DISSERTATION

The Role and Challenges of Nuclear Energy in Achieving Sustainable Development Goal of Clean Energy in India- A Study

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AS A PARTIAL FULFILLMENT OF REQUIREMENT FOR THE

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UNDER THE GUIDANCE OF

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DECLARATION

I, Saumya Shukla, bearing roll no. 19ML022, do hereby declare that the dissertation submitted is original and is the outcome of the independent investigations/research carried out by me and contains no plagiarism. The dissertation is leading to the discovery of new facts/techniques/correlation of scientific facts already known. This work has not been submitted to any other university or body in quest of a degree, diploma or any other kind of academic award.

I do hereby further declare that the text, diagrams or any other material taken from other sources including [but not limited to books, journals and web] have been acknowledged, referred and cited to the best of my knowledge and understanding.

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CERTIFICATE

This is to certify that the dissertation entitled "The Role and Challenges of Nuclear Energy in Achieving Sustainable Development Goal of Clean Energy in India- A Study" has been prepared by Saumya Shukla under my supervision and guidance. The dissertation is carried out by her after careful research and investigation. The work of the dissertation is of the standard expected of a candidate for Masters of Laws [LL.M.] in Constitutional Law and I recommend it to be sent for evaluation.

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ABBREVIATIONS

AEC	Atomic Energy Commission
AERB	Atomic Energy Regulatory Board
BARC	Bhabha Atomic Research Centre
BAU	Business As Usual
CDM	Clean Development Mechanism
CEM	Clean Energy Mechanism
CER	Certified Emission Reduction
COP	Conference Of Parties
DAE	Department of Atomic Energy
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
HLPF	High Level Political Forum
MDG	Millennium Development Goals
NAPCC	National Action Plan for Climate Change
NDC	Nationally Determined Contribution
NEA	Nuclear Energy Agency
NEP	National Energy Policy
NPP	Nuclear Power Plant
NSG	Nuclear Suppliers Group
PAC	Public Account Committee
SDG	Sustainable Development Goal
UNFCCC	United Nations Framework Convention on Climate Change

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Chapter 1- Introduction

1.1 Introduction

The word energy has been derived from the Greek work 'energia' and is considered to as a scalar physical sum that is a property of articles and systems which is directed ordinarily. Energy is constantly described as the ability to work.[1] Energy is a pivotal structure hinder in human life, and, therefore go about as a central point in choosing the financial advancement of the considerable number of nations. "*Under Section 2(h) of the Energy Conservation Act 2001, Energy means any form of energy derived from fossil fuels, nuclear substances or materials, hydro-electricity and includes electrical energy or electricity generated from renewable sources of energy or bio-mass connected to the grid*."[2] Energy comes in different structures like: Heat, Light, Mechanical, Electrical, Chemical, atomic and so on. All types of energy are put away in different ways, in the energy sources that we use on customary premise. Energy resources are mainly divided into two groups:

- Non-renewable sources – coal, oil, natural gas
- Renewable source – wind, solar, hydro, bio[3]

Energy is the essential of human life, every single part of human life relies on the energy from nuts and bolts like power for the contraptions, cooking, utilizing vehicles to transport people and products to investigating the space energy is required all over. One can securely say that that human life is by inconceivable without energy. Energy has been always

[1]CA. Rajkumar S. Adukia, *An Overview of Energy Sector in India* (last accessed on 27th May 2020) available at www.caaa.in/Image/47%20Energy%20Sector.pdf.com
[2] Section 2(h) The Energy Conservation Act, 2001, No52, Acts of Parliament, 2001(India)
[3] Supra note 1

believed to be champion in the most basic commitments for the human improvement and advancement of budget.

Also there is a strong relationship between the energy usage and budgetary headway. At one hand the betterment of economy depends upon the readiness of the reliable and modern sources of energy and on the other hand the element of monetary progression is believed to be related on the energy demand.[4]

In this period, we do know is that the world needs energy and in extending sums to support money related and social headway and gather a predominant individual fulfillment, explicitly in creating countries. Regardless, giving this energy around the globe goes with an obligation and promise to making and using our benefits constantly. For creating nation like India, the necessity for strong and sensible energy is progressively vital. It can improve and even extra lives. Solid energy helps the distinctive enterprises like todays cultivation, extended business and improved transportation. These are the structure snag that help people escape poverty and improve their lives.

An international body namely International Energy Agency has estimated that from2011 to 2030 the major demand of energy will witness an increase of 1.5% per year and general increment of 40% from 12,000 million tonnes of oil to16,800 million tonnes. The major drivers of this development are the developing nations of Asia followed by the Middle East.[5]

[4]S. Mahajan, *Renewable Energy Resources Available in India as an Alternative for Conventional Energy Resources*, 4 INTERNATIONAL JOURNAL OF ADVANCED BIOTECHNOLOGY AND RESEARCH, 175-179 (2013)
[5] Supra note at 1

1.2 Statement of Problem

There has been rapid change in the energy system globally due to the reasons like change in the mindset of consumers, development of new technology, entrepreneurial spirit of business leaders of next generation and reorientation of policymakers. The another major reason behind this change is the increasing concern regarding ecosystem due to development of concepts like sustainable development. The main changing point of this was The Paris Climate Change Agreement which led to voluntary reduction of greenhouse gas emission in a set time and thus unprecedented force is being applied for fast adaptation of sustainable development. This process is knocking the boundaries of conventional sources of energy.[6] This has also impacted the energy sector of India. there has been started the shift in focus form conventional sources to non-conventional sources of energy. India has started to make its laws and policies according to the changing dimensions of nuclear energy. The impact of U.S.-India Civil Nuclear Agreements will be significant as it will allow India to carry out the trade of nuclear fuel and technologies leading to enhancement in power generation capacity. India is expected to generate an additional 25 GW of nuclear power by 2020, bringing total estimated nuclear power generation to 45 GW.[7]Having the advantage of being clean energy among others it also has certain disadvantages, issues and challenges which must be looked into. The paper will look into implementation, implication, challenges and role of nuclear energy in controlling the climate change. It also studies the legal and policy framework of nuclear energy with the specific reference to

[6]Supra note at 1.
[7]Supra note at 11.

commitment of India to achieve the Sustainable Development Goal number seven ofensuring access to affordable, reliable, sustainable and modern energy.

1.3 Literature Review

1. Mayuresh A Mane, India's Expansion in the Nuclear Power Sector and Its Effects[8]

   This paper talks about the growth of nuclear sector over a period of time and the manner in which it has affected India as whole at different levels. The paper discusses in detail the effects of expansion of nuclear energy. It also discusses the effect of treaty with NSG and the effect of nuclear energy on electricity sector. though the paper gives knowledge about expansion and its affect, it fails to address the reason behind such expansion.

2. Sanjay Kumar Kar, How Important is Nuclear Power in India's Energy Transition[9]

   This article talks about the global scenario of energy sector and the recent challenges that are met by countries especially the developing countries like India. It talks about the endeavors that are done by government for achieving growth of atomic sector while also giving the global picture. The paper also discusses the future plans and prospects for India in nuclear sector. The paper surely gives ample knowledge of global scenario and present scenario in India but it fails to account not only reasons but also how historically there has been growth of nuclear sector.

[8]Mayuresh A Mane et al., *India's Expansion in the Nuclear Power Sector and Its Effects* 4 International Journal of Scientific & Engineering Research, 384 (2013).
[9]Sanjay Kumar Kar, *How Important is Nuclear Power in India's Energy Transition?* (last accessed on 4th April 2020) available at: www.energy.economictimes.indiatimes.com/energy-speak/how-important-is-nuclear-power-in-india-s-energy-transition/3265.com

It also does not look into any issues and challenges upcoming with such changes in the sector.

3. Aniruddh Mohan, The Future of Nuclear Energy in India[10]

   The paper talks about the India's energy sector status and its historical growth. It discusses in detail the reasons behind such growth of nuclear sector explaining several concepts with it. The paper gives a holistic view of the nuclear sector but does discusses role of nuclear energy in achieving sustainable energy goal for India and neither it discusses any issues related to it.

4. Luis E. Echávarri, Nuclear energy: Towards sustainable development[11]

   The paper talks about the advantages and disadvantages of nuclear energy in detail. There is discussion on the negatives of the nuclear sector as it is a challenging sector. the paper looks into economic aspect, waste management and especially its effect on environment as a whole. But the paper does not deal with sustainable energy goal aspect of nuclear sector and the future prospect of the nuclear sector.

5. R.B. Grover, Nuclear Energy and India[12]

[10]Aniruddh Mohan, *The Future of Nuclear Energy in India* (last accessed on 4th April 2020) available at: www.orfonline.org/wpcontent/uploads/2016/08/OccasionalPaper_98_NuclearEnergy.pdf.com
[11]Luis E. Echávarri, *Nuclear energy: Towards sustainable development* (last accessed on 4th April 2020) available at:www.oecdobserve.org/news/fullstory.php/aid/2076/Nuclear_energy:_Towards_sustainable_development.html.com
[12]R.B. Grover et al., *Nuclear Energy and India* 2 ATOMS FOR PEACE: AN INTERNATIONAL JOURNAL (2008).

This paper talks about nuclear energy programme of India which is based on closed fuel cycle comprising of three stages. It emphasizes on the importance of nuclear energy in overall energy mix of India for better economic growth. It also talks about importance of uranium for betterment of nuclear power in coming future. Is states that availability of uranium will influence the type of reactors to be used and fuel cycle that should be followed. But this paper does not take into consideration the environmental concerns behind shift in energy basket. Also it does not talk about the issues and challenges of nuclear power.

6. Subhash Mallah, Nuclear Energy Option for Energy Security and Sustainable Development of India[13]

   The paper starts with the relation between economic growth and climatic changes stating that energy is important factor of economy and clean energy can help in reducing carbon emission. It then proceeds to tell the current scenario of India's energy mix and how nuclear energy can be an alternative for clean energy. But this paper focuses only on power sector of India and not overall perspective for nuclear power. It also does not talk about the challenges and issues that will arise with nuclear power.

7. R.B. Grover, Green Growth and Role of Nuclear Power: A Perspective from India[14]

[13]Subhash Mallah, *Nuclear Energy Option for Energy Security and Sustainable Development of India* 38 ANNALS OF NUCLEAR ENERGY 331-336 (2011).
[14]R.B. Grover, *Green Growth and Role of Nuclear Power: A Perspective from India* 1 ENERGY STRATEGY REVIEWS 255-260 (2013).

This paper talks about role of renewable energy in fulfilling the demand of energy sector. It states that renewable energy cannot alone meet the increasing demand in India in the coming future. It then tells how atomic energy shall have crucial part in fulfilling the demand with other clean energy technologies.it talks about various advantages of nuclear energy over other energies. But it fails to address the legal aspect of nuclear sector and the disadvantages that are associated with nuclear sector.

8. Rijul Dhingra, Assessment of Renewable Energy in India[15]

   The paper talks about the situation of non-conventional resources of energy of the nation. It starts with discussing role of non-conventional energies and their advantages over the conventional sources. It also provides a complete view of non-conventional energy in the nation as well asevaluates the present scenario and installment of all of these technologies in nation till now. Paper additionally talks about various criteria's for assessing the various non-conventional energies. But this paper fails to pay exclusive focus on the nuclear sector and its role in diversifying India's energy basket.

9. Manasi Mahanty, Nuclear Energy in India: Debate and Public Perception[16]

   This paper talks about the different aspect of nuclear power and the role public perception plays in development of nuclear sector. It analyzes the disparity between

[15]Rijul Dhingra et al., *Assessment of Renewable Energy in India* 5 INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCE AND DEVELOPMENT 459-462 (2014).
[16]Manasi Mahanty, *Nuclear Energy in India: Debate and Public Perception* (last accessed on 10thMay2020) available at: www.space4peace.org/actions/India_2013/Nuclear%20Energy%20in%20India.pdf.com

perceived and calculated risk from nuclear power plants in India and to explore the ways in which the existing knowledge on both the risks could be integrated within a nuclear policy framework. This paper covers the aspects like risk assessment, economics, public policy making among others. But this paper does not discuss regarding role of atomic power for achieving short term goal of India and its importance in energy basket.

10. J.Y. Heo, The Casual Relationship Between Nuclear Energy Consumption and Economic Growth in India[17]

    This paper tries in exploring the longer and shorter run causality matters among consumption of atomic energy and development of economy in the nation with the help of using models like co-integration and error-correction. Paper covers period of 1969-2006. It states that consuming atomic energy will help in assist economic development and therefore, strategies about increase in supply of atomic energy will help in economic growth. This paper gives economic perspective of nuclear power but ignores all other factors related to nuclear power.

11. Surendra Laxminarayan Rao, Coordination in Energy Sector and its Regulation in India[18]

    This paper has a detailed discussion on status of present status of regulation in different segments of energy sector and then discusses the regulatory principles of

[17]J.Y. Heo et al., *The Casual Relationship Between Nuclear Energy Consumption and Economic Growth in India* 6 ENERGY SOURCES, PART B: ECONOMICS, PLANNING AND POLICY 111-117 (2011).
[18]Surendra Laxminarayan Rao, *Coordination in Energy Sector and its Regulation in India* (last accessed on 4th April 2020) available at: www.ogel.org/article.asp?key=2484.com

the sector. It also looks into various aspects of the sector like tariff determination, power purchase agreement and subsidies which are important part of regulation. The paper also discusses governance in energy sector and the weaknesses in the coordination of the sector. It leaves to assess the present loopholes in the administration by the regulatory bodies and the methods to overcome them.

1.4 Aim of Study

- To study the legal and policy framework of nuclear energy in India.
- To analyse the role of nuclear energy as clean energy mechanism to achieve India's commitment to Sustainable Development Goal 7.
- To study the issues and challenges related to legal and policy framework of nuclear energy in India.

