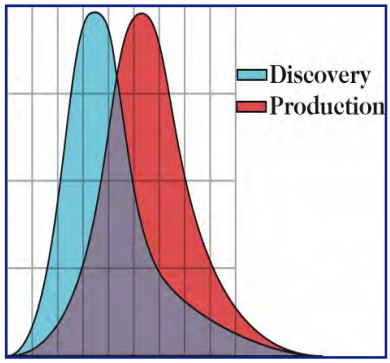
What Energy Future?



Supplementary information that may be used with the *What Energy Future?* DVD, and which teachers may find useful. This document also contains more detailed information about the video clips used on the DVD.

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What Energy Future?

Introduction

Energy and the cost of Energy is hardly off the front page any day now. Energy is a major issue for everybody - governments, local governments, agriculture, business, commerce, at school and at home. Everybody uses energy - especially people living in the western world. The world today has been largely shaped by energy booms of one sort or another in the past: coal-fired steam power drove the industrial revolution; oil-fired internal combustion engines have driven cars, trucks, trains and boats and planes; the rise of electricity came from coal fired power stations (though New Zealand has been lucky to have so much hydro-energy to make its electricity); highly refined oil has enabled jet engines and international jet travel; and nuclear energy has also been harnessed in large, wealthy countries to generate nuclear power.

For the last few decades western economies, and the economies of China and India and rich Asian countries have grown sharply and without hold-up because energy has been cheap. Coal has been cheap. Natural gas has been cheap. The 1970's aside - oil has been cheap. Nuclear power has remained a bit of an energy novelty. Over 80% of the world's energy has come from coal, oil and natural gas - mostly oil. The pressure to get energy from any other source has been minimal. For years nobody gave much of a thought to the idea that fossil fuels could actually run out.

In the last couple of years especially, all that has changed. The idea of growing what you put in the tank of your car, rather than sucking it out of a hole in the ground, no longer looks like economic madness. Nor does the idea of plugging your car into an electric socket.

While there is much debate about "peak oil" and how big the reserves of of oil and natural gas in the ground actually are - the painful fact is that oil, natural gas, petrol and diesel have suddenly become much more expensive. The pressure is on to develop alternatives.

Expensive fossil fuel makes solar power, wind power and other innovations - once thought silly ideas - very sensible and cost-effective.

Whether you agree that Climate Change is caused by human factors - such as burning large amounts of fossil fuel - or whether it is caused by some natural cycle such as sunspots - there is a significant scientific consensus that human society should do more to reduce or minimise the effects of carbon dioxide on our atmosphere - by burning less of it.

But it is very difficult to change our ways - especially when it is appreciated how rich and wealthy our lifestyles now are because of the ready availability of cheap oil and fossil fuel.

This DVD - *What Energy Future?* - has been specially made for use in secondary schools to provide good background information to students so they are able to better appreciate the history and economy of world energy, as well as to understand the extent that energy has been essential to the quality of life in places like New Zealand and Australia. The DVD also portrays the damaging side of the fossil fuel industry. It explores controversial issues about peak oil and how much oil is left as well. But the main emphasis of the DVD is to address the question: What Energy Future? A number of voices are contained in the DVD. Some advocate for pure renewables - such as solar, wind, the use of biomass (eg burning wood and other plant fibre to make heat, or the use of certain plants to make ethanol for fuel), others argue that renewable energy resources will not be enough for the world to exist as it has, and that nuclear power is crucial now.

The DVD does not have a recipe for the future, but it does raise many of the questions that are around today about energy, and it contains answers from a number of different voices. It also contains heaps of useful information. After viewing the sequences and engaging in debate and discussion students will be able to engage in the wider community debate about *What Energy Future?* and will appreciate the values and arguments from various points of view.

We also recommend the companion DVD to *What Energy Future?* which explores climate change issues. That DVD was produced earlier in 2008. Entitled: *All About Climate Change*, the DVD is also available from Team Video Pacific and can be ordered from their website: www.teamvideo.net

What Energy Future?

Source information about video & film clips on this DVD, and related website links:

The 19 film clip chapters on this DVD are available under these title headings:

1. **Toward Renewable Energy**
2. **Fossil Fuelled Economy**
3. **Necessary Nuclear Alternative**
4. **Nuclear? Too Risky!**
5. **Practical Energy Changes**

The DVD can be used by "clicking" which title area you want to view. You will then be presented with 4 film clip options, each of which presents arguments and information relating to the title.

