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An Analysis on Civil Nuclear Energy in India: Effectiveness and Way Forward

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Abstract

We cannot depend indefinitely on combustion of coal, gas and oil for most of our energy needs. Nuclear power is clean, safe, reliable, compact, competitive and practically inexhaustible. Today over 400 nuclear reactors provide base-load electric power in 30 countries. Fifty years old, it is a relatively mature technology with the assurance of great improvement in the next generation. Nuclear energy produces almost no carbon dioxide, sulphur dioxide or nitrogen oxides whatsoever. These gases are produced in vast quantities when fossil fuels are burned. One gram of uranium yields about as much energy as a ton of coal or oil - it is the famous "factor of a million". Nuclear waste is comparatively about a million times smaller than the waste generated by fossil fuels, and it is totally confined. Keeping in mind the benefits nuclear energy offers and considering it as an important alternative, the development of nuclear energy in India has been quite rapid. The regulatory and legislative framework are comprehensive, however, the fact that radioactivity comes with its own consequences cannot be ignored.

Keywords – Nuclear Power, Uranium, Nuclear reactors, Thorium, Radiation etc.

1. Introduction

The use of nuclear power in India is well recognized for civil purposes. India had started its nuclear power production with the help of two small boiling water reactors at Tarapur in the year 1960. So as to develop Nuclear power in India in consistency with our inimitable resource position of restricted uranium but great

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thorium reserves, India is following a three-stage programme. For the optimal use of these existing uranium resources, the first stage of this programme depends on the use of pressurized heavy water reactors (PHWRs), whose design was adopted in the year 1964, which use natural uranium very efficiently, producing plutonium as a by-product from spent fuel which further facilitates the use of our large thorium reserves for power generation in subsequent stages of the programme.[3] Moreover, this process involved the use of pressure tubes, instead of a heavy pressure vessel, which could be conveniently built with the country's available engineering capacity at that time.[4] These power reactors were considered to have the world's lowest capacity factors till the mid-1990s, which reflected the technical constraints that were being faced by the country because of its technological isolations. Nonetheless, energy generation rose impressively from 60% in 1995 to 85% during 2001-02, which in turn experienced a massive dropout again in during 2008-10, primarily due to the shortage of uranium fuel.[5]

There are currently twenty one operational nuclear power reactors/units in India [Tarapur (Maharashtra), Rajasthan, Madras (Tamil Nadu), Kaiga (Karnataka), Kudankulam (Tamil Nadu), Narora (Uttar Pradesh) and Kakrapar (Gujarat)] with a total capacity of 6780MWe across these six states,[6] which forms approximately 2.9 % of the nation's total energy generated. Other than these some are under construction[7] at Madras (Tamil Nadu), Kakrapar (Gujarat), Kudankulam (Tamil Nadu) and Fatehabad (Haryana). Approximately ten more are planned[8] for which the land has been suitably acquired. A three-stage nuclear energy programme has been envisioned by the GOI, whereby it seeks to fetch at least twenty five percent of its total energy from this energy source by the year 2050. The GOI had also envisioned an installed capacity of 20,000 MW of nuclear energy by the year

[3] Sanat Kumar, Executive Director (Projects), NPCIL; available at: https://dae.nic.in/?q=node/171 (Visited on February 01, 2023)

[4] *Nuclear Power in India*, WORLD NUCLEAR ASSOCIATION (Dec. 23, 2022, 10:40 AM), http://www.world-nuclear.org/informationlibrary/countryprofiles/countries-g-n/india.aspx.

[5] *Technological Advances in harnessing Nuclear Energy*; SCIENTIFIC INDIA (Feb. 02, 2023, 1:04 PM), http://www.scind.org/976/Technology/advances-in-harnessing-nuclear-energy.html

[6] NUCLEAR POWER CORPORATION OF INDIA LIMITED (Feb. 02, 2023, 02:30 PM) http://www.npcil.nic.in/main/AllProjectOperationDisplay.aspx.

[7] Having an Approximate capacity of 4300 MW; Ibid.

[8] Having an Approximate capacity of 33564 MW; Ibid.

2020, which has though been revised to 10,000 MW by the visible realities. In spite, it is estimated to touch the mark of 63,000 MW by the year 2032.[9]

II. Nuclear Energy – Social Justice and Right to Life

India is a nation that can neither be categorized as a developing nation nor as a fully developed nation. It is a nation that has always strived to walk in pace with all the progressing nations of the world by giving its utmost support towards the creation of a better future for the generations to come. India as far its legal setup is concerned is one of the most advanced nations having adopted a written, binding but not rigid Constitution for itself. Whereby, it seeks to provide its entire people their necessary rights and freedoms, ranging from the concept of equality to justice-social, economic and political.

Social justice can be understood as a concept that strives to provide every man his due, to be able to create a society in which its people are free from all types of disparity in their economic, political or social life. In short, social justice endeavours for the creation of a just society. Article 25(1) of the Universal Declaration of Human Rights also highlights the concept of social justice. It recognizes everyone‘s right to adequate living standards, coupled with adequacy of health and well-being of himself and his family. This it states must include the right to food, clothing, shelter, medical care and any other service, necessary for social wellness. Similarly, Article 11(1) of the International Covenant on Economic, Social and Cultural Rights, 1966 obligates the State parties to recognize everyone‘s right to adequate living standards, inclusive of food, clothing, and shelter along with the aim to continuously improve living conditions. As far as the national law is concerned, the Preamble to the Indian Constitution guarantees social and economic justice with equity of status and of opportunity to every citizen, so as to achieve individual and collective dignity with enhanced fraternity. Article 21 provides right to life, where life is not bare animal existence, but a life worth being lived. Taking note of the increasing need for electricity, especially considering our increasing dependence on the use of more and more electricity run equipment, it seems as if electricity should be observed as a vital part of the right to life. On the same time, Article 39(b)

[9] *India‘a Nuclear Ambition*, GREENPEACE (Jan. 23, 2023, 1:25 PM), http://www.greenpeace.org/india/en/What-WeDo/Nuclear-Unsafe/Nuclear-Power-in-India.

provides for equitable distribution of nation's material resources, maintaining that their ownership and control must be so distributed, so as to promote maximum public welfare. This welfare must be achieved by securing social and economic justice to all the sections of the society by reducing inequalities in employment opportunities and by endeavouring to eliminate status inequality.