1.5 Significance of Study

The study will help in understanding the legal and policy framework of nuclear energy in India. It will analyse the implications and challenges and will also evaluate the role of nuclear energy in achieving the Sustainable Development Goals.

1.6 Scope of Study

The study will be restricted only to analyse legal and policy framework of nuclear energy in India. The analysis of legal and policy framework will be in light of clean energy mechanism and India's commitment to achieve Sustainable Development Goals. It will also critically analyse the issues and challenges related to legal and policy framework of nuclear energy in India.

1.7 Research Questions

1. What is the legal and policy framework of nuclear energy in India?
2. What is India's commitment to Sustainable Development Goals?
3. What is the role of nuclear energy in achieving the clean energy mechanism in India?
4. What are the issues and challenges related to legal and policy framework of nuclear energy in India?

1.8 Research Methodology

The study will be doctrinal in nature. It will be a qualitative research. It will also be analytical and explanatory to some extent.

Analytical- There shall be analysis the manner in which the role of nuclear energy is changing in achieving the Sustainable Development Goal in India.

Explanatory- The study will explain the nature of change and challenges arising out of it in the nuclear energy in India.

The research will mainly rely upon the qualitative data. The primary sources of the research shall be the laws, rules, regulations, acts. The secondary data shall include books, journals, articles, commentaries. An analytical and descriptive approach shall be followed in the paper. The paper will cover only the nuclear energy of India.

1.9 Chapterization

Chapter 1- Introduction

This chapter will start with basic understanding of energy and its importance. It will then talk about the development in different parts of world in energy sector in brief. It will then

talk about the Indian perspective on energy sector. It will analyse the reasons behind changing dimensions of energy sector in India. It will then talk about sustainable development goal of India. It will discuss the long term and short term plans of India for achieving the sustainable development goals. It will then talk about importance of nuclear energy in helping to achieve the sustainable development goals of India.

Chapter 2- Emergence of Legal and Policy Framework of Nuclear Energy- International Perspective

This chapter will give general view of various aspects of energy. It will also discuss the international treaties and conventions which are signed by India and how they have been implemented in India and what are its effect in India. It will specifically focus on the treaties which have affected the environmental laws and have played role in shaping the SDG policies of India.

Chapter 3- Emergence of Legal and Policy Frame work of Nuclear Energy- Indian Perspective

This chapter will deal with the development of nuclear energy of India in detail. It will talk about the different legal aspects of nuclear energy of India for achieving the sustainable development goals.

Chapter 4- Legal and Policy Issues Related to Nuclear Energy in India

This chapter will deal with the different issues in the nuclear power sector of India. The major emphasis will be on legal and policy issues in India. It will analyse the problems associated with efficient nuclear trade which in turn is affecting the development of nuclear energy. It will also deal with manner in which these issues have been addressed and what

can be done to remove or reduce the issues for better and rapid development of nuclear sector.

Chapter 5- Conclusion

This chapter will summaries and conclude the research with specifically outlining the changing role of nuclear power in achieving short term goals of India.

Chapter 2- Emergence of Legal and Policy Framework of Nuclear Energy- International Perspective

2.1 Overview

For better understanding of the nuclear energy the clarity on terminologies and important concept is important and hence we will look into various concepts, importance of nulear energy and its relationship with

Energy Diversification

Energy diversification implies utilizing distinctive energy sources, providers and transportation courses to lessen reliance on a solitary asset or supplier. A nation that broadens its energy blend protects itself from energy interruptions and reinforces its energy security. Having a different energy blend is normally viewed as an imperative piece of energy security, having various sources enables a nation to proceed without disturbance on the off chance that one wellspring of energy falls flat.

The diversification of a nation's energy sources is called its energy blend. Diversification is basic to energy security, the most well-known energy sources, for example, raw petroleum, coal and flammable gas are on the whole products and are thusly subject to advertise powers which can result in intrusions to supply or extreme value rises. In the same manner ware like oil is generally defenseless to the transient stuns as a result of the geopolitical scenario, for example, the fear and clashes based oppressor assaults. The

process of diversification keeps in loop the general public to ingest a stun in one energy information like coal by expansion of utilization of any other sources like atomic or solar[19]

The word energy mix means mixture of different types of essential energy resources which is used to address different energy issues in a given place. It includes petroleum products (coal, gaseous petrol, oil), non-exhaustible waste, atomic energy and various facets of sustainable power sources (biogas, geothermal, solar, wind, hydro, biofuel, wood).[20] These various essential sources of energy are utilized for different purposes like giving fuel for transportation, warming and cooling mechanical structures, producing power among other usages.[21]

For each place or country, the energy mix is dependent upon:

- The availability of resources in the nation which can be utilized or importing capacity of the country.
- The extent and various types of energy that needs to be met.
- The different policies of the nation determined by various economic, social, environmental, geopolitical and other factors.

The IEA defines energy security as "*the uninterrupted availability of energy sources at an affordable price*".[22] There are several measurements of security for energies like:

[19]Jordan Hanania et al., *Energy Diversification* (last accessed on 20th June 2020) available at www.energyeducation.ca/encyclopedia/Energy_diversification.com
[20]Vikram Aggarwal, *Why India Needs to Further Diversify its Energy Basket* (last accessed on 20th May 2020) available at www.energy.economictimes.indiatimes.com/energy-speak/why-india-needs-to-further-diversify-its-energy-basket/2181.com
[21]S. Sharma, About the Energy Mix (last accessed on 20th June 2020) available at www.planete-energies.com/en/medias/close/about-energy-mix.com
[22]INDIAN ENERGY AGENCY REPORT (2018)

Security of energies for longer period- The energy security for long term helps in the supply of energy according to the feasible natural needs and monetary improvements.

Transient energy security-the energy security in transient phase revolves around the ability of the energy structure to respond to the unprecedented changes in the demand and supply balance in expeditiously manner.

Absence of energy security- the absence of energy security is generally associated to the negative impact on monetary and social aspects either in the form of unavailability of energy or an excessively unstable cost or not so aggressive cost.[23]

Concept of sustainable development

The most famous and widely accepted definition of sustainable energy has come from the United Nations report named Our Common Future in 1987 which states that "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[24] This report is commonly referred as the Brundtland Report which relies the definition of sustainable development on two key notion. Firstly "The concept of needs in particular the essential needs of the world's poor, to which overriding priority should be given and secondly The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."[25] The major concerns arising out of concept of sustainable

[23]*What is Energy Security?* (last accessed on 20th June 2020) available at www.iea.org/topics/energysecurity/whatisenergysecurity.com
[24]Our Common Future, The World Commission on Environment and Development (last accessed on 20th June 2020).
[25]Ibid

development can be viewed as result of definition of sustainable development given by the Brundtland Report.[26] These concerns could be broadly classified as follows:

- The depleting limited resources of earth
- The ecosystems carrying capacity
- The intra generational equity
- The intergenerational equity
- The non-materialistic need of human development
- The materialistic need of human development

Global Perspective

To have a better understanding of the energy mix and diversification we need to look at the global level consumption of energy by different regions in the world and their diversification in the energy sector given below:

Region wise consumption of different fuels, 2017 (Million Tonnes Oil Equivalent)

Area	Oil	Natural Gas	Coal	Nuclear Energy	Hydro Energy	Renewable Energy	Total
North America	1108.6	810.6	363.8	216.1	164.1	109.5	2772.8
South & Central America	318.8	149.1	32.7	5.0	162.3	32.6	700.6

[26]Ibid

Europe	731.2	457.2	296.4	192.5	130.4	161.8	1969.5
CIS	203.4	494.1	157.0	65.9	56.7	0.9	978.0
Middle East	420.0	461.3	8.5	1.6	4.5	1.4	897.2
Africa	196.3	121.9	93.1	3.6	29.1	5.5	449.5
Asia Pacific	1643.4	661.8	2780.0	111.7	371.6	175.1	5743.6

Source: BP Statistical Review of World Energy- all data, 2018

From the above table it can be inferred that the North America has the most diversified energy and a good balance in consumption of different resources followed by Europe while Middle East is least diversified followed by Africa as they are over reliable on gas, oil and have almost neglected renewable as well as nuclear energy. Even Asia Pacific is also dependent on coal and has not much explored the nuclear energy.

Indian perspective

India is a developing nation and has a huge demand on its energy resources to fulfill the need of the time. There is difference in the demand and supply chain of the energy and thus there is requirement of proper procedures and steps to be taken by the government of India so that there is increase in the supply of energy which will help India in facing the extreme constraint of energy supply in the present as well as future. Day by day the energy requirements are increasing in India at a very fast speed. Even though various steps and measures are being taken by the government for the better access to different sources of energy there is still quite a gap between the demand and supply chain of energy. Thus energy security is has become an issue in the county. An important method for reducing

gap between the demand and supply chain of energy is the protection and maximum utilization of the resources of energy available.[27] In the present scenario the most beneficial thing is to accomplish increase in the energy viability.

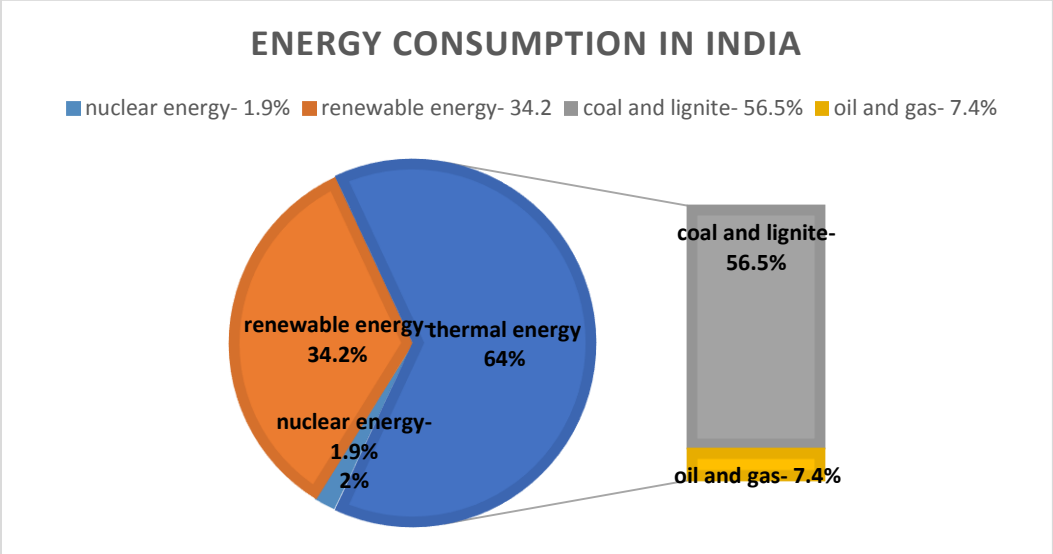
As per the report from the Expert Committee on Integrated Energy Policy, India must increase its capacity to generate the power by five to six time of its level in 2003-04 and also increase its energy supply three to four times to have a supported development of 8% through 2031-32.[28]

In the meantime, there is acknowledgment of a basic need to limit spending on oil based commodities, which are continuously getting to be costlier, and to progressively depend on sustainable power sources.

In the present scenario the energy sector of India is dependent upon the conventional sources of energy. While India mainly depends upon its own good amount of reserves of coal for its vast majority of needs, it is also one of biggest importer of raw petroleum in entire globe. But recently India has efficiently started to explore the different options like solar power and nuclear power. Several policies like Jawaharlal National Solar Mission has been launched which aims at setting up India as one of the leading nation in solar energy. Likewise, India is the fifth largest wind power industry in the world and presently includes the limit of 1800-2000 megawatts consistently. India is also focusing upon its nuclear sector and has planned to have 20,000 megawatts of nuclear power capacity by the

[27]Supra note at 1
[28]NATIONAL ENERGY POLICY (2006)

year 2020. Also India plans for additional supply 25% of electricity from the nuclear power till the year 2050.[29]



Source: Central Electricity Authority Report (2017)

With the aim of promoting clean energy and making shift in energy basket, the government has identified renewable sources like solar and wind along with the nuclear energy to work upon and make it a significant contributor in energy sector. The nuclear sector has an important role to play here. Nuclear sector entails the capacity of becoming prominent resource of energy in the nation if it is properly worked upon.

Relation between sustainable development and nuclear sector

The concept of sustainable development, as already discussed, according to the Brudtland Commission report means ability to meet the needs of present without compromising the

[29]Robert Gruendel & Reynaers Kini, *An Overview of India's Energy Sector*, (last accessed on 27th May 2020) available at http://files.dlapiper.com/files/Uploads/Documents/india-energy-sector-overview.pdf

needs of future generation.[30] It crosses the generations of people and national boundaries. It combines the concepts of social welfare, economic growth and environmental protection. The major challenge for the policy of sustainable development is to address the three dimensions i.e. social, economic and environmental in a balanced manner.[31] In the sustainable development debate it is the issue of energy which plays a defining role. The consumption and production of the energy forms the core of social progress and economic development. All the sources of energy available for producing power has some or other form of impact on the environment which includes the depletion of resources. Further, the energy policies are generally long term and determine the mode of consumption and production of power for decades.[32]

Every source of energy has certain advantages and disadvantages with respect to the principle of sustainable development. The analysis of the characteristics of the nuclear energy within the framework of sustainable development depicts that approach adopted in nuclear energy sector is in consistence with the basics of sustainable development goals on the passing on the assets to future generation with the minimum impact on environment.[33]

Generally, the nuclear energy has less impact on the environment and health during the normal course of operation. The nuclear energy sector can only continue to contribute to the sustainable development goals if it maintains the high standards of safety despite the

[30]Supra note at 9
[31]Nuclear Energy Association, Nuclear Energy and Sustainable Development (last accessed on 20th June 2020) available atwww.oecd-nea.org/sd/.com
[32]Ibid
[33]Ibid

fact that the competition is increasing in the power sector, the reactors are ageing and the industry is expanding to the new regions and countries.[34]

The concept of sustainable development mainly depends on the environmentally sound production of fuel and long term availability of fuel. "The factors contributing to the security of supply advantages are widespread geographical distribution of resources of uranium, the easy maintenance of stockpiles and the high energy density of the uranium (one ton of uranium is the energy equivalent of 14,000-23,000 tonnes of coal)."[35] Even the past practices of mining of uranium which had environmental issues are not licensed in today's time. The modern methods of processing and extraction minimize the impacts on the environment and the people.

