Enviroteach

An Environmental Education Resource for Teachers

From the Editor

Energy is all around us in various forms including light, thermal, kinetic and electrical energy. It plays a vital role in the functioning of our planet and is essential for everything we do as individuals and societies. In these winter months we are particularly conscious of our energy needs and how temperature affects our health and wellbeing.

This issue of *Enviroteach* explores the topic of energy and offers information and resources for teaching and learning about energy and sustainability. It looks at how energy production and use can impact on our environment – particularly our air and water. It includes suggestions for experiments your students can do to discover more about energy efficiency, heating, insulation, building design, moisture, ventilation and air quality.

Contact Environment Southland if you would like one of our education officers to assist you with this topic or anything else relating to the environment and sustainability. Call 0800 76 88 45 or email education@es.govt.nz.

All the best for term three!

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Environmental education officer

environment SOUTHLAND
Te Taiao Tonga

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Energy in our lives

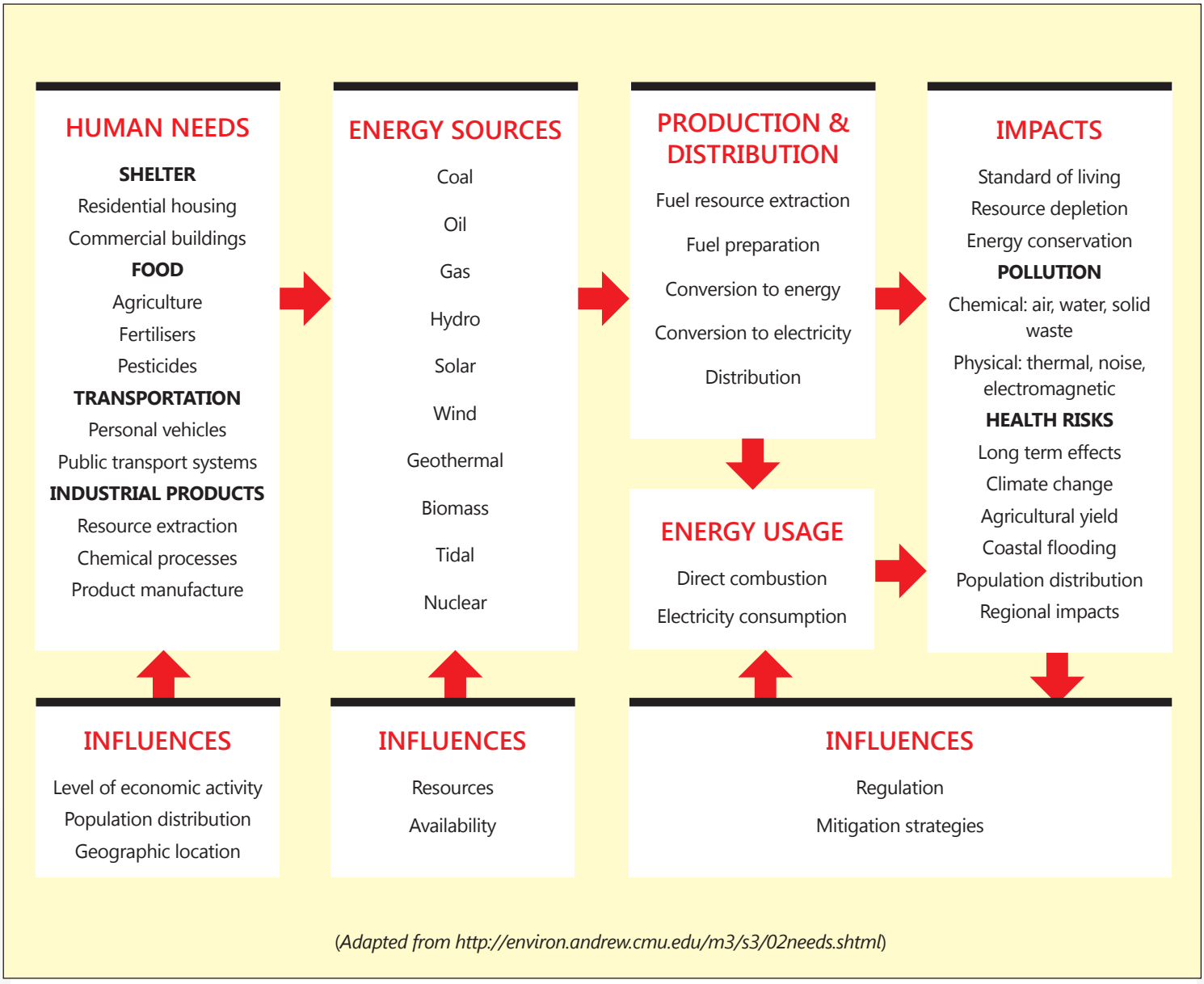
The earth's systems (atmosphere, hydrosphere, lithosphere and biosphere) are all powered by energy from the sun and the earth's own internal heat. The sun's energy drives our weather and climate, it is the main source of energy for organisms and it powers the biosphere's food chains. The earth's internal heat provides the energy for plate-tectonic motion, and for earthquakes and volcanic eruptions.

