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"Energy is the golden thread that connects economic growth, social equity, and environmental sustainability." – Former Secretary-General of the UN, Ban Ki-moon

Introduction

Sustainable development is key principle which shows the path of progress with harmony between different generations. The development which meets the needs of present generation without compromising the ability of future generations to meet their needs can be called as sustainable development[1]. Human beings are said to be at the center of concerns for sustainable development; they are entitled to a productive and healthy life in harmony with nature. Because nature is mother for allno one can use it with selfish motive. It belongs to everyone. Once Mahatma Gandhi said, earth provides enough to satisfy every man's needs, but not every man's greed. Earth is there to settle human needs not selfish desires. Whenever states use their resources, they should see to it that the rights of other states and environment should not be affected. So the right to development must be fulfilled so as to equitably meet the developmental and environmental needs of present and future generations.

The concept of sustainable development came up as policy guidelines for alleviation of the pressure for both humanity and the global ecosystem[2]. In 1970's the word sustainable development was coined and got prominence after publication of the World Commission on Environment and Development's report. It was also referred in Declaration on International Economic Cooperation adopted by the UN General Assembly in 1990, which recognizes that economic development must be environmentally sound and sustainable.[3]Even in Earth Summit meeting at Rio in 1992, similar opinion is formulated. So the sustainable development is a process of social and economic betterment, which satisfies the needs and values of all interest groups without foreclosing future options.

Keeping in view the importance of sustainable development, energy is the major requirement for the agricultural, industrial and socio-economic growth of any country or society. So, there is an ever-increasing demand for energy in its various forms.[4]

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* Assistant Professor, SDM Law College Mangalore

1 World Conference on environment and Development Brundtland Commission Report 1987

2 Dr. VidhyaBhagathNegi, *Environmental Laws issues and concerns*, (New Delhi: Regal Publications, 2011)

3 United Nations General Assembly, nineteenth special session-Agenda item ,available at <http://www.un.org/documents/ga/res/spec/aress19-2.htm>last visited, 12th June 2019.

4 Himani, *Environmental Conservation and Sustainable Development, policy analysis and administration*, (New Delhi: Anamika Publishers and distributors pvt ltd, 2002)

As for a contribution to climate change, the expert committee on an integrated energy policy set up by the planning commission takes a vague view of nuclear power prospects: 'They have noted that even if a 20-fold increase takes place in India's nuclear capacity by 2031-32, the contribution of nuclear to the energy mix is at best expected to be 5-6 percent.In contrast, renewable energy does not pollute the environment, nor produce greenhouse gases. It is the true solution to climate change.'[44]In July 2017, eight reactors – 2400 MWe (gross) – of nuclear capacity was fueled by indigenous uranium and being operated close to their rated capacity. The 14 units (4380 MWe gross) under safeguards were operating on imported uranium at rated capacity.[45]

Disadvantages of Nuclear Energy

There are certain disadvantages or drawbacks in nuclear energy and its generation.

a. Risk of Nuclear accidents – Chernobyl, Three Mile Island accident and Fukushima. Major impact on human life.
b. Meltdowns can render areas uninhabitable for very long periods.
c. Difficulty in the management radioactive nuclear waste which takes many years to eliminate.Radioactive wastes take almost 10,000 years to get back to the original form.
d. Expiration date of nuclear reactors – they have to be dismantled.
e. Nuclear plants have a limited life. The energy generated is cheap compared to the cost of fuel, but the recovery of its construction is much more expensive.
f. Nuclear power plants have threat from terrorist organizations. It undergoes vulnerability of nuclear plants to attack.
g. Nuclear power plants generate external dependence if a country does not sufficient have uranium mines.
h. If a country has uranium mines it might not have nuclear technology.i. Current nuclear reactors work by fission nuclear reactions. These chain reactions are generated, if control systems fail generating continuous reactions causing a radioactive explosion that would be virtually impossible to contain.
j. Use of the nuclear power in the military industry that world has witnessed after two nuclear bombs were dropped on Japan during World War II. This was the first and the last time that nuclear power was used in a military attack. The risk that nuclear weapons could be used in the future will always

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43 *Thierry Dujardin, Is Nuclear Energy Sustainable?* Harvard International Review, 2007 available at http://hir.harvard.edu/article/?a=1473 last visited, 20th January 2019.
44 India's nuclear ambition, Greenpeace India, available at <http://www.greenpeace.org/india/en/What-We-Do/Nuclear-Unsafe/Nuclear-Power-in-India/> last visited, 23rd February 2019.
45 Science and Technology-BARC Trombay and IGCAR, available at<http://www.mitrasias.com/barc-trombay-and-igcar/> last visited, 21st August 2019.

