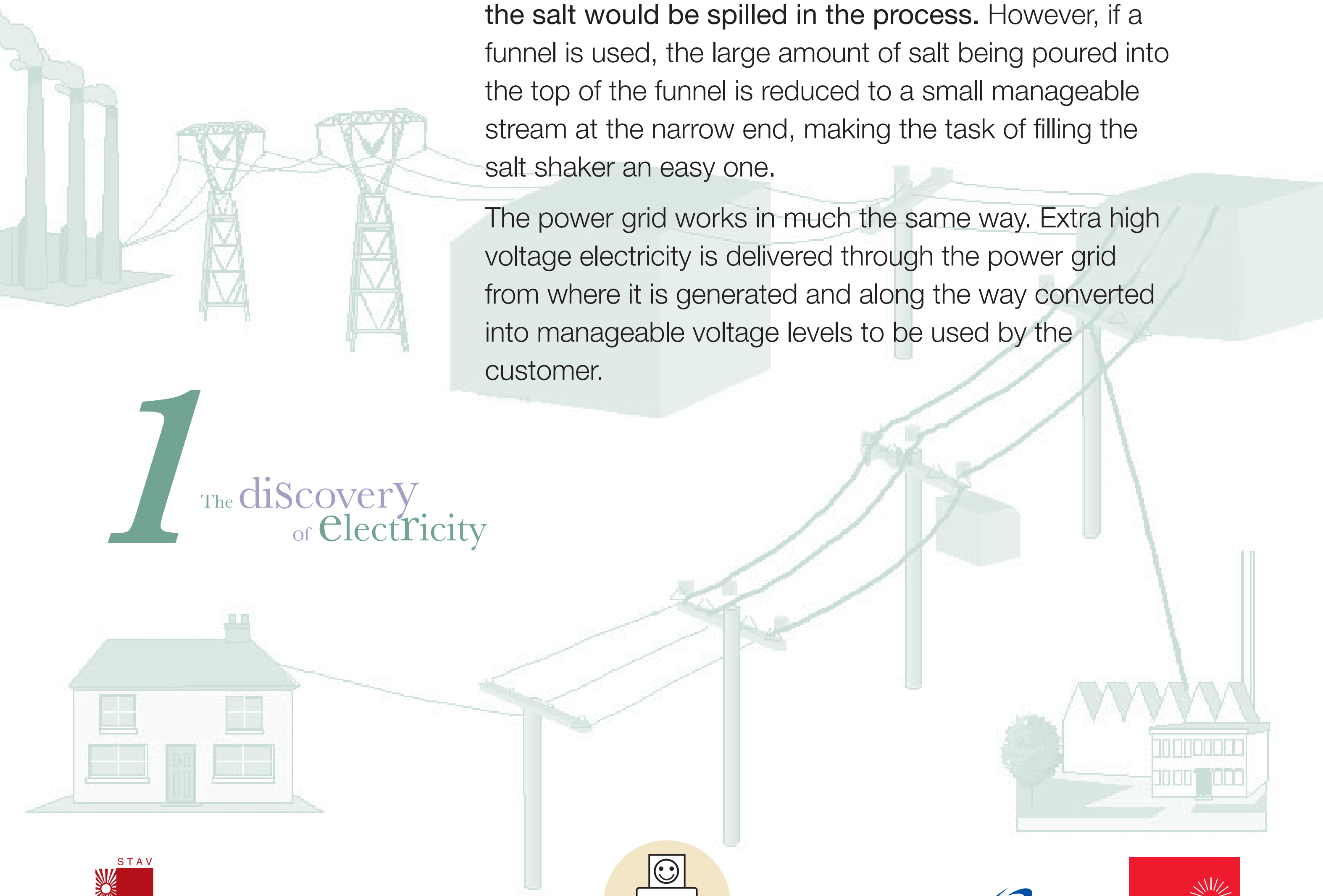
The discovery of electricity

What is a Power Grid?

Imagine filling a small salt shaker from a large bag of salt. It would be an extremely difficult job and much of the salt would be spilled in the process. However, if a funnel is used, the large amount of salt being poured into the top of the funnel is reduced to a small manageable stream at the narrow end, making the task of filling the salt shaker an easy one.

The power grid works in much the same way. Extra high voltage electricity is delivered through the power grid from where it is generated and along the way converted into manageable voltage levels to be used by the customer.



