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Significance of Energy Security in 21st century with reference to Nuclear Energy Scenario of India

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Abstract: *In contemporary international relations energy security is one of the most important and contested elements of state security in times of war and peace. Most of the conflicts and wars are directly or indirectly caused by energy resources mainly oil and gas in various regions of the world. The cut throat race and political struggle over energy resources have motivated the states to find out a strategic alternative which will be safe and cheap to sustain their industrial infrastructure. The new thinking has been prevailed and nuclear energy becomes an available source of energy to reduce the foreign dependence of states. Keeping in view this paper will briefly analyze the importance of nuclear energy in 21st century, however the main focus will over India energy scenario. The main argument is based on that India need to increase its energy production to meet the energy security challenges and reduce the politically insecure dependence on foreign energy supplies. In this context nuclear energy is one of the safest and profitable alternatives to balance the challenges. From last few years, India has focused on nuclear co-operation agreements with various countries for a regular nuclear fuel supply. Such agreements are with countries rich in nuclear fuel and possessing advanced technology in field of nuclear power production. The nuclear energy will provide sustainable structure of energy security scenario of India.*

Keywords: *Energy Security, Nuclear Energy, Oil, gas, coal, wind and solar energy.*

I. Introduction

As expanding economies continue to grow, the one source of energy that we can develop rapidly, cheaply and with next-to-no emissions is nuclear energy. (Craig Stevens)

In contemporary international relations energy security is one of the most important and contested elements of state security in times of war and peace. Most of the conflicts and wars are directly or indirectly caused by energy resources mainly oil and gas in various regions of the world. Every state is struggling for energy to balance the challenges and maintain the sustainability of industrial and economic growth. From last few decades energy security become center of attention in international politics and states foreign policies as every development on traditional security and non-traditional security fronts is linked with technology and technology dependent on energy. From economic point of view, nuclear energy is a source of livelihood, politically, it creates diplomatic and energy related relations. It also facilitates trade relations for the non-nuclear states. Strategically, if nuclear energy is used for peaceful purposes it will leads to the prosperity and development of the states. In this context energy security is an important element of state security and therefore the topic is of great importance in contemporary context.

The sources of energy varies from age to age and since centuries the main sources of energy have been fossil fuels such as Coal, Oil and Natural Gas and these resources are now dominant in most of the developing World. Other major contributors, of varying importance in different countries, include hydroelectric power, nuclear power and biomass.[1] In the universe of energy security, nuclear energy is the latest energy source to be used on a large scale which first emerged in the middle of the 20th century. During the 21st Century, the World will demand increasing supplies of energy and states need to think of a safe alternative to balance the challenges and meet the increasing demands. In 2001, the per capita consumption of energy for industrialized countries such as France and Japan was about 14 times that of India and almost 50 times that of Bangladesh, whereas it was only about one- half that of the United States. It might be desirable and practical for the United States to reduce its per capita energy use, but in many countries there is a need for more energy.

From 1980 to 2001 US energy consumption per capita changed whereas India's per capita consumption more than doubled and rose over 150 percent for Bangladesh – a considerable accomplishment especially considering the substantial population growth in those countries.[2] In 2004, almost 30 percent of the World's oil has come from the Persian Gulf region and the countries of this region have a disproportionately large share of

the remaining resources.[3] Coal will continue to constitute a major proportion of India's energy mix for many years to come. India is the third largest coal producer in the World after China and the USA. In the past, some coal had to be imported from Australia and New Zealand since India's own resources are of low quality, with high ash content.[4]

India is not well endowed with energy resources, at least not when compared to its requirements. Coal is the dominant resource and proven coal reserves, even if one assumes a modest growth in consumption at the rate of five percent per year, will last only until the middle of this century. According to the International Energy Agency Report 2007, China produced 2,481 tons of coal, the United States 990 tons and India 427 tons. While Indian coal production is much lower than that of China, its continuous increase would require investment in mining as well as railroad transportation. The continued depletion of coal reserves requires a focusing attention on coal mining so that reserves considered uneconomic at present can be exploited. Oil and gas reserves are very modest and India is already importing most of its requirements. India is not a well explored country in energy, however, and the recent stepping up of exploration for petroleum may yield positive results. Keeping in view these facts about energy scenario of India, nuclear energy is one of the profitable, safe and sustainable options to strengthen the energy security.