In D. S. Nakara v. Union of India[10], the SC has held that the key role of a socialist state is to eliminate inequalities in the life standards of the people, by eliminating inequalities in income, and in status. The directive principles of state policy (hereinafter referred as DPSP) lay down policy guidelines to be followed by the state for raising the living standards of the people. For this, the state is duty bound to provide its citizens such basic amenities of life which play an important role in shaping their future in a welfare state. The early notion of social justice referred to the extension of the three basic amenities of life to all, i.e. food, clothing and shelter. But, the feeling of social justice, being a relative concept,[11] changeable by time, circumstances, culture and ambitions of the people, there crept in a fourth necessity, called energy or to be more precise, electricity. With the dawn of globalization and modernization, there have been new advances in technology every day. Electrification has changed the overall lifestyle of man, suggesting it to have become an inevitable need of the time. Therefore the most significant milestone that the nation must achieve is 100% households having 24x7 quality supply of electricity for setting up a just social order.

To achieve this objective, it is necessary for the governments to make all efforts to increase the production of electricity, so that there is no single village or house which is left in the dark. Since, India has got abundant reserves of natural thorium, so nuclear technology may be one of the convenient technologies that could be adhered to. Using this technology, more efforts can be made for exploiting Uranium for electricity generation. It is presumed that the resultant electricity would be more cost effective which could thus be made available to the masses at cheaper rates.

But, the aim of the system is not only the production of electricity, but its production in a safe and sustainable manner. The concept of sustainable

[10] DS Nakara v Union of India, (1983)1 SCC 305 (India).
[11] V.R. KRISHNA IYER, SOCIAL JUSTICE - SUNSET OR DAWN 53 (Eastern Book Company, 1987)

development endeavours to strike a balance between human progress and its impacts on the physical environment, considering the drastic climatic changes and the needs of the future generation. In short sustainable development can be understood as, development with care and caution; keeping scope for prevention and cure. Wherefore, it is necessary that production of electricity through nuclear science should be watched from an eagle's eye while concerning its safe use. All necessary precautions and measures should be adhered to for maintaining the safety and security of nuclear material and for the prevention of nuclear proliferation. Considering this, the Indian legislature has enacted various laws that deal with the use of atomic energy for peaceful purposes, and have also considered the various international provisions while framing these laws. Further, there are many bodies and boards that are primarily engaged in the task of augmenting peaceful uses of nuclear energy.

III. Nuclear Energy as the Clean Energy

Nuclear energy is the clean, safe, reliable and competitive energy source. It is only source of energy that can replace the significant part of fossil fuels which massively pollute atmosphere and contribute to greenhouse effect. If we want to be serious about climate change and end of oil, we must promote more efficient use of energy, we must use renewable energies – wind and solar – wherever possible, and adopt the more sustainable life style. But this will not be nearly enough to slow accumulation of atmospheric CO2, and satisfy needs of our industrial civilization and aspirations of developing nations. Nuclear power should be deployed rapidly to replace coal, oil and gas in industrial countries, and eventually in developing countries.[12] The intelligent combination of energy conservation, and renewable energies for local low-intensity applications, and nuclear energy for base-load electricity production, is only viable way for future. Tomorrow's nuclear electric power plants will also provide power for electric vehicles for cleaner transportation. With new high temperature reactors we will be able to recover fresh water from sea and support hydrogen production.[13] We believe that opposition of some environmental organizations to civilian

[12] Siddharth Varadarajan, *India offers 10,000 MW of nuclear contracts to U.S.*, THE HINDU. September 20, 2008.
[13] Ravindra Tomar, *The Indian Nuclear Power Program: Myths and Mirages*, 20 ASIAN SURVEY. 517, 517-31 (1980).

applications of nuclear energy will soon be revealed to have been among greatest mistakes of our times.

A. Clean

Nuclear energy produces almost no carbon dioxide, and any sulphur dioxide or nitrogen oxides whatsoever. These gases are produced in vast quantities when fossil fuels are burned. Nuclear fission is among energy sources that are least polluting and have lowest overall environmental impact

B. Nuclear Waste

One gram of uranium yields about as much energy as the ton of coal or oil. Nuclear waste is correspondingly about the million times smaller than the waste generated by the fossil fuels, and it is completely confined. Volume of nuclear waste produced is very small. Since nuclear waste is deposited in very deep geological storage sites, hence, it does not enter the biosphere. Its effect on the ecosystem is very less. Waste generated by nuclear energy naturally decays over time while the chemical wastes, for example arsenic or mercury, they last forever. Most fossil fuel waste is in form of gas that goes up smokestack. We don't see it, but it is not without effect, causing global warming, acid rain, smog and other atmospheric pollution.

C. Safe

Nuclear power is safe, as proven by record of half the century of commercial operation, with accumulated experience of more than 12,000 reactor-years. There have been only two serious accidents in commercial exploitation of nuclear power:[14] Three Mile Island in 1979 (in Pennsylvania, USA) and Chernobyl in 1986 (in Soviet Union, now in Ukraine).

D. Reliable

Nuclear reactors provide base-load power and are available over 90% of time; intervals between refuelling have been extended and down time for refuelling have been reduced.

[14] Ravindra Tomar, *The Indian Nuclear Power Program: Myths and Mirages*, 20 ASIAN SURVEY. 517, 517-31 (1980).

E. Competitive

Cost of nuclear power is competitive and stable whereas fossil fuelled power, especially oil and gas, is at mercy of market.

