PHILIP POCOCK SECONDARY SCHOOL

The Energy Debate

SCH 4U1

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The Alberta Oil Sands

- Alberta Oil Sands – type of fossil fuel deposit . The sands contain a mixture of sand, clay, water, and a viscous form of petroleum
- Making fuel from oil sands requires energy for refining. The process generates 2-4x the amount of greenhouse gas per barrel of final product compared to conventional oil

- As it stands now, our economy relies on energy as an export
- The oil sands employs 500 000 Canadians
- Great potential for growth in development of the oil sands
- If we move towards more greener energies, we will lose this export and damage our economy.
- If we continue to develop this export we risk tremendous damage to our environment.

Renewable Energy

Wind Power

Although wind power provides less than one percent of global energy needs (as of 2009), it is currently one of the fastest growing renewable energy sources, with global installed wind power capacity increasing at a rate of over 18 percent annually. In many respects, wind power typifies both the benefits and some of the short-term drawbacks of renewables. As a power source, wind energy is highly attractive because it is plentiful, widespread, clean, and produces no greenhouse gas emissions. Against that, the construction of wind farms is not welcomed everywhere due to their visual impact. In addition, the expense of installing them is high: a wind farm with a capacity of about 100 megawatts typically costs hundreds of millions of dollars to set up—more if offshore—although the costs are coming down. The energy provided by wind farms is also intermittent. However, the period of peak demand (the winter months) generally matches the period of peak supply—unlike solar power, for example.

Renewable energy is energy generated from resources that are naturally replenished, such as sunlight, wind, rain, the heat from Earth's interior (geothermal energy), and ocean waves and tides. It also includes energy derived from recently dead plant material or biomass (see pages 116–117), but excludes fossil fuels such as coal, oil, and natural gas.

The main advantages of renewables over fossil fuels are first, that they generate far less carbon dioxide (CO_2), and so are a potentially valuable means of combating global warming. Secondly, they won't run out—most are derived (directly or indirectly) from radiant energy provided by the Sun, which is going to shine for several billion more years. If properly harnessed and developed, renewables should eventually be capable of completely replacing fossil fuels.

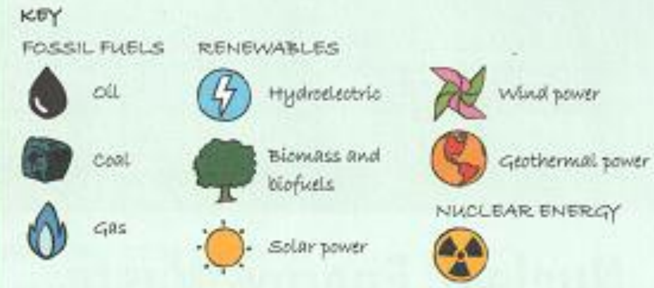
There are some downsides to renewables, mostly short-term. In particular, renewable energy projects can be expensive to set up, and it can be many years before they achieve net reductions in CO_2 emissions. Some forms provide only intermittent power, although this problem can be solved by intelligently linking the output of different renewable power sources into a grid.

