Energy In Today's World

In all science lessons we are told there is an energy crisis, fossil fuels are running out, pollution mounts, sea levels are rising and our world is heating up. We may not leave much of a planet to the next generation. This is a scary thought, but what exactly is happening and what can we do to prevent serious consequences for mankind and the planet? This article aims to highlight the Greenhouse effect and explain what Global warming is while also exploring the potential end of fossil fuels and the scope for the implementation of viable alternatives. The article will also consider what Biofuels are and their effect on pollution, how they are made and their advantages and disadvantages.

The Greenhouse Effect and Global Warming:

The Greenhouse Effect is thought to be the main cause of global warming. "The Greenhouse Effect: is the process in which the absorption and subsequent emission of infrared radiation by atmospheric gases warms the lower atmosphere and the planets surface." *(OCR A level Chemistry).* The Greenhouse Effect is regarded as a dangerous side effect of pollution and therefore made out to be a 'bad thing', but without the Greenhouse Effect life would cease to exist and the planet would be covered in ice. In fact the Greenhouse effect is more important than distance from the sun when it comes to temperature. The Greenhouse Effect is caused by gases; the main contributors are water vapour, carbon dioxide (CO_2) and methane (CH_4).

Car pollution is a major cause of Global Warming.

Will the Greenhouse Effect get worse?

A CO_2 molecule absorbs infrared radiation; this causes bonds within the CO_2 molecule to vibrate. The vibrating molecule can transfer some of its energy to other molecules in the atmosphere, leading to a warming effect. This process is what keeps heat in the atmosphere. Increased burning of fossil fuels will mean more greenhouse gases in the atmosphere, so more particles to absorb, vibrate, and emit energy. Therefore more heat will be trapped close to the earth's surface, and a subsequent increase in global warming will be experienced. An increase in global warming affects the world around us in many ways, an example being that temperature increases can cause ice caps to melt and sea levels rise. For low lying countries this could mean areas of land become inundated and are no longer available for productive use, contributing to over-population in the remaining territory, which is already being a problem in many developed and developing countries. Climate change also appears to be contributing to a change in weather patterns e.g. drought, heavy rainfall and brutal weather storms. Global warming could lead to changes in the Gulf Stream Current, perhaps being interrupted or even shut off due to massive influxes of melted fresh water from the northern ice caps. If this occurred, it would lead to severe weather changes, including merciless winters in Northern Europe.

Global Dimming:

Global Dimming is also thought to be increasing. Scientists have been calculating the amount of sunlight reaching the earth over the past 50 years and it has been calculated that 25% less sunlight has been reaching the Earth's surface. Global Dimming is thought to be caused by particulates of soot and ash, which are produced when fossil fuels are burnt. These rise into the air and reflect sunlight. Some scientists debate these results,

blaming faulty equipment and do not believe Global Dimming is occurring.

Biofuels:

There are many proposed solutions on how to stop pollution; such as carbon capture storage and lots of plans to phase out fossil fuels. An alternative fuel that can be used to power cars is Biofuel. Biofuel includes both Biodiesel and Bioethanol; these are made in two different ways. Bioethanol is made by either reacting ethylene with steam or a sugar fermentation process. Crops such as maize, corn, sorghum plants, cord grasses, Jerusalem artichoke, reed canary, saw dust, waste straw, myscanthus, wheat crops, straw, and willow can be used. The fermentation process has 3 steps: 1- fermentation of sugars, 2- distillation, and 3- dehydration and denaturing.

In theory cellulose and starch can be converted to sugars. Only a proportion of starch and the sugar (example sugar cane) can be converted, in an economical process ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$). During distillation to create ethanol all water must be removed, an ethanol-water-mix will not blend with petrol. With dehydration the most popular purification method uses a molecular sieve such as Zeochem (Z3-03). The sieve openings are large enough to allow in moisture but not the ethanol molecules, which results in production of dry ethanol. Another dehydration method is to use calcium oxides which acts as a drying agent. After dehydration, the hydrocarbon benzene may be added which denatures the ethanol and stops people drinking it.

Biodiesel is made in a very different process to Bioethanol; it is made by a process of Transesterification. Biodiesel can be made from vegetable oils as vegetable oil consists of triglycerides. Triglycerides are esters of glycerol and fatty acids. The large triglyceride molecules are broken up into smaller molecules using Transesterification; these smaller molecules are what make Biodiesel different to vegetable oil. The process of Transesterification involves reacting the triglycerides with methanol (or ethanol) in the presence of a potassium methoxide catalyst. Glycerol is produced as a by-product, and is sold to pharmaceutical companies or cosmetic industries.