F. Inexhaustible

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

G. Compact

The nuclear power station is very compact, occupying typically area of the football stadium and its surrounding parking lots. Solar cells, wind turbine farms and growing biomass, all require large areas of land.

IV. Departmental and Regulatory Setup in India

In India there have been a few Boards and Institutions that have been primarily engaged in controlling and managing the activities related to the uses of nuclear technology and nuclear materials. At the national level, the institutional set up is made up of the following major bodies, called as the Atomic Energy Commission, The Department of Atomic Energy, the Atomic Energy Regulatory Board, BHAVINI and Nuclear Power corporation of India Limited. These institutions have their decided code of conduct with specified areas of work, thus making the use of nuclear energy possible for peaceful purposes. The researcher has tried to give the basic details of the roles, powers and activities of these institutions.

A. The Atomic Energy Regulatory Board

The primary objective of Atomic Energy Regulatory Board is to guarantee that no risk is caused to the health of the people and the environment by the use of ionizing radiations and nuclear energy in India. Whereby, it lays down the basic requirements needed to be fulfilled by radiation users for maintaining nuclear safety. Wherefore, it mandates the nuclear and radiation facilities to undergo timely reviews and inspections, following a graded approach and by providing

considerable level of attention to high risk facilities.[15] Nonetheless, it states that the fulfilment of all the safety and regulatory requirements is the core responsibility of the facility's owner.

Atomic Energy Regulatory Board was instituted by the President of India in exercise of the powers given under Section 27 of the Atomic Energy Act, 1962, for carrying out various roles, regulatory and safety in nature, envisioned under Sections16, 17 and 23[16] of the Act. It is responsible to the Atomic Energy Commission (AEC). It was constituted on the November 15, 1983 and came into operation on December 31, 1983, pursuant to a gazette notification.[17] It comprises of not more than five members, including the Chairman and the Member-Secretary as its full time members.

The Atomic Energy Regulatory Board is empowered to lay down standards and frame rules and regulations, in collaboration with the Department of Atomic Energy, concerning the regulatory and safety necessities under the Atomic Energy Act, 1962. The main roles of Atomic Energy Regulatory Board may be broadly stated as:

a. Policy development in the field of nuclear safety, radiation safety and industrial safety, for facilities falling within its purview.
b. Development of the safety codes, standards and guides those are helpful in siting, constructing, designing, operating, commissioning and decommissioning of various plants, suitably in view of international recommendations and the local needs.
c. Granting permissions for siting, constructing, commissioning, operating and decommissioning of a nuclear or radiation facility, after undergoing an appropriate safety assessment.
d. Ensuring complete compliance with all the safety codes and standards, during construction or commissioning of either a Department of Atomic Energy or a non-Department of Atomic Energy installations.

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[15] ATOMIC ENERGY REGULATORY BOARD; https://aerb.gov.in/index.php/english/about-us/constitution-order (Dec. 31, 2022, 10:45 PM).

[16] Id. at 113 and 128

[17] ATOMIC ENERGY REGULATORY BOARD; https://aerb.gov.in/index.php/english/about-us/constitution-order (Dec. 31, 2022, 10:45 PM).

e. Giving technical advice the AEC/Department of Atomic Energy on matters relating to the siting, designing, constructing, commissioning, operating and also decommissioning of the plants under Department of Atomic Energy.
f. Reviewing a Department of Atomic Energy Project from all angles of safety, upon receiving requests for authorizing or commissioning or for operating such a project/ plants. Nonetheless, the Atomic Energy Regulatory Board shall review and satisfy itself upon the following points, before granting such authorization:
    i. The Final Design Analysis Report of project/ plant;
    ii. Any commissioning report and its consequent result; and
    iii. The anticipated operating procedures and the limits and conditions within which the operations are meant to be carried out without any undue risk to the personnel and population involved in such operations. Relevant additional supporting information may be called for by Atomic Energy Regulatory Board for carrying out the above purposes.
g. Reviewing the health and safety aspects in case of any modifications carried out to the design of the Department of Atomic Energy plant, such that it involves changes in its technical specifications.
h. Reviewing the earlier operating experiences considering the radiological and other safety measures that were recommended by the IAEA, International Commission on Radiological Protection or any such other international body provided they were accordingly adapted to suit Indian needs and conditions.
i. Prescribing the acceptable limits of radiations to which the occupational workers or other members of the public may be exposed, along with prescribing the limits for the release of radioactive substances and conventional pollutants in the environment.
j. Reviewing of the various plans prepared by different Department of Atomic Energy units on emergency preparedness, along with the plans prepared for non-Department of Atomic Energy installations and the once for large radioactive sources in transit.
k. Review the nuclear security aspects on safety concerning the nuclear facilities within its purview.
l. Promoting research and development for performing the above roles.

m. Reviewing of the training programme, qualifications and licensing policies for personnel.
n. Prescribing syllabi concerning safety of personnel training at all levels.
o. Enforcing of the rules and regulations on radiation safety and industrial safety that are propagated under the Atomic Energy Act, 1962 and the Factories Act, 1948 respectively.
p. Preserving relationships with national and foreign statutory bodies on safety matters.
q. Taking due steps for informing the public on the connotations of radiological safety.
r. Performing such other roles as the AEC may assign.
s. Informing the public of the 'nuclear incident' taking place in a nuclear installation situated in India, as an obligation imposed under the Civil Liability for Nuclear Damage Act, 2010.

For the performance of these roles, the Atomic Energy Regulatory Board has been conferred with the powers of a Competent Authority, for administering rules and regulations that have been laid down under the Atomic Energy Act, 1962. Additionally, it is also accredited to govern the provisions of the Factories Act, 1948, in order to secure industrial safety for Department of Atomic Energy units.[18] Whenever, the Atomic Energy Regulatory Board is in need of administrative support, it is provided by the Department of Atomic Energy.

