

Using Energy

Critical teaching ideas - Science Continuum F to 10

Level: Working towards level 8

Student everyday experiences

Energy is a word students frequently encounter and use every day. Students often associate energy with phenomena such as force, motion, heat and electricity, but they often consider this energy to be different to the energy associated with living things. Sound and or light are often not seen by students to be forms of energy at all. For some students, energy is primarily associated with animals (or humans): they see that only animals (or humans) can have energy.



These examples show that the meanings students have developed for the word ‘energy’ are less precise and more restricted than the way it is used in science. The ways students use ‘energy’ often vary across different contexts (e.g. electricity and living things).

Students are familiar with energy being purchased in the form of petrol, electricity or natural gas to be used by cars or household appliances. Students know that we produce heat in our homes by burning wood or natural gas or using electricity, but, as is explored in the focus idea [Energy producing and consuming reactions](#), they often do not recognise that the energy has been transformed by the appliance into several other forms of energy (e.g. motion, heat, sound and possibly light energy). Sometimes students think that energy is only present while the transformation is being made.

Many students have little knowledge of the comparative amounts of energy required by various household appliances or tools to operate. Most students commonly underestimate the amounts of energy needed to heat or cool things, and overestimate the energy required to operate electronic equipment like computers and CD or DVD players.

Many students know that electrical energy is generated in various ways, but they often do not distinguish the ‘origins’ or sources of this energy (e.g. solar, hydroelectricity or fossil fuels) from the ‘types’ of energy that are available from these sources (e.g. radiant, gravitational potential and chemical energy). For example, petrol is often seen as a ‘type’ of energy rather than a store of chemical energy. The difficulty of distinguishing between the source and type of energy reflects just one of the challenges presented to students in attempting to define or even describe what energy actually is.

 The focus idea [Is energy conserved or running out?](#) explores the problems in defining and describing energy.

Research: Carr, Kirkwood, Newman & Birdwhistel (1987), Driver & Millar (1986), Duit & Haeussler (1994), Skamp (2004), Solomon (1983, 1992), Watts (1983).

Scientific view

Because energy is so widely discussed in the world and carefully calculated by scientists it is often wrongly thought to physically exist as some kind of substance. The concept of energy has taken a long time to develop and is an invented idea created to better understand changes that occur in our world. Scientists do not 'know' what energy is.

Heat, gravitational and chemical energy and movement are all different forms of energy. There is nothing different about the energy associated with living things. Sound and light are also forms of energy. Sound energy involves the vibration (of the particles) in the medium through which the sound energy travels. Light, like radiant heat, is part of the electromagnetic spectrum and is also a form of energy (see the focus idea [Light and the nature of seeing](#)).

A 'force' acting on an object may result in the object moving faster and gaining kinetic energy or rising higher and gaining gravitational potential energy or being compressed or stretched resulting in stored elastic [potential energy](#). However, a force is not a form of energy.

The common forms of energy used in our houses are electrical energy, chemical energy available from fuels (and food), and energy originating from the sun. Electrical energy is transformed into many forms - mechanical/kinetic, sound, heat, light, and other forms of electromagnetic radiation - by everyday appliances. The chemical energy in fuels (e.g. natural gas, wood, heating oil) is mostly transformed into heat as we burn them.

All forms of energy can be measured using the same unit, [Joule \(J\)](#), regardless of whether energy is being considered in the physical, chemical or biological sciences. However, other units of energy (such as [Calorie](#) and [Kilowatt hour](#)) are used in different contexts. Most electricity bills are costed using kilowatt hours (kWh) and gas bills use megajoule (MJ) as their units of energy (one kWh = 3.6MJ).


To be useful energy needs to be stored in some forms to be transformed into other forms. Fuels are stores of chemical energy. We often transform these into heat and then mechanical/kinetic and then perhaps electrical energy. In hydroelectric dams, energy is stored as gravitational potential energy to be converted into kinetic and then electrical energy. Wind, coal, petrol and uranium are not forms of energy; they are sources or origins of forms of energy (kinetic, chemical and nuclear in the above examples).

Our homes are full of devices that transform energy (mainly electrical or chemical) into other forms. Electronic devices such as televisions, CD and DVD players and computers produce mainly light, sound and some waste heat and use much less energy compared to air conditioners and toasters. The rate at which energy is transformed is called [power](#) and is measured using the [watt \(W\)](#). Most household appliances and tools express their rate of energy transformation (power rating) in watts thus allowing comparisons of different appliances (e.g. comparing electric, gas and wood heaters). The power of car engines is commonly expressed in [horsepower](#), a non-metric unit.

More is said about the nature of the concept of ‘energy’ in the focus idea [Is energy conserved or running out?](#)

Critical teaching ideas

- Energy is the same in both living and non-living things. It has many forms and can be transformed in many ways.
- The common forms of energy used in our houses are electrical energy, chemical energy available from fuels (and food), and energy originating from the sun.
- The production of electrical energy involves chains of transformations of forms of energy using a range of sources such as brown coal, gas, hydro, wind and solar.
- We use energy at home mainly to heat, cool, illuminate and move things. The power rating of an appliance or tool (in watts), provides a useful way of comparing how fast these devices are transforming energy.

 Explore the relationships between ideas about energy in the [Concept Development Maps](#) – Energy Transformations, The Flow of Energy in Ecosystems and Energy Resources.