domestic production deficit.[8]

Nuclear program started before independence in India especially in 1944 when Homi J. Bhabha founded the Tata Institute of Fundamental Research. Later India passed Atomic Energy Act of 1948 focused on peaceful development of nuclear technology. In the year 1954 Department of Atomic Energy established and India reached a verbal understanding with the United States and Canada under the Atoms for Peace program by which US and Canada co-operated with India for establishment of CIRUS reactor.In 1955 construction began on India's first reactor, Apsara research reactor, with British assistance.The Atomic Energy Establishment, Trombay was inaugurated in 1957 which acquired its present name Bhabha Atomic Research Centre on 12 January 1967.[9]

So, India was one of the first countries to adopt nuclear power technology with the commissioning of the Tarapur power station in 1969.But India's nuclear energy programme began in the 1950's with a great deal of involvement of the US through the Atoms for Peace programme. It also helped to build and provide nuclear fuel for the nuclear reactors in Tarapur as well as through scientific cooperation. India tested its first nuclear device in 1974 and even the US formed the Nuclear Suppliers Group to oversee sales of nuclear material. Even after passing Nuclear Non-proliferation Act in the US Congress it continued to provide some nuclear fuel to India until 1980. France used to provide nuclear fuel to India till 1996. China and Russia have supplied nuclear fuel after 1996.[10]

Energy is the most fundamental requirement of every society or nation as it progresses through the ladder of development.Nuclear energy has to play an important role in India's energy scenario from three angles. First is that unlike renewables, nuclear sources can provide bulk energy in a certain manner to the base load. The Kudankulalm power projects' two reactors have added 2000 MW electricity to the southern states. Secondly, nuclear energy is a clean energy source and hence is very important to attain carbon free energy economy. Thirdly, nuclear energy enhances energy independence and energy security especially with the potential use of domestically available thorium input use. Nuclear energy production in the country is estimated to be at 6780 MW from the seven sites and twenty-two reactors.[11]

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8 South Asia Programme at Hudson Institute, India's Energy Challenge, available at <http://www.southasiaathudson.org/indias-energy-challenge/>last visited 25th May 2019.

9 Nuclear power in India, Civil service-General studies and daily current affairs, available at <http://www.careerride.com/view/nuclear-power-disadvantages-and-various-international-treaties-for-arms-reduction-19439.aspx>last visited, 20th February 2019.

10 S.V. Ranade, 'Environmental Information system-technology training and project management', available at <http://www.envis.org/posts/post/5/nuclear-energy-a-must-for-sustainable-development-of-india>last visited 24th June 2019.

11 Tojo Jose, 'Why nuclear energy is important for India?available' at http://www.indianeconomy.net/splclassroom/265/why-nuclear-energy-is-important-for-india/>last visited, 27th June 2019.

Industrialization and the rising concern over climate change have put India and other emerging economies in a unique position where these countries will have to negotiate a middle path between economic development and environmental sustainability. To alter its existing energy mix, which is currently dominated by coal, to accommodate a greater share of cleaner and sustainable sources of energy would be one of the primary challenges for India. Among the various sources of clean energy that have been explored, nuclear energy is perhaps the only strong and sustainable source of energy for large scale and continuous industrialization and urbanization. At present, only 3 percent of India's total electricity comes from nuclear power plants. An assessment of India's nuclear sector, especially after the Indo–U.S. Nuclear Deal suggests that nuclear energy could be a sustainable and a strong alternative to fossil fuels in India which could also reduce India's increasing dependence on petroleum imports.[5] The Planning Commission had recognized the seriousness of rural energy crisis as well as its complex nature. The National Rural Energy Planning exercise was started in 1981 to formulate developing approach for planning and implementation of Integrated Rural Energy Planning Programme[6].

Striking a balance between economic growth, quality of life and the exploitation of natural resources is necessary to provide decent energy services for growing population of developing regions. India's power sector is one of the most diversified power sectors in the world. The main source of energy is conventional such as coal, lignite, natural gas, oil, hydro power nuclear power etc., and non-conventional sources such as wind, solar, energy from agricultural and domestic waste in the form of biogas, etc. To supply power especially electricity which is highly demanded in the country power generation from different sources is required.