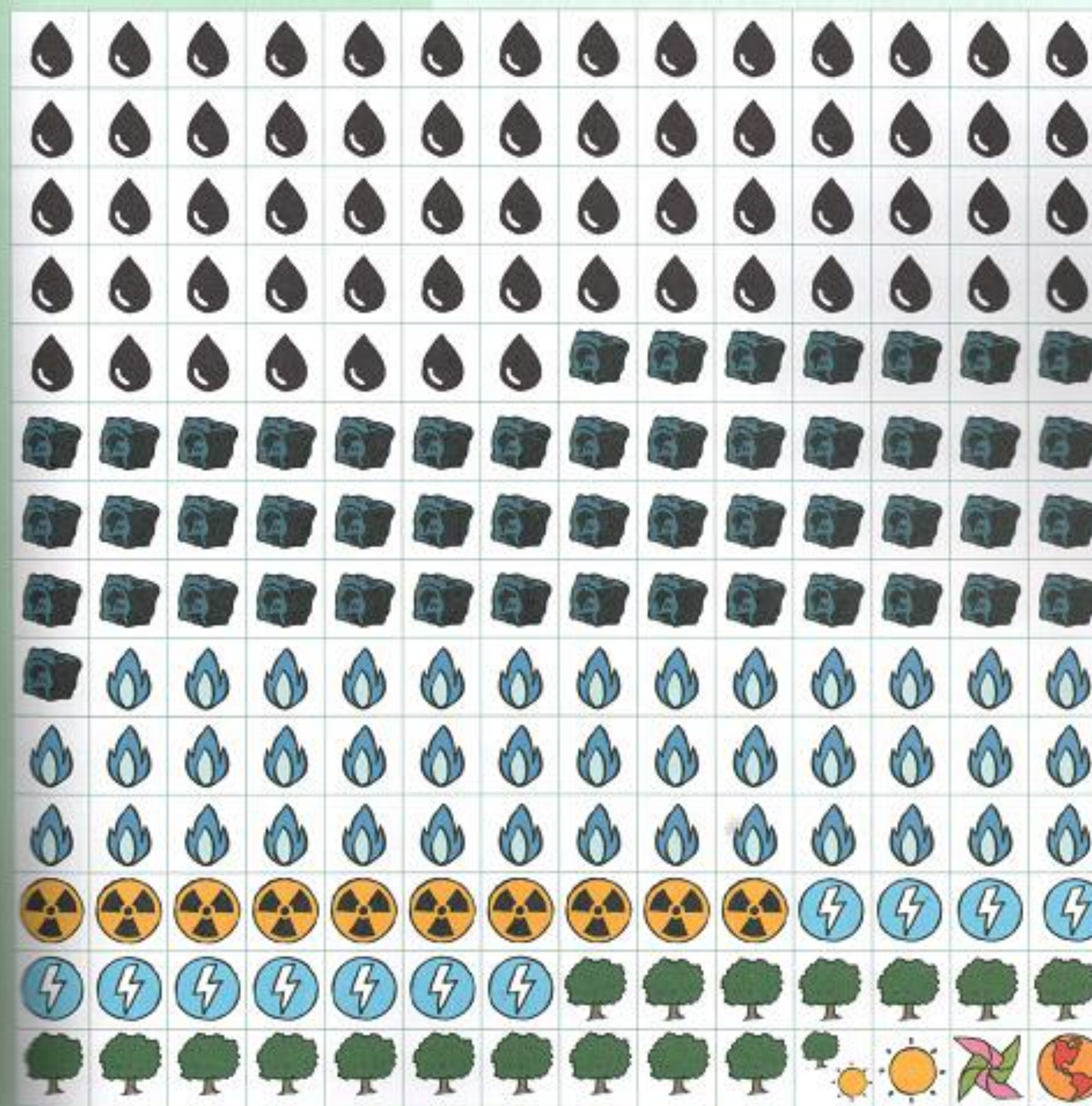
Jargon buster

MEGAWATT: A rate of energy production of a million watts, enough to power a few hundred homes in an average developed country. A thousand megawatts is called a gigawatt and a million is called a terawatt. The world's rate of energy consumption is currently (in 2009) running at about 17 terawatts.

