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Nuclear Energy: A Pathway to Greener India

Piyush Sinha

Department of Physics,
HNB Garhwal University Campus, Pauri, (Uttarakhand), INDIA

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ABSTRACT: Nuclear energy is considered a clean, safe, reliable, competitive and practically sustainable energy source. Using clean energy to produce electricity is one of the most important actions that are taken to reduce the impact of burning fossil fuels (coal, oil and gas) which massively pollute the atmosphere and contribute to greenhouse effect. With the fast pace of growth both in India's population and economy there is even a greater demand for energy. Commercial energy consumption has increased to about seventy percent from about twenty five percent in 1950 and the electricity share in the total energy consumption is about thirty to thirty five percent. Thermal power dominates India's electrical energy production, but environmental concerns and a rapid depletion of coal have forced power developers to look for cleaner alternatives such as hydro-electricity, solar and wind power and nuclear energy even though they cost more than the thermal power. Nuclear power from twenty reactors across India accounts only for less than three percent of the electricity that India generates. Given the huge potential of the nuclear energy in electricity generation, the paper presents in depth analysis and advocates the use of nuclear energy which can lead to more environment friendly greener India.

Key Words: Nuclear energy, Electricity, Greenhouse effect

I. INTRODUCTION

The core of an atom called nucleus is an unimaginable powerhouse of energy. This form of energy, often called nuclear fuel, is hundreds of thousands of times more powerful than the conventional fuels, which are basically dead plants and animals existing in the form of coal, petroleum, natural gas and other form of fossil fuel. To put things in perspective, imagine a kilometer-long train, with about 50 freight bogies, all fully laden with the most typical fossil fuel — about 10,000 tons of coal. The same amount of energy can be generated by 500 kg of nuclear fuel, naturally occurring Uranium, enough to barely fill the boot of a small car. When the technology is fully realized, one can do even better with naturally occurring Thorium, in which case the material required would be much less, about 62.5 kg, or even less according to some estimates , and thus enough to fit in a small bag (Note: 500 kg of naturally occurring Uranium would contain about 3.5 kg of Uranium-235 fuel). Nuclear power plants split uranium atoms inside a reactor in a process called fission. At a nuclear energy facility, the heat from fission is used to produce steam, which spins a turbine to generate electricity. A single uranium fuel pellet the size of a pencil eraser contains the same amount of energy as 17,000 cubic feet of natural gas, 1,780 pounds of coal or 149 gallons of oil. Compared to other non-emitting sources, nuclear energy facilities are relatively compact.

The amount of electricity produced by a multi-reactor nuclear power plant would require about 45 square miles of photovoltaic panels or about 260 square miles of wind turbines.

A renewable energy source uses an essentially limitless supply of fuel, whether wind, the sun or water. Nuclear energy is often called a sustainable energy source, because there is enough uranium in the world to fuel reactors for 100 years or more.

II. COMPARISON AT A GLANCE (FUEL AND LAND REQUIREMENT)

1 Kg of firewood can generate 1 kilowatt-hour (kW·h) of electricity.

1 kg coal: 3 kW·h

1 kg oil: 4 kW·h

1 kg uranium: 50 000 kW·h; (35, 00,000 kW·h with reprocessing)

Consequently, a 1000 MW (e) plant requires the following number of tones (t) of fuel annually:

26, 00,000 ton coal: 2000 train cars (1300 t each)

20, 00,000 ton oil: 10 supertankers

30 ton uranium: reactor core (10 cubic meters)

The energy density of fossil and of nuclear fuel allows relatively small power plant areas.

The low energy density of renewable, measured by land requirements per unit of energy produced is demonstrated by the large land areas required for a 1000 MW(e) system with values determined by local requirements and climate conditions (solar and wind capacity factors ranging from 20 to 40%) :

Fossil and nuclear sites: 1–4 km²

Solar thermal or photovoltaic (PV) parks: 20–50 km² (a small city)

Wind fields: 50–150 km²

Biomass plantations: 4000–6000 km² (a province)

As can be seen above nuclear power stations are very compact, occupying typically the area of a football stadium and its surrounding parking lots. Solar cells, wind turbine farms and growing biomass, all require large areas of land. Nuclear power is clean, safe, reliable, compact, and competitive. Today over 400 nuclear reactors provide base-load electric power in 30 countries. Fifty years old, it is a relatively mature technology with the assurance of great improvement in the next generation. (Hundreds of nuclear reactors furnish reliable and flexible shipboard power: military ships of course but the technology is adoptable to civilian maritime transport).