B. Department of Atomic Energy

Department of Atomic Energy has been primarily engaged in the development of nuclear power technology emphasizing on developing basic research techniques and applying radiation technologies for the promotion of agriculture, food, industry, medicine etc. It visualizes empowering India through technology for wealth creation and providing better quality life to its citizen by making India energy independent.

Department of Atomic Energy was constituted on August 3, 1954 and is under the direct charge of the Prime Minister. The Secretary to GOI in the Department of Atomic Energy shall be the ex-officio Chairman of the AEC. It is mainly comprised of five research centers, three industrial organizations, five public

[18] The Atomic Energy Act, 1962, s. 23.

sector undertakings and three service organizations. There are two boards under its auspices for promoting and financially supporting extra-curricular research in nuclear and allied fields, also supporting eight institutes of international repute and an educational society for educating the children of Department of Atomic Energy employees.

The programmes of the Department are based upon the following directives:

a. To raise the share of nuclear power by developing native and trustworthy technologies. It also seeks to intensify fast breeder reactors and thorium reactors;
b. To build and operate more research reactors for manufacturing radioisotopes and also to carry out applications using radiation technology in the field of medicine, agriculture and industry. It is occupied in developing better crop varieties and methods for controlling pests and insects, and is also coming up with new techniques for cancer therapy;
c. To develop new and superior technologies and also to encourage transfer of such technology towards industrial sector;
d. To support basic researches in nuclear energy and also increase interaction with related universities and academic institutions. Further, it supports research and development in various Department of Atomic Energy‘s programmes by promoting international cooperation in areas of advanced research. Department of Atomic Energy programmes relate to the National Common Minimum Programme, agriculture, health and education, food & nutrition security, water resources and energy security; and
e. To contribute towards national security.

The main task of the Department of Atomic Energy involves the designing, construction and operational procedures of nuclear power reactors. It also looks after those nuclear fuel cycle technologies that support the operations of nuclear power reactors. It carries out the processing of nuclear minerals, generation of heavy water, fabrication of nuclear fuel, reprocessing of fuel and management of nuclear wastes.

C. Nuclear Power Corporation of India Limited (NPCIL)

Nuclear Power Corporation of India Limited is a public sector enterprise. The administrative control of NPCIL lies with Department of Atomic Energy. It was registered as a Public Limited Company under the Companies Act, 1956 in September 1987. It is a profit making and dividend paying company. Its main purpose is to operate NPP's, along with the implementation of atomic power projects for electricity generation in accordance with the programmes and initiatives taken under the aegis of Atomic Energy Act, 1962. The revelation behind the inception of NPCIL was to become internationally capable in nuclear power technology to achieve long term energy security for the country. The Company's task is to produce nuclear energy as a safe, economical and environment friendly source of electricity to meet the country's rising electricity needs. NPCIL also has equity participation in Bharatiya Nibhikiya Vidyut Nigam Limited (BHAVINI).

Responsibilities of NPCIL include overall designing, construction, commissioning and operation of any nuclear power reactor. 22 commercial nuclear power reactors with an installed capacity of 6780 MW are being currently operated by NPCIL. It also has eight reactors under various stages of construction with an estimated total capacity of 6200 MW. NPCIL is also engaged in implementing projects on Sustainable Development.

The Corporation strives to get the most out of nuclear power stations in terms of power generation and profitability. Safety being its prime consideration with the motto of 'safety first and production next', NPCIL has a record of 48 years of safe operation. It seeks to safely increase the generation of nuclear power with the available resources. It seeks to provide sufficient man power at all levels through an appropriate human resource development programme, possessing improved skills and technology. It strives to strengthen the existing levels of environment protection along with the achievement of advanced modernization and technological innovations. It promotes sharing of such technological skills and expertise, both at the national and the international level. NPCIL implements its Corporate Social Responsibility (CSR) programmes that include Sustainable Development as one of its main tenets. It is also committed towards achieving excellence in environment safety standards by adhering to the National Environment Policy, laws and other applicable rules and regulations. It seeks to protect and conserve environmental resources by judiciously using them and also

for reducing the generation of nuclear and other environmental wastes, so as to improve environmental performances continuously.

V. Legislative Framework on the Use of Atomic Energy in India

These laws lay down the fundamental rules and procedures for the guidance of all the organizations functional in India, dealing for and with the peaceful and safe uses of nuclear material and technology. The laws deal with the generation of electricity in NPP's, the design and construction of NPP's, the regulatory bodies, etc.

A. The Atomic Energy Act, 1962

This Act[19] was enacted after thirteen years of the coming into force of the Indian Constitution and is applicable to the whole of India.[20] The main purpose behind its enactment was to deliver for the growth, regulation and use of 'atomic energy'[21] towards the welfare of public and for peaceful purposes.

Under the provisions of this Act, the total control and development of nuclear material and nuclear energy is left in the hands of the central government or its appointed authorities or even by establishing a 'Government Company'[22], which in the present situation is NPCIL. Whereby, it provides some general powers to the Central Government.[23] For instance, the power of manufacturing, production, development, use, disposal of any 'prescribed substances'[24], 'radioactive substances'[25], or articles required for carrying out such purposes. It has to power to conduct and facilitate researches connected with atomic energy,[26] and to produce and facilitate the generation of electricity.[27] It can disposal off any

[19] ATOMIC ENERGY REGULATORY BOARD, https://www.aerb.gov.in/images/PDF/Atomic-Energy-Act-1962.pdf (Jan. 11, 2023, 4:45 PM).
[20] The Atomic Energy Act, 1962, s.1, cl.2
[21] "atomic energy means energy released from atomic nuclei as a result of any process, including the fission and fusion processes"; See Section 2(1)(a), The Atomic Energy Act, 1962
[22] The Atomic Energy (Amendment) Act 2015, (India).
[23] The Atomic Energy Act, 1962, s.3.
[24] The Atomic Energy Act, 1962, s. 2(1)(g).
[25] The Atomic Energy Act, 1962, s. 2(1)(i).
[26] The Atomic Energy (Amendment) Act 1987, No. 29, 1987 (India).
[27] The Atomic Energy (Amendment) Act 1987, No. 29, 1987 (India).