The growing population of India and rapid expansion of its economy has led for faster energy consumption than the country's energy affordability. So effective measures must be taken to conserve and rationalize the energy sources to maintain the gap between demand and supply of energy to prevent the problem of energy crisis in in near future.[7]

India's energy consumption is growing at an exponential rate. The sustained and unprecedented economic growth in the country has placed an uncontrolled demand on the country's energy resources. While India's energy basket has a mix of all sources of energy, including renewables, 59% of its energy supply is fueled by coal. This forces India to import large amounts of coal to balance the

5 Development of Nuclear Energy Sector in India, *IDSA Task Force Report*, Institute for Defence Studies and Analyses, New Delhi publications, 2010

6 *Supra* note 4.

7 Sanjay Upadhyay and Videh Upadhyay, *Handbook on Environmental Law – Environment Protection, Land and Energy Laws*, First edition, Vol. 3, (New Delhi: Lexis Nexis, Butterworths: 2002).

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The target is to triple nuclear energy production to 17.3 GW by 2024. A long-term target of realizing 25% share for nuclear energy in total power production is on mission mode.

Shortage of nuclear fuel is the hurdle in limiting production in most reactors. The Plant Load Factor is around 60% for several plants because of unavailability of inputs.[12]

Energy produced from radio-active minerals like uranium, thorium etc is called nuclear power. Nearly 10000 tons of coal produces power that is produced by only 1 tine of uranium. Though India has plenty of uranium and thorium reserves lack of technical know-how causes low production of nuclear power. In India only 2% to 3% of the energy produced comes from nuclear power.[13]

Nuclear energy and sustainable development

Energy is the basic need for the development of any nation. Energy is indeed for agriculture, industry, technology, transport, communication and all other tertiary sectors which demand progress for all round development of any country. Minimum power supply has become basic need as food, shelter and clothing for the comfortable life of an individual in the society. So energy is the essence of progress of a nation.

The study indicates that most of the prosperous nations are extracting about 30-40 percent of power from nuclear power and it constitutes a significant part of their clean energy portfolio, reducing the burden of combating climate change and the health hazards associated with pollution. Meanwhile in India, we are not generating even 5000 MW of nuclear power from the total of about 150 GW of electricity generation, most of it coming from coal.[14]

The place of nuclear power in sustainability issues has generated substantial controversy so far because of its trade-off between low carbon electricity and the concerns related to the risk of accidents as well as environmental and human health issues associated with radioactive waste management. During the 9th session of the United Nations Commission on sustainable development in 2001, member states had a debate to consider nuclear power an essential component of their sustainable development strategies. They have decided that choice of nuclear energy rests with countries. But in 2002, the plan of the implementation of World Summit on sustainable development called for a series of actions to promote the wide spread availability of clean and affordable energy specifically the promotion of renewable energy resource, efficiency improvements and advanced energy technologies including cleaner fossil fuel technologies. In this context, nuclear energy belongs to the category of

12 *Ibid.*
13 Vishal Sharma, 'Nuclear Power in India', available at http://www.importantindia.com/11170/short-paragraph-on-nuclear-power-in-india/last visited, 19th June 2019.
14 P. K. Agrawal, *India's move towards sustainable development*' First edition, (New Delhi: MD Publications Pvt Ltd. 1996).

advanced energy technologies.[16]

Energy has become increasingly acknowledged as one of the key issues sustainable development culminating in the declaration by the UN Gen Assembly of 2012 development agenda as the International Yea Sustainable Energy for all. In September 2015 the international comm approved the post 2015 development agenda with a new set of sustain development goals fully recognizing energy as a fundamental pillar o own. "Energy is inevitable and now seen as precondition for susta economic growth and improved human well-being. It has an effec healthcare, education, job or business etc. Production and consumptio energy in a proper manner is another genuine need for sustainability.