"Even though the uranium resource is considered to be a finite resource with limited availability by some, the two periods of intense exploration in the 1940 and 1970 due to the increasing demand resulted in identifying the resource far more than what is anticipated requirement. Till date more than 2.3 million tonnes of natural uranium has been produced as well as the identified uranium resource has also increased over the same period. Till 2009 the identified conventional uranium resources are estimated to be sufficient for round hundred years of supply if the current rate of consumption continues."[36] It is also very important to analyse the nuclear power sector with regards to the three dimensions of the sustainable development.

[34]Ibid
[35]World Nuclear Association, Nuclear Energy and Sustainable Development (last accessed on 22nd June 2020) available at www.world-nuclear.org/information-library/energy-and-the-environment/nuclear-energy-and-sustainable-development.aspx.com
[36]Ibid

The economic dimensions of sustainable development and nuclear sector are as follows:

- The availability of uranium is much more vast and far greater in the terms of reserve production ratio when compared to availability of natural gas and oil resources. The deposits of natural ore of uranium which has been identified globally and which are utilized in OTFCs are enough for maintaining the present levels of nuclear power generation for more than century which is similar to the length of time for which coal based energy supply can be maintained with the currently identified sources. And with the large scale development of FRs with the closed fuel cycles will almost remove the resource constraint altogether.
- The nuclear power has been identified as one of the cheapest source of generating baseload power in the world when directly compared on levelized cost of electricity especially in situation where health damage cost or grid level system as both are minimal for nuclear power are accounted for.
- But due to the complexity and size of nuclear power plants along with the long time period required in their construction it seems that at once investment cost of coal and gas fires power stations and of offshore and onshore farms of wind are more favorable. But there exist various mechanism of financing exists to encourage risk associated with the nuclear project and to distribute them to different stakeholders.
- When it is compared to its counterparts the nuclear sector technology seems to be less sensitive to the policy changes like the geopolitical risks, resource price instability or adopting strict policy for climate change.[37]

[37]IAEA, Nuclear Power and Sustainable Development (last accessed on 10th July 2020) available at www-pub.iaea.org/MTCD/Publications/PDF/Pub1754web-26894285.pdf.com

The environmental dimension of sustainable development and nuclear energy are as follows:

- On the basis of life cycle the comparison of greenhouse gas emission shows that the nuclear power plants are one of the least carbon intensive sources of power (less than 15gm of CO_2 equivalent to per kilowatt hour). With the increase in the share of nuclear sector in the energy mix of the country it can be predicted that it will help in achieving a decarbonized power system at the lowest cost possible.
- The renewable sources of power and the operating nuclear power plants contribute in the sizeable environmental benefits in terms of eutrophication, ARDPs and reduced acidification and thus help in avoiding the damages to the human made structures and preserving the integrity of natural habitats among the other advantages.
- The major environmental challenge is the management of waste created during the process of the generation of electricity. Even when the nuclear energy is utilized for the generation of electricity there is generation of radioactive and other wastes in less volume due to the very high energy density of the uranium. Till now around 4/5 of the total waste generated from the nuclear sector has been already sent for controlled and safe disposal. The first depositaries for high level radioactive waste are expected to begin the operation in a decade. Nuclear fuel spent can be partially recycled and the new technologies are developing to turn the long life of radioactive waste into shorter life.
- The another important aspect of sustainable environment is the life cycle of the water use by the power generating technologies because even being a scares

resource it has multiple and competitive use. Substantial amount of water is required by the Nuclear Power Plants (NPP)which are equipped with the once-through cooling system but there are other alternative cooling systems like hybrid system having cooling tower which can decrease the amount of water required to a comparable level with the other alternative technologies. In the future the Nuclear Power Plants (NPP) will have to adapt the designs and operations which are capable of handling the issues of climate change like flood and drought so that the vulnerability of such events is reduced.

- Another major aspect of determining the sustainable development through energy sector is the usage of land for the generation of power and difficulty in the restoration of the land with its original characteristics after the dismantling of the infrastructure especially in the case of full life cycle of a plant. There is huge land consumption in the coal sector along with its mining, ground mounted solar PV and onshore wind generation. However in nuclear energy sector, a unit of nuclear based electricity requires only limited land surface (median footprint of 0.78 square meter year per megawatt-hour).[38]

The social dimensions of sustainable development and nuclear sector are as follows:

- The need of the hour is to have a more sustainable energy system which has minimum impact on the health of the human. Both the gas and nuclear power stations have level of toxicity very less and they also support for huge reduction of formation of particulate matter. The waste generated which is radioactive emits

[38]Ibid

insignificant amount. The natural exposure to various ionizing radiations like cosmic radiation or terrestrial radiation has higher in various orders of magnitude than that of human made, artificial radiation especially the one coming from the nuclear fuel cycle.

- The shift to a sustainable and especially a low carbon economy will help in improvement of well-being of the humans, enhancing employment and stimulating economic activities. Setting up of a nuclear power plant created several long term job opportunities in supply chain, operations and contracting. And if compared with the other alternative options then in the terms of investment of money per effective megawatt of capacity then also it yields good results. Further there is requirement of more skilled labors in designing and operating the complex nuclear technologies when compared with other technologies which implies that it has more potential to produce economic value during the process of construction of plant, operation and dismantling.
- In the nuclear power plant, the workforce is exposed to less risk of hazards and accidents as compared to the hydropower and fossil fuels supply chain. Generally, the coal sector has quite higher rate of fatality than that of oil and gas sectors. The nations which have large installed capacities and have long standing experience have largely less risks in the sectors of renewables and the nuclear energy.[39]

Due to so many advantages, the government has formulated several short term goals to increase the overall contribution of nuclear sector. Indian government has submitted its Intended Nationally Determined Contribution to UNFCCC as agreed in UNFCC COP21

[39]Ibid

in Paris 2015. The main focus has been on reducing emission intensity, increase share of non-fossil fuels by 40% in electricity generation, create additional carbon sink etc. To achieve these goals contribution of nuclear energy plays an important role. The plan for development of nuclear sector has been incorporated in 12th five-year plan of India and target has been under the National Energy Policy formulated by government of India.[40]

2.2 International Treaties and Conventions

India's energy sector is over dependent on coal and is not properly diversified but with change in time, the scenario of energy sector is also changing. There are lot of factors responsible for the changing scenario like rapidly increasing demand of energy, depletion of conventional sources among others but one of the major factor in shift of focus from conventional to non-conventional sources is international obligation on India. It means that India after independence started to participate at different forums at international level, being member of bodies like United Nations, World Trade Organization, World Health Organization etc. India signed several treaties and conventions. From past few decades the international forum has started to emphasize on climate change and the factors responsible for it. There has been a lot of discussion on reduction of pollution especially greenhouse gases and aim for sustainable development for betterment of future. There have been a lot of environmental treaties and conventions which India has signed like:

2.2.1 United Nations Environment Protection (UNEP)

In 1972 the United Nations Environment Protection (UNEP)was established with the aim to help the developing countries to create policies and to co-ordinate the environmental

[40]Ibid

activities around the entire world. It was established by the Maurice Strong and has its headquarters in Nairobi, Kenya. It is a subsidiary of the United Nations. 113 nations including India agreed on the action plans and principles for the protection of environment and thus became obliged for its implementation in domestic laws. For the implementation of the provisions of the conventions in India a new authority known as National Council for Environmental Policy and Planning under the department of science and technology was set up in 1972. In 1985 the aforesaid council converted into a full-fledged ministry known as Ministry of Environment and Forest. This ministry is the leading body in the country for the environmental protection.[41]

2.2.2 The Stockholm Conference, 1972

In 1972, a United Nations Conference on Human Environment was held in Stockholm where the report of Brundtland Commission was known as "Our Common Future" was released. The conference also gave the concept of sustainable development. The main aim of conference was to make all nations and industries agree to come together for reduction in pollution so that the cost could be equally divided among them.[42]

Implementation in India:

The Stockholm Conference and the Indian Constitution – The conference held in Stockholm had a huge impact on Indian laws on environmental laws. The most important effect of this conference can be seen on the constitution of India. After this conference the

[41] Anubhav Pandey, *International Conventions on Environment Protection Ratified by India* (last accessed on 10th June 2020) available at www.blog.ipleaders.in/international-conventions-environment-protection-ratified-india/.com

[42] K.R., *Agenda 21: Programme of Action for Sustainable Development* (last accessed on 25th June 2020)available at www.bgci.org/worldwide/article/0011.com

constitution of India was amended to include the provisions for environment protection. Article 48A and Article 51A(g) was added under Directive Principle of State Policy and Fundamental Duties respectively. India was the first country to make rules for protection and improvement of environment in the world.[43]

The Stockholm Conference and Indian laws- The Stockholm Conference of 1972 has also influenced the environmental statutes of India. India enacted the The Water (Prevention and Control of Pollution) Act 1974, The Air (Prevention and Control of Pollution) Act 1981, The Environment (Protection) Act 1986 and various other policies and rules after 1972.[44]

Water Act, 1976 – The main aim of the act is to save water resources of India from any kind of pollution. It specifically provides the legal definition of pollution in respect to water. The establishment of central pollution control board and state pollution control board for control and prevention of water pollution was done for the first time under this act.[45]

Air Act, 1981 – The main aim of the act is to control, abate and prevent any kind of air pollution. It also provides power to both the boards established under the water act to achieve the aim and objective of this act.[46]

2.2.3 United Nations Framework Convention on Climate Change (UNFCCC)

[43]Ibid
[44]Indian Environment (last accessed on 10th July 2020)available at www.lawteacher.net/free-law-essays/indian-law/indian-environment.php.com
[45]A. Ashok Desai, *Constitutional Accountability Towards Environment*, 42 Journal of the Indian Law Institute 29 (2000)
[46]Supra note at 40

India became the member of United Nations Framework Convention on Climate Change (UNFCCC) on 10th June 1992 and ratified it on 1st November 1993. Under the framework of UNFCCC, the developing countries like India do not require to bind to the Green House Gas (GHG) mitigation commitments due to their already low GHG emission and less technical and financial capabilities.[47] In India a separate ministry known as The Ministry of Environment and Forest has been constituted to look into issues of climate change and the working groups on UNFCCC has been made by it.

2.2.4 Kyoto Protocol

It is an international agreement which is linked to UNFCCC. It was adopted in 1997 by number of nations. It commits the parties by three flexible mechanisms to set the emission reduction targets which will be internationally binding. It requires that the developed nations and economies which are in transition to reduce GHG emission by an average of 5.2% below 1990 levels. On 26th august 2002 India accepted the Kyoto Protocol but its contribution is non-binding.[48]

There are three major Kyoto mechanism discussed below:

- The Clean Development Mechanism (CDM)- It is define under article 12 of the Kyoto Protocol. It basically gives allowance to remove or reduce emission so as to get carbon credits or Certified Emission Reduction (CER) credits which is equivalent to one to of CO_2. The earned CERS can be thus can be traded and sold

[47]India and UN Framework Convention on Climate Change (last accessed on 10th June 2020)available at www.planningtank.com/environment/india-un-framework-convention-climate-change-unfccc.com
[48]United Nations, 2303 *Treaty Series*. 162-63 (last accessed on 11th June 2020) available at www.treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVII-7-a&chapter=27&clang=en.com

to the developed or industrialized countries which will help them to achieve their emission reduction target. The main aim of this concept is to stimulate sustainable development and reduction in emission and it also provides for the way to developed nation in achieving their goal as achieving their goal alone on the basis of other two mechanisms may not be possible. But to get a project registered under CDM a number of steps and procedures needs to be followed as given under the protocol.[49]

- The Joint Implementation (JI)-It is defined under the article 6 of the protocol. It provides an option for nations under Annex I to choose project for carbon reduction or project for removal of sinks in the region of another nation under Annex I. The nation will be considered for achieving its own objective.[50]
- The International Emission Trading – It is defined under article 17 of the protocol and it states that any country under Annex I is eligible to buy emission units from any another country under Annex I.[51]

The protocol gave its first commitment period from 2008-2012 and the second commitment period from 2013-2020 and aims at 5% and 18% emission below 1990 level respectively but the parties committed to these periods have different compositions.[52]

2.2.5 The Paris Agreement, 2015

[49]Ibid
[50]Ibid
[51]Ibid
[52]Ibid

In November 2015 the Paris Climate Change Conference was held in the 21st session of the Conference of the Parties commonly known as COP21.[53] It was successful in accomplishing an important agreement to fight against environmental changes and to reinforce and rejuvenate exercises and the ventures necessary for low carbon in future. The most part of this agreement includes overall peaking of ozone harming substance transmission, long haul temperature objective, making sinks and supplies, alleviation through broadly decided commitments etc.

Implementation in India:

- National Environment Policy (NEP) 2006- it promotes the concept of sustainable development as well as the imperatives of social justice and respecting limitations of ecology. The current development scenario rejuvenates the focus on concept of sustainable development and aims to use the dual benefit of promotion of economic growth along with the climate change.[54]
- National Action Plan on Climate Change (NAPCC) 2008- it is implemented by the Prime Minister's Council on climate change. It will be done through eight national missions which outlines the priorities for adaptation and mitigation to combat climate change.[55]

Being signatory to such treaties and conventions has put India under obligation towards the environment and generally focus on sustainable development, reducing pollution and

[53]Ibid
[54]Ibid
[55]Ibid

protecting the flora and fauna due to which the contracting nations are forced to shift the focus towards clean energies including nuclear power.

