What is energy efficiency?

You will find that some of the information asked for is not on the displays at CAT. Your teacher should have this information.

In scientific terms the efficiency of a system is the amount of available energy that it turns into useful energy. This is a valuable concept when looking at an energy system which consumes a fuel, particularly a fossil fuel.

When looking at renewable sources of energy such as wind, water and solar power, the issues relating to efficiency are different because a fuel is not being consumed.

In general terms what are the issues with regard to these renewable sources?

What are the percentage levels of efficiency (in physics terms) for :

A large windfarm on a good site

A large hydroelectric scheme

Solar cells (photovoltaics)

A domestic solar water heating system

A different measure of efficiency is the amount of energy produced by a generating system in its lifetime, compared with the amount used in the whole process of building, maintaining and disposing of it, including energy used to deal with waste and pollution produced.

Think about different ways of generating electricity and list all the areas of activity which would consume energy for the following generating sources:

Coal

Wind

Hydro

Nuclear

Gas

Oil

Make a note of the lifetime of each system

The amount of energy produced by most renewable energy systems (apart from tidal or biofuels) varies according to the weather but it also varies according to where you put it. A large efficient modern windmill will produce over the year the equivalent of about a third of its rated output when it is put in a good site. A good site means one where the wind speeds are strong enough for a lot of the time. If you put the same windmill in a place with lower windspeeds then it will produce less power and be less efficient.
(Each type of wind turbine is designed to operate at a particular range of windspeeds).

The efficiency can also vary according to the size of the system.
Why would the size of a windfarm affect the overall efficency?

Large windfarms supply electricity to the national grid. Small stand-alone systems usually store electricity in lead acid batteries. What factors would affect the efficiency of such a system?

What advantages could there be to relatively small scale systems?

Look at the large solar electric roof at CAT. If you look at what a solar electric system produces over the course of the year, in Britain, it is about 10% of what it would, if it was producing its maximum constantly.
How much electricity could this roof be expected to produce over the course of a year?

Look at the passive solar energy systems used in the shop and the Self-build house. How could you evaluate those systems in terms of efficiency?

What other ways could you look at efficency?

Teachers' notes - What is energy efficiency?

You will find that some of the information asked for is not on the displays at CAT. Your teacher should have this information.

In scientific terms the efficiency of a system is the amount of available energy that it turns into useful energy. This is a valuable concept when looking at an energy system which consumes a fuel, particularly a fossil fuel.

When looking at renewable sources of energy such as wind, water and solar power, the issues relating to efficiency are different because a fuel is not being consumed.

In general terms what are the issues with regard to these renewable sources?

Space occupied – a low percentage efficiency system would need a large installation to provide large amounts of power, but does that matter?

Energy payback

cost

What are the percentage levels of efficiency (in physics terms) for :

A large windfarm on a good site – *40%, but it can only take 59.4% of the energy out of the wind*

A large hydroelectric scheme – *85%*

Solar cells (photovoltaics) – *16% (monocrystalline), 10% (polycrystalline), 6% or less (amorphous)*

A domestic solar water heating system

A different measure of efficiency is the amount of energy produced by a generating system in its lifetime, compared with the amount used in the whole process of building, maintaining and disposing of it, including energy used to deal with waste and pollution produced.

Think about different ways of generating power and list all the areas of activity which would consume energy for the following generating sources:

Amounts of energy consumed for the various sources varies greatly, of course. For example gas produces far less pollution than coal or oil.

Coal - Extracting raw materials, transporting materials, building installation, maintaining, getting fuel, processing and transporting fuel, decommissioning, dealing with waste products, dealing with pollution (of air, water, land)

Wind- Extracting raw materials, transporting materials, building installation, maintaining, decommissioning,

Hydro - Extracting raw materials, transporting materials, building installation, maintaining, decommissioning,

Nuclear - Extracting raw materials, transporting materials, building installation, maintaining, getting fuel, processing and transporting fuel, decommissioning, dealing with waste products, dealing with pollution

Gas - Extracting raw materials, transporting materials, building installation, maintaining, getting fuel, transporting fuel, decommissioning, dealing with waste products, dealing with pollution