1 The discovery of electricity

The discovery of electricity fact sheets reviewed and updated with the assistance of STAV Publishing

print friendly

CitiPower Powercor Australia

<Which is the better conductor – aluminium or copper?>

<Transmission system>

Perhaps the most recognisable part of the power grid is the network of transmission lines, supported by large metal pylons, that threads its way across the countryside. Other components of the grid include terminal stations, zone substations and sub-transmission lines.

Electricity is produced close to supplies of energy which is used to drive equipment used to generate our power. <Coal fields and water from dams> are the two most common forms of energy used in the production of electricity.

The electricity is then delivered to customers, who may live in the city or the country, by using the power grid.

Extra high voltage transmission lines are needed to carry large amounts of electricity over long distances. In Victoria, most of the transmission lines operate at voltages of 500 kilovolts (one kilovolt equals one thousand volts) or 220 kilovolts. These extra high voltage lines have higher energy efficiency than a large number of lower voltage lines. They are more economic to construct, operate and maintain.

Most transmission lines are overhead lines with conductors supported on steel lattice towers. The conductors are insulated from the towers by porcelain, glass or synthetic insulators. Transmission lines can also be constructed with underground cable. Extra high voltage underground cables are considerably more expensive than overhead lines of equivalent capacity.

3

The discovery of electricity

Substations (terminal stations)

The power carried over the extra high voltage lines must be changed to a lower voltage before it can be used in the home or industry. This occurs in several stages. Firstly, the electricity is delivered to substations to either change the voltage level of the power or to provide a switching point for a number of transmission lines. The voltage of the electricity is lowered at the terminal station to 66,000 volts (66kV) by a transformer.

There are 41 terminal stations in Victoria. They average 10 hectares in size and look like a paddock full of metal poles, boxes and wires. Some of the larger terminal stations are up to 50 hectares.

Zone substations

After the terminal station is where electricity distribution businesses such as CitiPower and Powercor come into play.

The electricity is distributed on the sub-transmission system which is made up of very tall concrete or wooden power poles and powerlines, or sometimes underground powerlines.

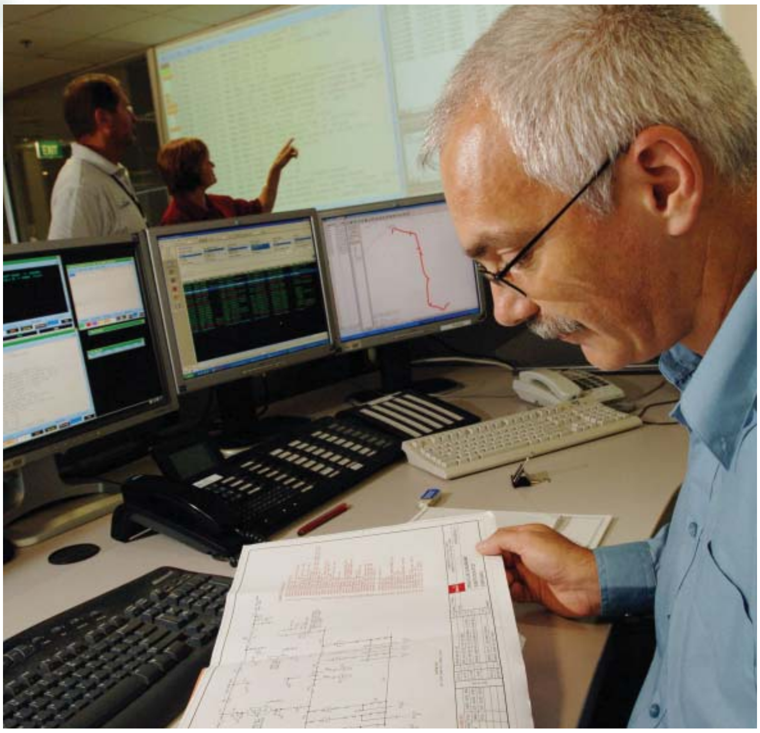
The sub-transmission system transports the electricity to one of Victoria's 235 **zone substations** where it is converted from 66,000 volts (66kV) to 22,000 volts (22kV) or 11,000 volts (11kV). Electricity at this voltage can then be distributed on smaller, lighter power poles.

From this point high voltage distribution lines transfer the electricity from the zone substations to distribution substations, where it is transformed to 230 volts for supply to customers.

a typical zone substation

Control centres

The flow of electricity through the power grid is controlled from several control centres throughout the State. These control centres use computers and communication systems to enable the operators to monitor both the flow of electricity and the condition of the power grid.