2.2.6 Sustainable Development Goals (SDG) 2015

The 17 Sustainable Development Goals (SDGs), with their 169 targets, form the core of the 2030 Agenda. They balance the economic, social and ecological dimensions of sustainable development, and place the fight against poverty and sustainable development on the same agenda for the first time. The SDGs are to be achieved around the world, and by all UN member states, by 2030. This means that all states are called upon equally to play their part in finding shared solutions to the world's urgent challenges. Switzerland is also required to implement the Goals on a national basis. In addition, incentives are to be created to encourage non-governmental actors to make an increasingly active contribution to sustainable development.[56]

Implementation in India

India has started to work upon achieving sustainable development goals through various laws, policies and mission. The government has basically made short term goals and long term goals for different sector involved in sustainable development goal. The government aims at achieving these goal through various ambitious policies. While some goals will take time to get achieved some can be achieved early if worked properly with well-planned strategies and governmental support. These goals are aimed at providing better, clean, bright future to the people. One of the SDG is to provide clean, affordable, reliable and

[56]17 SDG (last accessed on 30th June 2020) available at www.eda.admin.ch/agenda2030/en/home/agenda-2030

modern energy to all. To achieve this goal, the government has made several policies and have started many plans as well. For achieving the same, the government has made many short term goals. The government aims at shifting the focus from conventional sources of energy to clean sources of energy as this will also help in reducing the carbon emission which is one of the other commitment of Indian government. This shift will also help in shift in energy basket. India from a very long time has been dependent on fossil fuels for fulfilling its demand which has cause of depletion of resources leading to energy scarcity along with severe pollution. Being a developing nation energy security is an important factor to be considered for better and secured future. Proper energy diversification can ensure energy security as it will remove India's dependency on other nations for fossil fuel. Being a nation with proper energy security will also give a better stand to India at international level. But doing so is a difficult task. Energy diversification requires proper planning and execution. The government has to make such efficient policies and plans to promote it. Though it is not easily achievable but with continuous effort and well planned strategies it can be definitely achieved. India has also started working in this direction.[57]

Therefore, it can be summarized that India has been over dependent on the conventional sources of energy but with change in time the scenario is changing. India is now focusing on energy diversification due to many reasons like international obligation to reduce carbon emission, strengthen energy security, achieve sustainable development goals etc. in this changing scenario nuclear power being a clean energy can play an important role. The

[57]Ibid

government has also made several short term plans for energy sector for its rapid growth. Policies like National Energy Policy etc. are focused on development of energy sector.

In the next chapter we will deal with the nuclear sector of India in detail along with the short term plans for nuclear sector and how they can help in development of nuclear sector in the future.

Chapter 3- Emergence of Legal and Policy Frame work of Nuclear Energy- Indian Perspective

3.1 Development of Nuclear Energy in India

In 1947 India attained its freedom and in the very next year, in 1948 it set up the Atomic Energy Commission with the aim of development of atomic energy in India by framing policies. In 1954 another milestone was achieved when Department of Atomic Energy was established to implement the policies made by the Atomic Energy Commission and Mr. Bhabha was appointed as the secretary. Sir JRD Tata played a very important role in framing policies of atomic energy in the nation as he was one of the longest serving member to the Atomic Energy Commission.[58]

Homi Bhabha formulated three stage nuclear power programme for India with an aim to secure our nations long term energy independence. He presented the plan in 1954 at the conference of "Development of Atomic Energy for Peaceful Purposes" and in 1958 it was formally adopted by Indian government.[59] The three stages include:

- Stage I- pressurized heavy water reactor
- Stage II- fast breeder reactor
- Stage III- thorium based reactor[60]

[58]S.K. Jain, *Nuclear Power- An Alternative* (last accessed on 20th June 2020)available at www.ncil.nic.in/WriteReadData/userfiles/file/Promotion_of _scientific_environment_in_India.pdf.com
[59]Anil Kakodkar, *Nuclear Energy in India- Retrospect and Prospect* (last accessed on 21st June 2020)available at www.ipen.br/biblioteca/cd/unepapers/2004/pdf/04_Plenary_Session_2/IAEA-CN-114_P2-5.pdf.com
[60]Ibid

The Atomic Energy Act[61] governs the activities related to atomic energy in the nation. Nuclear Power Corporation of India Limited (NPCIL) implements the first stage (comprising PWHR and LWR) of commercial nuclear power programme while Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI) implements the second stage (comprising fast breeder reactors). Both these companies are completely owned by the central government according to the provisions of the act.[62] The main objective behind development of nuclear sector in India was becoming self-reliant to fulfill the energy needs and for peaceful use of nuclear energy for improving the quality of people's life. In 1969 the commercial Nuclear Power Programme started with the operations of TAPS 1&2(BWR) and currently it shares about 3% of country's installed capacity.[63]

Nuclear power has been well established in India for civil use. From the time of constructing 2 small boiling water reactors at Tarapura in 1960, the civil nuclear strategy has been aiming towards having full independence in the nuclear fuel cycle as it was necessary because it was excluded from the Nuclear Non-Proliferation Treaty (NPT) in 1970 because it acquired capability of nuclear weapons after 1970. It resulted in lack of technological assistance or fuel from other countries in India's nuclear power programme. In 1964 the pressurized heavy water reactor (PHWR) was adopted as it required no enrichment and less natural uranium than BWR and could also be built with engineering capacity of the nation at that time using pressure tube other than heavy pressure vessel. Due to country isolation it faced technical difficulties as it had one of the world's lowest

[61]The Atomic Energy (Amendment) Act 2015, No 5 Act of Parliament 2015 (India).
[62]Aaakash Chauhan, *Nuclear Energy in India* (last accessed on 2nd July 2020)available at www.helplinelaw.com/business-law/NCLR/nuclear-energy-in-india.html.com
[63]Ibid

capacity factors from its power reactors to mid-1990s but it rose from 60% in 1995 to 85% in 2001-02.[64]

But the scenario changed after 2008 after the NSG India specific agreement as the scope for civilian nuclear trade increased significantly. Since then several nuclear cooperation agreements have been signed with Australia, Russia, US, Kazakhstan, Russia and other several countries. Some of the agreements signed by India are:

India and US- India has signed 123 agreements with US which has ended India's nuclear isolation and the denial regime of technology against India which was there for almost three decades. It has in fact opened the doors for civil nuclear cooperation being an equal partner USA and the world.[65]

India and France- India signed cooperation agreement with France on 30th September 2008 and they both agreed that they will cooperate with each other in use of nuclear energy for non-explosive a peaceful purpose according to the provisions of the agreements.[66]

India and UK- India signed Joint Declaration on Civil Nuclear Cooperation with UK at New Delhi on 11th February 2010. The main aim of declaration to promote the wide ranging cooperation in nuclear field including the scientific institutions of both the nations and in nuclear trade.[67]

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[64]R Rajaraman, *India's Nuclear Energy Programme* (last accessed on 20th June 2020)available at www.dialouge.ias.ac.in/article/14149/indias-nuclear-energy-program.com
[65]Prarthana Mitra, *Explainer: What the New Nuclear Deal between Indi and US is all About* (last accessed on 25th June 2020) available at www.qrius.com/explainer-what-the-new-nuclear-deal-between-india-and-us-is-all-about/
[66]Ibid
[67]Ibid

India and Russia- On 12th March 2010 both Russia and India agreed on a framework for development Russian design reactor in India. The agreement sets the timeline for all the steps that are required to be taken for the development of Kudankulam units three and four. Also it talks about the development of two more reactors unit five and six at the same place and two more reactors at Haripur, West Bengal during the 12th five-year plan. The development of more Russian design reactors will be considered during the 13th five-year plan.[68]

3.2 Legal framework of Nuclear Energy in India

India has detailed and structured system for nuclear sector. Since this sector has been considered of utmost importance and of national interest thus it has always been kept under the prime minister since the independence. The different departments looking after the development of this sector are as follows:

3.2.1 Institutional Framework

There are several bodies set up for the functioning of the nuclear sector of India which are discussed below:

3.2.1.1 Atomic Energy Commission (AEC)

On 10th August 1948 the IAEC was established under the late Department of Scientific Research. Later on 1st March 1958 the government of India passed a resolution and replaced the commission be "Atomic Energy Commission of India" under the Department

[68]Ibid

of Atomic Energy (DAE) with more executive and financial powers.[69] The major roles of AEC are given as follows:

- Providing training to atomic scientist in the nation
- Organizing research in the field of atomic science in the nation
- Promotion of research in nuclear sector in the laboratories of commission
- Undertaking the prospecting of minerals in India and the extraction of those minerals for its use on industrial scale.

3.2.1.2 Department of Atomic Energy (DAE)

In the year 1954 DEA was established by presidential order and its headquarter is in Mumbai, Maharashtra.[70] Since its inception it has been directly under the charge of Prime Minister of India. The department has mainly engaged in the activities related to development of technology in nuclear power, implementation of radiation technologies in the fields of medicine, agriculture, industry and basic research. The DAE comprises of three industrial organizations, three service organizations, five research centers and five public sector undertakings.[71] There are two boards under its control for funding and promoting the extramural research the nuclear and related fields, mathematics and also one national level institute (deemed university). The department also supports eight other institutes which have international reputation and are engaged in the research of astronomy, education, basic sciences, astrophysics and cancer research. It also has in its pocket an

[69]DAE, Commission (last accessed on 17th June 2020) available at www.dae.gov.in/node/394.com
[70]DEA, About Us (last accessed on 17th June 2020) available at www.dae.gov.in/node/634.com
[71]Ibid

educational society which gives various educational facilities for the DAE employees children.[72] The major programmes of the DAR are as follows:

- Enhancement of the share of nuclear sector in the total share of power sector by implementation of indigenous technologies and other proved technologies.
- Development of thorium based reactors and fast breeder reactors with the associated facilities of fuel cycle.
- To build and operate research reactors for the construction of radioisotopes and other sources of radiation like lasers and accelerators along with the development and deployment of radiation technology applications in various fields like industry, agriculture, medicine and basic research.
- Development of advanced technologies like supercomputers, lasers, strategic materials, robotics, accelerators, instrumentation, areas related to the fusion research and encouragement to transfer technology industry.
- To carry out and support the basic research in the field of nuclear energy and other related areas of science, interact with academic institutions and universities, supporting the research and development projects which bear the programmes of DAE and promote international co-operation in the research of related advance areas and contribute to national security.[73]

3.2.1.3 Atomic Energy Regulatory Board (AERB)

On 15th November 1983, the president of India while exercising his power conferred upon him under the Atomic Energy Act, 1962 "to carry out certain regulatory and safety

[72]Ibid
[73]Ibid

functions under the act" constituted the Atomic Energy Regulatory Board (AERB). The regulating authority under Atomic Energy Regulatory Board (AERB) is derived from the notifications and rules framed under the Environment (Protection) Act, 1986 and the Atomic Energy Act, 1962. The main aim of the Atomic Energy Regulatory Board (AERB) is to make sure that use of nuclear energy and ionizing radiation does not have any harm to the environment and the health of the people.[74]

3.2.2 Legal Framework

India has made several laws for the better development of nuclear sector which are discussed in detail below:

3.2.2.1 Constitutional level

Under the constitution of India it is stated that Parliament has exclusive power to make laws with respect to any of the matters enumerated in List I in the Seventh Schedule (in this Constitution referred to as the Union List)[75] connected with the matter of atomic energy and mineral resources necessary for its production this means that it is the central government which has the powers to make the laws on the matters related to atomic energy and mineral resources and it has nothing to do with the state government.[76] Also matters listed under schedule VII of the Indian constitution are the matters of national interest and importance and are therefore dealt only by central government. This implies that atomic energy is a matter of national importance and therefore all the decisions regarding it are taken by central government.

3.2.2.2 Statute level

[74]AERB (last accessed on 30th July 2020)available at www.aerb.gov.in/english/about-us.com
[75] INDIA CONST. art. 246.
[76] INDIA CONST. list I, entry 6.

At statute level in India there are two main legislations which deal with the nuclear sector which are:

The Atomic Energy (Amendment) Act, 2015

The main aim and objective of the act is to provide the control, development and use of nuclear energy for the betterment of people of India and for the other peaceful purposes.[77] In year 2015 the amendment in the act took place. Section 2 and 14 of the act were amended. "Through the amendment there has been attempt to give more power to central government. As a result of this amendment there is now possibility of joint ventures among the other government companies and the NPCIL. Also the license will be granted only to entities such as government company or a department of central government

The Civil Liability for Nuclear Damage Act, 2010

The main aim and object of the act is to have civil liability for any damage due to nuclear incident and to provide quick compensation to the victims of the nuclear accident by a no-fault concept directing liability to the operator and appointment of Claims Commissioner along with the establishment of Nuclear Damage Claims Commission.[78]

3.2.2.3 Delegated legislation

There are several rules framed under the power of delegated legislation

- The Atomic Energy (Working on the Mines, Minerals and Handling of Prescribed Substance) Rules 1984

[77]The Atomic Energy (Amendment) Act, 2015 No 5, Acts of Parliament, 2015 (India).

[78]The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).

