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Increasing Utilization Efficiency of Nuclear Energy in a Carbon Constrained World

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Abstract - Energy is a resource on which civil society is built. It affects every aspects of life and is vital to the survival of the modern world. Energy is consumed in a variety of forms and produced from variety of sources. Oil, Coal, Solar, wind and nuclear energy sources have become a permanent necessity of modern society. Nuclear energy has come to the forefront of these sources, because of its advantages. Nuclear energy is clean, safe, reliable compact, competitive and practically inexhaustible. This paper explores nuclear power. Understanding its positive and negative aspects; a logical conclusion can be drawn in order to from an opinion on nuclear power that could change the world.

Keywords : Nuclear Power, Nuclear Fission, Fossil Fuels, Carbon Emission

Introduction- Nuclear energy is the energy in the nucleus or core of an atom, that is released in significant amount in process that affect atomic nuclei, the dense core of atoms [1]. One method of releasing nuclear energy is by controlled nuclear fission in devices called reactors. Huge amount of energy released in fission process provide power for society's benefit. The technology of using nuclear energy released by fission process has been in practice since 8 decades in all over the world [2]. Nuclear fission is a nuclear reaction or a process of radioactive decay, after which the atomic nucleus splits in to lighter nucleus. When the excitation energy exceeds the potential barrier, the heavy nuclei undergoes spontaneous fission without any external perturbation Fig.1.

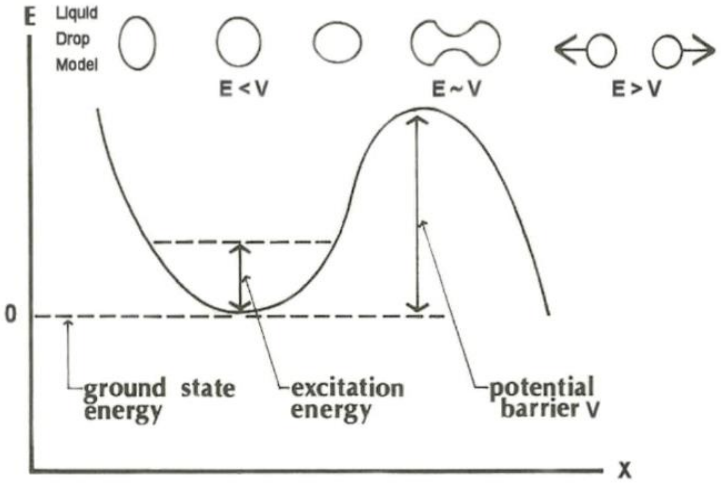

Fig. 1 Modeling of the fission process in terms of a fission barrier.

Modern fission artificially produced is usually initiated using a neutron that is embedded in a nuclear and disrupts its balance. In fission the mass varies during the reaction and energy released, calculated according to mass-energy equivalence principle is around 180-190 mega electron volts. The majority of the fission energy around 80% is carried away as kinetic energy and excitation energy of the fission fragments. In power reactors the kinetic energy of fission fragments first extracted as heat and then converted in to electrical energy.

Low Carbon energy Technology

Nuclear energy is environmentally the most benign compared with other options for electricity generation and is a key consideration in discussion of sustainable development [3]. Pathway for using energy resources for sustainable power production are shown in Fig. 2, highlighting the role of nuclear energy.