How the World Currently Supplies its Energy Needs

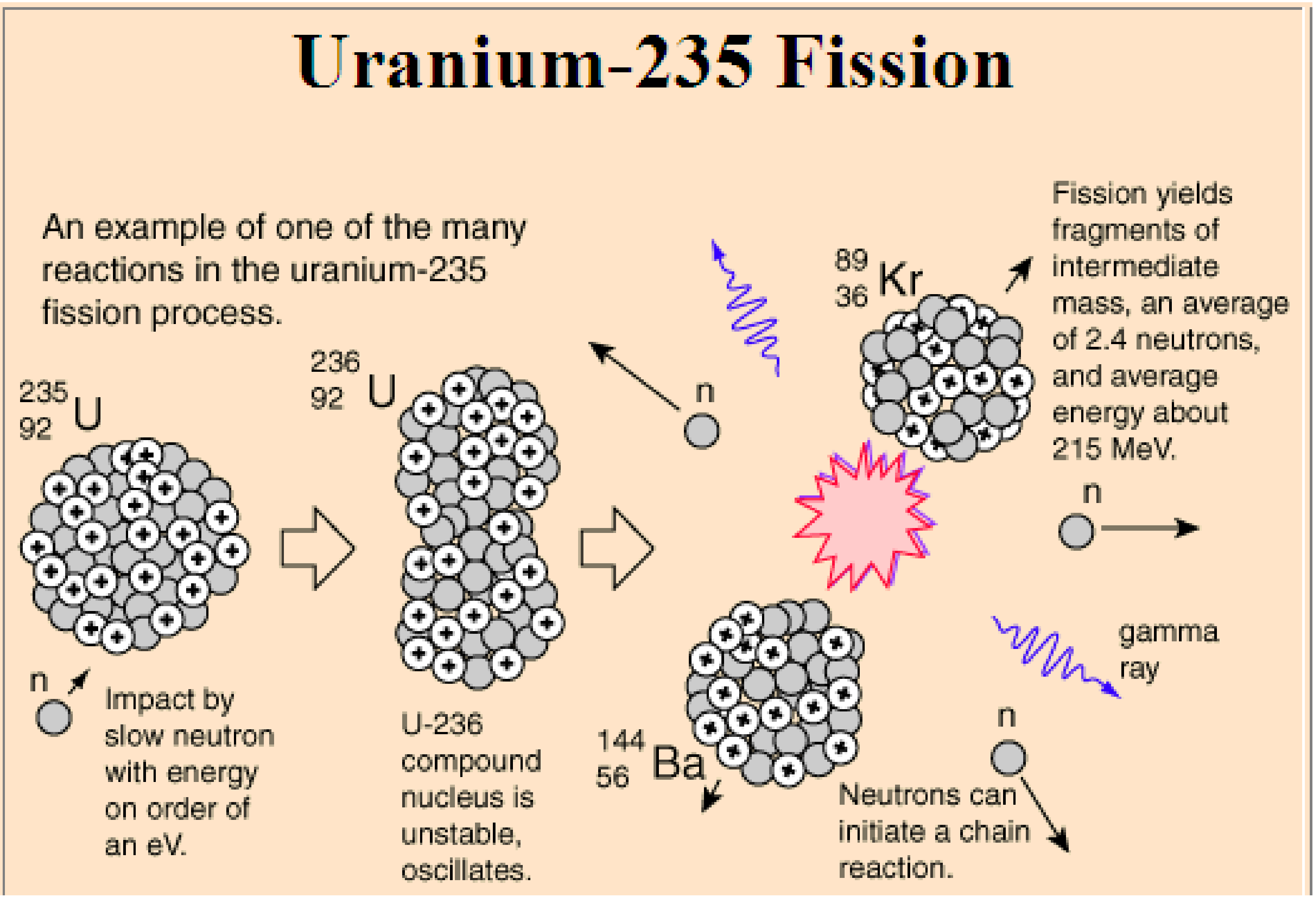
Currently, renewables supply only about 16.5 percent (about one sixth) of the world's energy needs, although that figure is gradually growing. They fill a little more than the two lowest rows of the chart below. Fossil fuels provide about 78.5 percent (nearly four fifths) of the energy needs, and the remaining five percent is supplied by nuclear power.