- The Atomic Energy (safe disposal of radioactive waste) Rule 1987
- The Atomic Energy Radiation Protection Rules 2004
- The Atomic Energy (Arbitration Procedure) Rules 1983
- The Atomic Energy (Factories) Rules 1996
- The Atomic Energy (Control of Irradiation of Food) Rules 1996

3.2.2.4 Non-mandatory guidance instruments

The Department of Atomic Energy, Government of India has framed following guidelines:

- Guidelines for Nuclear Transfer (Exports) 2006
- Guidelines for the Implementation of Arrangements for Co-operation Concerning Peaceful Uses of Atomic Energy, 2010

3.3 Other Initiatives

To develop nuclear sector for the purpose of achieving SDG in India, the government of India has come up with several plans and policies which are discussed as follows:

3.3.1 Sustainable Development Goals (SDG)

From 2000 to 2015 the Millennium Development Goals (MDG) had provided a major development framework and also achieved success in various areas like improving health, education and reduction in poverty in developing nations.

In 2015 all the member states of United Nations adopted the Sustainable Development Goals (SDG) (also known as Global Goals) as a universal call of action to protect the

planet, ensuring enjoyment of peace and prosperity by all the people and end of poverty till 2030.[79]

In September 2015 the SDG were adopted as the part of resolution "Transforming Our World: The 2030 Agenda for Sustainable Development." There are total 17 SDG and 169 associated targets and India is committed to achieve it. These comprehensively cover the environmental, social and economic dimensions of development and focus is on ending poverty in all its dimensions and forms. In India NITI Aayog has been assigned the role to oversee the implementation of SDGs at the central government level.[80]

There are 17 SDG which are given below:

- No Poverty
- Zero Hunger
- Good Health and Well-being
- Quality Education
- Gender Equality
- Clean Water and Sanitation
- Affordable and Clean Energy
- Decent Work and Economic Growth
- Industry, Innovation, and Infrastructure
- Reducing Inequality
- Sustainable Cities and Communities

[79]SDG India Index, NITI Aayog (last accessed on 30th June 2020) available at www.niti.gov.in/sdg-india-index.com
[80]Ibid

- Responsible Consumption and Production
- Climate Action
- Life Below Water
- Life On Land
- Peace, Justice, and Strong Institutions
- Partnerships for the Goals[81]

SDG 7 which talks about ensuring access to affordable, reliable, sustainable and modern energy for all has been divided into three targets which are as follows:

- By 2030, ensure universal access to affordable, reliable and modern energy services
- By 2030, increase substantially the share of renewable energy in the global energy mix
- By 2030, double the global rate of improvement in energy efficiency[82]

To achieve this sustainable development goal, the government of India formulated certain short term goals. These goals focus on development of nuclear sector for achieving the SDG. These strategies and plans are as follows:

3.3.2 National Action Plan for Climate Change (NAPCC)

By virtue of being a part of UNFCCC COP 21 India has committed itself for reduction of carbon emission. As agreed in the above mentioned meting India has formulated the NAPCC.[83] It was launched by the Prime Minister's Council on Climate Change. The main

[81]Ibid
[82]Ibid
[83]NAPCCC, Prime Minister's Council on Climate Change, Government of India (last accessed on 10th July 2020) available at www.nicra-icar.in/nicrarevised/images/Mission%20Documents/National-Action-Plan-on-Climate-Change.pdf

object is creating awareness between the different representatives of scientist, industries, public, agencies of government and promulgate steps to encounter the climate change. The plan has eight missions which are multi-pronged, integrated and long term strategies to achieve major goals of climate change.[84] The eight missions are as follows:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for A Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change[85]

3.3.3 Intended Nationally Determined Contribution (INDC)

In December 2015 all the nations across the globe agreed to create a new international climate agreement at the conclusion of UNFCCC COP21 in Paris. Working on the same line nations agreed to outline publicly what will be post 2020 climate actions they are intending to take under the new international agreement which will be known as their INDCs. These INDCs shall mainly determine the world will achieve the ambitious agreement of 2015 and follows the path of climate resilient and low carbon future.[86]

[84]Ibid
[85]Ibid
[86]Viji, *India's Intended Nationally Determined Contribution* (last accessed on 25th May 2020) available at www.vikaspedia.in/energy/environment/climate-change/india2019s-intended-nationally-determined-contribution.com

India has already made its submission of Intended Nationally Determined Contribution (INDC) to the UNFCCC. "The major features of the INDC are as follows:

- Putting forward and further propagating a sustainable and healthy ways of living based on values and traditions of moderation and conservation
- Adopting a clean and climate friendly way than what is followed till now by the others at a corresponding level of economic development.
- Reduction in the emission intensity of its GDP from 2005 level by 33%- 35% by 2030.
- To achieve around 40% of accumulative electric power installed capacity from non-conventional based sources of energy with the help of technology transfer and low cost of international finance including the Green Climate Fund by 2030.
- Creation of an additional carbon sink of 2.5-3 billion tonnes of carbon dioxide equivalent by the way of tree cover and additional forest by 2030.
- Better adaptation to climate change by enhancing the investment in development programmes in the sectors which are vulnerable to climate change especially water resources, coastal regions, Himalayan regions, health, agriculture and disaster management.
- Mobilization of new, domestic and additional funds from developed nations to implement the above adaptations and mitigations actions while keeping in view the resource gap and the resource required.

- Creating domestic framework, building capacities and international architecture for fast diffusion of cutting edge technology in climate in India and for joint collaboration for research and development for such future technologies.[87]

The main focus of INDC is on following aspects:

- Sustainable lifestyle
- Clean development of economy
- Reduction of emission
- Increase in the share of non-conventional based electricity
- Enhancement of carbon sink
- Better adaptation
- Mobilization of finance
- Transfer of technology

The INDC of India has major focus on adaptions for climate change. From the total eight missions given in the INDC of India four of them are focused on efforts for adaptation for increasing efficiency for water use, sustaining the Himalayan ecosystem, creation of sustainable habitats and sustainable agriculture.[88]

3.3.4 National Energy Policy (NEP)

To achieve these target set by the government formulated the National Energy Policy. The chapter seven of the policy is completely dedicated to the nuclear sector. Recently in the NDC of India it has been indicated that government has the intention to revamp the nuclear

[87]Ibid
[88]Ibid

power capacity tenfold by the year 2030 up to 63 GW. In the current scenario of achieving the bold ambition the policy namely The National Energy Policy (2018) lays down the strategy to achieve the target set for the nation.[89] The policy basically talks about the technology, economic viability, liability and public confidence. It asserts six strategies:

- For the growth of nuclear sector in India there is need of fast track nuclear power to meet the growing demand of energy. The Indian government has taken in account the actions plan of DEA for fast pace growth of nuclear sector. starting with the budget the provisions have been made for providing up to INR 3000 crores per year. Also the main act of nuclear sector namely Atomic Energy Act has been amended recently to allow formation of joint ventures between DAE PSUs like NPCIL with non-DAE PSUs of India. Currently the participation between foreign suppliers and private sector has been restricted to the construction activity only and for the expansion of the activities of involvement of parties in operation or ownership of nuclear plants there will be requirement of major amendments in the Atomic Energy Act.
- Presently the regulator of nuclear sector is AERB which is constituted under the AEA and functions independent of operator and Nuclear Power Corporations with Department of Atomic Energy as the administrative ministry. AERB operates in the scientific atmosphere and also has the technical support from the world's biggest set of well qualified in technical and scientific manpower. It has also

[89] DRAFT NATIONAL ENERGY POLICY (2018)

maintained one of the highest standards of safety in the world. also the Nuclear Safety Regulatory Authority Bill is under consideration of government of India.

- The indigenous designs of PWHR, FBR and imported LWR are time tested, standardized and promise options for nuclear technology in long run.
- Despite the fact that India has limited availability of uranium India has entered in fuel supply agreements with various foreign suppliers both for imported and domestic reactors. To address these, issue the provisions of Power Purchase Agreements (PPA) are expected to be adequate. There are several diplomatic engagements of India with the nuclear fuel supplier countries and it is expected that will give several positive results. Fast Breed Reactors have the benefit that it produces more fuel than it uses after the initial fuel loading and also it is not dependent on any external supplies.
- Mainly the capacity growth programme will be mainly driven by the PHWR, FBR and LWR and will be dependent on the availability of convenient sites. The government has taken correct steps for the capacity addition and rejuvenation of Indian industry by announcing about the development of ten units (which will be seven hundred megawatts each) of indigenously constructed PHWR and two more LWR at the Kudankulam site.
- The Make in India campaign is expected to be significantly uplifted by the large nuclear power programme. For the purpose of manufacture of components of reactors NPCIL will support it. There must be encouragement of joint ventures

between the domestic and foreign parties for manufacturing equipment in India because the growth of LWR is highly prospective.[90]

Therefore, it can be stated that atomic sector is well established in India. After almost decades of isolation India has now started signing agreements for cooperation with different countries due to the agreement with NSG. With change in scenario of the sector and other factors discussed in previous chapters the government has shifted its focus on nuclear sector. to achieve the short term goals, the government framed NDC and National Energy Policy to build the pathway of development of sector. Nuclear will have an important role in reducing carbon emission and achieving sustainable development goals too if the strategies laid down by the government are followed.

In the next chapter we shall deal with the issues and challenges of nuclear sector. The increasing role and contribution of nuclear sector has given birth to various issues. With analysis of issues especially legal and policy related among others we will find the ways to overcome those hurdles.

[90]Ibid

Chapter 4- Legal and Policy Issues Related to Nuclear Energy in India

Every coin has two aspects and so is the case with the nuclear sector. A prima facie look at the nuclear sector shows this sector as one of the most promising solution of problems due to climate change caused due to various factors. Initially nuclear sector was not much focused upon but with passage of time the technology advancement led to development of nuclear sector slowly and gradually. This sector has several benefits like it has low carbon emission etc. which are all discussed in the previous chapters. In this era where climate change has emerged as one of leading problem the international bodies like UN started focusing on concept like sustainable development. On the way to achieve sustainable development having clean, reliable and modern energy is one of the important factor and to fulfill this facet nuclear energy has emerged as an efficient solution. Nuclear sector having low carbon emission also helps in achieving the goal of reduction of carbon emission. But even after having so many advantages there are many disadvantages of this sector. Being a developing sector in most of the nation including India there are many issues and challenges in this sector. These issues and challenges are acting as bottleneck in the proper development of this sector. If these issues and challenges are not removed or at least reduced timely and efficiently then development of this sector will be badly hampered in India. Therefore, a detailed analysis of these issues and challenges is required along with this there is requirement to find the probable solution for these issues and challenges. Now we will look the current issues and challenges of nuclear sector in India.

4.1 Legal Issues

It was the independence in 1947 that the government started to look at the nuclear sector of India and the ways and possibilities of its development in India. In the very next year

India established AEC. The seed of development of nuclear sector in India was sow by Dr. H. J. Bhabha. He formulated three stage nuclear power plan for India in 1954 and in the same year DAE was also set up. The Atomic Energy Act of 1962 was enacted by the government to govern nuclear sector.

4.1.1 Atomic Energy (Amendment) Act 2015

This act formulated in year 1962 with aim and objective of the act is to provide the control, development and use of nuclear energy for the betterment of people of India and for the other peaceful purposes.[91] In the year 2015 the amendment in the act took place. Section 2 and 14 of the act were amended.[92] Through the amendment there has been attempt to give more power to central government. As a result of this amendment there is now possibility of joint ventures between NPCIL and other government companies. Also the license will be granted only to entities such as government company or a department of central government.[93]

4.1.2 The Civil Liability for Nuclear Damage Act, 2010

The act seeks to create a mechanism for compensating victims of nuclear damage arising from a nuclear incident. There are currently 21 nuclear reactors in the country.[94] There are three major international agreements which form the international framework of nuclear liability:

[91]The Atomic Energy (Amendment) Act 2015, No 5, Acts of Parliament, 2015 (India).
[92]Ibid
[93]Ibid
[94]Faizanur Rahman, *Civil Liability for Nuclear Damage Act, 2010: A Critical Review* 2 ENERGY LAW REPORTS 149-154 (2018).

(a) The Paris Convention of 1960,

(b) The Vienna Convention of 1963

(c) The Convention on Supplementary Compensation for Nuclear Damage of 1997.

The issues with the act which hinders the growth of nuclear sector due to which achievement of SDG becomes difficult are discussed as follows:

Limited Liability- Under section 6 of the Nuclear Damage for Civil Liability Act 2010, the total liability for a nuclear damage is limited.[95] No matter what is the extent of damage the total liability has been capped to SDR 300 million. The specified amount may not be enough to provide proper and adequate compensation to the victims in the case of any major accident. In the case of Chernobyl more than six lakh people were affected.[96] Even in India, in the case of chemical leakage in Bhopal more than five lakh people were affected.[97] Though these were not nuclear incident but were of the almost same magnitude. In the case of Bhopal gas tragedy case supreme court held that Union Carbide had to give compensation of 470 million dollars and also requested the government to fulfill any others liability.[98]Many major nuclear energy producing nations have not capped the total liability for any nuclear damage.

The section 7(1) read with the section 6(2) of The Nuclear Damage for Civil Liability Act, 2010 the liability of the operator is much lower than that from several other nations.[99] In

[95]Section 6, The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).
[96]United States Nuclear Regulatory Commission, *Backgrounder on Chernobyl Accident* (last accessed on 20th July 2020)available at www.nrc.gov/reading-rm/doc-collections/fact-sheets/chernobyl-bg-html.com
[97]Bhopal Gas Tragedy Relief and Rehabilitation (last accessed on 20th July 2020)available at www.mp.gov.in/bgtrrdmp/facts.htm.com"
[98]Union Carbide Corporation v. Union of India 4 SCC 584 (1991).
[99]Section 7(1) & section 6(2), The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).

India the liability of the operator has been limited to Rupees 500 crore. This implies that if the liability exceeds the given amount then it will be the liability of the central government to pay the compensation to the victims subject to the limit of SDR 300 million. Many nations who are main constructor of the atomic power are having greater limit set for the liability of operator.