Energy is at the heart of most critical economic, environmental developmental issues facing the world today. Clean, efficient, affordable reliable energy services are indispensable forglobal prosperity.The c energy systems are inadequate to meet the needs of the world's poor and jeopardizing the achievement of the Millennium Development Goals (MDG For instance, inthe absence of reliable energy services, neither health cl nor schools can function properly.[17]

Since nuclear energy is a nearly carbon-free electricity generation sou and benefits from a large and diversified fuel resource base, many countr including some that have been historically skeptical, are now expressing renewed interest in it. The sustainability of nuclear energy is at the heart of debate regarding its potentially increased role in a future sustainable ener mix. This question of sustainability should be examined in three dimensio economic, environmental, and social.[18]

Earlier days energy sustainability was calculated in terms of availabilit energy for the purpose of use. But in the ethical context of sustainab development it includes about global warming, environmental effects a question of waste management etc. The nuclear energy is one of the import sources of energy which has its own sustainability and problems pertaining it. To consider nuclear energy or any form of energy for that matter sustainable, it should possess the quality of durability, accessib availability as well as affordability. Production of energy for consumption inevitable but it should not make any disastrous effects on environ

15 Nuclear power and sustainable development, International Atomic Energy Agency, Vienna IAEA in Austria publishers, available at http://www-pub.iaea.org/MTCD/Publi PDF/Pub1754web-26894285.pdf last visited, 10th February 2019.

16 United Nations General Assembly Declares 2014-2024 Decade of Sustainable Energy f Meetings coverage and press releases, 2012 available at <https://www.un.org/press/ ga11333.doc.htm> last visited, 10th February 2019.

17 The Secretary-General's Advisory Group on Energy and Climate Change (AGECC) Energy Sustainable Future, Report And Recommendations April 2010 New York, available at www.un.orgmillenniumgoals pdfAGECCsummaryreport> last visited, 6th March 2019

18 Thierry Dujardin, Is Nuclear Energy Sustainable?,Harvard International Review, 2007 http://hir.harvard.edu/article/?a=1473 last visited, 4th March 2019.

...rgy should have the quality to be used for present and in future.

...EA, classified nuclear energy scenario sustainability as follows-

a. Safe, secure, economical and publicly acceptable nuclear power with security of supply which addresses conditions necessary for newcomers to deploy nuclear energy.

b. Safe disposal of all nuclear wastes in a complete once-through fuel cycle with thermal reactors.

c. Initiate recycling of used nuclear fuel to reduce wastes. Limited recycle that reduces high-level waste volumes, slightly improves Uraniumutilization and keeps most of the Uranium more accessible. It is a once-through breed and burn option, providing significant improvement in resource utilization.

d. Guarantee nuclear fuel resources for at least the next 1000 years via complete recycle of used fuel.

e. Reduce radio toxicity of all wastes below natural uranium level.[19]

Nuclear Risk and Energy Security

Every nation and the environment is potentially affected by the possibility of the radioactive contamination, the spread of toxic substances derived from nuclear energy and long-term consequence on health because of exposure to radiation will be there. So nuclear risks pose certain cautions to take up for nuclear security whenever is required otherwise the level of injury will be severe.[20] The Stockholm Conference in 1972 had called for a registry of emissions of radioactivity and international cooperation on radioactive waste disposal and reprocessing. The 1994 Nuclear Safety Convention and the 1997 Joint Convention are the first global treaties to commit states to control the risks of nuclear energy for environmental objectives.[21] From a national perspective, the security of future energy supplies is a major factor in assessing their sustainability. Whenever objective assessment is made of national or regional energy policies, security of supply is a priority.

There are certain risks with regard to using nuclear energy. The main risk related to nuclear energy is plant safety. Throughout the history of nuclear power generation there have been four major incidents of plant failure. The Kyshtym accident in fuel reprocessing in 1957 in Russia, the relatively smaller Three Mile Island meltdown in United States, the much bigger Chernobyl Plant accident in Ukraine in 1986 and at the Fukushima Daiichi plant of

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19 World Nuclear Association, sustainable energy, available at <http://www.world-nuclear.org/information-library/energy-and-the-environment/sustainable-energy.aspx> last visited, 3rd June 2019.

20 Patricia Birnie, Alan Boyle, & Catharine Redgwell, '*International Law and the Environment*' Third edition (Oxford: Oxford University Press, 2009).

21 *Ibid.* p. 508.

Japanese in 2011. The first accident was purely [illegible] underdeve[illegible] technology, and much of the blame for the next two disasters is attribute[illegible] human error. Even in the case of the Fukushima disaster of 2011, there [illegible] extraordinary natural forces in action, the rare occurrence of the tremend[illegible] stress load of an earthquake coupled with the unprecedented shear load [illegible] tsunami. There is a need for better technology and more stable plant de[illegible] across the world, but the occurrence of four failures in six decades cannot [illegible] made out as a case for completely disbanding the technology, which is [illegible] our foremost keys to graduating beyond the fossil fuel-based low-end [illegible] The best of technological progress, while being the biggest ally of man[illegible] does come at an incremental risk. The key is to learn and evolve to mitigate [illegible] risk, rather than use the first incident as an excuse to disband science. There [illegible] a need for better technology and more stable plant design across the world, [illegible] the occurrence of four failures in six decades cannot be made out as a case [illegible] completely disbanding the technology.