radioactive substance, etc. which were either acquired by it of its own or by NPCIL.[28] It also has the power to purchase, acquire, store or transport such substances. Further, the central government or its authorized person or institution, also has the power to declare or make publish any "restricted information"[29] and to declare any area or premises as "prohibited area"[30]. It can also take control[31] over radioactive substances or 'radiation'[32] producing plant for:

i. the prevention of radiation hazards;
ii. securing public safety and the safety of persons handling radioactive substances or radiation producing plant; and
iii. ensuring the safe disposal of radioactive wastes;

Whereby, in pursuance of its powers, the Central Government, via the Department of Atomic Energy vide its notification number S.O. 1592(E), dated April 28, 2016 has recently updated the list pertaining to Prescribed Substances, Prescribed Equipment and Technology.[33] Further, to regulate their exports and transfers, the Central Government has issued a set of guidelines entitled as "Guidelines for Nuclear Transfers (Exports)" vide its notification No.32/02/2016-ER. Whereby, the export of prescribed substances, prescribed equipment or transfer of related technology to any country will be governed by these principles and export controls will apply in case of nuclear transfers to any other country.[34]

This Act casts a duty on every person who had ever discovered the occurrence of thorium or uranium in India to explicitly notify about such finding to the Central Government or to any person authorized by it, within a period of three months from such discovery.[35] Similarly, even if a person believes about the occurrence of uranium or thorium at any place in India, he or she should immediately and

[28] The Atomic Energy (Amendment) Act 1987, No. 29, 1987 (India).
[29] The Atomic Energy Act, 1962, s. 3(c).
[30] The Atomic Energy Act, 1962, s. 3(d).
[31] The Atomic Energy Act, 1962, s. 3(e).
[32] The Atomic Energy Act, 1962, s. 2(1)(h).
[33] DEPARTMENT OF ATOMIC ENERY, http://dae.nic.in/writereaddata/pres_subs_0516.pdf (Feb. 12, 2023, 11:35 PM)
[34] DEPARTMENT OF ATOMIC ENERY, http://dae.nic.in/writereaddata/pres_subs_0516.pdf (Feb. 12, 2023, 11:46 PM)
[35] The Atomic Energy Act, 1962, s. 4(1).

likely intimate such belief.[36] If the Central Government at any time is satisfied that any person is mining a substance from which the isolation, extraction, usage or concentration of Uranium is projected by any physical, chemical or metallurgical process, then, to check and control such mining or concentration of uranium carrying substances,[37] it may ask such person to perform the above activities under such terms and conditions as it may notify from time to time, or may even impose total prohibition on his activities. In such a case, pursuant to Section 5(1), the Central Government may decide to pay compensation to such person. The amount of compensation must be determined under section 21; however, it may or may not be consistent with the value of any uranium contained in the abovementioned substance.[38] Nonetheless, if it decides not to pay any such compensation, it must record the corresponding reasons.[39]

Safety is one of the prime concerns of the Central Government when it comes to the use of radioactive substances. Considering this, it can make rules regarding any sites or premises in which radioactive substances are either mined, manufactured, treated, produced, deposited or used or wherever any plant producing radiation, equipment or appliance is put to use.[40] The main purpose behind framing such rules is to prevent any sort of injury that may be caused to the health of employees or other persons either due to radiations or by the ingestion of any radioactive substance, and also to secure the safe disposal of any radioactive waste products resulting from such activities. The Act also prescribes the qualifications of the employees including other service rules. It may also impose requirements, prohibitions and restrictions on employers, employees or any other persons. It also specifies requirements on erection or structural alterations of buildings. To ensure safety while transportation of radioactive substance or prescribed substance it may make rules necessary to prevent any injury during transport or an injury to the health of persons engaged therein.[41]

It may also order the non-disclosure of information contained in a document, drawing, photograph, plan, model, etc., which relates to a NPP or whose use is

[36] The Atomic Energy Act, 1962, s. 4(2).
[37] The Atomic Energy Act, 1962, s. 5(1).
[38] The Atomic Energy Act, 1962, s. 5(3) and 5(4).
[39] The Atomic Energy Act, 1962, s. 5(2).
[40] The Atomic Energy Act, 1962, s. 17(1).
[41] The Atomic Energy Act, 1962, s. 17(2).

proposed for the purpose of producing, developing or using atomic energy. Also, any information that relates to the purpose, method and process of operation of any NPP may also be restricted from being disclosed.[42] Every person is restricted to disclose information obtained by him during the discharge of his official duties.[43]

For ensuring safety in atomic energy operations, the act specifies that after its commencement, no patents will be granted for inventions relating to the production, control, use or disposal of atomic energy.[44] This prohibition will also apply to inventions for which application was made to the Controller of Patents and Designs appointed under the Indian Patents and Designs Act, 1911, before the commencement of this Act.[45] Nonetheless, if an invention is made by a person relating to atomic energy, he has a duty to communicate the nature and description of the invention.[46] Nonetheless, if a person is desirous to apply for a patent in a foreign country that relates to an invention relating to atomic energy, he shall obtain a prior permission from the Central Government before making the application.[47] Further, any invention in the field of atomic energy conceived in establishments controlled by the Central Government, etc. is regarded as an invention by the Central Government.[48]

Compensation is the most important feature that comes into light once one has suffered any form of damages. The act specifically lays down provisions in the form of principles that relate to the payment and determination of compensation. If compensation amount is fixed by an agreement, it shall be paid accordingly, otherwise an expert arbitrator, having knowledge as to the nature of rights affected, shall be appointed, for determining the amount of compensation payable.[49] In determining the amount, regard must be had to the compensation payable under section 9 for acquiring, discovering and extracting rights of any prescribed substance. Reliance must also be placed on the provisions of Section

[42] The Atomic Energy Act, 1962, s. 18(1).
[43] The Atomic Energy Act, 1962, s. 18(2).
[44] The Atomic Energy Act, 1962, s. 20(1).
[45] The Atomic Energy Act, 1962, s. 20(2).
[46] The Atomic Energy Act, 1962, s. 20(4).
[47] The Atomic Energy Act, 1962, s. 20(5).
[48] The Atomic Energy Act, 1962, s. 20(7).
[49] The Atomic Energy Act, 1962, s. 21(1).