From a long-term perspective, unconventional sources of gas such as coal-bed methane and gas hydrates could also be important for India[5] but India need to consider its domestic needs and international status as a rising power have accelerate its speed in developing the nuclear energy sector. India is certainly parallel to China for oil and mineral resources in Africa.[6] The search for 'equity oil' has been the single most important new element of India's economic diplomacy in the last years. Much like China, India has made investments in hydrocarbon fields around the World a major national priority. However, nuclear energy cannot be ignored in stance with India today.

According to International Energy Agency (IEA), 2007 the annual average of electricity consumption in the World is about 2,600 KWh per capita and the present population is about 6.5 billion. India and China are the World's two most populous countries advancing fast economically and developments in the energy sector of these two countries will influence World energy markets and the global environment. India and China due to their sheer size and consequent demand for energy can also be expected to lead innovation in energy technologies.[7] India has one of the oldest civilian nuclear programmes in the World and its current strategy based on self-reliance is unlikely to generate more than 10,000 MW of electricity.[8]

In 2005-06, India's import dependence was about 24 percent of its total primary energy consumption and about 33 percent of its commercial energy consumption in the same year. By 2031-32 India's import dependence could rise to 28% of its total primary energy consumption, or 32% of its commercial energy consumption under the most energy-efficient scenario. Under the business-as-usual scenario, India's import dependence by 2031-32 would rise to 49% of the total primary energy consumption and 54% of the commercial energy consumption. India's share of the World's supply of fossil fuels is projected to vary from as low as 3.7% to between 7.6% and 10.9% by 2031-32, depending on whether one considers the most energy-efficient scenario or business-as-usual scenario. Most importantly, India's incremental demand for commercial energy could account for 13% of the World's incremental supply of commercial energy in the most energy-efficient scenario, rising 21% of the World's incremental supply of commercial energy in the business-as-usual scenario.[9] India will therefore, have to go the extra mile to make the developed World understand that even under business-as-usual scenario, India's per capita energy consumption in 2031-32 is expected to be below that of China's per capita energy consumption in 2005, about 16 percent of the 2005 US per capita consumption and about 70 percent of the 2005 average World per capita consumption. [10]

Sources of Energy Security

Energy can be classified into several types based on the following criteria:

Renewable and Non-Renewable energy

Renewable energy is energy obtained from sources that are essentially inexhaustible. Examples of renewable resources include wind power, solar power, geothermal energy, tidal power and hydroelectric power. The most important feature of renewable energy is that it can be harnessed without the release of harmful pollutants.

Non-Renewable energy is the conventional fossil fuels such as coal, oil and gas, which are likely to deplete with time.

Renewable Energy

Though India possesses both conventional and renewable resources of energy, yet for such a large country, no single energy resource or technology constitutes a panacea to address all issues pertaining to the availability of fuel supplies, environmental impact and health externalities. Therefore, it is necessary that all

resources become an integral part of an energy mix – as diversified as possible – to ensure energy security to a country like India during the present century.[11] In other parts of the World, as in India too, conventional energy resources such as coal, oil and natural gas are limited and non-renewable, whereas renewable resources such as solar, wind etc are non-polluting and virtually inexhaustible. Renewable energy resources can provide national energy security at a time when the decreasing global reserves of fossil fuels threaten the long-term sustainability of the Indian economy. They can thus contribute towards reduction in our dependency on fossil fuels.[12] India is the fourth largest energy consumption in the World after the United States, China and Russia.

Oil and Natural Gas

India, a nation of more than billion people, has a massive appetite for energy to meets its growing development needs. Civilian nuclear energy will make it less reliant on unstable sources of oil and gas.[13] India's rapid growth in economy has also meant a rapid increase in its demand for oil. Although India has proven oil reserves, production is nearly at capacity, while demand continues rise. According to the US Department of Energy's Energy Information Agency (EIA), India produced an average of 846,000 barrels per day (bbl/day) of 'total oil liquids' in 2006 and used an average of 2.63 million bbl/d of oil, resulting in a shortage of nearly 1.8 million bbl/d. In addition, according to the EIA's estimates, India's oil demand increased 100,000 bbl/d in 2006 and will increased by similar amounts in 2007 and 2008, leading to the nation's growing 'energy deficit'. In some cases involving the acquisition of equity to fill its oil gap, India national companies have been actively seeking overseas sources of crude oil. According to EIA, the most active Indian oil company overseas is ONGC Videsh Limited which holds interests in twenty-five oil and natural gas projects in fifteen different countries in Africa, Asia, the Americas and the Middle East. The Indian oil companies have also been actively involved in Sudan's oil industry, as well as the operation of the major oil pipeline and terminus in Port Sudan.[14] India and China are the two fastest growing economies in the World and their energy needs are also growing fast. India's crude oil consumption grew by 5.5 percent in 2003-04 and by 15.8 percent in China. The rising demand of oil has been identified as one of the major factor behind the current high in oil prices. Both the countries India and China have combined oil demand is still less than half that of the US.