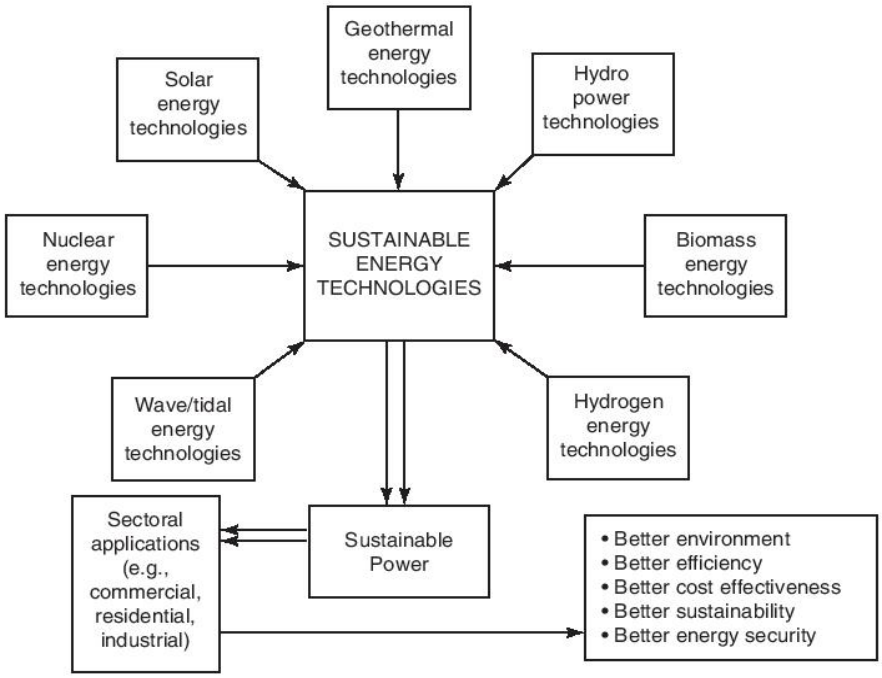

Fig. 2 Key energy resources for sustainable/low carbon energy technologies and there interdependences.

Utilization of sustainable energy source is expected to reduce energy related environmental problem emission of Co_2, No_x, So_x, non-methane hydro carbons and particulate matter. When comparing the energy released by a chemical reaction, as in the combustion phase of a Coal (c) atom or methane (CH_4) molecule, with a nuclear reaction on a nucleus of uranium (^{235}U isotope) by a neutron (n) the amount of energy (Q) differs from six order of magnitude

$$C+O_2= Co_2+Q, (3.6ev)$$

$$CH_4+2O_2= Co_2+2H_2O+Q (9.22ev)$$

$$^{235}U+n= F_1+F_2+\vartheta n+Q (211.5 Mev)$$

That means, on a large scale, 5 gram of nuclear fuel are energetically equivalent to 640kg of wood or 360m^3 of methane or 400Kg of coal or 350Kg of oil moreover with no Co_2 emission.

Nuclear Waste Management- Radwaste management is an important issue in the nuclear program, although waste quantities are very small [4]. The vast majority of waste (90% of total volume) is low level waste composed of only lightly contaminated items, such as tools and work clothing and contains only 1% of the total radioactivity. 7% waste in intermediate level waste while only 3% of the total value of waste is high level waste but contains 95% of the total radioactivity. Nuclear sector takes full responsibility for all of its waste. Many permanent disposal facilities are in operation for low and intermediate level waste and facilities for high level waste are under implementation and under construction.

Risk of Accidents- Although conventional nuclear power plants cannot explode like atomic bombs, accidents can happen in which dangerous levels of radiation might be released into the environment and result in human casualties. **Three Miles Island** is the most serious nuclear reactor accident in the United States occurred in 1979 at the Three Mile Island power plant in Pennsylvania, the result of human error after a valve failure. **Chernobyl** is the worst nuclear disaster in history both in cost and causalities [5]. In the investigation after the accident, it became apparent that there had been two fundamental causes. First, the design of the nuclear reactor, the reactor was not housed in a containment building and was extremely unstable at low power. This second, human error contributed greatly to the disaster. **Fukushmia** was a large reactor located in the Futaba district of Japan. On March 11, 2011 a 9.0 magnitude earthquake shook Japan causing structural damage and loss of many lives. The reactor that was in working shut down immediately when the earthquake hit it. A high amount of radioactive release occurred in the following four to six days. It is important to understand the severity of what occurred at Fukushima reactor was a failure in the design of a reactor.

Conclusion- Nuclear energy has many advantages over thermal power produced from fossil fuels, particularly in the environmental and sustainability areas. The technology is already developed and continues to get safer, cheaper and more efficient. Risks are the part of our daily life. Occasional air crashes, train collision, industrial and automobile accidents, electrocution, earthquakes, house collapse, failure of dams, meltdown of nuclear reactor courses and bursting of LPG gas cylinders are some instance. Because of their benefits obtained, man has learnt to accept these risks, by adopting safety precautions. The future of nuclear power is bright one with great strides being made to make reactors more sustainable, cheaper to build and safer to operate.

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