Nuclear energy produces both operational and decommissioning wa[illegible] which are contained and managed. Although experience with both storage a[illegible] transport over half a century clearly shows that there is no technical problem [illegible] managing any civil nuclear wastes without environmental impact, the quest[illegible] has become political, focusing on final disposal. In fact, nuclear power is [illegible] only energy-producing industry which takes full responsibility for all [illegible] wastes and costs this into the product – a key factor in sustainability. Ethic[illegible] environmental and health issues related to nuclear wastes are relevant and the[illegible] prominence has tended to obscure the fact that such wastes are a declin[illegible] hazard, while other industrial wastes retain their toxicity indefinitely. There [illegible] clear need to address the question of their safe disposal. If they cannot rea[illegible] be destroyed or denatured, this generally means that they need to be remo[illegible] and isolated from the biosphere. An alternative view asserts that indefi[illegible] surface storage of high-level wastes under supervision is preferable. This m[illegible] be because such materials have some potential for recycling as a fuel source [illegible] negatively because progress towards successful geological disposal wo[illegible] simply encourage continued use and expansion of nuclear energy. Howe[illegible] there is wide consensus that dealing effectively with wastes to achieve [illegible] levels of safety and security is desirable in a 50-year perspective, ensuring [illegible] each generation deals with its own wastes.[23]

The inherent risks of nuclear power are made greater in India by [illegible] structure of the country's nuclear establishment. The Atomic Ener[illegible] Regulatory Board is the organisation in charge of safety in all nuclear facili[illegible] which shares staff with the organisations it is supposed to be regulating

22 A P J Abdul Kalam, Srijan Pal Singh, '*Nuclear power is our gateway to a prosperous* [illegible] available at http://www.thehindu.com/opinion/op-ed/nuclear-power-is-our-gateway-to-a-prosperous-future/article2601471.ece last visited, 10th January 2019.

23 Dean Kyne & Bob Bolin, '*Emerging Environmental Justice Issues in Nuclear Power* [illegible] *Radioactive Contamination*' in Jayajit Chakraborty, Sara E. Grineski & Timothy W. Collins [illegible] *International Journal of Environmental Research and Public Health*, Vol. [illegible] 2016).

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provides fund to them. This compromises its ability to act independently and enforce vigorous safety regulations.[24]

Energy security is a high priority of all societies. It includes a set of concerns such as the vulnerability of primary fuel supplies to physical interruptions, possible unanticipated movements in the price of primary or secondary energy forms and the reliability of the supply of energy to end users.[25] There are certain guidelines and there are many efforts by the International Atomic Energy Agency (IAEA) to take this training aspect of nuclear security to all member states, but the member states also have a significant role to play.In terms of energy security, NITI Aayog,has proposed a group which is now looking at energy security plans for the next 100 years. The proposal entails the creation of a central body, the National Energy Commission, to work with all ministries that deal with any matter related to energy to construct a common strategy for energy security.[26]Various efforts are made in national and international level to develop the nuclear energy generation reactors more economical, safe, sustainable, and more resistance to proliferation of weapon grade plutonium which is a part Global Nuclear Energy Partnership.[27]

Nuclear energy insecurity leads to barriers on its sustainability. Nuclear energy is somewhat sustainable but few factors turn it as insecure and even though there is contribution of nuclear energy to the sustainable development, the possible risks, problems of radioactive waste management etc. decreases its credibility towards sustainable development. Whenever we speak about utility of energy the question of safety and security comes in to picture. Nuclear reactors have operated worldwide enviable safety records except for few mishaps. Today more than 425 power reactors are operating in the world producing 1/6th of the world's electricity. Important safety issues are radiation effects, radioactive waste management, decommissioning and accident risks in reactors. These have been adequately addressed and improvements continue.[28] The radiation doses to operating personnel and the public during normal operation are well within limits prescribed by the Atomic Energy Regulatory Board (AERB). Nowhere in the world have the effects of radiation been noticeable in normal operation of nuclear facilities.