Control centre operators monitor the flow of electricity

<Fill in the gaps Activity>

Interstate power grids

Electricity does not recognise state boundaries. The Victorian power grid is joined to similar power grids in New South Wales and South Australia. This allows the buying and selling of electricity between states.

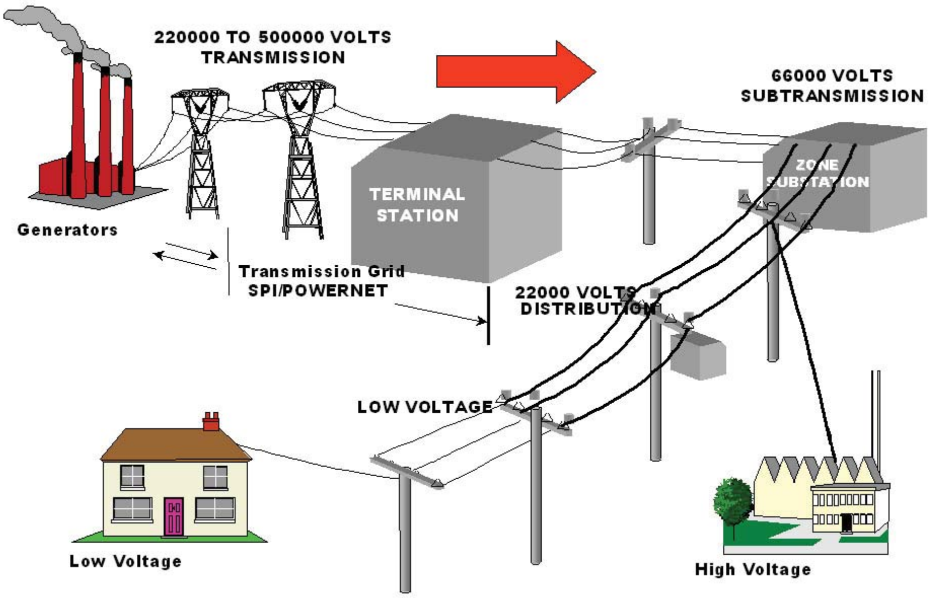
The connection with the New South Wales grid uses the 330 kilovolts transmission lines from the Snowy Mountains Hydro Scheme. In March 1990 the Victorian power grid was connected to the grid in South Australia by a 275 kilovolt line from a terminal station at Heywood in western Victoria to a substation near Mount Gambier in South Australia.

The Australian power grid extends from far north Queensland to South Australia, making it one of the longest power grids in the world.

The interconnected grid enables the more efficient use of resources and a reduced need for generating plants because generation capacity can be shared between the States. Tasmania will be connected to the south east Australian power grid once the Basslink undersea cable project is complete (scheduled for early 2006).