Human energy needs

As populations grow and societies become more developed, global demand for energy is increasing. Unfortunately, energy production, use, and distribution are contributing to some of the world's most pressing environmental problems, including climate change. In New Zealand, the energy sector is responsible for 22% of our country's greenhouse gas emissions.

The flow chart below provides an overview of human energy needs, where our energy comes from, how it is produced, distributed and used, and some of the associated impacts and influences.

To explore this further, watch this five minute TED Talk on the energy of the earth – http://ed.ted.com/lessons/a-guide-to-the-energy-of-the-earth-joshua-m-sneideman



(Adapted from http://environ.andrew.cmu.edu/m3/s3/02needs.shtml)

Energy and sustainability

New Zealand has one of the highest levels of renewable electricity generation in the world. Roughly three-quarters of our electricity comes from renewable sources - mostly hydro. The rest comes from burning coal, gas and oil at power stations.

Despite this, our greenhouse gas emissions are increasing. Since 1990, New Zealand's total greenhouse gas emissions have grown by about 21%. The sources that contributed most to this increase were emissions from agriculture, the energy sector and road transport.

For more statistics, visit www.stats.govt.nz/browse_for_stats/industry_sectors/Energy.aspx

What does climate change mean for New Zealand?

New Zealand's climate has already warmed by about 0.9°C since 1900. Future temperature increases will depend on the level of future global emissions. Without concerted global action to reduce emissions, New Zealand's temperature is expected to rise by about 3.5°C by the end of the century. The key risks for New Zealand are sea level rise, flooding and wildfires. Drought is also expected to increase. Some sectors, including forestry, farming and fishing, are especially vulnerable to the effects of climate change.

Climate change is a global problem requiring a global response. It affects all regions, people and economies across the world. In July 2015 the New Zealand Government announced that our post–2020 climate change target is to reduce greenhouse gas emissions to 30% below 2005 levels by 2030.

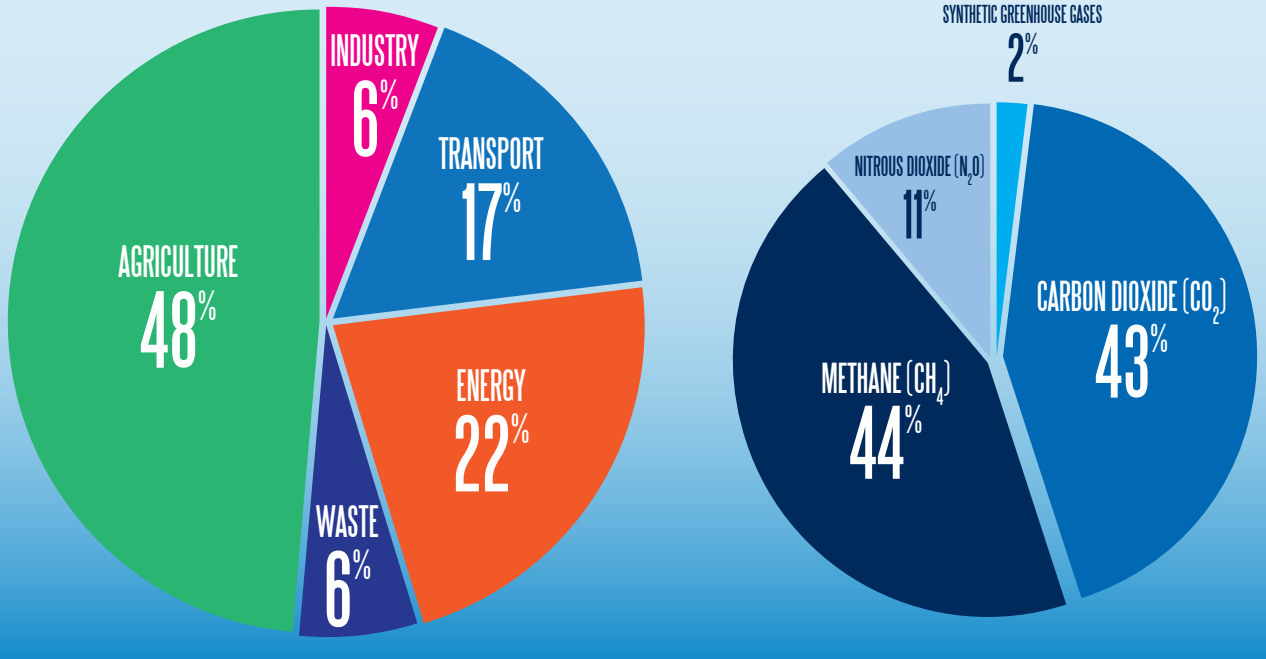
The main ways we can lower our greenhouse gas emissions are by:

- switching from fossil fuels to renewable sources
- reducing our energy consumption
- improving energy efficiency.

To explore how New Zealand intends to reduce our country's emissions, refer New Zealand's Climate Change Target – www.mfe.govt.nz

New Zealand's greenhouse gas emissions

Source: New Zealand's Greenhouse Gas Inventory for the year 2013. Emissions from forestry are not included in the estimate of total emissions. Percentages may not add up to 100 due to rounding.



Practical investigations

It is important for students to be comfortable in their learning environment. The Ministry of Education recommends that the temperature in the classroom should be maintained at 18–20°C.

Heating accounts for a large portion of a school's costs, so it is important to ensure heat is used efficiently and is not wasted. Understanding how heat is gained, transferred and lost can help your class to conserve heat in winter and reduce electricity usage. The temperature of the classroom is also influenced by insulation, building design humidity and ventilation. These interrelated factors are explored further on the next pages.

Heat loss

Heat is thermal energy. Thermal energy can be transferred from place to place through the processes of conduction, convection and radiation. Heat inside the classroom can be transferred to the outside environment by conduction through the walls, floor, roof and windows. It can also be transferred by convection. For example, cold air can enter the classroom through gaps in doors and windows, and convection currents can transfer heat energy from the ceiling to the roof. Heat energy can also leave the building by radiation through the walls, roof and windows.

1. Use thermometers to measure and record changes in the temperature of your classroom through the day. Instruct your students to present the data in graphs, and then analyse and explain the results.
2. Compare temperatures outside and inside the classroom. Explain the differences observed.
3. Investigate how effectively different materials conduct heat (e.g. www.all-science-fair-projects.com/project1437_58.html). Discuss the qualities of a good conductor versus a good insulator.

A thermal imaging camera can be used to detect heat leakage from a building.

Energy efficiency

1. Use power meters to compare how much electricity is used by different appliances. Power meters can be purchased from some electrical stores or online. Environment Southland's education team has some that schools can book.
2. Do an electricity audit and identify ways your school can reduce electricity use. The Measuring Change website offers instructions and forms – www.measuringchange.org.nz/audit-tools/energy.
3. Analyse energy use at your school using the Energy Challenger tool (best for large schools) – www.contactenergy.co.nz/aboutus/shared/energy-challenger.
4. Analyse energy use at home using the Energywise Home Energy Efficiency Calculator – www.energywise.govt.nz/how-to-be-energy-efficient/dst_recommendations/56956/17413.

Insulation

1. Design an experiment to investigate how different insulating materials affect the rate at which an object cools.
2. Compare the thermal insulation properties of different materials, e.g: www.all-science-fair-projects.com/print_project_1439_148

   www.sciencebuddies.org/science-fair-projects/project_ideas/MatlSci_p016.shtml#procedure

   www.all-science-fair-projects.com/project389_58.html

   www.all-science-fair-projects.com/project726_58.html
3. Find out whether your school building is insulated and which materials have been used.

Building design

1. Investigate how features such as room size, ceiling height, roof colour, orientation to the sun and thermal mass affect room temperature – www.all-science-fair-projects.com/project1350_148.html

Moisture

We have all observed how water condenses on cold windows in winter. It is normal for the air in your classroom to contain water vapour. However, when a surface (such as a cold window) becomes cooler than the dew point temperature of the air around it, that water vapour condenses. The amount of moisture in the air of your classroom will influence how easy it is to heat the classroom. The higher the moisture level in the air, the harder the air will be to heat.