Radioactive waste management is an important issue in the nuclear program although radioactive waste quantities are very small. Radioactive waste is isolated from the biosphere while the gases from fossil plants are enter the

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24 India's nuclear ambition, Greenpeace of India, available at http://www.greenpeace.org/india/en/What-We-Do/Nuclear-Unsafe/Nuclear-Power-in-India/ last visited on 20th March 2019.

25 Nuclear power and sustainable development , International Atomic Energy Agency, VIENNA 2016. IAEA in Austria publishers, available at <*http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1754web-26894285.pdf*> *last visited on 8th September 2018)*

26 South Asia Programme at Hudson Institute, India's Energy Challenge, available at <*http://www.southasiaathudson.org/indias-energy-challenge/*> *last visited on 10th September 2018)*

27 Ashish Ghosh, *Environmental Conservation-Challenges and Actions*, (New Delhi: A.P.H. Publishing Corporations, 2008) p.168.

28 Godfrey Boyle, *'Energy systems and sustainability-Power for a sustainable future'* in Bob Everett (eds), *Business and Economics*, (Oxford: OUP Oxford, 2012) at p 405.

atmosphere. India developed the technology for radioactive waste management well in time and new breakthroughs are not required. Further developments are expected in the technology of partitioning and actinide burning which will considerably reduce the storage time.Decommissioning is neither a hazardous nor a costly operation. The cost of decommissioning is included as a small fraction of generation cost itself.

Though assimilating facts regarding nuclear technology is difficult not only for laymen but for the educated elite, efforts to educate the public should continue. Public acceptance of nuclear energy is important for its growth and transparency in all aspects of nuclear technology is basic for confidence building.[29]

Challenges of Energy Generation in India

India currently possesses 21 operational nuclear power reactors, which account for a nominal 3 percent of the country's energy generation. This paper provided a review and analysis of the challenges that nuclear power must overcome inorder to meet the requirements of just sustainable development. The results make it clear that there are two fundamental challenges. First, innovative technical solutions need to be discovered for the fundamental inherent environmental handicaps of nuclear energy technology. Second, the nuclear industry must also address difficult issues of equity both in the present and for future generations.[30]

India's dependence on imported coal and subsequent high energy prices has continued to hurt India's energy sector. There is a need for diverse and sustainable energy resources, increased investment in domestic resources and efficient delivery to the consumer. India's economic future depends on its ability to aggressively expand renewable investment and cut back on energy imports, while focusing on energy diversification and the reduction of the current massive account deficit. It is also necessary for the government to develop bilateral and regional strategic partnerships to enhance innovation and technology in the energy sector. With the strategic implementation of reforms India can draw upon its untapped energy potential. The drop in global oil prices gives the government the opportunity to cut back on fuel subsidies and increase certain energy prices. In addition, the government has proposed many projects for the advancement of renewable energy sources, especially solar energy. Most significantly, in this regard National Energy Commission can potentially play a big role in protecting India's energy security.[31]

India has chosen to pursue nuclear energy as a source of energy and is planning a rapid expansion of the nuclear power sector in the coming decades

29 S.B. Bhoje, & S. Govindarajan, *'The need and the role of nuclear energy in India'*, available at www.iaea.orginiscollection NCL Collection Store_Public3106031060524.pdf> last visited September 2018.

30 Joshua M. Pearce, *'Limitations of nuclear power as a sustainable energy source'*, available at www.mdpi.com/journal/sustainability last visited, 20th January 2019.

31 *Supra* note, 26.

The Green scenarios should be considered.Development deficits and lack of sufficient energy are also issues, that can create their own security problems over time.India has chosen to develop a closed fuel cycle because of its limited domestic sources of uranium.[32]

India faces many acute challenges of energy development, which has caused the country's leaders to consider India's indigenous energy sources and how it can increase energy supply to better meet the exponentially expanding energy demand. Given this demand, India has chosen to pursue nuclear energy as a source of energy and is planning a rapid expansion of the nuclear power sector in the coming decades.[33]Coal, fossil fuels add more carbon dioxide into the air, but while nuclear energy is carbon free, there are associated challenges, such as security threats and other risks.We have to use some modern techniques through which we can supply nuclear energy required to the consumption in the country. We must calculate how much uranium would be required to meet a scenario of nuclear power as part of the overall energy supply. For this particular scenario, by 2025 there would not be enough additional uranium to commit to a new nuclear power plant. Depending on the scenario, this may shift to 2035 or 2040, within the next 20 to 25 years there will not be sufficient uranium to move away from fossil fuels to a reasonable extent, particularly when uranium is used in a once-through mode, which is most common today.[34]

Even though the coal reserves of India are still the life line of major energy production, it is a finite source and increasing dependency on coal can never be a model for sustainable development at the current pace of its utilization. Other than future crisis in coal-based energy production, the issue of global warming and climate change makes it compulsive to look for clean energy, curb carbon emission and contribute to the global cause[35].