Payment of compensation- In the absence of any method for determination of way of payment of compensation to the people affected by the atomic accident in the case when the amountis in excess of the maximum amount decided by act. Also the act does not talk on the priority of claims for the compensation that has to be made neither does it talk about the in what proportion will the compensation be made. Some of the nations like Belgium and Brazil specify that in such situation it is the right of the government to reduce the compensation to be given to the victims on the proportional basis. [100]

Limited time to claim compensation- Under section 18 of the Nuclear Damage for Civil Liability Act 2010 the maximum time to claim compensation for property is ten years and for personal injury it is twenty years.[101] This time limit may be insufficient in certain cases where the effects of radiation due to accident is seen after a substantial period of time. In some of the rare cases the effect of damage can also be seen in the next generation of those who were exposed to the nuclear radiation. In some of the nations like South Korea, Romania and Netherlands the time limit I of thirty years.[102]

[100]Bill on Third Party in the Field of Nuclear Energy, 1981
[101]Section 18, The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).
[102]Nobert Pelzer, *The Indian Civil Liability for Nuclear Damage Act, 2010- Legislation with Flaws?* 56 INTERNATIONAL JOURNAL FOR NUCLEAR POWER 2-9 (2011).

The liability under other acts not defined- Under section 5(1) read with the section 46 of the Nuclear Damage for Civil Liability Act 2010, it is stated that "compensation to be paid by an operator under this Bill shall not reduce his liability under any other law, and this Bill will not override any other law in force in India that the operator can be held liable under."[103] But the statute has not specifically told about the kinds of laws that will be applicable. Due to this the different interpretations by different courts may limit or unnecessary increase the scope of these provisions. Some of the laws under which the parties involved in generation of nuclear power can be held liable are Environmental (Protection) Act 1986 (fine and imprisonment up to five years), Water Act 1974 and Air Act 1981 (fine and imprisonment up to six years) among others.[104]

No time limit for payment of compensation- Under section 36 of the Nuclear Damage for Civil Liability Act 2010, it is stated that "the operator and the insurer to the extent of his liability must deposit the amount that is to be distributed as compensation within the time period given in the award made by the Claims Commissioner."[105] In the case when the amount is above rupees 500 crores hence the government at central level becomes liable for payment of amount left, there is no provisions which talks about the time limit that can be told by the Commission or the Commissioner to the central government for payment of such amount.

Central government to notify extent of damage- Under section 2(g) of the Nuclear Damage for Civil Liability Act 2010, it is stated that for (a) economic loss arising from loss of life

[103]Section 5(1) & section 46, The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).
[104]Supra note at 57
[105]Section 36, The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).

or personal injury, (b) costs of measuring damaged environment, and (c) loss of income resulting from damage caused to the environment, the extent of damage will be notified by the central government."[106]"The government decides the extent damages suffered by the victims in these specified cases which is also one of the parties under the act to pay the compensation in some cases as discussed above. There may arise conflict of interest when the same party has the power under the act to decide the extent of damaged caused and is also liable to pay the compensation to the victims. Also since the jurisdiction of civil courts is barred in this case there will be no judicial or independent body to assess and decide the damage suffered. Therefore, this feature of the act is in violation of principle of separation of power enshrined under the constitution of India as a core judicial function of determination of fair amount of compensation will be performed by the executives.[107]

Difference with international agreements- Under section 17 of the Nuclear Damage for Civil Liability Act 2010, the operator has the right to take recourse against the supplier.[108] This clause may become an obstacle if India wishes to join the international agreements on civil liability for nuclear damage. One of the main reasons behind the enactment of this law was to join an international nuclear liability agreement as given under the statement of objects and reasons. The three main international agreements on civil liability for nuclear damage gives the right of recourse against persons actually causing damage only if firstly there is a written contract and secondly if the damage resulted from the act or omission of somebody with the intention to cause harm. But the Nuclear Damage for Civil Liability

[106]Section 2(g), The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).
[107]Legislative Briefs (last accessed on 2nd June 2020)available at www.prsindia.org/uploads/media/Nuclear/Final%20Brief%20%civil%20liability%20for%20nuclear%20damage%20bii.pdf.com
[108]Section 17, The Civil Liability for Nuclear Damage Act 2010, No 38, Acts of Parliament, 2010 (India).

Act 2010 of India gives an additional remedy of recourse against any supplier of materials of nuclear sector if the damage is caused due to the willful act or negligence of the party. This additional clause in the Indian act may become obstacle for India to become a party to any of these international agreements.[109]

4.2 Policy Issue

The nuclear sector of India does not have a uniform and dedicated policy. Even though nuclear sector has gained importance in the recent past for the purpose of achieving SDG in India the government has failed to formulate an efficient policy for the working of nuclear sector. Despite the fact that nuclear sector has always been directly in the control of the Indian Prime Minister for reason it being subject matter of national importance, the government of India has either set the target of nuclear sector through five years plan or has inculcated it in the Integrated National Energy Policy (2006). Recently in the NDC of India it has been indicated that government has the intention to revamp the nuclear power capacity tenfold by the year 2030 up to 63 gigawatts. Under current scenario achieving such huge ambition the policy namely the NEP (2018) lays down the methodology for achievement of targets decided nation.[110] The policy basically talks about the technology, economic viability, liability and public confidence. These methods of executing the plans are insufficient to achieve the complete development of nuclear sector as either they lack complete and detailed procedures and methods for achieving these targets or the targets set by these steps are generally over ambitious which lead to failure in completion of these targets in the pre decided set of time.

[109]Ibid
[110]DRAFT NATIONAL ENERGY POLICY (2018)

Nuclear sector is a matter of national importance along with being technology driven and has science in the core of it. Also in the present scenario nuclear sector has emerged as one of the best options to achieve the SDG of India because it has low carbon emission and does not pollute the environment in comparison to non-renewableresources of energy. Due to all these reasons it is required that a proper and detailed policy is framed keeping in view the changed role of nuclear sector in the present scenario with the help of all the stake holders involved and experts on this matter so that there is proper development of nuclear sector and India is able to achieve the goals already set by it.

4.3 Regulatory Issue

For the purpose of safe climate regulation is an important component in a given system. In the case of nuclear sector, the regulation helps to standardize the complex safety methods and also to maintain an oversight to for see any operational defects or discernible design in the Nuclear Power Plant (NPP) and for the same reason it is always recommended to keep the regulatory system independent of the operators and promoters of the nuclear sector as well as to avoid any kind of conflict of interest and to be able to shut down any Nuclear Power Plant (NPP) if they are found to be in breach of any safety standards. As suggested by the International Atomic Energy Agency (IAEA) the basic starting step for better regulation of nuclear sector is the independence of safety regulator from both the government and the industry so that they are able to take decisions independently purely based on the principles of safety and devoid of any political or commercial interference.[111]

[111]World Nuclear Organization, *India's Nuclear Regulation Must Improve* (last accessed on 20th July 2020)available at www.world-nuclear-news.org/RS_Indins_nuclear_regulation_must_improve_2408121.html.com"

In India, it can be said that the regulator has only been at best functionally independent and not institutionally independent. This has led to rise in serious doubts regarding the efficiency of the regulator to be able to enforce complex safety measures and strict penalties in the case of non-compliance of safety recommendations. In India the most important and comprehensive law covering the activities of the nuclear sector is the Atomic Energy Act, 1962 and it is complemented by the other rules and laws on other different and narrower issues. The administration under the Atomic Energy Act, 1962 has been given to Department of Atomic Energy (DAE) while the Atomic Energy Regulatory Board (AERB) is answerable to the Atomic Energy Commission (AEC) whose chairman is also the secretary of Department of Atomic Energy (DAE).[112]

Both the operators of NPP (NPP) in India and the Managing Director of the NPCIL (NPCIL) are the members of Atomic Energy Commission (AEC). Hence it can be understood that the regulatory structure as inherently subordinate as the regulators are answerable to both the operators and the promoters of the nuclear sector in the nation.[113] The former chairman of Atomic Energy Regulatory Board (AERB) Dr. Gopalakrishnan has even gone on record to say that "95% of the members of the AERB's evaluation committees are scientists and engineers on the payrolls of the DAE"[114]

The CAG (CAG) of India has already assessed the activities of the AERB (AERB). The CAG submitted a report in 2012 which concluded that "the legal status of AERB continued

[112]Aniruddh Mohan, *Nuclear Safety and Safety in India: The Way Forward* (last accessed on 10th June 2020)available at www.esearchgate.net/publication/324079229_Nuclear_Safety_and_Regulation_in_India_The_Way_Forward.com
[113]A. Gopalakrishnan, *Issue of Nuclear safety* (last accessed on 20th April 2020)available at www.frontline.in/navigation/?type=static&page=flonnet&rdurl-fl1606/16060820.htm.com"
[114]Ibid

to be that of an authority subordinate to the Central Government, with powers delegated to it by the latter"[115] and "that the Atomic Energy Regulatory Board (AERB) did not have the authority for framing or revising the rules relating to nuclear and radiation safety."[116]

Further the report also highlighted the fact that even though government issued an order in 1983 the Atomic Energy Regulatory Board (AERB) has till date not developed an overarching nuclear and radiation safety policy for India.[117] Numerous non-governmental experts on many occasions have also questioned the ability of Atomic Energy Regulatory Body (AERB) to take strict action against the nuclear operator. The report of CAG of 2012 has stated that the NPCIL and Department of Atomic Energy (DAE) have not complied with the 375 recommendations out of 3200 recommendations made by the Atomic Energy Regulatory Board (AERB).[118] This depicts the poor authoritative control of Atomic Energy Regulatory Board (AERB). It is already known that the regulation plays an important role in all the stages that are important for setting up of nuclear power stations starting from the nuclear plant siting, construction, commissioning and finally operation. After knowing the important and crucial responsibilities of Atomic Energy Regulatory Board (AERB) its non-autonomous structure has given birth to serious doubts regarding its capabilities.[119]

4.4 Other Issues

There are several other issues in the atomic energy sector which hinders the growth of the sector for achieving the SDG. Some of them are discussed below:

[115]CAG, Report No. 9- Performance Audit on Activities of Atomic Energy Regulatory Board (Department of Atomic Energy) (2012).
[116]Ibid
[117]Ibid
[118]Ibid
[119]Supra note at 80

4.4.1 Land Needs

Going with the past practice NPCIL (NPCIL) has intended to construct Nuclear Energy Parks each having the capacity of six reactors of 1.6 gigawatt, eight reactors of new generation of one gigawatt or 10 gigawatts at a single place. There has been planning of five such reactors in Mithi Virdi Gujrat, Kovvada Andhra Pradesh, Haripur West Bengal, Jaitapur Maharashtra and Kudankulam in Tamil Nadu. These could provide around 40-50 gigawatts till 2050. The park in Andhra Pradesh faced certain challenges and protest which led to change in place of Westinghouse AP 1000 to the AP.

As per the code of Atomic Energy Regulatory Board (AERB) an area of radius 1.5 km is to be built around the power plant in which habitation of humans is not permitted and this area is called exclusion zone therefore in India there is requirement of significant areas of land in Nuclear Power Plants (NPP) because of "requirement of extra 1.5 km for the exclusion zone around the plant. This area is the part of project and is included under the land acquired for the project."[120]

There have been significant delays in the development of these parks and in some cases the NPCIL has been forced to search for other locations due to the huge protest and opposition to the plans of the government to acquire land for the development of nuclear energy parks. There is already a lot of debate on the matter of land acquisition and the government is even trying to pass its land acquisition bill in the parliament. The bill talks about the exemptions from going through the steps of attaining consent of eighty percent of land owners where the land is acquired for the private projects and consent of seventy

[120]A.D. Roshan et al., *Monograph in Siting of Nuclear Power Plants* (last accessed on 27th June 2020)available at www.aerb.gov.in/AERBPortal/pages/English/t/sj/Siting.pdf.com"

percent of land owners where the land is to be acquired for the public private partnership projects to the five categories of project. But there is no requirement of consent for the government projects. Originally these changes were introduced in the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.[121] The five categories which are exempted are infrastructure projects, affordable housing, rural infrastructure, defence and industrial corridors. The exemption to these five categories of project was extended under the bill from "(a) the requirement of a social impact assessment (principle introduced in the act of 2013) (b) the limits that apply for acquisition of irrigated multi-cropped land through issuing a notification."[122]"The government should make sure that the amount of land that is being acquired is the minimum amount land required for the project before issuance of these notification. The Nuclear Power Plants (NPP) can be categorized as infrastructure projects and thus can be exempted."[123]

Since there was lack of majority of the government in the upper house of the parliament as well as there was strong campaign by the opposition against the bill which led to the stalling of bill in the Rajya Sabha. The government produced this bill three times lapsed on 31st August 2015. This was considered as victory for the farmers by the opposition party.in 2016 May it was said that the government is planning to get the opposition on the board to pass all the 45 bills pending in the upper house including the land acquisition bill with the

[121]Land Acquisition: An Overview of Proposed Amendments to the Law (last accessed on 29th June 2020)available at www.prsindia.org/theprsblog/?p=3515.com
[122]Ibid
[123]Ibid

addition of numerous advantages for the farmers to address the concerns raised by the opposition.[124]

But however failure government while passing the bill has made land acquisition yet another obstacle for development of nuclear power plants in the nation which may prove detrimental to the plans of India to increase the nuclear capacity significantly and thus restricting the vendors of foreign reactors from construction of any new sites of nuclear reactors.