23(1) of the Land Acquisition Act, 1894, as far as they may be made applicable to the provisions of section 9.[50] The arbitrator is to also consider the compensation payable under section 11 and 12.[51]

The Civil Liability for Nuclear Damage Act, 2010

The main purpose behind the enactment of the Civil Liability for Nuclear Damage Act, 2010 (hereinafter referred as CLND) was to make provisions for civil liability in case of 'nuclear damage'[52] and for the payment of immediate compensation to the victims of such an incident. The compensation is decided on the basis of the principle of no-fault liability. The appointment of Claims Commissioner and the establishment of Nuclear Damage Claims Commission both are incidental to the provisions of this Act.

The Act obligates Atomic Energy Regulatory Board to notify a 'nuclear incident'[53], within fifteen days of the mishap, with widely publicizing the nuclear incident.[54] Considering this the Atomic Energy Regulatory Board vide its Directive No. 01/2013 has provided the standards and assessment procedure for the notification of the happening of a nuclear incident. Nonetheless, if Atomic Energy Regulatory Board is satisfied that the threat or risk involved in such a nuclear incident is irrelevant, in that case it is not so obligated to notify the nuclear incident.[55]

The Act authorizes any person suffering nuclear damage to claim compensation. For deciding claims for compensation, either one or more Claims Commissioner (hereinafter referred as CC) is appointed by the Central Government,[56] as per the specified qualifications.[57]

For adjudicating such claims, he has to follow the prescribed procedure. If the CC needs to hold an enquiry, he may associate with him nuclear experts. The CC has

[50] The Atomic Energy Act, 1962, s. 21(2)(a).
[51] The Atomic Energy Act, 1962, s. 21(2)(b).
[52] The Civil Liability for Nuclear Damage Act, 2010, s. 2(g).
[53] The Civil Liability for Nuclear Damage Act, 2010, s. 2(i).
[54] The Civil Liability for Nuclear Damage Act, 2010, s. 3(2).
[55] The Civil Liability for Nuclear Damage Act, 2010, s. 3(1).
[56] The Civil Liability for Nuclear Damage Act, 2010, s. 9.
[57] The Civil Liability for Nuclear Damage Act, 2010, s. 10.

all the powers of a civil court as are given to it under the Code of Civil Procedure, 1908 (5 of 1908), for trying suits and is deemed to be a civil court for the purposes of section 195 and Chapter XXVI of the Code of Criminal Procedure, 1973 (2 of 1974).[58]

Upon notification of a nuclear incident, the CC is duty bound to cause wide publicity for inviting applications from the persons who have been affected by it, for claiming compensation for the nuclear damage.[59] Such applications may be made by any person sustaining personal injury, by the owner of the damaged property, by the legal representatives of the deceased or by any other person who has been duly authorized to be the agent of such person, owner or legal representative.[60] The application is to be made in the prescribed format, along with the required documents, not later than three years from the nuclear damage.[61] Once the application is received, the CC must notify it to the operator and provide both the parties an equal opportunity of being heard, before disposing off the application. He must dispose of the application by making an award within a period of three months from its receipt. Nonetheless, while deciding upon the amount of compensation, the CC must not consider any benefit, reimbursement or amount that has been already received by the applicant as an insurance amount.

The right to claim compensation extinguishes, if it is not made within a period of ten years, where damage has been caused to property and twenty years, where some sort of personal injury has been suffered. The time limit commences from the date of occurrence of the incident. Nonetheless, where such nuclear incident involved some sort of nuclear material that was either stolen, lost, jettisoned or abandoned before the happening of the said incident, then the period of ten years shall be calculated from the date of the nuclear incident, but shall not exceed a period of twenty years from the date of such theft, loss, jettison or abandonment.[62]

In case of the happening of a nuclear incident, if the Central Government is of the opinion that in larger public interest, the claims for compensation needs to be decided by a Commission instead of a CC, it may notify for the establishment of

[58] The Civil Liability for Nuclear Damage Act, 2010, s. 12.
[59] The Civil Liability for Nuclear Damage Act, 2010, s. 13.
[60] The Civil Liability for Nuclear Damage Act, 2010, s. 14.
[61] The Civil Liability for Nuclear Damage Act, 2010, s. 15.
[62] The Civil Liability for Nuclear Damage Act, 2010, s. 18.

a Nuclear Damage Claims Commission (hereinafter referred as NDCC).[63] The NDCC is comprised of one Chairperson and not more than six other members. Such persons must possess special knowledge in the field of nuclear law and liability arising out of a nuclear incident. A CC who has held that post for at least five years may also be appointed as the Chairman of the NDCC.[64]

An application before NDCC must made in the prescribed form, not later than three years from the date of knowledge of nuclear damage by the victim.[65] For dealing with these claims under Section 31 or 33, the NDCC has original jurisdiction. Though NDCC is not bound to follow the procedure laid down in the Code of Civil Procedure, 1908 (5 of 1908), yet it must not deviate from the principles of natural justice. Nonetheless, for discharging its roles, it has the same powers as are vested in a court of civil jurisdiction. The NDCC must also dispose of the application within a period of three months after providing an opportunity of being heard to the parties concerned. After the award the insurer or any other person, other than the operator, who is required to pay any amount in accordance with the award and up to the extent of his liability, as may be decided under the contract, has to deposit that amount within the stipulated time and manner, as may be directed by the CC or the NDCC. The remaining amount, above the amount deposited by the insurer, etc., has to be deposited by the operator. If the insurer or the other person specified fails to deposit the amount of award within the stipulated time, then such amount may be recovered from him as arrears of land revenue. Any amount so deposited must be disbursed to the specified persons within a period of fifteen days from such deposition.[66]

Keeping in mind the large population density of our country and the national policy favouring the setting up of more and more NPP‘s for expansive energy growth, the safety and security of the NPP‘s, of the people and of the environment are extremely important. Wherefore, provisions have been set as part of equitable justice and as part of national and international law, pertaining to remedy the loss/damage to the environment, to human health, life and/or property.