There is international pressure to reduce greenhouse gas effect in atmosphere for which need of clean energy came to limelight for energy security and sustainable development. Nuclear energy is one of the sustainable solutions to overcome the environmental problems.[36]

Even though India is fourth largest energy consumers of the world the presence energy crisis in India is much severe in nature.Production of energy for consumption is inevitable but it should not make any disastrous effects on environment. Other than these, the energy should have the quality to be used

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32 Committee on India-United States Cooperation on Global Security: *'Technical Aspects of Civilian Nuclear Materials Security'*, National Academy of Sciences, National Institute for Advanced Studies, Bangalore, India *National Academies Press*, 2013 available at https://books.google.co.in/books?id last visited, 13th December 2018.

33 *Ibid.*

34 Manu V Mathai, '*Nuclear Power, Economic Development Discourse and the Environment-The case of India*', (New York: Routledge-Taylor and Francis Group, 2013) p.137.

35 *supra* note 27, at 153.

36 Nuclear energy option for energy security and sustainable development in India, available at <https://www.researchgate.net/publication/251574313_Nuclear_energy_option_for_energy_security_and_sustainable_development_in_India>, last visited, 20th September 2018.

for present and in future. Sonew avenues for energy production without threat to environment quality are the need of the hour.

It also helped to build and provide nuclear fuel for the nuclear reactor at Tarapur as well as through scientific cooperation. India tested its first nuclear device in 1974 and even the US formed the Nuclear Suppliers Group (NSG) to oversee the sales of nuclear materials. Even after passing Nuclear Non-Proliferation Act in the US Congress it continued to provide some nuclear fuel to India until 1980. France used to provide nuclear fuel to India till 1996. China and Russia have supplied nuclear fuel after 1996[37].

India has planned to set up four nuclear power parks to house 25 reactors capable of producing 45,000MW of energy through a public private partnership. The main target was to reach 60,000 MW of nuclear power by 2026. They have selected four sites in West Bengal, Orissa and Andhra Pradesh in East coast andGujarat in the West.[38]

In the US, there are four principal challenges which are correctly laid down which remain equally valid in India. They are:-

a. Nuclear power remains economically competitive in the world energy market, to be specificenergy companies must better control capital costs.

b. In order to satisfy the public's expectations of exceptional safety performance, current plants must continue to operate safely and future plants must continuously improve safety in expanding world markets.

c. Nuclear power and its fuel cycle must be viewed by the public and by the national leaders as sustainable: in particular, nuclear fuel must be managed in a manner that is cost effective and safe for the extended period of time that used fuel remains highly radio-active, and the nuclear fuel supply must be extended for centuries in the face of depleting fossil fuels.

d. The nuclear materials from the fuel cycle must be protected from proliferation and misuse for non-peaceful purposes.[39]

Requirements to Achieve Sustainability of Nuclear Energy

India has a flourishing and largely indigenous nuclear power programme and expects to have 14.6 GWe nuclear capacities on line by 2024 and 63 GWe by 2032. It aims to supply 25% of electricity from nuclear power by 2050.Due to earlier trade bans and lack of indigenous uranium, India has uniquely been developing a nuclear fuel cycle to exploit its reserves of thorium. Early in 2016 India had 300 GWe installed capacity, 210 GWe being fossil fuel-fired. There was 40 GWe of large hydro, 43 GWe of other renewables and less than 7 GWe

37 S.V. Ranade, *Environmental Information system-technology training and project management*, available at http://www.envis.org/posts/post/5/nuclear-energy-a-must-for-sustainable-development-of-india last visited, 14th December 2018.

38 *Supra* note 27, at p. 166

39 *Supra* note 27, at p.167.