4.4.2 Fuel Requirement

Due to the limited resources of uranium in India there is closed fuel cycle operation which is made for complete utilization uranium available. This is a main element of the three stage nuclear programme adopted by India in 1958 and also if needed act as plutonium guarantor for the strategic programmes. As per the former chairman of Atomic Energy Commission (AEC) Mr. Anil Kakodkar "India considers a closed nuclear fuel cycle of crucial importance for implementation of its three-stage nuclear power programme"[125] as the stage three has objective of longer time to tap the huge energy present in source of thorium of India. Mr. Anil has confirmed "this is central to India's vision of energy security and the government is committed to its full realization through the development and deployment of technologies pertaining to all aspects of a closed nuclear fuel cycle."[126] For the optimum utilization of

[124]Hebbar Nistula, *Land Ordinance Gets a Burial* (last accessed on 30th June 2020)available at www.thehindu.com/news/national/land-acquisition-ordinance-bill-gets-a-burial/article.7597517.ece.com"
[125]Anil Kakodka, *Closed Nuclear Fuel Cycle Central to India's Vision of Energy Security* (last accessed on 22nd June 2020) available at www.thehindu.com/todays-paper/closed-nuclear-fuel-cycle-central-to-indias-vision-of-energy-security-anil-kakodkar/article3078568.ece.com"
[126] Ibid

resources this strategy of recycling and reprocessing of plutonium and uranium might work because India has high reserves of thorium and low level of reserves of uranium.

Dr. Singh, minister of state under the Prime Minister office recently told the Lok Sabha that the Atomic Minerals Directorate for Exploration and Research (AMD), a constituent unit of Department of Atomic Energy (DAE), has established sizeable in-situ resources of uranium and thorium in the country. Till October, 2014, AMD has established 214,158 tonnes in-situ U3O8 (181,606 tonnes Uranium) resources and 11.93 million tonnes of in-situ resources of monazite resources, which contains about 1.07 million tonnes of Thorium dioxide (ThO2).[127]

Recently there was boost in the reserves of uranium in India due to the new found of Tummalapalle miens of uranium in AP and it contains capacity to become one of the biggest mines of entire world. while the Indian government also has several "uranium supply agreements" with the nations like Russia, France etc. for importing the most of its uranium needs.

The thorium reserves of India are so huge that it has the potential to provide the power to thorium reactors for around a century. Due to this fact only India has formed its plan for the third stage of deploying thorium reactors on a large scale. But as already discussed the technology of thorium is a longer time aim and not the instant resort for nation. The

[127]DAE, *Lok Sabha Starred Questions- Commercial Use of Radioactive Elements* (last accessed on 26th June 2020)available at www.dae.nic.in/writereaddata/Issq341.pdf.com

question of security and safety also arises. Till now no nation has been able to demonstrate a commercial as well as viable programme for thorium reactor.

The uranium resource required for future reactors as well as the operational reactors India has plans to continue importing the uranium. The recent agreement of India with Australia is under the process of ratification by the parliament. Also any reactor that is supplies by the foreign vendors comes with a sure supply of fuel. Therefore, fuel will not be an obstacle in the projected reactors of India by 2050.[128]

4.4.3 Requirement of Enrichment and Reprocessing Capacity

The fuel spend is an important resource rather than being waste for disposal in India. For the separation of uranium and plutonium for reuse in the closed fuel cycle there is requirement of reprocessing the fuel spend. In 1964 the first reprocessing plant of India was established in Trombay. Presently there are three operating reprocessing plants in India based upon the technology of Plutonium Uranium Redox Extraction (PUREX) at Kalpakkam, Tarapur and Trombay. The plants of Kalpakkam and Tarapur process oxide fuels from PWHR and the Trombay plant reprocesses the spent fuel from the reseach reactors.[129] Atomic Energy Regulatory Board (AERB) operates all these reprocessing plants.

The development of Integrated Nuclear Recycle Plant has also begun in India which can give three- fold growth in the capacity of reprocessing by the year 2020. This plant is planned to be developed at Tarapur and its design will be such that it will be able to separate

[128]Ibid
[129]BARC, Reprocessing- Indian Programme on Reprocessing (last accessed on 28th June 2020)available at www.barc.gov.in/publications/eb/golden/nfc/toc/Chapter%206/6.pdf.com"

the nuclear waste in two different components, one where 99% of the radioactivity will be dissipated in the three hundred years and another where the waste will remain radioactive for a much longer time.[130]

The nuclear establishments in India repeats its strategy to grow its capacity of reprocessing for matching the expansion of civil nuclear programme for which it may not face any major obstacle. Further the new plant which is under the construction at Kalpakkam especially to reprocess the Fast Breeder Reactor Oxide Fuel to make sure that there is no mismatch between the fuel available and the reactor."[131]"Since India has more than forty years of experience in the reprocessing technology of fuel spent and it has successfully operated closed fuel cycle for recovering plutonium and uranium for reuse in the nuclear reactor thus the reprocessing of fuel may not become a major obstacle in achieving the set target.[132]

For the issue of enrichment capability presently the PHWR of India are unenriched uranium. But there are certain directions towards the change in the future with the increase in availability of Slightly Enriched Uranium (SEU) from the international market while successful testing of SEU in one of the Indian PHWR. One of the advantages of SEU over the natural uranium is the high burn up inside the reactor leads to increase in the amount of power generated for the same amount of the uranium. In the current PHWR of India the burn up achieved by the natural uranium is around 6700-7000 megawatts-days per ton of uranium oxide while in SEU PHWR the burn up achieved is about three times of

[130]Sekhar Basu, *Our Policy is to Reprocess All the Fuel Put into a Nuclear Reactor* (last accessed on 2nd July 2020)available at www.thehindu.com/opinion/interview/our-policy-is-to-reprocess-all-the-fuel-put-into-a-nuclear-reactor/artcle/4041223.ece.com
[131]DAE, Lok Sabha Starred Question- Reprocessing Capacity (last accessed on 5th July 2020)available at www.dae.nic.in/writereaddata/ISSQ315_240811.pdf.com
[132]Ibid

that."[133]"After the subsequent approval the SEU fuel bundle are being produced from 2018 onwards. The reactors from foreign like Russian VVER uses LEU fuel supplied by the vendor. Any agreement related to the building of foreign reactor in India will mostly be inclusive of commitment of the vendor to supply the fuel for the majority if not the complete lifetime of the reactor.[134]

India has developed the plans for increasing the capacity for enrichment along with the reprocessing facilities.[135] Thus enrichment capacity may not become an obstacle for India in rapid expansion of the atomic power programme for civil purpose till 2050.

4.4.4 Requirement of Manufacturing

Nuclear power plants are simultaneously critical on their requirement of heavy engineering components and forgings while also requiring delicate and precision-engineered equipment for purposes of measurement and safety. The most engineering heavy requirement of nuclear reactors is the reactor pressure vessel.[136]

The 20th century first generation and second generation nuclear reactor are mostly through integrated supply chains in the nation with less or no input for supplies from outside. But with the third generation Nuclear Power Plants (NPP) it is not the case. There is a complete range of international suppliers are contributing to the supply chain of materials. For example for the large third generation reactors which is

[133]R. Ramachandran, *Use of Enriched Uranium in PHWRs Proposed* (last accessed on 3rd July 2020)available at www.thehindu.com/news/national/use-of-enriched-uranium-in-phwrs-proposed/article2924900.ece.com
[134]Ibid
[135]Joao Peixe, *India's Atomic Fuel Reprocessing Capacity to be Upgraded* (last accessed on 3rd July 2020)available at www.oilprice.com/Latest-Energy-News/World-News/Indians-Atomic-Fuel-Reprocessing-Capacity-To-Be-Upgraded.html.com
[136]World Nuclear Association, *Heavy Manufacturing of Power Plants* (last accessed on 12th July 2020)available at www.world-nuclear.org/information-library/nuclea-fuel-cycle/nuclear-power-reactors/heavy-manufacturing-of-power-plants.aspx.com

greater than one gigawatt, there is requirement of forging press round the 14,000-15,000tes for the production of reactor pressure vessel, this capacity is presently in nations like China, France, Russia and Japan.[137] The Westinghouse sources of reactor vessel for the AP 1000S from the Japan Steel Works (JSW) and in the absence of any civil nuclear agreement with Japan will hinder the development of AP 1000s in India. All the nations which have good nuclear power programmes have been able to achieve them with the help of domestic manufacturing base which covers most of the supply chain of things which are required for construction of Nuclear Power Plants (NPP). The upliftment of nuclear sector is dependent upon the reliability of supply chain of components and the cost and capacity.[138]

If India shifts the nuclear policy towards the foreign reactors having more than one gigawatt capacity, then India will have to rely on the external suppliers for a great extent due to the lack of present infrastructure for large production of type expected for 14,000-15,000 tones forging pressure required for building the reactor pressure vessel. The manufacturing of nuclear plant material is dominated by four companies in India namely Godrej Group, Bharat Heavy Electronics Ltd. (BHEL), Walchandnagar and Larson &Turbo Limited. Out of four of these companies L&T is running largest integrated steel making and foreign facility at Hazira as a joint venture with the NPCIL which is known as L&T Special Steel and Heavy Forgings (LTSSHF)."[139]"Also Larson and Turbo has collaborations along the JSW for usage of the ingots till 200 MT but it is falling short of the maximum 650 mega tonnes that is used by JSW's ability of the Japan. But the

[137]Ibid
[138]Ibid
[139]Larson and Turbo Limited, L&T Special Steels and Heavy Forgings (last accessed on 1st July 2020)available at www.Itshf.com/our-facilities/india/hazira/.com

"L&TSpecial Steel Heavy Forgings will help India to have the capacity of domestic production for complex and heavy forging for NPCIL proposed 700 megawatt PHWRs.[140]

Currently the nuclear plant at Hazira has the facility of 900 mega tonnes of forging press and has the plan to expand till 17,000 mega tonnes in the coming time. This future plan will India in the domestic manufacturing of the AP 1000 reactor vessel.

Thus the present manufacturing capacity of India covers only the supply chain for 700 megawatt PHWR with the foreign reactors which means there will be requirement of more foreign supplier agreements. Engagement with the foreign suppliers implies that India will have to deal with the issues like booking queues, capacity and uncertainty. "Like for the coming five years the suppliers for large single piece integral pressure vessel are booked."[141] Therefore, supply chain and manufacturing constraint shall have a crucial part in deciding nuclear future of India and shall depend upon the policy adopted for the foreign as well as domestic reactors.

4.4.5 Manpower Requirement

One of the important factor to develop the nuclear sector is the availability of human resources. In India there is shortage of both nuclear engineers and scientists. "According to the projection exercise of 2006 done by the Department of Atomic Energy (DAE) it was

[140]Newsvoir, *L&T Forgings for India's PHWR Nuclear Programme*, FINANCIAL EXPRESS, October 03, 2015
www.financialexpress.com/companies/lt-forgings-for -indias-phwr-nuclear-programme/144462/.com
[141]Anil Sasi, Westinghouse AP1000 Reactors: Patchy Records, Cost Concerns Loom Large, INDIAN EXPRESS, June 22, 2016 www.indianexpress.com/article/business-others/westinghouse-ap1000-reactors-patchy-record-cost-concerns-loom-large-2867947/.com

calculated that there is requirement of increase in the manpower for growth of the nuclear programme in the coming time and to replace the retiring personnel. There will be requirement of recruiting and training around 650 engineers every year in industrial units and public sector and around 700 scientists every year in research and development."[142] As per the report of PAC of the legislature over Atomic Energy Regulatory Board (AERB) it has been noted that the regulatory body of the nuclear sector also faces the shortage.[143]

The educational initiatives under the nuclear sector for new technologies have to face the challenge of high requirements of the technical knowledge and concerns regarding the secrecy, security and safety. Through the establishment of Global Center for Nuclear Energy Partnership (GCNEP) India has taken an important step for the training in nuclear technology. Even though the center is still under construction it has started the off campus training workshops and programmes. This center will have five schools for conducting research namely School for Studies on Applications of Radioisotopes and Radiation Technology, School of Nuclear Material Characterization Studies, School on Radiological Safety, School of Nuclear Security Studies and School of Advanced Nuclear Energy System Studies.[144] Also the center will give training to the national as well as the international participants, it will conduct the courses in partnership with IAEA and other interested nations, it will host international seminars and will allow to undertake the research project to both the national and international scientist.