print friendly

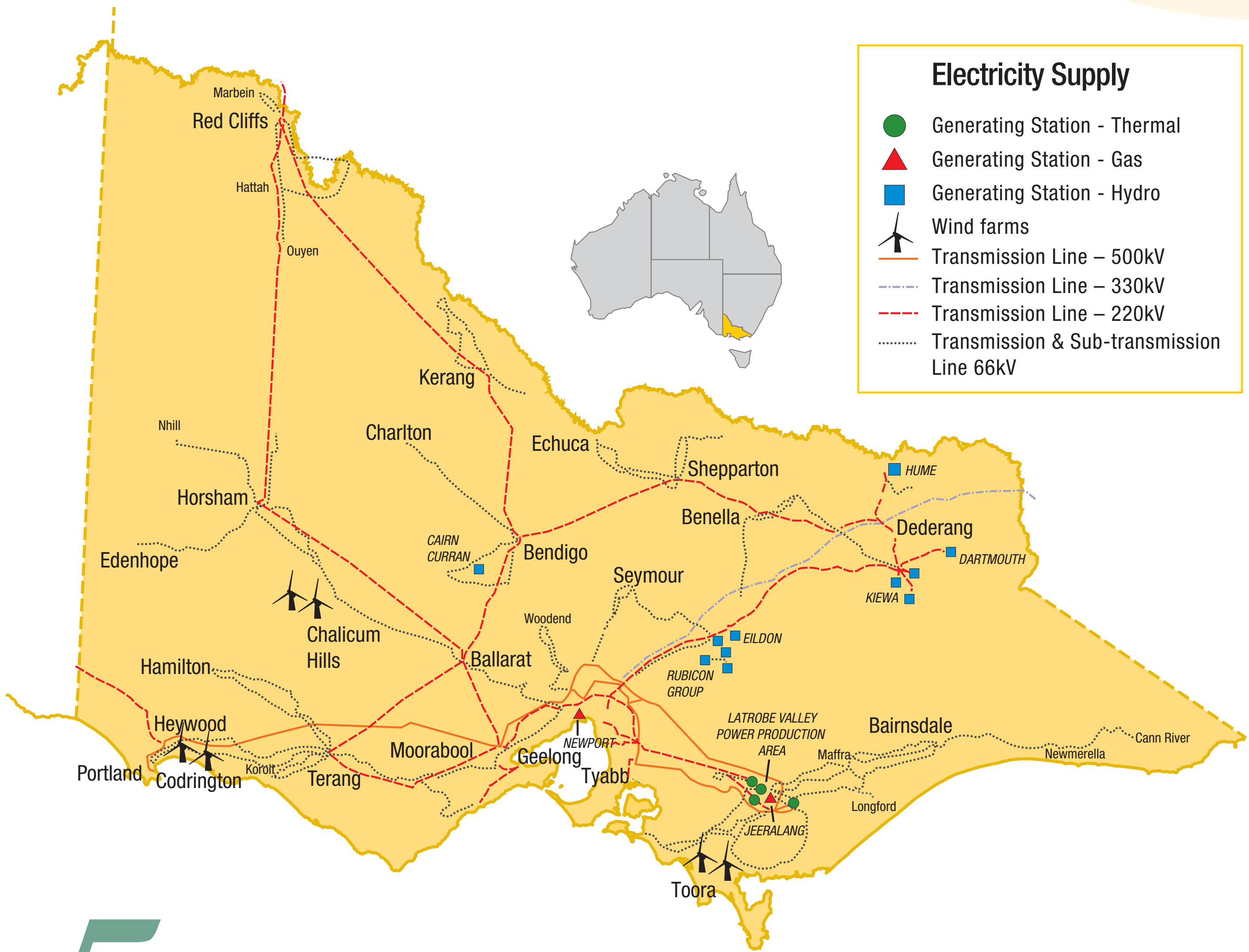
How electricity is delivered



Further investigations

Electricity transmission system
<www.energyquest.ca.gov/story/chapter07.html>

Natural gas distribution system
<http://www.energyquest.ca.gov/story/chapter09.html>



Fill in the gaps Activity

6

Use the fact-sheet. What is a Power Grid, to answer the questions below:

1. What type of lines are used to take electricity from the power generation plant to the terminal stations?
2. List three components of the power-grid.
3. How many terminal stations are there in Victoria?
4. Terminal stations convert power from ______kV to ________kV. (What conversion factor is this?)
5. Where does the electricity go after leaving the terminal stations?
6. What conversion happens in the zone sub-station?
7. Where is the electricity converted to the standard 230V for domestic use?
8. What provides the energy source to drive the thermal generating stations?
9. How many hydro generation plants are there in Victoria?
10. How are the High Voltage power lines insulated from the metal transmission poles?

The discovery of electricity

STAV PUBLISHING

Activity written by Michaela Patel on behalf of STAV Publishing.

CITIPOWER

Powercor AUSTRALIA

Investigation: Which is better?

In the olden days, copper was the most common metal used for electric wires. These days, aluminium is more likely to be used in getting power from the power station to your house.

Which is the better conductor? Aluminium or copper?

7

The discovery of electricity

Make a simple circuit to compare the conductivity of aluminium and copper.

Write down your method before you start, including a diagram of the circuit you'll use.

Check with your teacher before you start to build the circuit.

- Use the internet to find out how conductive copper and aluminium are and compare your results with accepted values.

  <http://www.scescape.net/~woods/elements/aluminum.html#top>
  <http://www.scescape.net/~woods/elements/copper.html>

- Why is aluminium now so widely used to transmit electricity?

Research

- What is the difference between AC (alternating current) and DC (direct current)? What form of electricity comes to your house? Make a list of appliances in your house that use AC and DC power.

- Research the scientific debate between Nikola Tesla and Thomas Edison over the pros and cons of AC versus DC electricity. Hold a class debate on the topic, using the information gathered as your defence.