Biofuels are argued by some to be highly *Carbon-Neutral,* releasing only the same amount of carbon dioxide as absorbed during growth. In addition, when burnt they don't produce significant quantities of harmful gases, sulfur dioxide and the nitrous oxides, known to cause acid rain. The only products released during burning of Bioethanol are water and carbon dioxide. Bioethanol can be used in engines with minor modifications, which reduces costs. The most important benefit to Biofuels is that they are renewable. Using Biofuels means we would never have to worry about pollution or them running out.

Biofuels also have some disadvantages. 25% of all US corn is used to make ethanol (2009), with parts of the world starving can we afford to us this food on fuel? The cost of producing ethanol is also high, with a 100m gallon ethanol refinery costing something like $140m to build. Water is also a problem, with each gallon of ethanol requiring 1700 gallons of water throughout the whole production cycle. This means that a year's production from an ethanol refinery shipping 100m gallons per year would need around 170,000,000,000 gallons of water throughout the whole production cycle.

If we wanted to completely replace imported fuels, over two-thirds of the available farmland would be needed to be used for growing Biofuel crops, which simply isn't viable given the loss of food production that this would entail. In developing countries, space is made for Biofuel crops by cutting

down rainforests, destroying habitats and leading to a reduction in carbon dioxide absorption by the cut down plant life. Once again space used for growing crops means less space for growing food and food shortages may result.

Another disadvantage with Bioethanol is that it cannot be transported in pipes because it is too hygroscopic (it is a substance that takes up water from the atmosphere), so how will it be transported and will money have to be used to develop a new means of transport?

Biogas and Biofuels:

Biogas has a similarity to Biofuels in that it is renewable. However the process in which Biogas is made is what makes it so different to the Biofuels. Biogas is made via anaerobic fermentation of waste. Micro-organisms digest the waste material, which contains many carbohydrates. Biogas is made in a fermenter which is kept under a constant temperature.

Biogas is a gas, and is most easily used immediately as it is difficult to store. Bioethanol and Biodiesel are liquids which can easily be stored for use at a later date.

Viable Solutions:

Food crops are not the only source of triglycerides to make Biodiesel; some types of algae can also be used. One benefit of algal farms is that they use sewage as feedstock. Algal farms could yield 60,000 litres of Biodiesel per acre per year, and it is postulated that 150 million gallons of Biodiesel could be produced from just 15,000 square miles, which is 10,000 gallons of Biodiesel per square mile. By way of comparison, to produce the same amount of ethanol by fermentation would require approximately 312,500 square miles of crops. Already Algae seems a more viable solution, this method of making fuel is being pioneered in the Netherlands, among other locations, where algae are pumped through transparent pipes, allowing light to support photosynthesis. When mature algae emerge from the pipeline, the triglycerides are removed and processed into biofuel.

Algae growing on a street curb- could this be a feasible solution?

In current extraction methods only a proportion of starch and sugar can be converted into ethanol, potentially more parts of the plant can be broken down to sugars to convert into ethanol, known as Cellulosic ethanol. Presently there is a lot of research going on into Cellulosic ethanol.

Genetic engineering may also be used to produce microbes that can produce fuels, using straw, grass, wood chips, and various waste products as feed-stocks. Some scientists believe it'd be better to design a new organism, others feel the answer lies in modifying existing organisms to make fuels from sugars and biomass. Another idea is to 'create' bacteria that can take in CO_2 from the air and turn it into fuel. There are some ethical implementations associated with making/manipulating organisms.

The ideas outlined above may appear to be good, but they also need to be sustainable. In order for an energy source to be viable, it must be produced from renewable/inexhaustible sources. It must also produce few or no damaging emissions when burned, and must be produced by a process

which is cheap, safe and easy to install where needed e.g. in a car. Finally, it must also be easy to store and transport. Not all biofuels will meet these criteria.

Are we seeing the end to fossil fuel reserves?

Current estimates say that oil reserves will run out in 30-100 years' time. But most of these estimates are based on current consumption, so if we stopped using oil, or less of it, it would therefore last longer. However these estimates don't take into account tar sands or shale oil.

Tar sands are a mixture of sand, clay, water and heavy crude oil (heavy crude oil has a high density, which is 'thicker' than normal crude oil and harder to flow). Tar sands are found in Canada and Venezuela, each are estimated to have stores of oil equivalent to the worldwide crude oil reserves. Solvents have to be added to heavy oil to make it flow properly, the mixture is then piped to a refinery. Heavy fractions are converted into more useful light fractions (synthetic oil), using the familiar process of fractional distillation. USA, China and India are currently investigating extracting petroleum products from tar sands, with seemingly no regard for the effect on Global Warming.

As the pursuit of limited fossil fuels reserves becomes more difficult, nations, particularly those with a fuel based economy such as USA, Russia and China, are looking to find earth minerals and oil wherever they can. This comes at a cost to the planets security, as treaties go unsigned and agreements are broken. As an example the USA hasn't signed the Law of the Sea, a safe guard instigated by the United Nations, nor the Kyoto Protocol (to reduce emissions).