1. Try out some these condensation experiments – www.middleschoolchemistry.com/lessonplans/chapter2/lesson3
2. Do a survey of the school to find out which windows have condensation on them on cold mornings. Explain why some do, and some don't.
3. Use a humidity monitor to measure and record humidity levels in the classroom. Humidity monitors can be purchased from some local electrical stores or online. Environment Southland's education team has some that schools can book.
4. Investigate out how humidity affects temperature, e.g. www.sciencebuddies.org/science-fair-projects/project_ideas/Weather_p017.shtml).

Ventilation

Ventilation is the process of moving air into and out of a room by natural or mechanical means. Ventilation is essential for the health and comfort of people inside buildings. Ventilation supplies air for us to breathe and removes moisture, odours and indoor pollutants like CO_2. Too little ventilation can result in poor indoor air quality, while too much may cause higher heating and cooling requirements. (Source: http://energy.gov/eere/energybasics/articles/ventilation-system-basics)

1. Design an experiment to investigate how air movement affects the rate of cooling.
2. Investigate whether air movement affects evaporation (e.g. www.all-science-fair-projects.com/category58p3.html)
3. The Ministry of Education has a survey you can use to assess ventilation and air quality in your classroom (go to the Ministry of Education website and search for "Designing Quality Learning Spaces: Ventilation & Indoor Air Quality". Get students to do the survey and then suggest actions that can be taken to improve the situation.

Outdoor air quality

Environment Southland monitors air quality in Invercargill, Winton and Gore and reports the results to the public each week during winter. Our scientists determine the quality of the air by measuring how much particulate matter less than 10 microns in diameter (PM_{10}) is in the air.

PM_{10} is the most widespread air quality problem in Southland and is caused predominantly by burning coal and wood in domestic fires. High levels of PM_{10} are associated with poor health, especially breathing difficulties, so the Ministry for the Environment has set strict National Environmental Standards for Air Quality. Average daily levels of PM_{10} should not exceed 50 micrograms/m^3.

We can all contribute to reducing air pollution and improving our air quality by choosing good quality firewood and by operating our burners in ways that minimise smoke – which contains harmful PM_{10}. Burning wet or green wood and banking fires are major contributors to smoke and air pollution. Ideally, the moisture content of firewood should be less than 25%.

Last year, Environment Southland released its Proposed Regional Air Plan. This has a number of proposed rules designed to improve Invercargill air quality and meet the national standards.

A moisture meter helps determine how dry your firewood really is.

Practical investigations

1. Collect weekly newspaper reports on air quality or visit the Breathe Easy website to access air quality data for Invercargill, Winton and Gore. Students can analyse the data and discuss any patterns they observe.
2. Use a moisture meter to measure the moisture content of firewood and help you decide whether it is dry enough to burn. Environment Southland's education team has some that schools can borrow.

For more information on Southland's air quality, steps we can take to improve it and the Proposed Regional Air Plan to help meet the National Environmental Standards for Air Quality, go to:

BreatheEasySouthland.co.nz

Case Study

Manapouri Power Scheme –
New Zealand's largest water user

We are very fortunate to live in New Zealand where so much of our electricity comes from renewable sources. But even renewable sources of energy can have impacts on our environment. This case study looks at the impacts of hydroelectric generation on the Waiau River.

Meridian Energy Limited's Manapouri Power Station (MPS), at the West Arm of Lake Manapouri in Fiordland National Park, is New Zealand's largest hydroelectric power station. Electricity generated at the power station is fed into the national grid through the Invercargill and Makarewa substations. The power station produces around 5,100 giga-watt hours (GWh) per year, which represents about 12.5% of New Zealand's entire power requirement. Meridian has a contract to provide electricity to the Tiwai Point aluminium smelter, near Bluff, which is New Zealand's largest user of electricity.

Water from Lake Manapouri is used to generate electricity at the power station and then discharged into Doubtful Sound. There are very few hydroelectric power schemes in the world where 100% of the used water is removed from one catchment and displaced elsewhere.

Meridian's diversion of water through the power station is easily the largest water take in New Zealand. Before the power station was constructed, the Waiau River was one of New Zealand's largest rivers, in terms of volume discharged (520 cubic metres per second) - second only to the Clutha River, in Otago. However, electricity generation at the MPS has significantly affected the river. The scale of damming, diversion and abstraction in this catchment has resulted in a flow regime that is highly modified and no longer "natural."