Power from nuclear fission

- Heat is used to boil water and the resulting steam drives a turbine.
- The spinning turbine drive generators that produce electricity.
- Most widely used nuclear reaction is fission
- Uranium-235 is used



- Bombardment with a neutron induces fission
- $\Delta H = 1.9 \times 10^{10}$ kJ/mol
- More neutrons produced, which can yield more reactions

Nuclear fission

- Canadian reactors (CANDU) use natural uranium (0.7% uranium-235 and 99.3% uranium-238).

Arguments for: very little air pollution – does not contribute to greenhouse or acid rain. Also uranium is cheap. –with fast reactors, uranium will likely never run out.

- Arguments against: -possible accidents (Chornobyl), or as the result of natural disaster (Fukushima Daiichi)

bite size facts

- Nuclear waste is radioactive material that largely comes from nuclear reactors or is a by-product of nuclear weapons production.
- Some 20 countries currently hold about 125,000 tons of the most dangerous waste in temporary storage, while they decide what to do with it.
- Some components of radioactive waste will still be highly radioactive in a million years' time.
- It is believed that most of the dangerous radioactive waste will eventually be buried deep underground.

Nuclear Energy Waste

Other Methods

Some scientists think that in future the problem of disposing of HLRW might be reduced through a procedure called transmutation. This would involve using additional nuclear reactions to process the waste and reduce its volume or hazard level. But implementation of this form of processing looks to be several decades away. Sending HLRW into the Sun could be an attractive method of disposal but is not possible at present because of the unacceptably high risk of an explosion during the rocket launch.

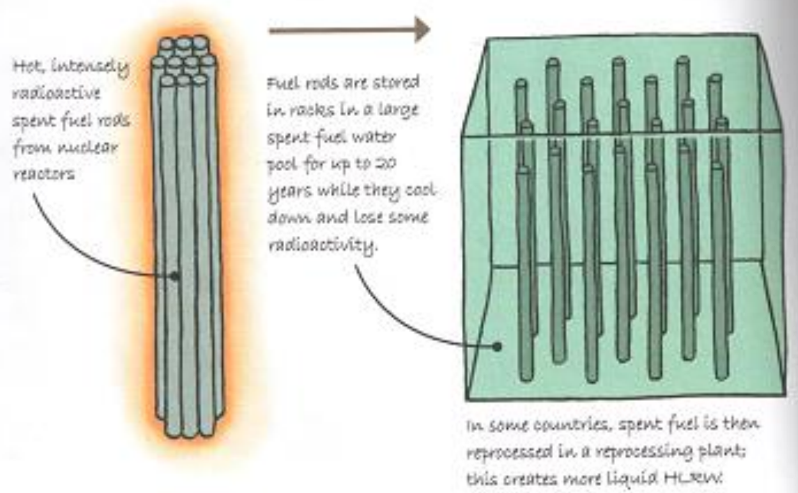
One of the major environmental concerns of our age is how the radioactive waste from nuclear power plants and weapons programs built up in various countries over several decades is to be disposed of. The most hazardous material, called high-level radioactive waste (HLRW), consists mainly of spent fuel from nuclear reactor cores or material derived from this spent fuel. It is intensely radioactive and dangerous to living things. It also generates a lot of heat.

The Scale of the Problem

The different radioactive isotopes in HLRW have different half-lives (see page 18), which means they remain hazardous for different periods of time. Some have half-lives of up to a million years or more, so any

What Happens to the Most Dangerous Waste?

Although the diagram on the right gives an overview of the process, the exact details vary between countries. So far, no country has begun the final stages of geological disposal. Many are still trying to decide on suitable disposal sites. Some HLRW has, however, reached the stage of being vitrified (dispersed in glass).