Clean Power. Nuclear energy produces almost no carbon dioxide, and no sulfur dioxide of nitrogen oxide whatsoever. These gases are produced in vast quantities when fossil fuels are burned.

Nuclear power is a clean form of energy, since it does not result in an emission of toxic gases such as carbon dioxide, nitrogen dioxide or sulfur dioxide, which is why it is also called as green energy. Nowadays, where air pollution is one of our main concerns, an option like this is certainly preferable over the combustion of fossil fuels which causes much more pollution.

Nuclear waste. One gram of uranium yields about as much energy as a ton of coal or oil-it is the famous "factor of a million". Nuclear waste is correspondingly about a million times smaller than fossil fuel waste, and it is totally confined. In the USA and Sweden, spent fuel is simply stored away elsewhere; spent fuel is reprocessed to separate out the 3% of radioactive fission products and heavy elements to be vitrified (cast in glass) for safe and permanent storage. The remaining 97% - plutonium and uranium – is recovered and recycled into new fuel elements to produce more energy.

The volume of nuclear waste produced is very small. A typical French family's use of nuclear energy over a whole lifetime produces vitrified waste the size of a golf ball.

Nuclear waste is to be deposited in deep geological storage sites; it does not enter the biosphere. Its impact on the ecosystems is minimal. Nuclear waste spontaneously decays over time while stable chemical waste, such as arsenic or mercury, lasts forever. Most fossil fuels waste is in the form of gas that goes up the mole stack. We don't see it, but is not without effect, causing global warming, acid rain, smog and other atmospheric pollution.

According to nuclear scientists, compared to fossil fuel waste, nuclear waste that occurs due to the production of nuclear energy is not only to a lesser extent, but also limited in order not to affect someone in his entourage. It has been proven that if a family of four uses nuclear energy for all its needs, the waste generated during a lifetime would be as small as a golf ball.

Reliable Source. A major benefit of nuclear energy is that it is a very reliable source of energy, because most nuclear reactors have a lifespan of 40 years, which can easily be extended again for 20 years.

Nuclear reactors provide base-load power and are available over 90% of the time; intervals between refueling have been extended and down time for refueling have been reduced. In the USA, these improvements over the years have been the equivalent of adding one reactor a year to the existing fleet. Most reactors are designed for a life of 40 years; many are reaching that age in good condition and extensions of 20 years have usually been granted.

Competitive Edge. The cost of nuclear power is competitive and stable. The cost of nuclear fuel is a small part of the price of a nuclear kilowatt-hour, whereas fossil fueled power, especially oil and gas, is at the mercy of the market.

Inexhaustible in Nature. Uranium is found everywhere in the crust of the Earth – it is more abundant than tin, for example. Major deposits are found in Canada and Australia. It is estimated that increasing the market price by a factor ten would result in 100 times more uranium coming to market. Eventually we will be able to recover uranium from sea water where 4 billion tons are dissolved.

Easier Management. Nuclear waste that results during the generation of nuclear power is much easier to manage, because it is just dumped in geological position, where it decays over a period of time and not has a negative impact on the ecosystem. This proves to be done of the main advantages of nuclear power compared to the chemical waste, such as arsenic or mercury, that refuses to dissipate, or toxic gases that cause global warming, acid rain and smog.