[63] The Civil Liability for Nuclear Damage Act, 2010, s. 19.
[64] The Civil Liability for Nuclear Damage Act, 2010, s. 20.
[65] The Civil Liability for Nuclear Damage Act, 2010, s. 31.
[66] The Civil Liability for Nuclear Damage Act, 2010, s. 36.

Nuclear and radioactive releases are undoubtedly dangerous to human health and environment. In case of a nuclear accident potent enough to cause contamination of the surroundings, Disaster Management Plans (hereinafter referred as DMP) are of paramount importance. Considering that nuclear/ radiological emergencies can occur due to factors beyond human control, the law on disaster management was formulated by the Parliament.

VI. Conclusion

Humanity will have to methodically reduce its dependency on large-scale ignition of fossil fuels for energy production in coming decades, with purpose of carrying out this change. All energy sources may be considered and some will be deployed in useful 'niche' applications. Nonetheless, only nuclear power plants are capable of sustainably and reliably supplying large quantities of clean and economical energy needed to run industrial societies with negligible emission of greenhouse gases. Nuclear energy meets all standards of sustainability as defined by United Nations Brundtland Commission.

In the first phase, world's industrial nations should take lead in transforming major part of their stationary electrical energy producing capacity from fossil-fuel based to nuclear-fission based. With the long term energy policy and proper incentives, this could be achieved within the few decades. Such the transformation could drastically reduce global rate of greenhouse-gas emission with respect to both atmospheric carbon-dioxide and methane.

Renewable energy sources will not be able to supply needed large quantities of energy sustainably, economically and reliably. In addition, renewable energy sources with fossil-fired backup power will in many cases not contribute towards reduction of greenhouse-gas emissions. Distorting market with subsidies and by legislation to attract intermittent energy technologies into applications for which they are not well suited is economically wasteful. Also, replacing stand-alone coal-fired stations with stand-alone gas-fired stations will, in many cases, not result in the reduction in rate of emission of greenhouse gases due to (often poorly quantified) problems of methane leakage. Countries that depend on imported natural gas should be aware that they carry full responsibility for their part of global consequences due to atmospheric leakage of methane associated with their part of imported gas, including leakage taking place outside their borders.

One solution to avoid 'free riding' would be the grid-connection fee, to be imposed on countries with the large intermittent producing capacity, for purpose of compensating adjacent countries for use of their interconnected electric grids as back-up power, and for having to accept surplus intermittent energy at times when it is not needed, thus forcing their base-load power plants to operate in the uneconomic 'accommodative' mode.

Intermittent energy sources with stored-energy facilities might, in some cases be economically viable, particularly for isolated locations without access to the electric grid. But 'heavy lifting' in terms of replacing global use of coal, oil and gas must come from the large-scale deployment of nuclear fission energy, with the goal for full fuel recycling for maximum long-term sustainability of this critical zero-carbon energy source.

Nuclear power is the intense source of energy and transport infrastructure needed for nuclear fuel is very small. 10,000 MWe nuclear power capacity needs only about 300–350 tons of enriched fuel per annum, as against 35–50 million tons of coal needed for the coal fired thermal power station of same capacity requiring about the shipload or 20 trainloads per day to transport coal. Pressure on rail, port and other infrastructure will be immense when large thermal capacity is added, apart from emissions arising out of transporting such large quantities of coal. Land needed for setting up the nuclear power station is also less when compared to thermal coal-fired power stations and hydroelectric stations which involve large submergence of land.[67]

i. Energy Policy

Integrated Energy Policy of country recognizes that nuclear power based on indigenous resources can provide long term energy security for country and recommends continued support for three-stage program and development of thorium fuel cycle. It also recommends exploring possibility of setting up large nuclear capacities based on imports once necessary agreements for international cooperation are in place.

[67] T.L. SHANKAR (1985), ENERGY POLICY FORMULATION: THE INDIAN EXPERIENCE 70-86 (R. S. Ganapathy, S. R. Ganesh, R. M. Maru, S. Paul, R. M. Rao ed., Sage Publications 1985).

ii. Privatisation and Deregulation

Nuclear power generation and related fuel cycle activities are under Central Government. Department of Atomic Energy is responsible for setting up and operating nuclear power plants. Other related fuel cycle (both front-end and back end) activities are carried out by different units of Department of Atomic Energy, GOI. As of now, there is no equity participation by private sector in area of nuclear power generation[68]. In order to facilitate having possibility of joint ventures with other public sector company, Atomic Energy Act 1962 was amended in year 2015. This is essentially aimed to attract investment in nuclear power sector for capacity addition.[69]

iii. Role of Government in Nuclear R & D

Most of R&D related to nuclear power is funded and carried out by Department of Atomic Energy under Government of India. Nonetheless through extra mural research funding, R&D is also carried out in some of academic research institutions outside Department of Atomic Research Centre.

iv. Nuclear Energy and Climate Change

India is the large country and so needs the large electricity producing capacity. Power generation in India was 4.1 billion kWhr in 1947-48 and in 2014-15; it was about 1272 billion kWhr including captive power. In next 50 years, it may increase by the factor of 12 or more. At present, the major component of electricity is generated using fossil fuels and there are environmental concerns like greenhouse gas (GHG) emissions associated with energy generation using fossil resources. If India continues to rely on fossil resources as at present, it will have serious effects on local, regional and global environment.