In order to keep operating the MPS, Meridian has to comply with its water use permits. A host of conditions are attached to the consents, which aim to reduce the environmental effects on the Waiau River. For example, Meridian needs to ensure that the river has a continuous flow throughout the year, and that in summer at least 14 cubic metres per second of water flows through the Mararoa Weir. It must also regulate fluctuations in the levels of the lakes to replicate natural fluctuations, and maintain ecological stability and recreational values of shorelines. These conditions are intended to address a number of issues including: river mouth closure, fish habitat and passage (native and trout), recreational use (jet boating, fishing etc), landscape and amenity values, riparian management, weed and pest issues, iwi issues such as the mauri (life force) of the river and mahinga kai, impacts on town water supplies and groundwater sources.

Manapouri Power Station at the West Arm of Lake Manapouri

Educational resources

- **Invercargill City Council:** Free, impartial advice on sustainable building practice and cutting energy consumption available to all Invercargill and Bluff residents. Eco Design Advisor, Keiron O'Connell, offers guidance on creating warmer, drier and healthier buildings, reducing energy bills, insulation, upgrading your existing building, new building design and layout, passive heating and cooling, improving indoor air quality and effective water use. He is also available for talks and presentations – phone (03) 211 1777 or email keiron.oconnell@icc.govt.nz
- **Bay of Plenty Regional Council's** "Energy Resource for teachers": A teaching kit on energy generation, use, efficiency and safety for students from levels 2-4 – www.boprc.govt.nz/residents/teachers/teacher-resources/energy-teacher-resource
- **Conservation Cup:** Organised by Torque IP for schools that participate in the School Energy Efficiency Programme. The largest electricity competition for schools in New Zealand. This year's competition runs from 24 August to 18 September 2015. Sign up by 30 July – http://conservationcup.co.nz
- **ElectroCity:** A Genesis Energy resource. An online computer game that lets players manage their own virtual towns and cities and learn about energy, sustainability, and environmental management in New Zealand. Includes teacher resources – www.electrocity.co.nz
- **Energy Efficiency Conservation Authority:** The government agency that works to improve the energy efficiency of New Zealand's homes, schools and businesses and encourage the uptake of renewable energy. EECA's action sheets for schools are a free resource to help schools identify energy efficiency improvements – www.eecabusiness.govt.nz/schools
- **Energy-efficient schools:** A guide for trustees, principals, teachers, students, caretakers and energy managers. Outlines why and how schools can reduce energy use and cost. Produced by the National Energy Research Institute in partnership with the Enviroschools Foundation and the Energy Efficiency and Conservation Authority – www.enviroschools.org.nz/resources/resources-for-enviroschools/energy_efficient_schools_large.pdf
- **Glossary:** A very comprehensive and helpful glossary of energy-related terms from the US – http://energy.gov/eere/energybasics/articles/glossary-energy-related-terms
- **New Zealand Energy Strategy 2011–2021 (Ministry of Economic Development)** – http://www.med.govt.nz/sectors-industries/energy/pdf-docs-library/energy-strategies/nz-energy-strategy-lr.pdf
- **PowerNet** – Understanding the electricity industry – www.powernet.co.nz/helpful-information/understanding-the-electricity-industry
- **The Royal Society of New Zealand** has a publication that uses science to explore the ways we use energy in our houses and ask questions about the energy issues that face New Zealand in the future. It provides some sample data from the Household Energy End-use Project (HEEP) to allow you to explore how the energy use in your house compares to other houses – www.royalsociety.org.nz/teaching-learning/resources/alpha/a134
- **Schoolgen** – a Genesis Energy website to support the Schoolgen project with activities and real-time data showing the electricity generated at Schoolgen sites – www.schoolgen.co.nz
- **The Energy $mart Schools Trust:** "The Energy $mart Schools Trust" has developed a multi-level thematic unit for schools. The unit focuses on energy conservation and how we can all play our part in alleviating the associated problems that New Zealand now faces, such as greenhouse gases, landfill waste and global warming – www.energysmartschools.co.nz
- **The Southland Regional Energy Strategy:** This strategy outlines the opportunities for Southland with regards to energy generation, storage and use. The strategy also provides a high level overview of areas of risk which will need to be addressed while considering the opportunities, in order to maintain economic, cultural and social wellbeing as well as protect the environmental values which support us – www.venturesouthland.co.nz
- **Vector's "Be sustainable with energy" programme for schools:** Linked to the New Zealand curriculum, each programme includes student workshops, a fun website and a dedicated educator (available in Auckland and Taranaki) who can present the programme to the class – www.vectorschools.co.nz