[142]R.B. Grover & R.R Puri, *Development of Human Resources for Indian Nuclear Power Programme* 38 SADHANA 1052-1064 (2013).
[143]Public Accounts Committee, Activities of AERB (last accessed on 3rd July 2020)available at www.164.100.47.134/Isscommittee/Public%20Accounts/15_Public_Accounts_90.pdf.com
[144]Ibid

The capacity building and initial training for the nuclear programme is given by the DAE (DAE), these five universities will provide courses in post-graduation in the field of nuclear engineering to go along with the H.J Bhabha National Institute which established in 2004 by the Department of Atomic Energy (DAE). Since there is increase in the demand of manpower in the coming times, it can only be fulfilled only if the Department of Atomic Energy (DAE) supports and encourages the institutes offering nuclear education. Since there is lack of teaching faculty the International Atomic Energy Agency (IAEA) has also started a web based nuclear engineering programmes which are specifically relevant in India. International Atomic Energy Agency (IAEA) has also established Asian Network for Education in Nuclear Technology. Department of Atomic Energy (DAE) should give leverages to such initiatives and networks for better capacity building in the nuclear science.[145]

4.4.6 Public Perception

Despite the fact that nuclear sector has better performance than others in the field of economy and environment, the contribution of nuclear sector in the Sustainable Development Goals (SDG) shall be decided by the public and political support. Since the general public is mainly unaware about the complex technologies of the nuclear sector as there is very less direct interaction it creates the situation of wherein the advantages of nuclear sector are not clear and the risk are exaggerated. "For increasing and maintaining the public support the decision makers must understand the factors affecting perception of

[145]Ibid

risk, providing tailored information and make sure that participative and transparent process lead to consistent and fair decision making."[146]

4.4.7 Safety Concerns

The major public concerns regarding the nuclear power sector are generally related to the issues of security, proliferation and safety. Despite the fact that there has been historic trend to increase the safety in the nuclear sector the Fukushima Daiichi incident of 2011 March encouraged more efforts. These efforts include regional, national and international short term and long term actions including the International Atomic Energy Agency (IAEA) Action Plan on Nuclear Safety (2011) mitigating and evaluating the safety issues of Nuclear Power Plants (NPP) to external harms. The nuclear power sector should not only b safe but also be used specifically for the peaceful purposes which are supported by safeguards measures to build the confidence and encourage the technical co-operations. Overall the coming up of safe designs of reactors with passive safety measures, resource management with closed fuel cycle, improved methods of waste reduction and technology which does not divert the materials to development of weapons can be mainly used to solve the rising issues of safety.[147]

4.4.8 Financial Concerns

To ensure that the reach to the energiesin as usual BAU circumstances where there's dominance of fossil fuels in the energy mix of the country India will require around INR 28 lacs crores for encouraging the production capacity alone while not including the other

[146]NUCLEAR POWER FOR SUSTAINABLE DEVELOPMENT (2017) available at www.iaea.org/sites/default/files/np-sustainable-development.pdf.com
[147]Ibid

related costs. India has two options to choose from. Firstly, if India increases the share of renewable energy sources moderately by reducing the conventional sources from 60% to 50% the financial requirement of the India will increase to INR 34 lacs crores. Secondly if India choose energy mix with net-zero emission by 2050 then it must reduce conventional component further from 50% to 27% by 2030 which will have financial requirement of INR 42.5 lac crores. For achieving the goal 7 of the SDG to address energy security India will have to mitigate the carbon emission along with the increasing its targets considerably for renewable energy. Till the end of financial year of 2014-15 the total renewable energy capacity installed in India was 35.77 GW and the government of India has the plan of increasing this capacity to 175 GW till the end of 2022. The price for assisting 20GW utility scale of sun energy till year 2022 in current values under the existing policies is INR 46.97 billion. There is estimation of requirement of INR 54 lakh crore from 2015-30 for installing the infrastructure for transmission and distribution, providing access to the clean cooking fuel and increasing the generating capacity with the huge share of non-conventional energy. There is estimation of short fall of INR 26 lacs crore.

The various other issues and challenges of the nuclear sector in India are as follows:

- No proper strategies to regulate the wide variety of radiation and nuclear facilities with huge dispersal
- To meet the expectations of the present day with respect to the radiation and nuclear safety and security
- Concern regarding the security and safety of huge number of radioactive sources which is spread over such a vast nation and about the related import and export guidance.

- Proper methods to ensure the safety of old plants through periodic review and by providing the ageing management programme and sufficient safety upgradation.
- Difficulties in adopting the regulations and the regulatory system according to the new and foreign designs of nuclear technology and applications.
- Development of competence in the various kinds of technologies and different designs of the reactors.
- Development of sufficient human resource which is ready for safety supervision of this large radiation and nuclear programme.
- Methods to approach the regulatory research related to the new technologies.

Other than already discussed problems of the nuclear sector of India there may arise the regulatory challenge from the policies for making the entire energy sector competitive. With the ever growing competition in the sector it has become very essential to promote the commercial interest along with the safety requirements. It is for the Atomic Energy Regulatory Board (AERB) the challenge to make sure that any amount of economic pressure does not affect the safety provisions of the nuclear sector. the board will also require to adopt a market oriented environment along with working on the new relations with the utilities keeping the best standard of safe environment. Even though these are tough job for board, it will be able to face these current challenges because it has evolved over a period of time systematically and there exist a proper and effective body now.

4.5 Suggestions

India should focus on following aspects to overcome the challenges of nuclear for better achievement of Sustainable Development Goals (SDG):

- Uniform policy- India should try to envisage a uniform and detailed policy specifically for the nuclear sector. a detailed policy on the manner and method to achieve the targets set by the government should be formulated. The policy should be made keeping in mind the changed role of nuclear sector to achieve SDG.
- Reduce the loopholes in current laws- The current legislations have many loopholes due to which there is no proper and smooth development of nuclear sector. The government must amend the laws and remove the lacunas so that it can help in achieving SDG.
- Laws to be at par with international norms- the current laws on nuclear damage is not at par with the international conventions on the basis of which the law has been framed. Already being out of NPT had made Indian nuclear sector isolated though now situation has changed on that part but inconsistency with international agreements will stop India from becoming member which will affect the development of the sector. India will not be able to share technology with other countries. Therefore, such inconsistency should be removed.
- Independent regulatory body- An independent regulatory body id the need of the hour for the development of the nuclear sector. The regulatory body governing the nuclear sector in India is not independent due to which nuclear sector cannot develop properly.
- Value non-market benefits- we should focus on the establishing a level playing field for nuclear sector with others options with low carbon sources of energy to recognize its energy security and environmental benefits and should remunerate it

accordingly for smooth and efficient development of the nuclear sector. this will also aid in overall achievement of SDG.

- Keeping the options open- as long as safely possible the existing nuclear power plants should be authorized for the lifetime extension. This will help in resolving or at least reducing the issues till some extent.
- Creation of favorable financing framework- India should focus on creating financing and risk management framework for the better mobilization of funds for the existing and new power plants at an acceptable cost while taking into considerations the long time horizons and risk profile of nuclear project.
- Value dispatch ability- India must design its electricity market in such a manner that it properly values the services of the system needed for maintenance of electricity security including the frequency control services and capacity availability. It should also ensure that the service providers including that of nuclear power plants can be compensated in a competitive as well as non-discriminatory manner.
- Updating the safety regulations- at the places where it is necessary India should update its safety regulation so as to ensure that the safe operation of the nuclear power plants is continued. Also if technically possible the safety regulation must include allowance of flexible operation of the nuclear power plants so that it can also provide associated services.
- Supporting the new construction- India should create its licensing regime in such a way that it does not lead to the delay in the projects and any increase in the cost which is unjustified by the safety measures.

- Encourage innovative and new reactor designs- India should focus on encouraging the innovation in the designs of new reactor that has shorter lead time, less capital cost and technologies that can help in improving the flexibility in operating the atomic power plants for more facilitation in integration of expanding solar and wind capacities in the electricity system.
- Maintenance of human capital- India should develop and protect the human capital as well as project management capabilities in the nuclear engineering.

There are issues and challenges with both the foreign and domestic reactors means that we must adopt two level plan. Firstly, we must encourage the small indigenous reactors and provide domestic finances and resources for the same. It will make sure that India will become a major player of nuclear sector technology at international level and this in turn will give encourage to scale up the civil nuclear capacity. If India is successful at executing this plan, then it will help India to build PWHR in the other nations which will help in earning valuable capital which will help in further expansion of fleet of PHWR at home. Secondly, since the time political commitment and will is strong, the government of India in the recent times has spent most of its diplomatic ammunition in attempt to secure the membership of NSG which was ultimately an unsuccessful attempt, it is very important for India to understand that it does not require NSG membership for importing nuclear technology that has already been cleared by the way of exemption given to India in 2008.[148]These diplomatic and political influence can be spent in a better way in securing the bilateral civil nuclear deal with the Japan which is one of the obstacle that must be crossed to construct the EPR and AP 1000s. With the creation of mature domestic market

[148]Observer Research Foundation, *India Can Do Without NSG Membership* (last accessed on 19th July 2020) available at www.orfonline.org/research/india-can-do-without-nsg-membership-syas-expert/.com

for nuclear sector with installation of both the foreign and indigenous reactors and making its laws at par with international agreements India can become an important player of nuclear energy at international level.[149] It will be able to get the membership of various exclusive clubs, with the help of both technological and economical weightages backed by the geopolitical moves and not the other way around. India must work on maintaining harmony between development of domestic laws, politics and technologies along with the foreign overtures to develop the nuclear sector of India so that it can achieve the SDG.

[149]Ibid

Chapter 4- Conclusion

Ever since the human civilization started the need of energy has been felt. Energy is the basic building block of human life. It is used in different forms and in various circumstances. Traditionally the major sources of energy were conventional sources of energy like coal, oil and gas. But with time it was realized that these resources are limited and takeover million years to form and therefore once they deplete it will be very difficult for humans to survive. Also extreme usage of these sources started having negative impact on human health and environment. These all factors forced humans to look for better and reliable sources of energy. This shifted the focus of humankind towards the non-conventional energy resources for example hydro power, solar, wind and bio fuel. Amidst all these process another option also emerged in the form of nuclear energy. The technological advancement nuclear energy became a viable source of energy. Since nuclear sector is technology driven it benefitted nations which were developed enough to build such technology. Therefore, in developing nations including India it came in focus only after India gained its independence in 1947.

Nuclear sector in India has come a long way. Something that started even before independence continued even after achieving independence. After getting independence India established Atomic Energy Commission in the very next year. This commission was responsible to look after the policies for nuclear sector. In the year 1954 another two major events happened first was setting up of Department of Atomic Energy and another second was three stage plan for nuclear power by Dr. H J Bhabha which was approved by the government in 1958. India despite facing numerous issues due to the fact that it was newly independent nation after almost 200 years of colonization, focused on its nuclear sector.

The major step taken by India in 1974 by testing nuclear weapon gave a setback to India in the form of international sanctions. India did not become part of Non-proliferation Treaty (NPT) as it found it to be discriminatory. It is an international treaty with the aim for promotion of use of atomic energy for peaceful purpose and for prevention of spread of nuclear weapons. The members to this treaty could share with each other the nuclear technology but since India was not a part of this it became isolated and was completely self-dependent due to which India could not achieve great nuclear advancement which it could otherwise had gained. The other reasons for slow growth of nuclear sector in 20th century was unviability of funds because India was still a developing country and was considerably poverty stricken. Another reason was presence of limited quantity and quality uranium ore in India. According to the report of International Atomic Energy Agency (IAEA) India has only 1,58,000- 1,29,012 tons of uranium as reasonably assured resources and 29,270 tons of uranium as inferred resources.[150] These all factors were responsible in the slow development of atomic energy for almost fifty years in India..

With the passage of time the scenario changed. India started becoming an active member at the international level on various platforms and forums. India became member of important international bodies like United Nations, World Health Organization etc. India started participating in various conferences especially related to environmental concerns. The rapid development of science and technology gave birth to various environmental issues which became grave day by day. This led to shift of focus of international community toward the changing climatic conditions. Emission of greenhouse gases led to

[150]Joint Report of OECD, NEA and IAEA *"Uranium 2014: Resources, Production and Demand"*(last visited on 22nd July 2020) available at www. oecd-nea.org/ndd/pubd/2014/7209-uranium-2014.pdf.com

increase in global warming, ozone layer depletion, melting glaciers and several other fatal issues which came to be known as threat to human kind in the coming future. Being concerned by the increasing environmental issues the international community decided to work together in harmony to tackle these issues. In 1972 the United Nations Environment Protection (UNEP)was established with the aim to help the developing countries to create policies and to co-ordinate the environmental activities around the entire world. The first and major step towards this was Stockholm Conference of 1972. In this conference report of Brundtland Commission known as "Our Common Future" was released which gave the concept of sustainable development. This conference had a deep impact on Indian laws. It led to amendment in Indian constitution and enactment of several environmental specific laws like water Act of 1974 and air act of 1981, The Environment (Protection) Act 1986 etc. for better regulation, management and protection of the environment in India. India also became the member of United Nations Framework Convention on Climate Change (UNFCCC) on 10th June 1992 and ratified it on 1st November 1993. India also became the part of Kyoto Protocol which is an agreement under UNFCCC on 26th August 2002. It commits the parties by three flexible mechanisms (Clean Development Mechanism, Joint Implementation and The International Emission Trading) to set the emission reduction targets which will be internationally binding. Another major agreement is the Paris Agreement of 2015. It was implemented in India by formulating NEP 2006 and NAPCC 2008. Through these steps India has committed to environmental change and has set the target for the same. In the year 2015 another major event happened when all the countries which were member of United Nations at that time adopted SDG which are also known as global goals. These are 17 integrated goals to protect the planet, end the poverty and to

ensure peace and prosperity to all the people by year 2030. India being member of United Nations has also adopted these Sustainable Development Goals and has started working towards achieving these through various methods and process. Nuclear sector emerged as one of the most important method for achieving these SDG.

The promising nuclear sector came with its own sets of issues and challenges. There are several issues like legal issue which involve the Atomic Energy Act which has become obsolete with the time. With the ever growing technology and development of the atomic sector, the provisions under the act are not sufficient to meet the issues arising. Also The Civil Liability of Nuclear Damage Act, 2010 also has many loopholes. India also lacks a uniform and comprehensive policy for growth of nuclear sector. Even though the National Energy Policy talks about the targets of nuclear sector it fails to address the detail methodology and process to implement and achieve those targets in the given time. Nuclear sector is a vast sector which is highly scientific and technological advancement driven and hence involves numerous technicalities and requires an extremely well-crafted policy to achieve the Sustainable Development Goals in the given set of time. There are many other challenges of the nuclear sector like financial issues. Since it demands continuous research and development and import of technology it requires huge investment which is difficult for a developing nation like India. It also has the issue of waste management. It generates quiet an amount of radioactive waste which if not dealt properly can become fatal for the people of India. Other challenges include requirement a huge pieces of land for setting up of plant, fuel requirement, manufacturing needs. Nuclear sector is also affected by the perception of public regarding the safety. India needs to resolve these issues and overcome

these challenges as soon as possible for the better growth of nuclear sector so that it is successful in achieving the Sustainable Development Goals.

India must look forward to solve the issues and find new ways to develop the nuclear sector. It should focus on formation of uniform policy for the nuclear sector with regards to the changing role of atomic sector in achieving the SDG. The focus should be on the removal of loopholes and challenges of the Civil Liability for Nuclear Damage Act 2010 so that the obstacles in development of nuclear sector can be removed. It should work on the other issues and create a smooth road for better development of nuclear sector so that it can help in achieving the SDG.

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