Oil - Extracting raw materials, transporting materials, building installation, maintaining, getting fuel, processing and transporting fuel, decommissioning, dealing with waste products, dealing with pollution (of air, water, land)

Make a note of the lifetime of each system

Coal about 30 years

Wind 20-25 years

Hydro design life of 50 years, but they last for 100+ years

Nuclear 25 years

Gas

Oil

The amount of energy produced by most renewable energy systems (apart from tidal or biofuels) varies according to the weather but it also varies according to where you put it. A large efficient modern windmill will produce over the year the equivalent of about a third of its rated output when it is put in a good site. A good site means one where the wind speeds are strong enough for a lot of the time. If you put the same windmill in a place with lower windspeeds then it will produce less power and be less efficient.
(Each type of wind turbine is designed to operate at a particular range of windspeeds).

The efficiency can also vary according to the size of the system.
Why would the size of a windfarm affect the overall efficency?

Less energy used to build infrastructure, including cabling

Large windfarms supply electricity to the national grid. Small stand-alone systems usually store electricity in lead acid batteries. What factors would affect the efficiency of such a system?

Conversion losses in storage in batteries, wouldn't normally be able to take advantage of very high wind speeds, proportionately greater energy use in building infrastructure

What advantages could there be to relatively small scale systems?
They might be appropriate to the specific energy requirement
They are more able to be under the control of a community

Look at the large solar electric roof at CAT. If you look at what a solar electric system produces over the course of the year, in Britain, it is about 10% of what it would, if it was producing its maximum constantly.
How much electricity could this roof be expected to produce over the course of a year?

What other ways could you look at efficency?
Land use

Renewable Energy

Take a quick walk around the site to see where all the examples of renewable energy are. Some are just displays. Some are producing very useful energy.

Frequently when people talk about using renewable energy they seem to be only thinking about generating electricity. There are 4 different ways of generating electricity renewably on site here and there are also 3 ways of using renewable energy to heat things and one used for some transport.

Sources to be seen are wind, water (two forms), solar (in 3 ways, not including photosynthesis), biofuels, and muscle power (apart from the pedal generator in the Power House).

See if you can identify what they all are. This is not a guessing game. It's designed to get you observing and questioning as you observe.

3 ways to heat things with renewable energy:

the transport one:

4 ways of generating electricity:

There are other renewable ways of generating electricity available to us in Britainwhich we do not display at CAT. What are they?

Some of these ways of using renewable energy have extremely low impacts, particularly the solar heating ones. All have some sort of impact.

These impacts vary enormously in their importance. When considering each technology we need to ask certain questions;

- Does its use increase the greenhouse effect (and thereby add to climate change)?
- Does it cause physical pollution of air, water or land?
- What is its energy payback (the amount of energy that goes into the whole process compared to the amount you get out in its lifetime)?
- What does it cost in financial terms?
- Does it occupy a large amount of useful land?
- How much usable energy could we get from this?

There are more questions that you could add to this list but these are arguably the most important.

As you go round and look at these technologies on the site make notes on the different technologies in relation to these issues (but you wont find all the answers out on the displays).

Think about impacts in another way. People often get concerned about installing a particular type of energy generator in a place because of its impact on that particular place. We need to think about what its impact would be globally. For example, if it cuts down CO_2 emissions it will, to some degree, reduce climate change and might save lives in areas prone to drought or to flooding thousands of miles away.

But also, think about what will happen to that particular place itself if we do not do not do something serious to reduce CO_2 emissions.

We need to plan a sustainable future for Britain. We need to use renewable sources of energy but we also need to use it efficiently so that our need to generate power is as low as possible.

Think about what time of year the particular sources you have listed will produce most energy and when they will produce least.

What would an energy mix for Britain look like that would produce what we need when we need it?

Renewable Energy (teacher's notes)

Take a quick walk around the site to see where all the examples of renewable energy are. Some are just displays. Some are producing very useful energy.

Frequently when people talk about using renewable energy they seem to be only thinking about generating electricity. There are 4 different ways of generating electricity renewably on site here and there are also 3 ways of using renewable energy to heat things and one used for some transport.