1. Toward Renewable Energy: These clips are from a film made in the US before the recent upsurge in oil price and increase in major climate change disasters around the world. The film clips serve as a gentle introduction to global energy and fossil fuel, and also to renewable energy alternatives. One clip explores the hydrogen fuel cell idea in some detail. The clips are:

History of Energy (4 mins) - Clip starts with fire, and quickly explains the use of wood, coal, and oil for energy. It also suggests that fossil fuel resources are depleting, and introduces climate change issues.

Solar Panels (2.5 mins) - Clip explains the amount of energy that arrives on earth each day from the sun, and explains that sunlight is made up of photons, which can be used to generate electricity when applied to silicon panels. Simple examples are shown, and it is suggested that large areas of solar panels could generate a lot of electricity.

Wind & Hydro (3 mins) - Clip includes many images of typical wind turbines and wind farms. It also mentions that if there is no wind, then no electricity can be generated, and that it is also useful to have hydro/dam energy sources which can generate electricity at night and when there is no wind or sun - provided there is water in the dams.

Biomass and Hydrogen (6.5 mins) - Clip is a useful and simple introduction to the idea of biomass - where plant growth is used to produce stalks or wood chips which may be burned to produce heat energy (which can in turn be used to drive generators to make electricity). It also introduces the idea that some plants make sugar which can be processed (by fermentation for example) to make ethanol (the same alcohol as in drinks) which can be burned as a fuel in cars (in Brazil most cars run on ethanol). The clip explains the use of batteries in cars, so that cars can run on electricity. However, today, battery powered cars have a short range - usually less than 100kms - and don't have much power to accelerate quickly. This leads into an explanation of the hydrogen fuel cell option for transport energy. Hydrogen gas burns in air to produce almost as much energy as petrol. The clip shows how research is progressing to put hydrogen fuel storage or fuel cells on cars to power them. NB: hydrogen is a way of storing energy. It is not "cheap" energy. Hydrogen is produced by passing an electric current through water. At least as much energy is used making hydrogen, as you get back when it is burned as a fuel.

2. Fossil Fuelled Economy: These clips are extracts from a recent US film called Crude Impact. It is highly recommended. Further information about the whole film, and about the issues and arguments it raises can found at: www.crudeimpact.com . This film is very critical of the fossil fuel industry, and also about the destructiveness of the western society which a low cost and wasteful fossil fuel economy has enabled. Clips include:

Peak Oil (6.5 mins) - Clip first introduces the global fossil fuel economy, and through an examination of the recent history of oil resources in the USA (which used to be self-reliant on crude oil - but which is now dependent on crude oil imports - like NZ and Australia), explains the idea of peak oil. This is explained through noting that the discovery of new crude oil reserves underground is at a lesser rate than the extraction of known reserves. Known global reserves and their extraction rates are mapped.

Our Oil Dependence (5 mins) - This richly illustrated clip shows how much of our lives and the things we use originate from the fossil fuel industry and its by-products. A good example is a synthetic fibre shirt. Other examples include the plastics which are made from oil and coal by-products. These items are quite apart from our reliance upon the cheap energy afforded by cheap fossil fuel. It also shows dramatically how the world's food supplies and their transport are hugely dependent on cheap fuel.

Oil Damages (6 mins) - Clip shows the explicit damage done to the world's environment from the oil industry in particular - damage done where crude oil is extracted from the ground, damage done at refineries, damage done where crude oil tankers have been damaged at sea and lost crude oil has destroyed coastal ecosystems. It also argues that cheap oil has enabled the human species to be so successful in colonising the earth, that other species are severely endanagered. It argues that even if we discover a clean energy alternative, then our wasteful and damaging ways could still end up destroying the earth and the life forms that live upon its surface.

Brighter Future (4 mins) - Clip introduces some renewable energy alternatives that exist. The use of energy saving lightbulbs is demonstrated. Energy efficiency and conservation is advocated. The clip ends with one of the experts who is interviewed, speaking out to the audience: "tag - you're it".

3. Necessary Nuclear Alternative: These clips are short extracts from a film made in the US recently by a retired engineer with almost 50 years experience in industry of one sort or another. More information about the film, and much useful factual information can be obtained at: www.nobodysfuel.com/intro.html .While the style of the film is much less glossy and interesting than a typical television documentary, it contains a great deal of very useful information about the world's energy economy. It should not be ignored just because Mr Lightfoot believes the world must build more nuclear power. There is much of educational value. The clips are:

How We Use Energy (8 mins) - Clip is similar to the Oil Dependence clip of the previous title, but emphasises the point that much of what we in western society take for granted - such as sanitation, water supply, transport systems, recreation spaces, air travel, home heating - all rely upon energy, and today that energy is mainly sourced from fossil fuel. Graphs depict the income/capita of people living in the West and compares that with income/capita of people living in India and China - countries that are growing very fast today - and many other poorer and less developed countries. He argues that the world will need more energy - not less - if it is to develop so that people can lead useful and productive lives.