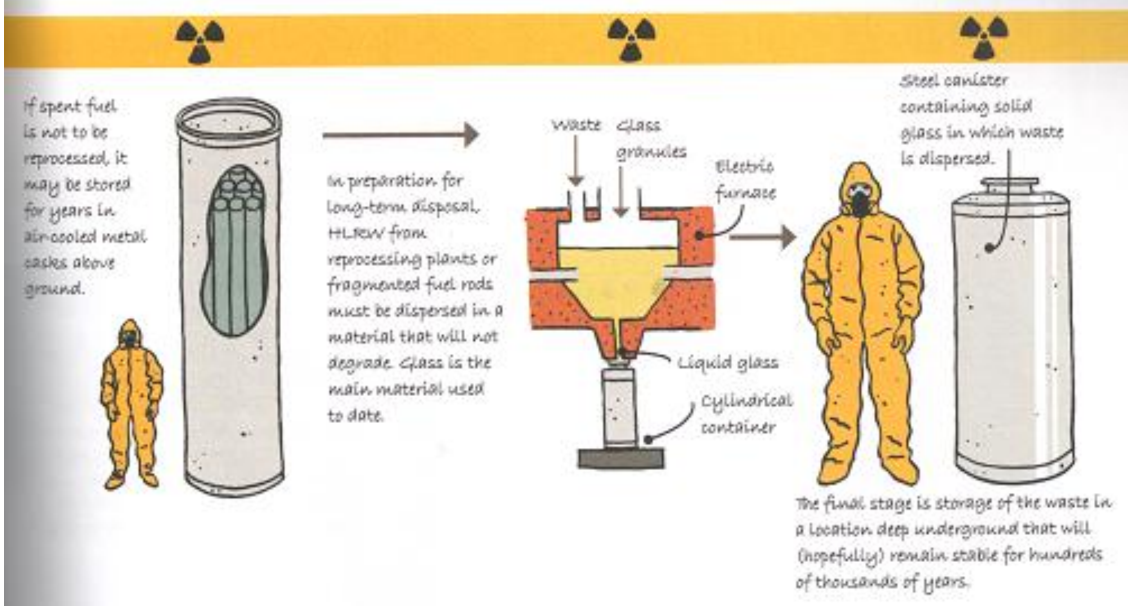
long-term strategy for dealing with HLRW has to have a timeframe of hundreds of thousands to millions of years. While most countries holding HLRW expect eventually to store it in locations deep underground, only a few—Finland, Sweden, and France among them—have made a definite decision on where they will store it and have started to implement their plan. Others, despite years of studying the problem, have yet to decide where they will store their nuclear waste. This is connected to the difficulty in finding sites where scientists can be 100 percent certain that the waste will not be disturbed for a million years.

Environmental Concerns

The general plan in most countries for dealing with HLRW is outlined below. There are environmental worries about several stages in the implementation of this process, especially about possible accidents or terrorist attacks at spent fuel pools, where a failure of cooling systems could lead to a fire and major release of radioactivity. There are also concerns about accidents during the transport of HLRW, and worries about the safety of long-term storage in sites underground.

Jargon buster

REPROCESSING: Chemical treatment of spent fuel rods from nuclear reactors to recover still-usable plutonium and uranium.

