Nuclear Energy and Resolving Environmental Problems: Examining the Case of India

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It is a well known fact that energy, primarily in the form of electricity, is the lifeline of modern societies since most socio-economic activities are driven by electrical power and per capita electricity consumption is a parameter for assessing the quality of life. Therefore, it is hardly surprising that a nation's aspiration for economic growth and development brings it face to face with the necessity of rapidly and substantially augmenting its electricity production.

India presently enjoys a per capita energy availability of 778 kWh, which compares dismally with an advanced country like Canada that enjoys a per capita availability of 15, 138 kWh. According to the Human Development Index, for a developing country to become a developed one it must be able to provide 4,000 kWh to every citizen. As is evident, India is far from the target, even as the population of the country continues to grow at 1.58%. The inability to provide adequate electricity will have an impact on the growth of the economy (especially employment), which in turn, will have implications for the socio-economic development of the human resources potential of the country.

At one level, it looks very easy to solve this problem through the construction of more plants for electricity generation. However, the crunch lies in the *kind of plants* that are built because power plants are the biggest and fastest growing contributors to greenhouse gas (GHG) emissions. Traditionally, the choice of the plant has been influenced by considerations such as the availability of the type of fuel and technology, and the cost of the plant. For instance, when China embarked on its fast track economic growth, it resorted to rapid construction of coal fired plants because coal was available indigenously as well as easily through imports, the technology was the easiest to assimilate, and the price of such plants was the lowest. However, the environmental cost of these plants is evident today. The huge GHG emissions from them have not only resulted in a semi-permanent smog over most Chinese industrial hubs and urban conglomerates, but also led to an increase in respiratory ailments. China also suffers from a high number of environmental deaths among coal miners either due to accidents in mines or because of coal dust induced diseases.

The lesson that needs to be drawn from here is that while trying to resolve the challenge of energy poverty, it is imperative that a nation pays adequate attention to the overall picture of available energy sources and their advantages and limitations, including environmental implications. It would be counter-productive for a nation to anchor its economic growth on energy sources that severely raise its environmental vulnerability, thereby leading to a drain of the economic resources on mitigation strategies.

India's Present Energy Mix

Presently, India draws the bulk of its electricity (about 64%) from thermal sources, especially coal. In fact, nearly 55% of the country's total commercial energy need is met by coal fuelled plants. Hydropower comes a distant second at 18.2%, and then renewable sources provide another small share of the electricity at about 15%. Finally, nuclear reactors provide 3% of the total electricity generation. Despite its rather meager contribution, nuclear energy holds substantive promise from the perspective of meeting India's humungous energy needs in a secure and sustainable low carbon way. This is because nuclear power emits the least amount of greenhouse gases. In fact, the complete nuclear power chain, from uranium mining to waste disposal, including reactor and facility construction, emits only 2–6 grams of carbon per kilowatt-hour.

Carbon Dioxide Emissions from Power Technologies in g/kWh

Coal

Advanced Coal

Oil

Gas

Nuclear

Hydro

Wind

960-1300 800-860 690-870 460-1230 9-100 2-410 11-75

As can be deduced from the table above, the strategies and technologies adopted by countries with large energy requirements will have critical implications for the local and global environment. Illustratively, France that meets 42% of its primary energy consumption from nuclear energy has the lowest per capita carbon dioxide emissions in Europe. India, even with such a low per capita consumption of electricity, is already the third largest emitter of GHG gases. So, the choices it makes for augmenting its electricity production on way to bridging a huge power deficit will have significant environmental consequences.

The fact that nuclear energy has a low carbon footprint is well accepted. However, the environmental benefits from nuclear energy cannot be quantified only on the basis of the low GHG emissions, but must also take into account the savings in emissions they bring about by replacing thermal plants that would otherwise be required. For instance, according to the estimates made by *Nuclear Engineering International* with regard to the USA, its 100 odd nuclear plants prevent the emission of 650 million metric tons of carbon dioxide every year. Or, in the absence of Canada's nuclear plants, its GHG emissions would rise by 12%. Or, that in 2011 with the closure of Japan's nuclear plants (that catered for 30% of its electricity production) after the accident at Fukushima, the country's emissions rose by 3.9% over the last year. For a world that is desperately looking to reduce the impact of human-induced climate change, these figures are of critical importance.