Coal

Coal continued to dominate electricity generation due to its abundance availability and suitability for base load needs and relatively low cost. Coal has a variety of energy uses, but in 2006, approximately 78 percent of coal was used for power generation. The total extractable coal reserves are roughly 22,540 million tons of oil equivalents (Mtoe). The current utilization of coal supply sources is approximately 184 Mtoe and the range of utilization of coal in 2032 is expected to between 573 and 1082 Mtoe. Given current production rates and barring technological advancements, the extractable reserves could last 80 years and if 'all inferred reserves also materialize then coal and lignite can last for over 140 years at the current rate of extraction.' Other estimates suggest that at current consumption and production rates India's coal could last as many as 200 years. But with a moderate projected growth rate of five percent in domestic production, currently extractable coal resources may be exhausted in approximately 45 years. The extent of extractable coal reserves may rise in the future, however, since only about 45 percent of the potential coal bearing area has been covered by regional surveys. Given the abundance of Indian coal, all estimates and projections for future installed generation capacity suggest coal will remain the major supply for electricity generation until 2032 and possibly beyond.[15]

The coal-dominant energy scenario developed by the Planning Commission suggests as much as 45 percent of the coal required to be imported in 2032 with 8 percent GDP growth, while the least coal dependent scenario suggests 11 percent could come from imports. The cost of imported coal remains economically competitive for power generation in certain areas of India due to the low calorific value of 3,500 kcal/kg versus 6,000 kcal/kg for imported coal, the cost of imported coal transported under 500 km is cheaper than domestic coal transported greater than 1,400 km. as such, the exhaustion of coal resources could reduce the energy independence of the country, but only in the long term and only if technological innovations do not occur to prolong the life of the resource.[16] On the other hand, India's power demand is projected to double over the current production level of 100,000 mega watts by 2012 and further increase by 8-10 times, i.e., up to 800,000-1,000,000 MWs by 2050.[17]

Solar and Wind Energy

Solar energy, except for domestic use, also requires large tracts of land. Besides, solar electricity costs about Rs 20 per KWH, compared to coal-based power which is available at Rs 2-2.50 per unit. Wind energy is already being exploited in India, but only as a supplementary source. Its supply is erratic and its potential, according to Kirit Parikh, is no more than 20,000 MWs.[18] The National Survey on Importance of Nuclear Energy, conducted in Jabalpur (MP) and Bareli (UP) revealed that 88 percent people (in Jabalpur) and 59

percent respondents (in Bareli) believe that though the nation definitely has potential for solar and wind energies but despite of all their advantages, they are not stable and are dependent excessively on weather and sunshine conditions.[19] In January 2010, Jawaharlal Nehru National Solar Mission (JNNSM) was launched by the Prime Minister with the objective to help reach grid parity by 2022 and help set up indigenous manufacturing capacity. The target is to set up 20,000 MW grid solar powers and 2,000 MW of off-grid capacity including 20 million solar lighting systems and 20 million square meter solar thermal collector area by 2022. This mission is implemented into three phases. The first phase is of three areas (up to March 2013), the second phase till March 2017 and the third phase will continue till March 2022.[20]