How Much Oil is Left? (9 mins) - Clip provides very useful information about where the world's energy comes from - from all sources. What makes it particularly interesting is its idea that human society used to be totally dependent on only renewable sources of energy - eg burning timber for heat and to run early steam engines. And then coal and oil were discovered, which allowed huge development and growth to occur, but only because of the availability of cheap energy which was not renewable. The clip also explains the phenomenon sometimes referred to as peak oil. This is a very useful clip to explain the world's fossil fuel dependent energy situation today.

Renewables Not Enough (11 mins) - In this Clip, Mr Lightfoot acknowledges the available options for renewable power - especially wind, solar and biomass - as being useful, but believes that there will never be enough energy from such sources of energy to meet global world needs. His criticism is a useful counter balance to the generalised support for renewables contained in the title 1 film clips.

Why We Need Nuclear (7 mins) - While this clip is not a very good explanation of nuclear power, it does present some interesting arguments in support of nuclear power - eg: each power station has a small footprint; nuclear power doesn't produce carbon (because it doesn't burn fossil fuel); nuclear power stations produce electricity even when the sun is not shining and there is no wind. He addresses some of the safety issues. His goal is "fast breeder reactors". To date this is a relatively untested technology. Mr Lightfoot's arguments underline the fact that there is no easy solution to world energy.

4. Nuclear? Too Risky! : These clips are from a film made in the Australia recently by people concerned at the risks they consider are posed by an expansion of the nuclear power industry. The film is called *Climate of Hope* - and was Produced and designed by Scott Ludlam and the Anti-Nuclear Alliance of WA (ANAWA) with the support of John Butler's JB Seed foundation. In particular they are concerned about the risks to Australia: eg if Australian uranium ores are mined more intensively; if Australian outback lands become locations for the underground disposal of nuclear waste; or if Australia itself should develop nuclear power to meet energy and electricity needs. The clips included on this DVD are:

About Nuclear Power (4 mins) - Clip is a useful introduction to nuclear energy and nuclear power. It begins with the history - Albert Einstein - and explains the science with helpful animation - fission and radioactive decay. It tracks through the early development of the industry - early reactors and their use

in generating electricity - and also that their by-products can be used for making nuclear weapons such as those used to bomb Hiroshima.

About Nuclear Industry (6.5 mins) - Clip uses elegant computer animations to explain and illustrate the nuclear economy and industry. It explains: mining - how much spoil is needed to extract uranium; purification processes used to refine radioactive minerals; fission processes used in power stations; re-processing that is needed when fuel rods are spent; and the need for very long term storage or underground disposal/storage of radioactive wastes. The clip asserts that so-called fast breeder reactors - ones which can more fully use uranium fuel rods and which produce much less waste - are still only at the testing stage, and cannot be relied upon in future.

Nuclear Hazards (4.5 mins) - This clip uses animation to explain how different types of radiation can affect different parts of the human body. It also contains documentary footage of some of the better known nuclear accidents that have happened.

For Australia? (5 mins) - This clip introduces nuclear debates which are specific to Australia. The clip introduces the possibility that other countries - such as USA - might be interested in dumping or disposing of their nuclear wastes in areas of Australian outback. In particular it maps locations of uranium ore deposits which some are arguing should be mined. The clip notes that the uranium mining industry is very fossil fuel intensive - arguing that almost as much energy has to be put in to getting nuclear power (mining, refinement, construction of plant, managing waste, re-processing), as is got from it. The overall message: nuclear power is unsafe and too expensive.

5. Practical Energy Alternatives: These clips are short extracts from two different films made in Britain and New Zealand. The clips about Combined Heat & Power, and about energy innovations in Denmark and Sweden were made in a film by Greenpeace UK as part of its campaign to educate the community about energy alternatives. Check this really useful page about this Greenpeace film called *The Convenient Solution*. The other clip is from a New Zealand made film called *City of Cars*. This clip also contains useful information comparing NZ cities of Wellington and Auckland - with Australian cities of Perth and Brisbane especially, but also Melbourne and Sydney. Clips are:

Combined Heat & Power (6 mins) - Clip explains how the fossil fuel powered electricity power stations typical in New Zealand's North Island and throughout Australia - waste almost 2/3 (66%) of the energy they use as heat - which is released into rivers, the sea or the atmosphere to cool the power station. It goes on to show how by biulding smaller power stations closer to where people live, the heat energy produced can be piped into the city for heating and for other uses - thereby using more of the energy released through burning fossil fuel - rather than wasting it.

