NUCLEAR POWER AS AN ENERGY SOURCE

What is nuclear energy?

Figure 1 Mushroom cloud after bombing Nagasaki[1]

When we as laymen think of nuclear energy, the first image that comes into mind are the bombs dropped on Hiroshima and Nagasaki or if not the Chernobyl or Three Mile Island Nuclear power plant disasters.

It is true that nuclear energy has been harnessed by mankind to do more bad than good. Nuclear bombs of thousands of times more destructive power as Little Boy and Fat Man dropped during The Second World War have been manufactured and are ready to be launched at the press of a button. But it is a fact that nuclear energy can and is being used for peaceful purposes as well. Nuclear energy has been harnessed to develop electricity in many countries. Unlike the electricity generated from fossil fuels, electricity generated from nuclear energy is clean with no harmful effect on the environment apart from the problem of disposing of spent nuclear fuel rods.

The discovery of Radioactivity

The first to make the discovery of radioactivity was the French chemist Becquerel. Until radioactivity was discovered it was thought that all natural processes were based on chemical reactions or rearrangements of combinations of atoms. Becquerel discovered a process that seemed to release energy from an unknown new source that was not chemical.

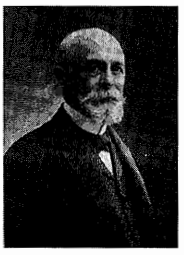

Figure 2 Henry Becquerel 1852-1908

[1]http://en.wikipedia.org/wiki/Image:Nagasakibomb.jpg

Production of Energy in the Nuclear Process

As Henry Becquerel found, it is possible for changes to occur in the structure of the nuclei of atoms and these changes are called nuclear reactions. Energy in varying quantities is released during this process and the energy thus created in a nuclear reaction is called nuclear energy, or in other words atomic energy. Nuclear energy is produced naturally and also can be produced in man-made operations under human control.

A good example for naturally occurring nuclear energy is our closest star the Sun. The nuclear reaction that takes place within the Sun and other stars is called Nuclear Fusion.

An example for the man made nuclear energy is the nuclear reactors which are a part of nuclear power plants and provide electricity and thus energy for humans to carry out their activities. Man-made nuclear reactions also occur in the explosion of atomic and hydrogen bombs.

Nuclear energy can be produced in two different ways. One is nuclear fission where large nuclei are split to release energy. The other method is nuclear fusion where small nuclei are combined to release energy.

Nuclear Fission

In nuclear fission, the nuclei of atoms are split, causing energy to be released. The atomic bomb and nuclear reactors work by fission. The element uranium is the main fuel used to undergo nuclear fission to produce energy since it has many favourable properties. Uranium nuclei can be easily split by shooting neutrons at them. Also, once a uranium nucleus is split, multiple neutrons are released which are used to split other uranium nuclei. This phenomenon is known as a chain reaction.

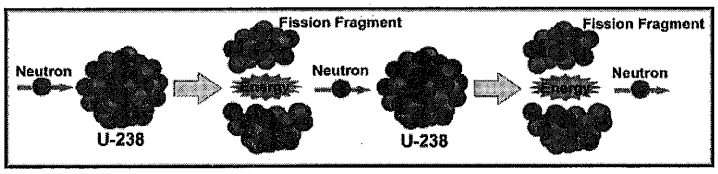

Figure 3 Fission of uranium 238 nucleus [2]

A vast quantity of energy is released during this process. For example the energy released by splitting one atom is 10 million times greater than is released by the burning of an atom of fossil fuel. This energy released during the chain reaction is in the form of heat energy and is utilized to generate steam which in turn drives turbines that assist in producing electricity.

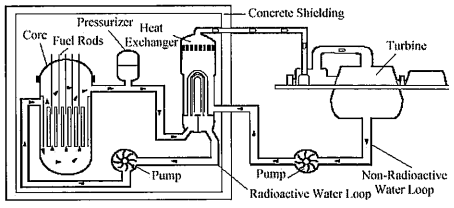

Figure 4 Schematic diagram of a nuclear reactor

[2] http://library.thinkquest.org/3471/nuclear_energy_body.html

Nuclear Fusion

In nuclear fusion, the nuclei of atoms are joined together, or fused. This happens only under very hot conditions. The Sun, like all other stars, creates heat and light through nuclear fusion. In the Sun, hydrogen nuclei fuse to make helium. There are current attempts that are going on to harness this power and the first fusion power plant which is a collective effort by a number of nations is being built in France.