Setting the Context: India's Nuclear Energy Programme

India's Civil Nuclear Programme was established in 1948; India's Atomic Energy Commission turned to the United Kingdom for the design and enriched uranium fuel for its first nuclear reactor, APSARA. Similarly, the CIRUS reactor was supplied by Canada, while the heavy water used in it came from the United States. India's first power reactors at Tarapur and Rawatbhata were supplied by the United States and Canada respectively.[21] India was one of the first countries to recognize the peaceful uses of nuclear energy and its nuclear programme is the oldest one among the Asian countries.[22] In 1962, Homi Bhabha, the founder of India's nuclear programme, predicted that by 1987 nuclear energy would constitute 20,000 to 25,000 MW of nuclear power. Neither of these predictions came true. Despite over 50 years of generous funding, nuclear power amounts to only 3,900 MW, just 3.1 percent of installed electricity capacity of 1, 27,056 (as of September 2006). Even if the DAE meets its current projections of 20,000 MW by the year 2020, it will only be 8-10 percent of projected total electrical generation capacity.[23] The Department of Atomic Energy (DAE) in India is carrying out nuclear energy programme. The Indian nuclear energy programme is based on three stages programme:

- The first stage was building heavy water reactors and generating power using natural uranium as fuel. The available uranium deposits in India can generate only 10,000 to 12,000 Megawatt electric (MWe) from the Pressurized Heavy Water Reactors (PHWRs).
- The second stage was development of Fast Breeder Reactors (FBRs) using plutonium reprocessed from heavy water reactors and thorium as fuel. The successful experience of the FBR led to the establishment of the prototype fast breeder reactor at Kalpakkam.
- The third stage is to use Uranium-233 generated through thorium-uranium.

  In India, nuclear energy development began with the objectives of peaceful uses of atomic energy in improving the quality of life of the people and to achieve self-reliance in meeting the energy needs. The commercial nuclear power program started in 1969 with the operation of Tarapur Atomic Power Station (TAPS) 1 & 2 Boiling Water Reactors (BWR), currently shares about 3 percent country's installed capacity. India's energy demands thus playing a complementary role. However, in long term, it is expected to play a significant role in meeting the huge electricity demand of the country. Incidentally, India is not a very energy resource rich country. Currently, India's energy resource base status suggests the optimal mix of all the available energy resources to meet its growing demand of electricity which is projected to be about 800 GWe by 2032 and 1300 GWe by 2050.[24]

With rising international oil prices and speculation about depleting oil reserves, the concern for energy security is nerve-racking factor of states at national and international level. India is the second most populous country of the World with its vibrant economy and impressive growth of Gross Domestic Product (GDP) during last few years has been facing a formidable challenge in meeting its energy needs. Energy is an essential input for the sustained growth in development. With ascendant economy, a shift from the use of non-commercial energy sources to commercial energy sources, particularly electricity has resulted in surging demand outstripping the supply. In spite of being the fifth largest electricity producer in the World, India's per capita energy consumption rates remain low in comparison to many developing countries. The growing economy of the energy sector of the country is also undergoing a massive revamp from policy changes to investment pattern and restructuring the preference for sources of power.[25] In this scenario, nuclear energy is a practical option as well solution for India to overcome the present energy challenges and future political bullying.

In this structure nuclear energy is not simply a technical or financial issue as it is more about political and strategic stability of a particular state. For India it has been an intensely a political issue as well as a strategic challenge. Because India refused to sign the Nuclear Non-Proliferation Treaty (NNPT) which came into force in 1970 and conducted nuclear tests in 1974 and in 1998, it was treated by the international community as a nuclear outlier and put under severe technological sanctions. The sanctions implied that India could not enter into nuclear cooperation with other countries after its 'peaceful nuclear experiment' in 1974. But India has made a virtue out of necessity. Since it had no access to nuclear technologies after 1974, it sought to develop a broad based, indigenous nuclear energy programme in which it achieved notable successes.[26] India has a shortage of uranium. During the years of sanctions, India could not import uranium. Our indigenous supplies of natural

uranium were limited and this put a severe constraint on the programme. On the other hand, Indian has an abundance of thorium, a naturally occurring non-fissile material which can be converted into fissile uranium-233. The question was could India use thorium instead of uranium as a nuclear fuel? It needed a programme which minimized if not totally eliminated the use of natural uranium and so India embarked on a nuclear programme which minimized the use of uranium. Accordingly, India's nuclear energy programme is based on a three-stage progression conceptualized by Homi Bhabha, the father of India's nuclear energy programme, way back in 1954. The main aim of the three-stage programme is to utilize the abundant thorium reserves of the country in reactors especially designed to use U-233 manufactured from the irradiated thorium- 232.[27]