  <http://www.pbs.org/tesla/index.html>

  <http://en.wikipedia.org/wiki/War_of_Currents>

- Find out about the hydro-electric scheme in the Snowy Mountains. How much power does this generate? When was it built? How do hydro-electric power stations work? How many are there in Australia?

  <http://www.snowyhydro.com.au/>

Useful websites

The following sites might be useful in your research and planning for these activities.

<http://www.powercor.com.au>

<www.howstuffworks.com>

<http://hyperphysics.phy-astr.gsu.edu/hbase/emcon.html#emcon>

STAV PUBLISHING

Activity written by Michaela Patel on behalf of STAV Publishing.

What is a Power Grid?

Imagine filling a small salt shaker from a large bag of salt. It would be an extremely difficult job and much of the salt would be spilled in the process. However, if a funnel is used, the large amount of salt being poured into the top of the funnel is reduced to a small manageable stream at the narrow end, making the task of filling the salt shaker an easy one.

The power grid works in much the same way. Extra high voltage electricity is delivered through the power grid from where it is generated and along the way converted into manageable voltage levels to be used by the customer.

<Transmission system>

Perhaps the most recognisable part of the power grid is the network of transmission lines, supported by large metal pylons, that threads its way across the countryside. Other components of the grid include terminal stations, zone substations and sub-transmission lines.

Electricity is produced close to supplies of energy which is used to drive equipment used to generate our power. <Coal fields and water from dams> are the two most common forms of energy used in the production of electricity.

The electricity is then delivered to customers, who may live in the city or the country, by using the power grid.

Extra high voltage transmission lines are needed to carry large amounts of electricity over long distances. In Victoria, most of the transmission lines operate at voltages of 500 kilovolts (one kilovolt equals one thousand volts) or 220 kilovolts. These extra high voltage lines have higher energy efficiency than a large number of lower voltage lines. They are more economic to construct, operate and maintain.

Most transmission lines are overhead lines with conductors supported on steel lattice towers. The conductors are insulated from the towers by porcelain, glass or synthetic insulators. Transmission lines can also be constructed with underground cable. Extra high voltage underground cables are considerably more expensive than overhead lines of equivalent capacity.

Substations (terminal stations)

The power carried over the extra high voltage lines must be changed to a lower voltage before it can be used in the home or industry. This occurs in several stages. Firstly, the electricity is delivered to substations to either change the voltage level of the power or to provide a switching point for a number of transmission lines. The voltage of the electricity is lowered at the terminal station to 66,000 volts (66kV) by a transformer.

There are 41 terminal stations in Victoria. They average 10 hectares in size and look like a paddock full of metal poles, boxes and wires. Some of the larger terminal stations are up to 50 hectares.

Zone substations

After the terminal station is where electricity distribution businesses such as CitiPower and Powercor come into play.

The electricity is distributed on the sub-transmission system which is made up of very tall concrete or wooden power poles and powerlines, or sometimes underground powerlines.

The sub-transmission system transports the electricity to one of Victoria's 235 zone substations where it is converted from 66,000 volts (66kV) to 22,000 volts (22kV) or 11,000 volts (11kV). Electricity at this voltage can then be distributed on smaller, lighter power poles.

From this point high voltage distribution lines transfer the electricity from the zone substations to distribution substations, where it is transformed to 230 volts for supply to customers.

Control centres

The flow of electricity through the power grid is controlled from several control centres throughout the State. These control centres use computers and communication systems to enable the operators to monitor both the flow of electricity and the condition of the power grid.

Interstate power grids

Electricity does not recognise state boundaries. The Victorian power grid is joined to similar power grids in New South Wales and South Australia. This allows the buying and selling of electricity between states.

The connection with the New South Wales grid uses the 330 kilovolts transmission lines from the Snowy Mountains Hydro Scheme. In March 1990 the Victorian power grid was connected to the grid in South Australia by a 275 kilovolt line from a terminal station at Heywood in western Victoria to a substation near Mount Gambier in South Australia.

The Australian power grid extends from far north Queensland to South Australia, making it one of the longest power grids in the world.

The interconnected grid enables the more efficient use of resources and a reduced need for generating plants because generation capacity can be shared between the States. Tasmania will be connected to the south east Australian power grid once the Basslink undersea cable project is complete (scheduled for early 2006).

Further investigations

Electricity transmission system
<www.energyquest.ca.gov/story/chapter07.html>

Natural gas distribution system
<http://www.energyquest.ca.gov/story/chapter09.html>

The discovery of electricity fact sheets reviewed and updated with the assistance of STAV Publishing