Nuclear power generation process

Of the several known methods to produce electricity, by far the most practical for large scale production and distribution involves the use of an "electrical generator." In an electrical generator a magnet (rotor) revolves inside a coil of wire (stator) creating a flow of electrons inside the wire. This flow of electrons is called electricity. Some mechanical device (wind turbine, water turbine, steam turbine, diesel engine, etc.) must be available to provide the motive force for the rotor.

In a hydroelectric power plant, water, flowing from a higher level to a lower level, travels through the metal blades of a water turbine, causing the rotor of the electrical generator to spin and produce electricity.

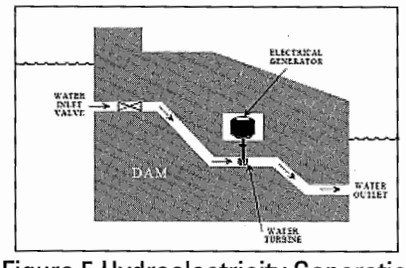

Figure 5 Hydroelectricity Generation

In a fossil-fuelled power plant, heat, from the burning of coal, oil, or natural gas, converts (boils) water into steam (A). The steam is then piped to the turbine (B) where the steam passes through the blades. The blades rotate and there by spins the electrical generator (C), resulting in a flow of electricity.

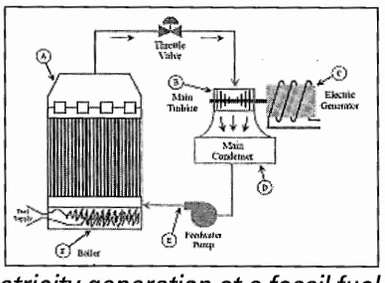

Figure 6 Electricity generation at a fossil fuel steam plant

Power generation in a nuclear reactor is not much different from the above methods. A nuclear power plant uses the heat released during the fission reaction in order to turn water into water vapour. Only water vapour is discharged in to the environment and no harmful gasses or other pollutants are released as in the case of a fossil fuel driven power plant.

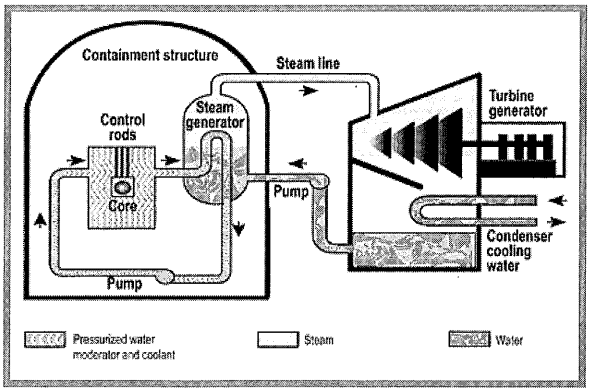

Figure 7 Electricity generation at a nuclear steam plant

Advantages of Nuclear Energy

The usage of nuclear energy to meet our future energy needs will have the following advantages.

Inexpensive Fuel as uranium is found in abundance all over the world.

An efficient energy generation process which is the most efficient so far discovered and Uranium-235 can produce 3.7 million times energy as the same amount of coal.

The waste produced during the nuclear power generation process is more compact and far less than any of the fossil fuel driven energy production processes. The operation of a nuclear power plant producing 1000MW for one year will consume only two metric tons of fuel and thus produce only close to two metric tons of waste. A coal power plant of the same capacity operating over the same period will produce over 350,000 tons of ash will release over 4 million tons of carbon dioxide, carbon monoxide, nitrogen oxides and sulphur oxides in to the environment.[3]

Unlike coal or oil which has a big probability of causing pollution and damage to the environment during transportation uranium can be transported with no such risk.