In 1979-80 the nuclear energy generated about 600 MW of electricity, about 950 MW in 1987, and 2720 MW in 2000. In 2002-03, the Department of Atomic Energy was allocated Rs. 33.5 billions, dwarfing in comparison to Rs 4.7 billion allocated to the Ministry of Non-Conventional Energy Sources (MNES), which is in charge of developing solar, wind, small hydro and biomass based power.[28] Today, about 17 percent of the world electricity is generated from over 441 nuclear reactors operating in 32 countries. Additional 32 reactors are under construction and many more are on the drawing board. The life of quite a few reactors in some countries has also been increased. Nuclear power today is a significant contributor to global supply of electricity. There are many countries in the World whose lion's share of electricity is met by nuclear power reactors. In some countries, public pressure has demanded to call for a referendum on nuclear energy considering it as a safe, clean and efficient means of meeting the expanding energy needs. The Asian countries specially are poised to witness a substantial growth of nuclear power in coming decades.[29]

Over the past two-three decades, India has attained mastery over the design and development of PHWRs and presently the DAE is in the process of increasing the design output to 700 MWe from the existing 220 MWe. At the same time, it is also working to reduce the gestation period of these reactors. Since 1984 in the second stage, a 40 MWth FBTR has been operating at Kalpakkam. The safe and successful operation of FBTR has provided the Indian scientific community necessary inputs for the design of a prototype 500 MWe PFBR, which is being constructed at Kalpakkam. The MOX fuel for the PFBR composition has been irradiated to its target burn-up of 100 GWd/t without failure of any of the pin in the subassembly. In the third stage, KAMINI a 30 kwth reactor is operating and India is also working on a 300 MWe Advanced Heavy Water Reactors (AHWR). According to Dr. Anil Kakodkar, former Chairman of the Indian Atomic Energy Commission, the Indian AHWR offers a quicker proliferation resistant solution for the energy hungry World. A special feature of the AHWR is that it can be configured to accept a range of fuel types including low-enriched uranium, uranium-plutonium, thorium-plutonium, low-enriched uranium-thorium and uranium 233-thorium in full core. Besides, India is also working on proliferation resistant technologies, which include accelerator based energy technology, compact high-temperature reactor, solid state superconducting tokamak etc.

In early 1970s, the historical records show that almost 25 percent of global electricity was generated from oil while nuclear share constituted only 3 percent. In 2002, however, the global electricity supply structure changed. Oil's share declined to 7.2 percent while nuclear constituted 16.6 percent. Nuclear absorbed approximately 75 percent of the decrease of oil's share (17.8 percent). In 2004, according to International Energy Agency, there is no doubt that nuclear energy has made a major intrusion in the electricity market. In the post liberalization era, India is on an economic overdrive and has developed a great craving for energy. Although coal is the dominant energy source providing 72 percent of the electricity in India, it is an exhaustible source of energy likely to last for only another 5 or 6 decades.[30]

The use of nuclear power for electricity generation commenced about fifty years ago. Today, at about 16 percent of the total electricity generation in the World, nuclear power produces as much electricity as was produced from all sources. However, in India, out of total installed capacity of 1, 45,588 megawatts (as on 30 July 2008); the share of nuclear power is little less than three percent. In India, nuclear power is one of the fastest growing power-generation industries. Currently, India has 20 nuclear power plants in operation generating 4780 megawatts of electricity, while seven more are under construction and are expected to produce an additional 5300 megawatts.