Sources to be seen are wind, water (two forms), solar (in 3 ways, not including photosynthesis), biofuels, and muscle power (apart from the pedal generator in the Power House).

See if you can identify what they all are. This is not a guessing game. It's designed to get you observing and questioning as you observe.

3 ways to heat things with renewable energy:

- *solar water heating*
- *passive solar space heating (new shop & Self-build house)*
- *woodchip burned for heating*

the transport one:

- *cycling*

4 ways of generating electricity:

- *wind*
- *hydro-electricity*
- *solar cells (photovoltaic cells)*
- *wave*

There are other renewable ways of generating electricity available to us in Britain which we do not display at CAT. What are they?

- *tidal*
- *other biofuels (oilseeds, straw etc.)*

There is no significant potential for using geothermal to generate electricity in Britain

Some of these ways of using renewable energy have extremely low impacts, particularly the solar heating ones. All have some sort of impact.

These impacts vary enormously in their importance. When considering each technology we need to ask certain questions;

- Does its use increase the greenhouse effect (and thereby add to climate change)?
- Does it cause physical pollution of air, water or land?
- What is its energy payback (the amount of energy that goes into the whole process compared to the amount you get out in its lifetime)?
- What does it cost in financial terms?
- Does it occupy a large amount of useful land?
- How much usable energy could we get from this?

There are more questions that you could add to this list but these are arguably the most important.

As you go round and look at these technologies on the site make notes on the different technologies in relation to these issues (but you wont find all the answers out on the displays).

Passive solar – sometimes costs more, produces pleasant, light spaces

Solar water heating – costs a fair bit, good efficiency and energy payback

woodchip burned for heating – produces CO_2 which should be absorbed by replacement trees, uses land

cycling – fitter people

wind – fairly cheap, very good energy payback, uses land but not valuable land, no physical impact except a concrete pad, huge resource

hydro-electricity – very cheap in long term, extremely good energy payback, changes a landscape permanently, not a large resource in Britain (huge schemes elsewhere in the world sometimes have huge negative impacts)

solar cells (photovoltaic cells) – could go on roofs and not occupy space, expensive, energy payback not nearly as good as wind or water (but better than fossil fuels or nuclear), supplies most in summer when we use least (but have less from wind and hydro)

wave – does not occupy land (except a bit on coasts), large resource, needs more development

tidal – cheap in the long term, very good energy payback in long term, very predictable (comes twice a day, every day), can mean barrage across estuaries which changes habitats of wading birds (what happens to those when sea levels rise 2m?)

other biofuels (oilseeds) – uses land, sometimes a lot of processing (not always)

Think about impacts in another way. People often get concerned about installing a particular type of energy generator in a place because of its impact on that particular place. We need to think about what its impact would be globally. For example, if it cuts down CO_2 emissions it will, to some degree, reduce climate change and might save lives in areas prone to drought or to flooding thousands of miles away.

But also, think about what will happen to that particular place itself if we do not do not do something serious to reduce CO_2 emissions?

See comments on tidal above but also all landscapes will change

We need to plan a sustainable future for Britain. We need to use renewable sources of energy but we also need to use it efficiently so that our need to generate is as low as possible.

Think about what time of year the particular sources you have listed will produce most energy and when they will produce least.

What would an energy mix look like that would produce what we need when we need it?

Things Biological

What is so important about biodiversity?

There is enormous biodiversity on this site.
Some of this is the result of deliberate actions taken. What examples can you see of this?

Some biodiversity has developed as a result of things we have done on the site but it is an incidental benefit, not the main purpose. What examples can you see of this?

Identify and describe as many different habitats as you can find here.

None of the organic waste produced on the site ends up in landfill. In a landfill site it would decompose anaerobically. What gas would it then produce and why do we want to avoid that?

Some of our paper and card waste goes for recycling and the rest goes into compost heaps. Food waste is fed to the animals and the remains composted.
Describe the processes going on in the compost heaps.

We deal with toilet waste in a variety of ways. Go and look at the new toilets between the top railway station and the shop. Look in the composting toilet (unisex) and at least one of the others and look at the sign describing what happens on the railway platform. From that position on the platform you can see the infrastructure that deals with the waste.
Describe how these processes treat the waste.