Denmark & Sweden (7 mins) - Examples of energy innovation are shown in this clip. Information and ideas shown here help to overcome arguments that more efficient uses of energy are either not possible or too idealisatic. These countries are much colder in winter than New Zealand and Australia, but nevertheless the approaches taken to use sunlight and to avoid wasting energy are really helpful in showing that it is possible to do things differently - though sometimes it is essential that government pass strong legislation or regulation to force change.

Transport: Auckland & Perth (11 mins) - This clip contains extracts from a documentary made independently in Auckland by a transport planner concerned about the emphasis on private car travel in the planning of Auckland's transport systems. Noted Australian experts Peter Newman and Dr Paul Mees, and Swedish urban planner Jan Gehl critique Auckland's land use and transport planning, and also provide comparative information about Australian cities - some of which share the same sprawling wasteful development patterns evident in Auckland. The energy point made is that sprawling cities like Auckland, which lack good public transport systems, are extremely wasteful of transport fuel, which results in inefficient and wasteful city economies.

Analysis: How bad is the nuclear accident in Japan?

(Reuters - 13 March 2011) - The Japanese nuclear safety agency rated the damage at a nuclear power plant at Fukushima at a four on a scale of one to seven, which is not quite as bad as the Three Mile Island accident in the United States in 1979, which registered a five. But what does that mean?

The International Atomic Energy Agency — an inter-governmental organization for scientific co-operation in the nuclear field — said it uses the scale to communicate to the public in a consistent way the safety significance of nuclear and radiological events.

The International Nuclear and Radiological Event Scale, or INES, ranges from one to seven with the most serious being a seven referred to as a "major accident", while a one is an "anomaly". The scale is designed so the severity of an event is about ten times greater for each increase in level.

The Chernobyl explosion in the Ukraine in 1986, the worst nuclear power accident ever, was rated a seven. That was the only event classified as a major accident in nuclear power history, exploded due to an uncontrolled power surge that damaged the reactor core, releasing a radioactive cloud that blanketed Europe.

The Three Mile Island accident in Pennsylvania was a partial core meltdown in which the metal cladding surrounding the fuel rods started to melt. That metal surrounds the ceramic uranium fuel pellets, which hold most of the radiation and power the reactor.

Nuclear reactors operate at between 550 and 600 degrees F (between 288 and 316 degrees C). The metal on the fuel rods will not melt until temperatures are well above 1000 degrees F. The ceramic uranium pellets themselves won't melt until about 2000 degrees.

About half the reactor core at Three Mile Island melted before operators restored enough cooling water to stop the meltdown. The core holds the uranium fuel rods, which must be cooled by water to prevent overheating.

So what happened at Fukushima?

The blast at the 40-year-old Daiichi 1 reactor came as plant operator Tokyo Electric Power Co (Tepco) worked to reduce pressure from mildly radioactive steam in the core after the total loss of power needed to keep water circulating to prevent the reactor fuel from overheating.

That blast led to fears of a disastrous meltdown at the plant, which automatically shut after the quake, even though the government has insisted that radiation levels were low.

The cause and exact location of the blast still needs to be established, nuclear experts queried about the incident said.

A couple of examples of fours on the INES scale include a fatal overexposure of workers following an incident at a nuclear facility at Tokaimura, Japan in 1999 and the melting of one channel of fuel in the reactor — though no radiation was released outside the site — at Saint Laurent des Eaux, France in 1980.

Q&A: Dangers posed by Japan's quake-hit atom plant

(Reuters - 13 March 2011) - Radiation leaked from Japan's quake-stricken Fukushima Daiichi nuclear plant on Saturday after a blast blew its roof off. Assessments of the danger varied. The critical issue is what happens to the radioactive reactor fuel.

"We don't know enough about what the status of the fuel is in the reactor core," nuclear expert Mark Hibbs of the Carnegie Endowment for International Peace said. "The issue is whether the core is uncovered, whether the fuel is breaking up or being damaged, or whether the fuel is melting."

WHAT HAPPENED ?

An explosion occurred at the 40-year-old Daichi 1 reactor as plant operator Tokyo Electric Power Co (Tepco) tried to reduce pressure in the core after the total loss of power needed to keep water circulating to prevent it from overheating.

This led to fears of a disastrous meltdown at the plant, which shut down automatically after Friday's quake. The government later said radiation levels were low because the explosion had not affected the reactor core container, although it had severely damaged the main building.

