White Paper

The benefits of Nuclear Power and the longevity of it's fuel source.

Stewart Scott
Head, Nuclear Services

The benefits of nuclear power: Co2 reduction and fuel source.

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Modern Nuclear Power is the cleanest way of producing electricity, with a long term secured fuel source. The new generation reactors provide lower Co2 emissions than any comparable generation method, and can provide a safe, long term solution, to the worlds growing power demands.

Introduction

Modern nuclear energy plants emit less than one hundredth of the greenhouse gas emissions of coal or gas fired power stations. It is an energy source which is not dependant on the combustion of fossil fuels, and uses an elemental fuel source which is abundant in the earths natural resources. Modern reactor designs are quicker to build than previous generations, produce less waste, and are inherently safe

The benefits of nuclear power: carbon emissions and fuel source

The audited environmental product statement of the Vattenfall Energy utility , of Scandinavia, shows that their Nuclear Power Plants emit less than one hundredth the Greenhouse Gases of Coal or Gas fired power stations.
The new third generation Nuclear Power stations currently in planning and construction provide an economic electricity provision even when construction, operation, waste disposal, and decommissioning costs are considered.
Nuclear Power plants pay back the energy required to build them in in a short time of operation, less than 6 months.
Nuclear reactors use Uranium, a common natural resource, as their base fuel source, current world proven reserves of Uranium are sufficient to supply current world demand for 85 years. Speculative reserves could provide an additional 300 to 400 years of supply.

The cost of Uranium ore is a very small fraction of the operating costs of Nuclear Power.
Planned fourth Generation Nuclear Plants can fully utilize all the energy in natural Uranium., and research is developing to use Thorium as a fuel source. There is sufficient Uranium and Thorium on Earth for Fourth Generation reactors to supply the growing total World demand for energy for hundreds of centuries.
A single kilogram of Uranium can provide many times the energy output of coal, gas , oil. These 3 carbon fuel sources are now becoming depleted, and are becoming more in the control of a group of fewer countries who can dictate their global supply . Uranium is mined in many countries with neutral political views, where this natural resource supply can be relied upon.

Greenhouse emissions of nuclear power

There is world-wide concern over the prospect of Global Warming primarily caused by the emission of Carbon Dioxide gas (CO_2) from the burning of fossil fuels. Although the processes of running a Nuclear Power plant generates no CO_2, some CO_2 emissions arise from the construction of the plant, the mining of the Uranium, the enrichment of the Uranium, its conversion into Nuclear Fuel, its final disposal and the final plant decommissioning.

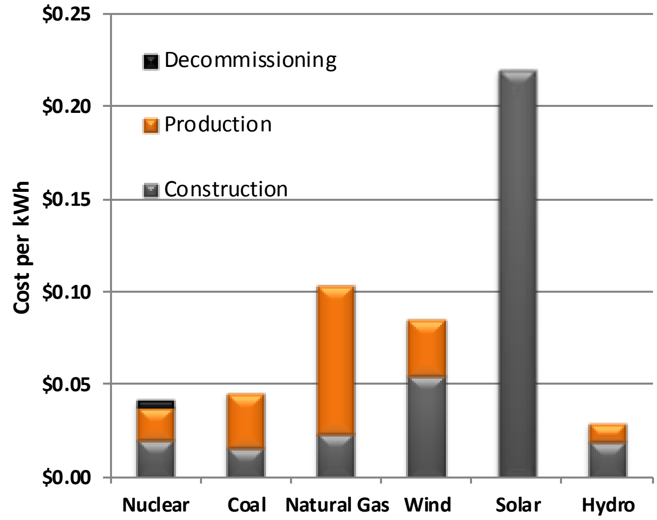
The amount of CO_2 generated by these secondary processes primarily depends on the method used to enrich the Uranium, (the gaseous diffusion enrichment process uses about 50 times more electricity than the gaseous centrifuge method), and the source of electricity used for the enrichment process. However it is still very low when compared to fossil fuel power generation. To estimate the total CO_2 emissions from Nuclear Power we take the work of the Swedish Energy Utility, Vattenfall, which produces electricity via Nuclear, Hydro, Coal, Gas, Solar Cell, Peat and Wind energy sources and has produced credited environment product declarations for all these processes.

Vattenfall(1) finds that averaged over the entire lifecycle of their Nuclear Plant including Uranium mining, milling, enrichment, plant construction, operating, decommissioning and waste disposal, the total amount CO_2 emitted per KW-Hr of electricity produced is 3.3 grams per KW-Hr of produced power. Vattenfall measures its CO_2 output from Natural Gas to be 400 grams per KW-Hr and from coal to be 700 grams per KW-Hr. Thus nuclear power generated by Vattenfall, which constitutes some of best practice in the industry, emits less than one hundredth the CO_2 of Fossil-Fuel based generation. In fact Vattenfall finds its Nuclear Plants to emit less CO_2 overall than any of its other energy production mechanisms including Hydro, Wind, Solar and Biomass although all of these processes generate much less in their life cycle than fossil fuel based generation of electricity.