We also have reed beds to deal with much of the “grey” water and “black” water from the site.
The main one can be seen on your left after you have left the car park on your way towards the main road (just before going across the river).
What is “black” water?

What is “grey” water?

The world is basically a plant decomposer system. Discuss.

Buildings and materials

Places around the site to find information – the Whole Home, the Shop/Information Centre, Self-build house, all the buildings

Here when we choose materials to build with we think about a number of things:

- They should be produced as locally as possible so that minimal energy is used to transport them
- They should use as little energy as possible in the production process (embodied energy)
- They should not be harmful to health (builders' or users')
- They should be renewable (not using up a finite resource)
- They should be visually attractive
- They must perform the required task

Some of the buildings on this site were built over a hundred and fifty years ago and were refurbished 25 years ago when CAT opened. Other buildings have been added over the years.
Various different materials have been used in the buildings.
Ideas about what materials we should use have changed over the last 25 years with improved information.
Compare the materials you can see used in the Wates House (where the Whole Home display is) which was built in 1976, and those used in the ATEIC building (where the Information Centre and shop are), built in 2000, and the Theatre, built in 1999. Explain why the various materials have been used.

There are houses in Britain which have walls built of earth and which are hundreds of years old. How has modern technology been used here in the ATEIC building to improve on what could be done in the past?

Which materials have been used as insulation in the buildings on the site?

Which materials have been used to store heat?

Explain the difference between materials which insulate and ones which store heat.

Materials which store heat can be used to keep a temperature stable. They can help to stop a building from getting too hot as well helping to stop it getting too cold. How can this work?

Why do you think we no longer use (or use as little as possible) the following materials?

Cement and concrete blocks

PVC (poly vinyl chloride)

Where is PVC used in buildings?

A small amount of plastic is used in the buildings here. Why do you think it is used and where?

The ATEIC building and the Self-build house have been designed so that solar energy can come in through windows to heat the building up (this is called passive solar heating). Draw a quick sketch of the ATEIC building to show –

how the solar energy can come in
how the heat produced is stored
how excess heat can escape

What material has been used for the outside render on the ATEIC building?

What material has been used for the internal plastering?

What sort of timber has been used for roofing (outside)?

What sort of timber has been used structurally inside?

Look at the Self Build house. What role do the trees play in the passive solar system? (They have a different role in the winter and the summer.)

Building houses so that they use passive solar energy does not cost more. Why do you think so few new houses are designed to use solar energy in this way?

Solar energy is doing at least 3 useful jobs in this house (4, if the people staying here on a course have chosen to dry clothes in the conservatory). What are the three?

There are about 40,000 houses in Britain which have solar water heating systems. On average they can get 50% of their water heating from solar energy (not for heating the house but for all the other uses of hot water). How much does solar water heating cost?

Why do you think it is cheaper to put in solar water heating when a house is being built or when the roof is being replaced?

How can terraced houses be more energy efficient than detached ones?

What rules would you set for all people to follow when they are designing new buildings in Britain?

What about aesthetics? Do environmentally low-impact houses have to follow a particular style?
What impact does energy saving and using solar energy have on the look of a house?

Would it be possible to design an efficient, low energy house which looked very much like what people see as a “normal” house?

Would there be any difficulties in doing that and if so what would they be?

Follow up activity for school/college or on the long coach trip home – design your own ideal low impact home.

Materials and design

Places around the site to find information – the Whole Home, the Shop/Information Centre, self-build house, all the buildings

Here when we choose materials we think about a number of things:

- They should be produced as locally as possible so that minimal energy is used to transport them
- They should use as little energy as possible in the production process (embodied energy)
- They should not be harmful to health (builders' or users')
- They should be renewable (not using up a finite resource)
- They should be visually attractive
- They must perform the required task

In practise in some situations it is not possible to fit all these criteria. Then you have to prioritise and decide which are essential.
Go and look at the Molehole. What materials have been used here for the molehole itself and the models?

How do the materials for the models fit our criteria?

Have a look at the mole herself. What material is she made of? Think about the design specification for her. Is there a material we could have used that would have fitted all the criteria above?