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of nuclear. The government's 12th five-year plan for 2012-17 targeted the addition of 94 GWe over the period, costing $247 billion. Three-quarters of this would be coal- or lignite-fired, and only 3.4 GWe nuclear, including two imported 1000 MWe units planned at one site and two indigenous 700 MWe units at another. By 2032 total installed capacity of 700 GWe is planned to meet 7-8% GDP growth, and this was to include 63 GWe nuclear. The OECD's International Energy Agency predicts that India will need some $1600 billion investment in power generation, transmission and distribution to 2035."[40]

There are lots of challenges which are standing as obstacles while producing nuclear energy and even after production in relation to waste management. So, sustainability of all forms requires many reformations in the process of production of nuclear energy and in the end process.Sustainable nuclear energy system requires few important points. They are-

a. Radical improvement in Green House Gas emissions intensity-The embodied energy of the entire nuclear energy life cycle must be reduced. To improve the GHG emissions of the nuclear energy life cycle should be given a high priority such as-

   (i) transitioning to enrichment based on gas centrifuge technology(ii) utilizing nuclear plants in combined heat and power (CHP) systems to take advantage of the 'waste' heat, (iii) using nuclear power for thermal processing with the attendant increases in efficiency (iv) down blending nuclear weapons stockpiles for nuclear power plant fuel (v) utilizing only the highest concentration ores.

b. Elimination of nuclear insecurity- On technical grounds, this requirement entails making nuclear power plants that cannot physically melt down. Again, this requirement does not mean reduce the probability that it can happenbut it must be physically impossible for it to happen by improved reactor design. This would also enable additional increases in efficiency. For example, following suggestion above (ii) nuclear power plants could be placed in the middle of population centers and act as district heating utilities in addition to providing electricity.

c. Eliminate radio-active waste and minimize environmental impact during mining and other operations- In order to prevent future humans from being forced to care for current energy-generated waste products a means of eliminating all radioactive waste from the generation of nuclear energy is needed. Using techniques that recycle waste may also reduce the amount of mining necessary and thus could also cut down on environmental impact. In addition, a method to recycle water or the use of other cooling fluids such as air and eliminate all thermal pollution needs to be developed and deployed.

[40] World Nuclear Association, *'Nuclear Power in India'* available at <https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/india.aspx> last visited, 20th August 2019.

d. The nuclear industry must gain the public trust- In many countries, the public does not trust the nuclear energy industry and the government bodies that oversee it. For example, the radioactive releases from Pennsylvania's Three Mile Island have been contentious and there is substantial evidence that the releases were under-reported to the public by officials by at least an order of magnitude.[41]

Advantages of Nuclear Energy

1. Lower greenhouse emission-it's an emission free energy as it produces less greenhouse gases so preserve the Earth's climate.
2. No air pollution- As it do not emit carbon dioxide, sulfur dioxide, or nitrogen oxides as part of the power generation process.
3. It avoids ground-level ozone formation and prevent acid rain.
4. Throughout the nuclear fuel cycle, the small volume of waste byproducts actually created is carefully contained, packaged and safely stored.
5. Water discharged from a nuclear power plant contains no harmful pollutants and meets regulatory standards for temperature designed to protect aquatic life.
6. Nuclear energy does not depend on natural aspects which is main disadvantage of renewable energy.[42]
7. One of the major social advantages using nuclear energy is that it greatly increases the security of energy supply. It helps to reduce dependence on fossil fuels, especially oil and gas.

Key economic features of the existing nuclear power plants are their low and stable marginal production costs as well as very low sensitivity to fuel costs. Natural uranium accounts for less than 5 percent of the total cost of electricity generated from nuclear power plants. Total nuclear fuel cycle costs, primarily for enrichment, fuel fabrication, and spent fuel treatment and disposal, amount to 15 percent to 20 percent of total costs. In contrast, the cost of coal amounts to roughly 45 percent of the total cost of electricity generated by coal-fired power plants and the cost of gas amounts to at least 75 percent of costs for gas-fired power plants. In other words, increasing the current price of uranium by 100 percent would increase nuclear electricity cost by 5 percent while increasing the price of gas by 100 percent would increase gas-fired electricity cost by 75 percent. Needless to say, this is an advantageous asset for nuclear energy in these times of high volatility of fossil fuel prices, nuclear energy can compete favorably with alternatives for base-load electricity

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41 Joshua M. Pearce, *Limitations of nuclear power as a sustainable energy source*, available at www.mdpi..com/journal/sustainabilitylast visited on 25th December 2018.

42 Nuclear power in India, Civil service-General studies and daily current affairs, available at <http://www.careerride.com/view/nuclear-power-disadvantages-and-various-international-treaties-for-arms-reduction-19439.aspx> last visited, 15th September 2019.