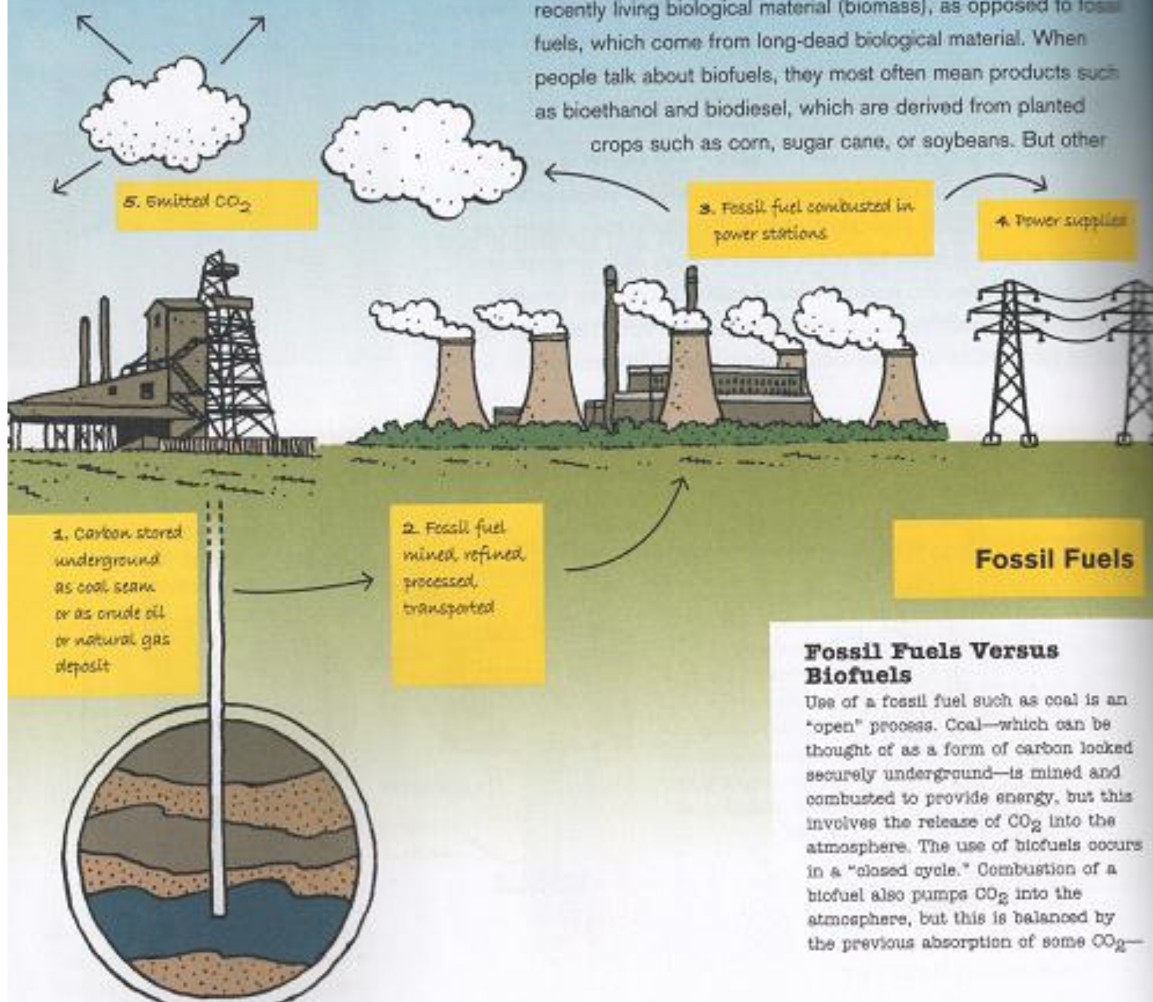


bite size facts

- Biofuels can be used as vehicle fuels or combusted to heat buildings or to produce electricity in power plants.
- Use of biofuels for road transport can produce an overall saving in CO_2 emissions of anything between 20 and 90 percent.
- World production of bioethanol, a common biofuel, is now running at over 17 billion gallons a year and increasing at a rate of over 30 percent a year.
- A crop area the size of the US would have to be planted with biofuel crops to power all the world's cars.

Biofuels

Biofuels are solid, liquid, or gaseous fuels that are derived from recently living biological material (biomass), as opposed to fossil fuels, which come from long-dead biological material. When people talk about biofuels, they most often mean products such as bioethanol and biodiesel, which are derived from planted crops such as corn, sugar cane, or soybeans. But other