A survey done by the US Geological Survey (USGS) in 2008 believes that 25% of undiscovered, theoretically recoverable hydrocarbons in the world maybe contained in an area north of the Artic Circle. In numbers this is roughly equivalent to 90 billion barrels of oil. The Artic accounts for 13% of undiscovered oil, 30% of undiscovered natural gas and 20% of undiscovered natural gas liquid in the world. Ten years ago a barrel of crude oil was $10, now 1 barrel of crude oil is $140. This is expected to double again in the next few years. Extracting fossil fuels is very expensive, and due to the rising cost, exploration of the Artic and its recoverable reserves is becoming very attractive for business.

Other than the Artic there is also exploration of the Falklands islands. There is an oilfield in the Falklands and oil exploration companies are working to reach it. As well as physical difficulties in reaching oil deposits, international politics can also prevent recovery of these reserves. The sovereignty of the Falkland Islands is disputed, and Argentina has threatened legal action against any companies involved in oil exploration in the Falklands area.

Other Fuels:

While Biofuels are a good way forward with renewable fuels and energy, there are also a lot of other alternatives out there. The 'renewables' are wind, wave, tidal, hydroelectric, biomass, solar and geothermal energy. Each one provides clean, renewable energy, which is non-damaging to the planet and atmosphere. The 'non-renewables' are coal, oil, gas and nuclear fuels (Uranium and Plutonium), these fuels are finite resources and are damaging to the atmosphere.

Wind power uses wind turbines in exposed places. A wind turbine has its own generator that allows energy to be produced while the turbine is in action. Solar energy includes photovoltaic cells and thermal solar panels, with both techniques using sunlight, but in slightly different ways. Solar cells work by generating electricity from absorbed sun light.

The sun light strikes the cell and an amount is absorbed. The energy of the absorbed light is transferred to electrons, allowing them to flow freely in the form of an electric current. Thermal solar panels use sun light to heat water, which flows through the pipes and is heated by sunlight before being piped into the house to be used. Hydroelectricity needs a dam, with rainwater being stored in an artificial lake. When electricity is needed, the stored water is allowed to flow through turbines which subsequently turn generators and produce electricity.

Could Hydroelectric Power help the energy crisis?

Wave power uses small converters in positions around the coast. The up and down motion of the waves can be used to drive a generator. Tidal power uses large barrages built across rivers estuaries, which have turbines in them. When the tide comes in or out, water passes through the turbines, and turns them at controlled speeds thus generating electricity. Geothermal energy is only possible where thermal rocks lie near the surface. Water is piped down to the hot rocks, and returns as steam to drive the generator. Biomass is a collective term used for the organic substances that can be burnt to produce electricity. The waste material is burnt to heat water to produce steam which drives turbines and produces electricity. Sometimes it is fermented to produce other fuels such methane or ethanol.

To maintain enough a viable wood supply we need sustainable farming.

An interesting development in electricity generating was discovered by scientists from Lawrence Berkeley National Laboratory, California. They developed a harmless virus that can produce electricity. It generates electricity under mechanical stress. This discovery is a huge step forward in development of viable renewable alternative fuels.

Reducing Pollution:

Pollution is a huge world threatening problem, which fortunately has been recognised and measures are being adopted to reduce pollution.

It's not just gas pollution that ruins our environment.

The Montreal Protocol is classed as one of the most successful global environmental agreements ever to be signed. This protocol introduced steps to control global emissions of CFC's. It also implemented a time frame for these steps to be completed by. The protocol first came into action in 1989 in which 30 countries signed it, by 2006 197 had signed it.

The Kyoto Protocol commits countries to reduce their emissions of greenhouse gases by 5% by 2012. It targets 6 gases: CO_2, CH_4,

N_2O, HFC's, PFC's (Perfluorocarbons) and SF_6.It was put forward in 1997 with 100 countries signing the protocol. Originally the USA refused to sign it. In 2006 CO_2 emissions were approximately 32 billion tonnes, 25% of this coming from the USA, for the Kyoto Protocol to really work the USA needed to sign. While the USA has now signed they show no intention to ratify or follow the protocol.

The world around us is changing, either through natural causes or human influence. This change is the cause of debate among

countries, scientists and pressure groups and that debate is good. But the world is at a crucial tipping point; fuels are expected to run out and with pollution as it is there may not be much of a planet for the next generation. We cannot let debate slow the process of change and innovation, or be used to let non-conforming countries carry on with little regard to the damage they are doing to planet earth. We may have already reached peak oil production, and it is inevitable that oil reserves will go into terminal decline. If so it makes the search for viable alternatives more important than ever, making Biofuels a key component in the upcoming years.

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