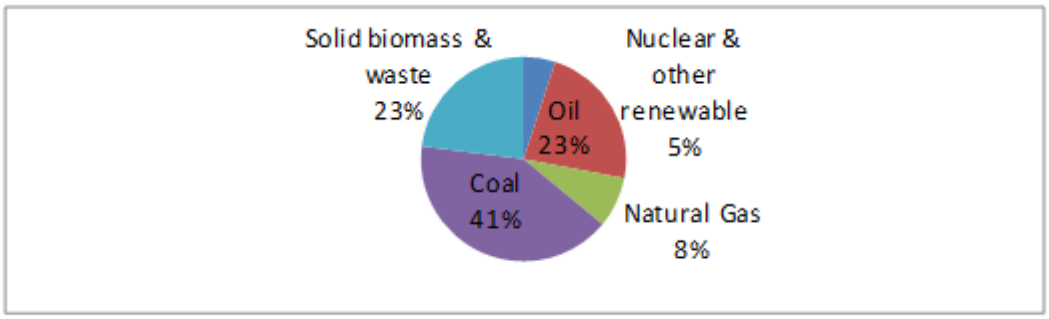
Nuclear power supplied 20 billion kWh (3.7%) of India's electricity in 2011 from 4.4 GWe (180 GWe total) capacity and after a dip in 2008-09 this is increasing as imported uranium becomes available and new plants come on line. In the end of 2011, 350 reactors years of operation had been achieved. The target since about 2004 has been for nuclear power to provide 20 GWe by 2020, but in 2007 the Prime Minister referred to this as 'modest and capable of being 'doubled with the opening up of international cooperation'. However, it is evident that even the 20 GWe target would require substantial uranium imports. In June 2009 NPCIL said it aimed for 60 GWe nuclear by 2032, including 40 GWe of PWR capacity and 7 GWe of new PHWR capacity, all fuelled by imported uranium. This target was reiterated in late 2010 and increased to 63 GWe in 2011. But in December 2011 parliament was told that more realistic targets were 14,600 MWe by 2020-21 and 27,500 MWe by 2032, relative to present 4780 MWe and 10,080 MWe when reactors under construction were on line in 2017.[31] Nuclear energy has certain benefits as nuclear power is the cleanest form of mass energy generation,

producing no greenhouse gases like CO_2, SO_2 and ash. The use of nuclear energy in place of other energy sources helps to keep the air clean, preserve the earth's climate, avoid ground-level ozone formation and prevent acid rain.

Therefore, the growth of nuclear energy in developing and populous countries is a matter of great benefit for mankind in view of its potential to protect the earth from irreversible environmental damage. Uranium has the advantage of being a highly concentrated source of energy, which is therefore easily and cheaply transportable. In addition the fuel cost contribution to the overall cost of electricity produced is relatively small. Therefore, abundant, affordable and clean energy is just what nuclear power can provide towards the sustainable growth of the economy.

In India, natural gas is used largely for power generation and nuclear energy can, therefore, readily substitute for gas. India import 20 percent of its requirement of natural gas and slated to go up about 75 percent in 2020. Besides, gas for electricity is a relatively cheap and clean fuel which is easy to handle and has an impeccable safety record. It would be a grave mistake to shut down this option.[32] India's national oil company, Indian Oil Corporation Ltd (IOC), in November 2009 joined with NPCIL in an agreement 'for partnership in setting up nuclear power plants in India'. The initial plant envisaged was to be atleast 1000 MWe, and NPCIL would be the operator and atleast 51percent owner. In November 2010 IOC agreed to take a 26 percent stake in Rajasthan 7x8 (2x700 MWe) as a joint venture with the option to increase this to 49 percent. The estimated project cost is Rs 12,320 crore (123 billion rupees, $2.7 billion), and the 26 percent will represent only 2 percent of IOC's capital budget in the 11th plan to 2012. The formal JV agreement was signed in January 2011. The cash-rich Oil and Natural Gas Corporation (ONGC), which (upstream of IOC) provides 80 percent of the country's crude oil and natural gas and 84 percent government-owned, is having formal talks with AEC about becoming a minority partner with NPCIL on present or planned 700 PHWR projects. It was later reported the ONGC intended to build 2000 MWe in joint venture with NPCIL (51percent).

Total energy consumption of India till 2012



Source: www.iea.org.

Nuclear power plants operating in India

There are currently 20 reactors are under operation (18 PHWRs and 2 BWRs) generating a total output of 4870 MWe. India's placed sixth in the World to operate 20 or more reactors. About seven reactors are under construction (4 PHWRs of 2800 MWe, one PFBR of 500 MWe and 2 VVERs of 2000 MWe). In addition, about 36 reactors are being proposed which could generate about 37100 MWe, which would include additional PHWRs, imported LWRs and indigenous FBRs.[33]

Nuclear power plants operating in India

Power Station	Operator	State	Type	Units/No	Total Capacity (MW)
Kaiga	NPCIL	Karnataka	PHWR	220x4	880
Kakrapar	NPCIL	Gujarat	PHWR	220x2	440
Kalpakkam	NPCIL	Tamil Nadu	PHWR	220x2	440
Narora	NPCIL	Uttar Pradesh	PHWR	220x2	440
Rawatbhatta	NPCIL	Rajasthan	PHWR	100x1 200x1 220x4	1180
Tarapur	NPCIL	Maharashtra	BWR (PHWR)	160x2 540x2	1400
			Total	20	4780