As nuclear energy is emission free there are no harmful emissions released to the environment that contribute to global warming and acid rain.

Nuclear power is one of the cheapest sources of energy that humans have presently discovered and is comparable with coal.

The by-product of plutonium can be re processed to be used as fuel.

Radioactive materials, produced in reactors, are used in diagnostic and therapeutic treatments in medicine, weld inspection (radiography), power sources in remote locations and space applications, sterilization of medical equipment and food irradiation.

[3]http://www.nucleartourist.com/basics/reasons1.htm

Disadvantages of Nuclear Energy

The use of nuclear energy has the following disadvantages.

When building a nuclear reactor a lot of safety features have to be built into it and this makes it very costly to build the power plant.

Uranium and its by-products from the use in reactors are highly radioactive and can seriously affect human health if not handled correctly.

Due to the radioactive nature of the Nuclear waste disposal is complicated as it takes a long time for the radio activity to reduce to acceptable levels.

The knowledge, technology and materials necessary for civil nuclear programmes equip countries with the ability to develop nuclear weapons if they so desire.

There is always the possibility of nuclear accidents although the new generation nuclear plants are much safer and there have been only two accidents among the 437 power plants in operation world wide.

Worldwide use of Nuclear Energy

Nuclear power plants provide approximately 16 percent of the world's electricity production. In total, 16 countries rely on nuclear energy to supply at least one-quarter of their electricity needs.

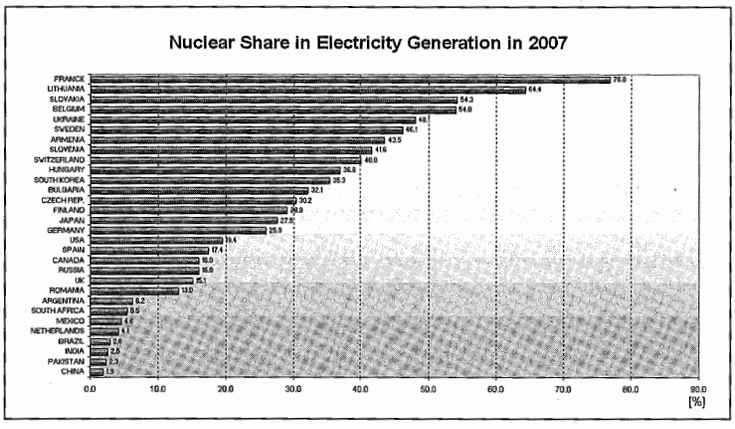

Figure 8 Nuclear share of electricity generation in year 2007[4]

Although the interest in nuclear power plants reduced with the Chernobyl and Three Mile Island accidents, as of late interest in safer nuclear energy has been revived due to global warming. Fossil fuel which is a major source of energy world wide has been directly linked with global warming and efforts are underway world wide to cut down on fossil fuel usage. Hence an increase on the world wide use of nuclear energy can be predicted for the future.

IAEA, Nuclear Power Reactors of the World, Reference Data Series April 2008, P78

Conclusion

Unless all nations of the world act together to reduce CO2 emissions all countries of the world are going to reap the repercussions of global warming. One significant step towards reducing the CO2 emissions is to cut down on the usage of fossil fuels. Nuclear power enables us to do just that by providing clean energy with no impact on the environment. What is needed is just the will to change.

Humans by nature are resistant to change and this can be seen in our reluctance to embrace nuclear power as an energy source. However it is encouraging that the government of Sri Lanka has shown interest in this field. As a result the CEB has included the pursuing of the nuclear option in its long term agenda.

Japan was reduced to rubble during the Second World War and was twice the target of nuclear bombs dropped by the USA. Despite this, Japan has been able to rise from beneath the ashes as a phoenix and become an economic giant in today's world. 30% of the energy needs of Japan are being fulfilled by nuclear power and this percentage is bound to rise further. If the population of a country that was subject to the horrors of the destruction and devastation caused due to nuclear power were able to overcome their fear and embrace nuclear power as a source of energy for their needs, surely Sri Lankans will have no difficulty in accepting nuclear power as their primary source of future energy.

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