Fossil Fuels Versus Biofuels

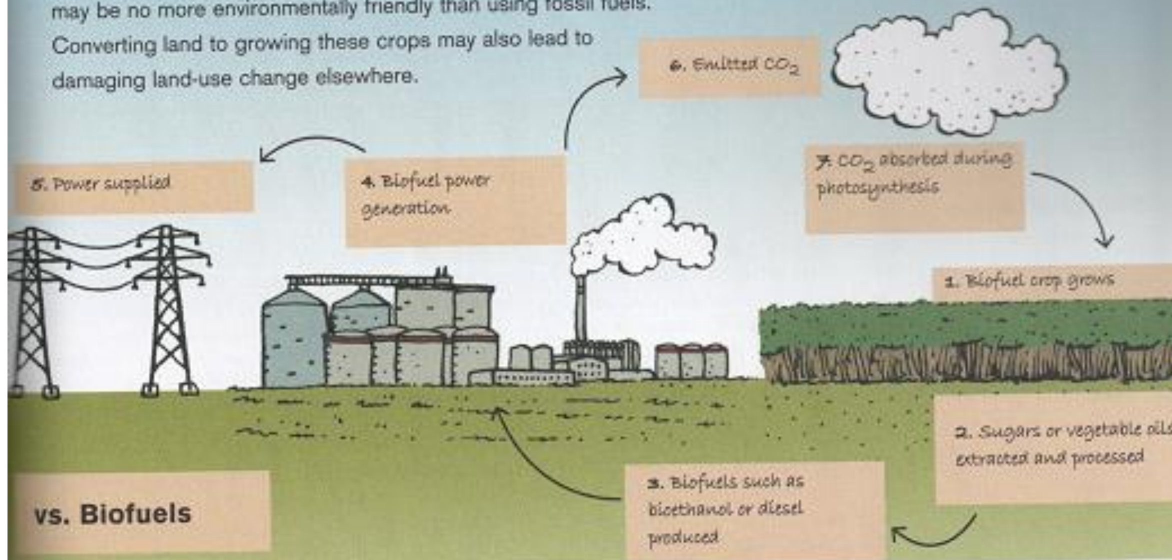
Use of a fossil fuel such as coal is an "open" process. Coal—which can be thought of as a form of carbon locked securely underground—is mined and combusted to provide energy, but this involves the release of CO_2 into the atmosphere. The use of biofuels occurs in a "closed cycle." Combustion of a biofuel also pumps CO_2 into the atmosphere, but this is balanced by the previous absorption of some CO_2—

types of biomass—such as dead trees, animal waste, and biodegradable human waste—also have the potential to be used as biofuels.

In theory at least, biofuels have an environmental advantage over fossil fuels such as coal, oil, and gas (see *Fossil Fuels Versus Biofuels*, below). In practice, however, in-depth studies of the environmental costs of biofuels indicate that many are not especially environmentally friendly. For example, growing corn in the US, soybeans in Brazil, and palm oil in Malaysia as biofuels may be no more environmentally friendly than using fossil fuels. Converting land to growing these crops may also lead to damaging land-use change elsewhere.

Jargon buster

PHOTOSYNTHESIS: A process by which green plants and some other organisms use light energy to convert CO_2 and water into carbohydrate (a nutrient), with the release of oxygen.



through the process of photosynthesis—when the plant from which the biofuel is derived was growing.

Main Drawbacks

Some of the main issues and problems relating to the use of biofuels are:

- Converting forests, swamps, or prairies to produce biofuels can release vast amounts of CO_2 into the atmosphere, which can take decades to mitigate. Apart from the CO_2 emitted if the wood from forest clearances is burned, additional CO_2 gas is released when biomass in disturbed soil—for example, roots—is broken down.
- Calculating exactly the volume of greenhouse gases produced in burning biofuels is complex and inexact. So projects that at first sight seem to be "carbon saving" may actually turn out in the end to be "carbon emitting."
- There is also a food versus fuel choice with biofuels. Should food-producing farmland be diverted to the production of biofuels?

The Way Ahead

New biofuels under development, including those made from algae, grass, wood, and recycled products such as cooking oil, look likely to be more environmentally friendly than the current sources of biofuel. Moreover, planting biofuel crops on degraded and abandoned agricultural lands has a clear advantage over the destruction of forests for biofuel crops.