Projects under construction

Power Station	Operator	State	Type	Units	Total Capacity (MW)
Kudankulam	NPCIL	Tamil Nadu	WER-1000	1000x2	2000
Kalpakkam	Bhavini	Tamil Nadu	PFBR	500x1	500
Kakrapar	NPCIL	Gujarat	PHWR	700x2	1400
Rawatbhatta	NPCIL	Rajasthan	PHWR	700x2	1400
			Total	7	5300

In the coming decades, the challenge for India's national security is going to be to ensure a steady availability of energy. India's high dependence on energy imports raises security concerns ranging from the need to build elaborate and secure pipeline networks and other necessary infrastructure, to monitoring political and economic development in countries/regions from where India sources the bulk of its imports. India, a nation of one-billion-plus population without access to modern fuels, low overall income and consumption levels, and the urgency of accelerating economic growth, substantively increasing energy supply is a huge challenge. But nuclear power development holds a viable way out.[34]

Nuclear energy is an important source which can play an important role for sustainable supply of energy. In 2010, India has 20 nuclear power plants in operation generating 4780 MW of nuclear power while other 7 are under construction and are expected to generate an additional 5300 MW. India has a flourishing and largely indigenous nuclear power program and expects to have 14,600 MWe nuclear capacities on line by 2020. It aims to supply 25% of electricity from nuclear power by 2050.

- Because India is outside the Nuclear Non-Proliferation Treaty due to its weapons program, it was for 34 years largely excluded from trade in nuclear plant or materials, which has hampered its development of civil nuclear energy until 2009.
- Due to these trade bans and lack of indigenous uranium, India has uniquely been developing a nuclear fuel cycle to exploit its reserves of thorium.
- Now, foreign technology and fuel are expected to boost India's nuclear power plants considerably. All plants will have high indigenous engineering content.
- India has a vision of becoming a world leader in nuclear technology due to its expertise in fast reactors and thorium fuel cycle.

II. Conclusion

Energy security will remain the core of states security and of all energy sources nuclear energy will remain on the top agenda of states to meet the challenges in 21st century. Nuclear energy is the most eco-efficient of all energy sources because it produces the most electricity relative to its environmental impact. Nuclear energy production is highly beneficial to the development of the country. In Indian context, electricity demand has grown an average of 4 percent per annum over last 30 years. While taking into account current rate of economic expansion, the demand will grow much faster. For the overall development India need to develop more nuclear energy plants to secure its economic, political and strategic asserts. Because cheap and clean energy called nuclear energy will decide the future of industrial world.

India is one of the world's largest growing economies needs bulk of energy sources to fulfill requirements of its industries as well as expanding population. Currently, India is heavily relying on petroleum and oil to meet its energy demands. In such a critical situation, energy security for a state like India is undoubtedly a source of serious concern. To meet these challenges, India has embarked on a mega project to expand its energy resources base. One of the critical areas identified in this regard is the nuclear energy sector.

Economically though initial costs of setting up nuclear power plants are quite higher but in long run output is cheaper. For India nuclear energy is highly significant in order to catch up the developed world and speed up social development. Moreover it is a recognized fact that energy services play a critical role in enhancing the human and economic development. Thus, the central thrust in India's energy policy after independence has been upon augmenting the country's energy system. In the globalised international relations nuclear energy is viable option for India to mitigate its energy deficiency.

References and End Notes

[1]. David Bodansky, Nuclear Energy: Principles, Practices, and Prospects, USA: Springer, 2004, pp.1-2.
[2]. Ibid, p. 3
[3]. bid, p. 10