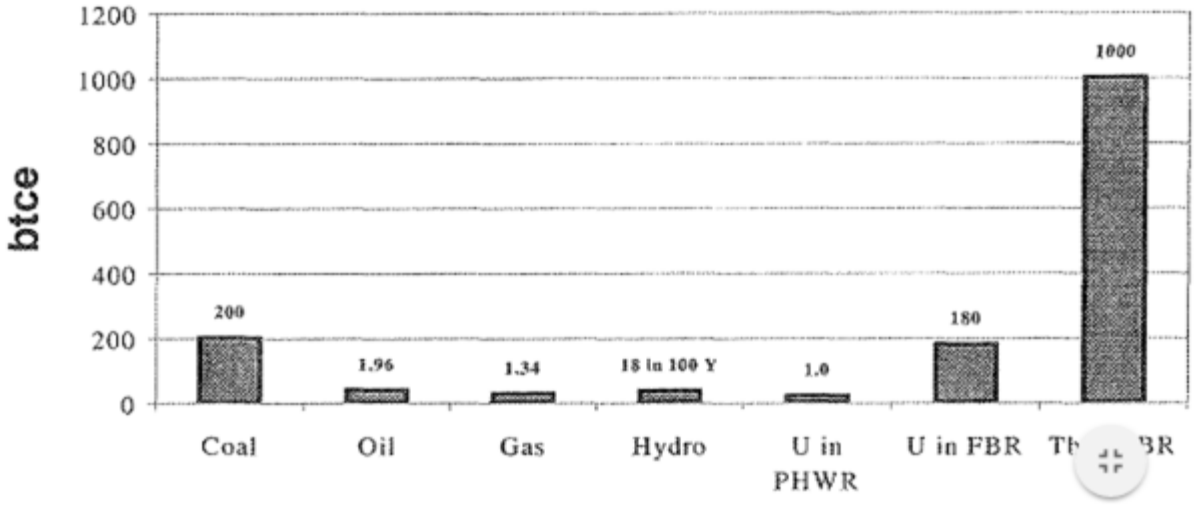

Fig. 1. Energy resources in India.

Easy availability. The availability of nuclear power is comparative with other energy sources such as oil and gas, as the cost of nuclear fuel is a small part of the overall reaction, so even if there is a slight fluctuation in the market the reaction should not be affected. The source of nuclear energy is uranium and in available in abundant in the Earth's crust with large deposits being discovered in Canada and Australia. Therefore, since the source of nuclear energy is available now and for centuries to come, this form of energy is virtually inexhaustible.

No fear of radiation. The greatest fear associated with nuclear energy is the fear of radiation, which could be overcome by educating people about radiation and its behavior. People would be surprised to know that the radiation was part of our environment, since its existence, and that the radiation in moderate amounts can even be beneficial to our health. With this nuclear fact in mind, the radiation need not feared from, but can be channeled appropriately to serve humanity in a positive way.

Nuclear economics. Nuclear energy is very beneficial for a growing nation. Nuclear power plants are known to have very high upfront capital costs but very low operating costs. Think about it like buying a hybrid car. The purchase price can be significantly more than a car with a gas engine but the fuel costs are much lower. We buy it because it'll be cheaper in the long run to pay more upfront and less over time. Nuclear economics are similar.

High upfront capital costs are typically welcomed by the country that is building the plant. A large amount of work will go to Indian contractors to pour concrete, lay rebar, erect structural steel, weld pipe, install equipment, etc. Much on the equipment will be purchased from Indian suppliers. Because of this, the money spent on the plant goes right back into the country's economy.

Importing uranium is significantly cheaper than importing gas, coal, or petroleum. This is important for a country low on natural resources. In this way, more money is directed domestically towards growth.

III. CONCLUSION

Today, India finds itself going through a phase of rapid ascent in economic empowerment. Since liberalization, industries are evolving at a significantly higher rate. As per report the focus of our government for this decade will be on the development of key infrastructure and the uplifting of the 600,000 villages where 750 million people live, as vibrant engines of the economy. In 2008, we crossed the trillion-dollar mark, and it took more than six decades for us to reach that milestone. However, it is predicted that the Indian economy will double again, to reach the $2-trillion mark by 2016, and then again redouble, to reach the $4 trillion milestone by 2025. All this economic growth will need massive energy. It is predicted that the total electricity demand will grow from the current 150,000 MW to at least over 950,000 MW by the year 2030, which will still be less than one-fourth of the current U.S. per capita energy need. In fact, by 2050, in all likelihood the demand could go even higher, and the per capita energy demand would be equal to the current French or Russian figure of about 6000 W per capita**.**

To fill the gaps in electric power production in India, nuclear energy resources as shown in figure because of their abundance and efficiency can be a big boost. As already discussed above because of their Reliability, Competitive edge, inexhaustiveness in nature, easier management, easy availability, easy availability, good economics and above all the environment friendly property the nuclear energy need to be given the driving seat in its utilization for energy needs in India. If the Nuclear Power Industry lives up to its promises for modern, 3rd generation plants, the total levelised cost of nuclear power including constructions, operational, waste disposal and decommissioning costs minimum per Kilowatt-hour depending on various parameters discussed in the paper. Nuclear power plants pay back the energy required to build them in less than six months of operation. Current world proven reserves of Uranium are sufficient to supply current world demand for 100 years. Speculative reserves provide an additional 150 years of supply. The cost of Uranium Ore is a very small fraction of the operating costs of Nuclear Power. Fourth Generation Nuclear Plants can fully utilize all the energy in Natural Uranium. There is sufficient Uranium and Thorium on Earth for Fourth Generation reactors to supply the total world demand for energy for hundreds of centuries.

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