In the case of India, where neither population nor electricity demand has yet stabilised, the environmental cost of meeting its surging electricity requirement only through thermal plants would be huge. In fact, given that India's indigenously available coal deposits are of such low quality, with a high ash content and low calorific value, the need to adopt low carbon energy sources is even more important. Moreover, since coal reserves are also concentrated in a few parts of the country, plants in areas away from coal mines need haulage of fuel over long distances, thereby raising the cost, tying down the rail/road network, and creating its own environmental repercussions.

Besides nuclear, renewable energy sources such as wind, biomass, solar, hydro are the other options from an environmental point of view. However, except for hydro power in the few places where it is plentiful, none of these has proven suitable for large scale power generation where continuous, reliable power supply is needed, and it is well known that reliability and evenness of electricity supply is even more critical for an increasingly digitized society. Therefore, while wind and solar do hold promise, the technologies are yet to mature for large scale use.

Sustainably Bridging the Electricity Deficit

In such a scenario, if the growing Indian economy continues to rely on traditional thermal energy sources, carbon emissions would significantly rise and environmental consequences like greenhouse effect, global warming and climate change would progressively exacerbate. Despite technology improvements in thermal plants and

implementation of stringent environmental measures, pollution is sure to rise with the upsurge in energy production from thermal plants.

In comparison, nuclear plants do enjoy certain distinct environmental advantages. Firstly, as stated earlier, they emit no carbon dioxide, the biggest contributor to global warming. In fact, they do not produce nitrous or sulphur dioxide that causes smog or acid rain. Secondly, being a dense source of electricity, the land requirements of nuclear plants are only a fraction of solar or wind power plants. It has been calculated that "for a 1,000 MW power plant, nuclear requires about one square mile of space compared with 50 square miles for solar, 250 for wind and 2,600 for biomass." Thirdly, the fuel requirements of a nuclear plant are much lower compared to a thermal plant. A 1,000 MWe plant coal fired plant has an annual requirement of 38,000 railroad cars of coal, or 40,000 barrels of oil per day, while a nuclear plant of the same size only needs 6 truckloads of fuel. As extrapolated, this "means that for nuclear there are proportionately fewer mining disasters, fewer agonizing deaths from ailments such as Black Lung, and fewer deaths and injuries in railroad accidents while transporting the fuel." This also has significant benefits by cutting down pollution caused by fuel transportation. Fourthly, the amount of waste generated by a nuclear plant is small in volume as compared to the impact that fly ash from a thermal plant causes to several kilometers around it. Fifthly, a comparative techno-economic analysis that accounts for location of coal mines, transportation of fuel, availability of railroads, modern systems of construction and resource management, and ash content and associated environmental impact and necessary mitigation measures, etc. skews the equation in favour of nuclear energy. An EU study has estimated that inclusion of health and environment costs would double the EU price of electricity from coal and increase that from gas by 30 per cent.

Therefore, for India, cash strapped as it is, nuclear energy can play the double role of not only providing electricity from a reliable and mature technology in which the country has more than 300 reactor years of experience, but also do so in an environmentally friendly manner that further assists the country by reducing expenditure that might otherwise be necessary for environmental and health mitigation efforts. Of course, renewable energy also offers an attractive alternative and the country has substantially exploited its hydel potential. However, both the hydroelectric plants and wind farms also bring problems of human displacement and rehabilitation, besides being poor sources of base load electricity. Meanwhile, solar energy though holds great potential, its commercial viability for large scale electricity generation and storage are issues that still demand more R&D. In the meantime, nuclear energy presents itself as a commercially proven and environmentally sustainable, large-scale electricity source.

One aspect of nuclear power that has become a major concern since the incident at Fukushima relates to the possibility of accidents at nuclear plants causing release of radioactivity into the atmosphere and thereby posing a danger to humans. Much public apprehension has been expressed on this, ignoring the fact that nuclear plants have been in operation for over six decades, but that only three major accidents have ever happened. Even so, except in the case of Chernobyl (which has been attributed to human error), no human fatalities associated with the plant took place in the other two. After Fukushima, even greater attention has been paid to the issue of nuclear safety and every country operating such plants has tightened its safety and regulatory oversight.

However, one conclusion that most countries have arrived at in order to alleviate public concern over nuclear safety is to increase awareness on the advantages of nuclear power. This opportunity should also be used to better understand the role of nuclear energy in addressing environmental concerns. Obviously, nuclear energy alone does not represent the solution to the complex environmental issues confronting mankind. But, it undeniably has a role to play, especially in a country like India, where increase in electricity production is imperative but which must be undertaken in a manner that causes the least disturbance to the environment. Enhancing energy production and sustaining the environment are therefore not an either/or choice. India must be greedy enough to want both. And, nuclear power does provide a solution worthy of consideration.

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