[4]. Commander G. S. Khurana, "Security of Maritime Energy Lifelines: Policy Imperatives for India" in Ligia Noronha and Anant Sudarshan (ed.), India's Energy Security, New York: Routledge, 2009, pp. 111-112.
[5]. Ravi B Grover, "Nuclear Power Growth: An Option for Sustaining Indian Energy Requirements" in Ligia Noronha and Anant Sudarshan (ed.), India's Energy Security, New York: Routledge, 2009, p. 196.
[6]. C Raja Mohan, "Energy Security and Indian Foreign Policy" in Ligia Noronha and Anant Sudarshan (ed.), India's Energy Security, New York: Routledge, 2009, p. 131.
[7]. Ravi B Grover, n. 5, pp. 193-194.
[8]. C. Raja Mohan, n. 6, p. 138.
[9]. Surya Sethi, "India's Energy Challenges and Choices" in Ligia Noronha and Anant Sudarshan (ed.), India's Energy Security, New York: Routledge, 2009, p. 21.
[10]. Ibid, p. 23
[11]. K.K.Parnami, "Indo-US Nuclear Deal", Jaipur: Rawat Publications, 2009, p. 7.
[12]. Ibid, p. 10.
[13]. Condoleezza Rice, "Our Opportunity With India", March 13, 2006, Available at http://www.Washingtonpost.com.
[14]. K. Alan Kronstadt, "India-US Economic and Trade Relations", Congressional Research Service Report for Congress, p. CRS-57, August 31, 2007, Available at http://www.fas.org.
[15]. S.K.Chopra, Energy Policy for India – Towards Sustainable Energy Security in India in the Twenty First Century, New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd., 2004, p. 56.
[16]. John Stephenson and Peter Tynan, "Will The US-India Civil Nuclear Cooperation Initiative Light India?" in Henry Sokolski (ed.) Gauging US-Indian Strategic Cooperation, March 2007, p. 53, Available at http://www.StrategicStudiesInstitute.army.mil/.
[17]. Lalit Mansingh, "The Indo-US Nuclear Deal in the Context of Indian Foreign Policy" in P.R. Chari (ed.), Indo-US Nuclear Deal: Seeking Synergy in Bilateralism, New Delhi: Routledge, 2009, p. 181.
[18]. Ibid.
[19]. National Survey on Importance of Nuclear Energy", Jabalpur (MP) and Bareli (UP), April 25-May 3, 2012, Available at http://www.npcil.nic.in.
[20]. "India Energy Book 2012", World Energy Council, Available at http://www.energyoutlook.2012.pdf.
[21]. Zia Mian, A. H. Nayyar, R. Rajaraman, and M.V.Ramana, "Plutonium Production In India And The US-India Nuclear Deal" in Henry Sokolski (ed.), Gauging US-Indian Strategic Cooperation, March 2007, p.102, Available at http://www.strategicStudiesInstitute.army.mil/
[22]. Arvind Gupta and K.D.Kapur, Emerging Asian Nuclear Environment: Implications for India, New Delhi: Lancer's
[23]. Books, 2012, p.364.
[24]. International Seminar on "Indo-US Nuclear 'Deal' – India, South Asia, NAM and the Global Order", Mumbai, 10- 11 March , 2007.
[25]. Dr. S.K.Jain, "Nuclear Power – An Alternative", p. 2, Available at http://www.npcil.nic.in.
[26]. Ramendra Gupta, Nuclear Energy Scenario of India, p.1, Available at http://www.ucil.gov.in/web/Nu-Energy-of-Indiapdf.
[27]. Arvind Gupta, "India's Nuclear Energy Programme: Prospects and Challenges", Strategic Analysis, 5 May 2011, p.374, Available at http://www.tandfonline.com/loi/rsan20.
[28]. Ibid
[29]. "Nuclear Energy in India and Foreign Investment", p. 4, Available at http:// www.indiajuris.com
[30]. Ramendra Gupta, n. 16, pp. 2-3.
[31]. J.Y. Heo, S.H. Yoo and S.J. Kwak, The Casual Relationship Between Nuclear Energy,Consumption and Economic Growth in India, 11 April, 2011, Available at http://www.tandfonline.com/loi/uesb20.
[32]. "Nuclear Power In India", World Nuclear Association, April 2013, Available at file:///G:/significance/Nuclear%20Power%20in%20India%20%20%20Indian%20Nuclear%20Energy.htm#.UX_oWNqLTyV
[33]. Ardhendu Sen, "Nuclear Deal and Energy Security", Economic and Political Weekly, Vol. 41, No.16, p. 1490, April 22-28, 2006.
[34]. Arvind Gupta and K.D.Kapur, n. 22, p. 365.
[35]. Jasjit Singh (ed.), Nuclear Power and Non-Proliferation: Conflict or Convergence, New Delhi: Knowledge World, 2004, p. 84.