We use timber frequently in buildings and displays. How does this fit the criteria above?
(In this area we can get all sorts of timber locally from plantations where we know the trees are being replanted)

If timber is being used in this way what is the impact on the carbon cycle? What impact does it have on the amount of CO_2 in the atmosphere?

Look at the display of compost bins. What are the pros and cons of the various designs here, particularly in relation to the materials used.

Before the Centre was developed here, the site was an empty pile of slate with a few trees, no ponds and virtually no soil.
Everything here (buildings, displays and gardens) has been designed for this particular context, mostly by staff at CAT. Some things have been designed to look very “natural”, such as the lake which is the reservoir for the railway.

Choose something on the site (a display, feature or building) and redesign it to do the job better, either in the materials use, effectiveness or aesthetics. Bear in mind that cost is an important factor. (You could make some notes for this now and continue the design process later).

Technology used at the Centre is not all ‘high’ or ‘low’, but is ‘appropriate’.
An example of ‘high’ technology is the water balanced cliff, railway. How is the technology used on the railway appropriate?

An example of ‘low’ technology is the hydram (near the solar water heating display). How is the technology used here appropriate?

Follow up design work – Design an ideal sustainable home.

Health issues & sustainability

Information about some of these issues is in the Whole Home display.

Whose health?
Global warming leads to changes in the climate, habitats and landscapes all over the planet.
What health problems does this raise for people in:

the Sahel region of Africa

Britain

Holland and Bangladesh

What does our lifestyle have to do with the problems caused for people in other countries by global warming?

Here at CAT we try to use materials that will not damage people's health. What building materials can be harmful to health? Explain why each one is harmful.

About 97% of the electricity used in Britain is generated by using nuclear and fossil fuels. What impact can this have on people's health?

What is the impact on people's health of the growing use of cars?

Many people living on low incomes in Britain live in homes which are draughty, damp and expensive to heat. How can technologies that you see here relate to those problems improve people's health?

How can we improve our health in the way that we manage our gardens?

We treat all CAT's waste water and sewage on the site and we put it to good use in the end.
How do we do this?

How does our sewage treatment relate to health issues?

Study guide - leisure and tourism

Aims and Objectives

The aim of the Centre is to inform, educate and inspire visitors. (See p4 for this.)
What evidence do you see around you of these aims being put into practice?

What problems do you think are caused by trying to educate people and ensure that they have fun?

Give an example of a display which you think aims to combine fun and information.

How well do you think it works and why?

What improvements would you make to it (without huge expenditure)?

What problems do you think are caused by trying to educate people and earn an income?

Do you see any contradictions caused by this? describe them and suggest changes that could be made.

History

The Centre is on the site of an old slate quarry. Do you think that this is obvious to visitors?

Do you think more should be made of this?

What might the advantages and disadvantages of doing so be?

Transport

Go round the transport maze. Most visitors arrive by car but it is clear that the Centre thinks that a reduction in the use of the motor car would be environmentally beneficial. What does the centre do to address this dilemma?

What else could it do?

What could be done by local and national government and private industry to address this issue?

What implications does this whole issue have for the tourism trade in general?

Visitors

What do you think people in the following groups get out of a visit to the Centre?
What could be done to improve the experience of people in each category?

a. families with small children on holiday

b. families with teenagers on holiday

c. elderly people

d. people with limited mobility

e. adults who are unable to read the signs (through illiteracy or poor eyesight)

C.A.T. is trying to reach and provide something for all sectors of society, of all ages and with all levels of educational background. What are the challenges created by this?

Management

C.A.T. works as a co-operative, with all the permanent staff getting equal pay and having an equal say in the running of the place. Do you think that there are any ways in which that is observable to the visitor or that it makes any difference to the experience of the visitors?

Customer care

Comment on the standards of customer care which you observe at C.A.T. In what ways could this be improved?

Impact

This is a predominantly Welsh speaking and farming area. Some of the coastal towns have catered for tourists since the nineteenth century but at that time there was a thriving quarrying and mining industry in this area. At its peak this quarry employed hundreds of people. Employment in the quarries and mines has declined to very little now and the numbers employed in farming are far less than they used to be.
What do you think would be the impacts on the area and community of centres such as C.A.T?