Student 1: Low Excellence
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Currently New Zealand relies on energy sources such as hydro, wind and solar. While these sources provide consistent clean energy, nuclear power sources may be able to provide energy in much greater quantities. However the New Zealand Free Zone, Disarmament and Arms Control Act of 1987 prevents any nuclear power plants from being constructed or operating in New Zealand.

With the first nuclear fusion power stations expected to be operational by 2030, many of the issues presented by nuclear fission could be addressed making it possible for New Zealand to consider a nuclear power programme. If New Zealand were to open nuclear power stations the most likely approach would be Deuterium-Tritium fusion.

Some of the benefits of nuclear Fusion are there are no CO_2 emissions as no fossil fuels are burned, there is no high-level waste generated, there is no need to import fuel as it is collected from seawater, it creates domestic job for scientists and unlike in fission reactors, there is no chance of a meltdown.

How it works

Deuterium (^2_1H) can fuse with Tritium (^3_1H) to produce Helium (^4_2He) and a neutron (^1_0n) at very high temperature. After the reaction takes place, it will be found that the combined mass of

(1) the Helium atom and the neutron is less than the combined mass of Deuterium and Tritium. This is because the constituents of Helium (2 neutrons and two protons) have more binding energy than the constituents of Deuterium and Tritium, the neutron produced is free so has no binding energy. Overall the constituent parts of the products have less energy than the constituent parts of the reactants. This energy is given off by the reaction and can be harnessed for human use.

The missing mass of the products is related to the energy produced by Einstein's formula: $E=\Delta mc^2$ which shows that mass and energy are the same thing so must be conserved. Where E is the amount of energy produced in Joules, Δm is the missing mass or $m_{reactants}$ -

(2) $m_{products}$ and c is the speed of light which is constant ($3.00 \times 10^8 ms^{-1}$). The mass lost in the reaction is called the 'mass deficit' and the greater the mass deficit, the greater the increase in total binding energy. The change in binding energy is equal to the energy released or absorbed by a reaction so a greater increase in binding energy means a greater yield of energy.