At this level it is important that students understand that there are a number of forms of energy and that one form is frequently transformed into others. These ideas can be developed without attempting to define energy, or even trying to say what it is. Similarly at this level, dealing with issues of energy transformation does not require the exploration of the more difficult concept of Conservation of Energy. One reason that this is more difficult for students than is commonly realised is that some forms of energy (i.e. chemical and nuclear) are more difficult to understand than others (see the focus idea [Energy producing and consuming reactions](#)). Another reason is that while energy is conserved, we are constantly told by the media that society is running out of energy (see the focus idea [Is energy conserved or running out?](#)).

Teachers will have to decide when to shift from the more common (and user friendly) phrase ‘We are using (say) electrical energy in a toaster’ to the more accurate, but less friendly ‘We are transforming electrical energy (into other forms)’. The former statement carries the danger of reinforcing common conceptions about energy being a substance or electricity being used up. This issue becomes more important at later levels when one is presenting energy as being always completely conserved.



Teaching activities

The ideas students bring to learning about energy are usually not very strongly held. As stated earlier, energy is an invented concept. Teaching will involve some presentation (rather than discovery or proving from experiment) of current science.

Promote reflection on and clarification of existing ideas.

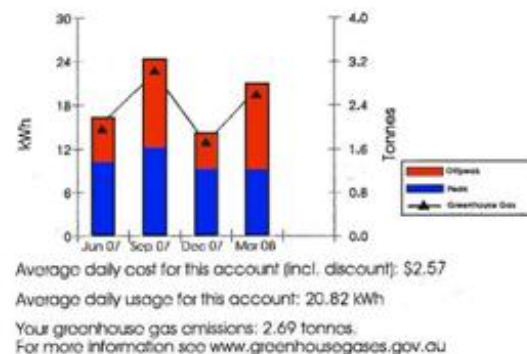
Begin a discussion of energy uses in the home with questions that start from things students are comfortable with and then gradually extend their thinking. One sequence would be to begin with a very concrete question such as ‘What are some things that we use electricity to do in the home?’ and collect responses on the board.

Calling for some ways of grouping the responses that involve (say) heating can lead to developing a (short) list of some types of energy that we produce from electrical energy. This process will probably include clarifying as appropriate what are and are not considered forms of energy (e.g. sound and light are, force is not). Having identified heat as one form of energy that we produce from electrical energy, a question such as ‘What are other ways that we produce this form of energy in the home?’ can lead to clarifying common energy transformations in the home and also identifying the main ways that we bring energy into homes. The discussion could be extended with a question such as ‘Which of these forms of energy are produced in human/animal bodies?’

Collecting evidence/data for analysis.

This topic provides opportunities to set homework that genuinely depends on the task being done at home. Nearly all electrical and many other home tools and appliances are marked with a power rating (wattage) that measures the rate of energy input. Students can collect data on this to list and compare the power ratings of appliances and tools. Once again, running some preliminary discussion and predictions about what they expect to find will make this much more purposeful.

An extension to this home based activity is to have students collect a copy of their recent electricity bill provided by their supply company. It is now a government requirement that these bills include a graph which enables the consumer to compare the seasonal use of electricity and to display the total greenhouse gas emissions.



Have students compare their accounts and calculate their electricity use at different seasons of the year. Arrange for the class to access the Government website to investigate greenhouse gas emissions:

- [Victorian Climate Change](#)

Clarifying and consolidating ideas for communication to others.

There are many examples where what is essentially the same appliance or tool can be bought with a significant range of power ratings. Drills, food processors and televisions are just three examples. The more powerful tools or appliances can be used for tasks that the less powerful ones cannot (or cannot do as well); this different usage can be linked back to notions of the energy (or power) needed for different tasks. Groups of students could each take a different appliance or tool, find advertising pictures of different versions and construct and present a poster of these versions that compare power rating and potential use.

Helping students work out some of the ‘scientific’ explanations for themselves.

The procedure of Concept Attainment (‘What’s my rule’ – PEEL Publications) can be used to allow students to work out the idea that ‘sources of energy’ are different to ‘forms of energy’. The procedure can be used to generate a lively whole class discussion. Begin by providing students with one entry each in a two column table focusing on related but different concepts. This could be done using an overhead, data projector or white board. The rule for one column would list examples of energy sources and the other column would list examples of energy types.

Stress to the students that they will not be told what the rule is for each column. The objective is to have the class induce the nature of the rule as, one by one, more examples are revealed under each column to help clarify differences. The choice of the first pair of initial terms should allow for lots of possible rules. As each subsequent example is added to each of the lists, students can eliminate potential rules that the examples no longer support.

Consider inviting students to suggest potential examples that they think can be listed under each column. Accept or reject their examples according to each rule. Having negative examples that do not fit the rule may assist students to formulate the rules more quickly. Consider introducing the teaching strategy first to the class with some simple examples such as ‘shapes that contain a right angle’ or ‘animals that eat grass’, before tackling the example provided below.

What’s my rule?	What’s my rule?
coal	movement
natural gas	heat
wood	nuclear
chocolate	light
wind	electrical
hydro	chemical
uranium	radiant

Further resources

Websites

- [Energy](#) – this CSIRO site provides a range of further resources on aspects of energy.
- [Sustainability Victoria Resource Smart](#) – this site provides a range of classroom activities and information on sustainability.
- [ResourceSmart AuSSI Vic](#) – is a Victorian Government initiative that helps schools benefit from embedding sustainability in everything they do.