"The most probable (cause of the blast) is that the coolant, particularly if it's water, can overheat and turn to steam more rapidly than it was designed to," said nuclear fuel technology professor Timothy Abram at Manchester University.

The cause and exact location of the blast still needs to be established, said nuclear physics professor Paddy Regan at Surrey University. "So far it looks like it's not the reactor core that's affected, which would be good news." The World Nuclear Association, a London-based industry body, said the blast was probably due to hydrogen igniting and that this was unlikely to cause a big accident by itself. "It is obviously an hydrogen explosion," communications director Ian Hore-Lacy said. "If the hydrogen has ignited, then it is gone, it doesn't pose any further threat."

HOW SERIOUS COULD IT BE?

Views differ. Stratfor, a risk consultancy, initially said there appeared to be a reactor meltdown, but others disagreed, dismissing any comparisons with the 1986 Chernobyl nuclear disaster in Ukraine.

In an updated analysis, Stratfor said new developments "may suggest positive signs for authorities' efforts to contain the problem." But "many dangers and risks remain," it added. Abram, the Manchester professor, said it was unlikely it would develop into anything more serious, though this would depend on the integrity of the fuel. He believed it "pretty unlikely" that the fuel had been significantly damaged.

"If the fuel is substantially intact, then there'll be a much, much lower release of radioactivity and the explosion that's happened might be just due to a build-up of steam in the reactor circuit," he said. Apparently backing this view, the government said the plant's concrete building collapsed in the blast, but the reactor container inside did not explode. The top government spokesman said Tepco, the operator, planned to fill the leaking reactor with sea water to cool it down and reduce pressure.

Carnegie's Hibbs said: "If they are suggesting that the reactor vessel is intact and that they have a way to get cold water into the core of the reactor to cool that core down, that is very good news indeed."

It is too early to say that a "catastrophe has been averted," Stratfor said.

A nuclear technology expert who declined to be named said the situation was still "very serious" as the cause of the explosion had yet to be determined. He blamed the accident on rising pressure inside the reactor.

Further Internet based resources of use and interest:

Resources of General interest to schools

The need to build energy-efficient, healthy, daylit schools in California is important, as local communities embark to construct or renovate tens of billions of dollars worth of K-12 educational facilities over the next 10 to 15 years. In response, this information was produced to educate and motivate school decision makers, facilities staff, designers, and others to fund, design, and build high performing schools.

Energy Education Resources USA: Kindergarten Through 12th Grade is published by the National Energy Information Center (NEIC), a service of the Energy Information Administration (EIA), to provide students, educators, and other information users a list of generally available free or low-cost energy-related educational materials.

Links on this page are for activities and materials dealing with energy conservation, alternative energy, and the environmental impacts of energy use and transportation.

When it comes to using energy wisely, the more that are motivated the better. In this video, Mr. Muzak "enlightens" kids about the benefits of efficient lighting while Nurse Comfort "finds a cure" for drafty windows.

Australia Energy Education Resources

Australia's energy statistics at a glance. Info collated by International Energy Agency of OECD.

These fact sheets are a key part of achieving the Australian Institute of Energy's mission to promote understanding and awareness of energy issues and its objective to ensure enhanced community awareness of issues in the production and use of energy and in responsible energy policies.

Climate Movement Australia…. Scroll down to see: Pittwater High would become a power station through energy self-sufficiency using the renewable energy of the sun. Our immediate goal has been reached in setting up 72 panels providing roughly enough energy to power 10 classrooms all year round or 3 family sized homes.

The focus of our energy advisory service in South Australia is to assist you minimise your household energy consumption and related greenhouse gas emission by; showing you how to substantially reduce your household energy consumption whilst improving comfort, and encouraging you to source more of your energy from renewable sources e.g. solar.

Anti-Nuclear Australia. Very comprehensive campaigning website packed with info.

The Anti-Nuclear Alliance of Western Australia. This website promotes the objectives of this alliance which include campaigning for an end to the nuclear industry and the adoption of safe energy strategies.

Energy Efficiency policy measures in Australia. Information provided by International Energy Agency of OECD. Click the links to be referred to Australian based sites - some government - relating to the initiative or measure.

New Zealand Energy Education Resources

New Zealand's energy statistics at a glance. Info collated by International Energy Agency of OECD.

Energy efficient schools in NZ. An interactive web version of our resource for schools, **Energy efficient schools. A guide for trustees, principals, teachers, students, caretakers, and energy managers** has been developed with funding from the Ministry of Education.

Energy Efficiency policy measures in New Zealand. Information provided by International Energy Agency of OECD. Click the links to be referred to NZ based sites - some government - relating to the initiative or measure.