Comparable cost of electricity production, and fuel sources

To provide the worlds growing electrical demand certainty of supply, health and safety and costs are the prime criteria. Certainty of supply depends on the long term dependable operation of the generation plant, which in itself depends on fuel supply, downtime for maintenance, and operational efficiency factors. Lack of sun, wind and low water flow effect solar, wind and water turbine generation. Uncertainty of long term fossil fuel supplies , and spiralling costs, effect fossil fuel powered generation.
The table on the right shows a comparison of the main types of electrical production currently available, it can be seen that although Hydro is the lowest overall cost of production the availability to generate this type of power will not meet our growing demand.

It can be seen that nuclear is not only comparable in cost with other energy generation sources, but can be readily expanded to meet the worlds demand, along with minimal CO_2 impact on our planet.



Availability of the fuel source

Uranium, the prime raw fuel source for current reactors, is present at an abundance of 2 - 3 parts per million in the Earth's crust which is about 600 times greater than gold and about the same as tin. The amount of Uranium that is available is mostly a measure of the price that the industry is willing to pay for it. At present the cost of natural Uranium is a small component in the price of electricity generated by Nuclear Power. The known reserves amount to about 85 years supply at the current level of consumption with an expected further 400 years supply in additional or speculative reserves. Australia has 25% of the known global resource. The price of Uranium would have to increase by over a factor of 3 before it would have an impact of the cost of electricity generated from Nuclear Power. Such a price rise would stimulate a substantial increase in exploration activities with a consequent increase in the size of the resource, (as has been the case with every other mineral of value). (2)

Advanced technologies are being developed which are far more efficient in their use of Uranium, or which utilize another suitable element, Thorium, which is 3 times more abundant than Uranium. If perfected these technologies can make use of both the spent fuel from current nuclear reactors and the depleted Uranium stocks used for enrichment. Taken together these provide enough fuel for many thousands of years of energy production. This will mitigate the demand for newly mined Uranium.

Uranium is a dense metal found at an abundance of 2.8 parts per million in the Earth's crust. It is a highly reactive metal that does not occur in a free state in nature, commonly occurring as an oxide U_3O_8. Prices for Uranium in the world market are quoted in $US per pound of U_3O_8. The amount of Uranium commercially recoverable depends upon the market price of the metal.

The current market price is around US$100/kg, after peaking at over $300/kg in 2007. In the early 1990's the spot price of Uranium reached historical lows of less than US$22/kg. The cost of mining Uranium is a very small factor in the cost of running a nuclear power station and so movements in the price have little effect on the price of the power produced.
The sources of uranium are: mining, commercial inventories, (from earlier periods of oversupply), reprocessing of spent fuel rods from nuclear power plants and down blending, (mixing of enriched uranium with natural or depleted uranium), of highly enriched uranium from dismantled nuclear weapons. Global consumption of uranium is approximately 60,000 tonnes of Uranium metal per annum of which 56% is sourced from uranium mining. The majority of the balance comes from stockpiles and down blending in former Soviet countries as they reduce or eliminate their stock of nuclear weapons. The importance of this source and that of commercial inventories is expected to diminish over the next ten years.
Reasonably assured reserves, (or proven reserves), refers to known commercial quantities of Uranium recoverable with current technology and for the specified price. As well there are estimates of additional and speculative reserves in extensions to well explored deposits or in new deposits that are thought to exist based on well defined geological data. These are necessarily subject to a larger uncertainty, however, the historically low price of uranium over the past ten years has provided a disincentive to exploration. This is beginning to be rectified as the price recovers. Further exploration will reduce the uncertainty in the estimates of additional reserves. There are large quantities of Uranium in sea water at a concentration of approximately 3 parts per billion. Extracting this Uranium is a significant challenge but substantial progress has been demonstrated by researchers in Japan.
The use of recycled fuel rods in association with Plutonium, and known as MOX, (mixed oxide), is now becoming a more common way of producing a high quality fuel which also has the advantage of utilising the existing stocks of weapon grade Plutonium.

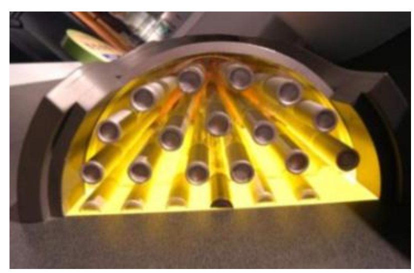
Future developments in Small Modular Reactors

There is revival of interest in small and simpler units for generating electricity from nuclear power, and for process heat.

This interest in small and medium nuclear power reactors is driven both by a desire to reduce capital costs and to provide power away from large grid systems.
The technologies involved are very diverse.

As nuclear power generation has become established since the 1950s, the size of reactor units has grown from 60 MWe to more than 1600 MWe, with corresponding economies of scale in operation. At the same time there have been many hundreds of smaller power reactors built both for naval use, (up to 190 MW thermal), and as neutron sources, yielding enormous expertise in the engineering of small units. The International Atomic Energy Agency (IAEA) defines 'small' as under 300 MWe, and up to 700 MWe as 'medium. Together they are now referred to as small and medium reactors (SMRs). (3)

Today, due partly to the high capital cost, and construction time, of large power reactors generating electricity via the steam cycle, and partly for the need to service small electricity grids, there is a move to develop smaller units. These may be built independently or as modules in a larger complex, with capacity added incrementally as required. Economies of scale are provided by the numbers produced. There are also moves to develop small units for remote sites, or industrial use.
These units will, along with major large nuclear plants, lead the way in the diverse use of safe, clean, nuclear power for future generations.



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insight@enzenglobal.com
www.enzenglobal.co.uk