[68]T.L. SHANKAR (1985), ENERGY POLICY FORMULATION: THE INDIAN EXPERIENCE 70-86 (R. S. Ganapathy, S. R. Ganesh, R. M. Maru, S. Paul, R. M. Rao ed., Sage Publications 1985).

[69] T.L. SHANKAR (1985), ENERGY POLICY FORMULATION: THE INDIAN EXPERIENCE 70-86 (R. S. Ganapathy, S. R. Ganesh, R. M. Maru, S. Paul, R. M. Rao ed., Sage Publications 1985).

Therefore, it is necessary that India continues to develop nuclear energy and meets the significant percentage of its electricity needs based on nuclear energy.[70]

Despite strong rationale for reducing GHG emissions that contribute to global warming, for meeting increasing demand for electricity, and for improving national security aspects of energy supply, installation of nuclear power projects is slower than other projects. There is considerable anti-nuclear sentiment in country. There are several reasons why nuclear power has not met expectations for capacity growth projected several decades ago. One factor is that public perception of nuclear energy is unfavourable; in part due to concern about effects of radiation that public associates with nuclear energy. These challenges are –

v. Need of Independent Regulator

Atomic Energy Regulatory Body (Atomic Energy Regulatory Board) has functioned as regulator in-charge of nuclear power reactors in country. Atomic Energy Regulatory Board draws professionals from Department of Atomic Energy facilities as one cannot doubt technical competence of Atomic Energy Regulatory Board professionals. Nonetheless, recently, Atomic Energy Regulatory Board's role and its importance as the regulator become prominent in public discourse on account of its structural dependency. With separation of military and civilian nuclear programme, it is imperative that regulator is independent financially as well as statutorily.

Close tie between regulator and regulated is never desirable. THE move towards this has been made with draft legislation on "Nuclear Safety Regulatory Authority Act" under consideration. This will help to provide statutory independence to regulator. Nonetheless, the major challenge is finding suitable scientists with relevant knowledge outside ambit of nuclear establishment. Nonetheless, it must be

[70] T.L. SHANKAR (1985), ENERGY POLICY FORMULATION: THE INDIAN EXPERIENCE 70-86 (R. S. Ganapathy, S. R. Ganesh, R. M. Maru, S. Paul, R. M. Rao ed., Sage Publications 1985).

mentioned that lack of any major accident have shown that regulator in India has been effective.[71]

vi. Nuclear Fuel Availability

Domestic availability of uranium, only fuel source as of now, is one of major concerns in going ahead with nuclear programme. Presently it is mined only in Jharkhand and Andhra Pradesh, which is also of low quality. THE few other sites, including in Karnataka and Meghalaya, reportedly have uranium deposits. Techno-eco feasibility of opening new mines would however very much depend on eco-sensitive nature of these sites and public perception in area. The estimate of resource availability is also the matter of contention. Possibility of import of uranium, which has opened up now, could ease situation. Concern here is somewhat varied perceptions and approaches on part of potential exporting countries.[72]

vii. Import Cost

Nuclear power has higher overall lifetime costs compared to natural gas with combined cycle turbine technology and coal, at least in absence of the carbon tax or the equivalent "cap and trade" mechanism for reducing carbon emissions. India is planning to import high capacity reactors from abroad. Cost of these reactors is considerable higher compared to domestic ones. If the domestic reactor costs around five to seven crores per MW estimated cost of the imported reactor is found to very between 16 crore/MW to 36 crore/MW based on technology. This could have the significant impact on cost of power.[73]

viii. Higher Capital Cost

New nuclear power plants typically have high capital costs for building first several plants, after which costs tend to fall for each

[71] Ravindra Tomar, *The Indian Nuclear Power Program: Myths and Mirages*, 20 ASIAN SURVEY. 517, 517-31 (1980).
[72] Siddharth Varadarajan, *India offers 10,000 MW of nuclear contracts to U.S.*, THE HINDU. September 20, 2008.
[73] Siddharth Varadarajan, *India offers 10,000 MW of nuclear contracts to U.S.*, THE HINDU. September 20, 2008.

additional plant built as supply chains develop and regulatory processes settle down. Fuel, operational and maintenance costs are relatively small components of total cost. Most operating nuclear plants are economical to operate when costs going forward are considered, i.e. when sunk capital and construction costs are ignored. Nonetheless, new plants appear to be more expensive than alternate sources of base load generation, notably coal and natural gas fired electricity generation, when both capital and operating costs are taken into account. Coal plants have capital costs intermediate between those of gas and nuclear. Nonetheless, if CO2 emissions were in future to become subject to control and the significant "price" placed on emissions, relative economics could become much more favourable to nuclear power.

ix. Waste Disposal

Nuclear power has perceived adverse safety, environmental, and health effects, heightened by Three Mile Island and Chernobyl reactor accidents, but also by accidents at fuel cycle facilities in United States, Russia, and Japan. There is also growing concern about safe and secure transportation and disposal of nuclear materials and security of nuclear facilities from terrorist attack. There are many radioactive waste streams created in various parts of nuclear fuel cycle.[74] Nuclear power has unresolved challenges in long-term management of radioactive wastes. United States and other countries have yet to implement final disposition of spent fuel or high-level radioactive waste streams created at various stages of nuclear fuel cycle. Since these radioactive wastes present some danger to future generations. Management and disposal of high-level radioactive spent fuel from nuclear fuel cycle is one of most intractable problems facing nuclear power industry throughout world. Spent fuel from nuclear reactors contains radioactive material that presents health and environmental risks that persist for tens of thousands of years. At

[74] Ravindra Tomar, *The Indian Nuclear Power Program: Myths and Mirages*, 20 ASIAN SURVEY. 517, 517-31 (1980).

present, no nation has successfully demonstrated the disposal system for these nuclear wastes.

x. International Policies

Opening up possibility of trade has helped India secure fuel supply for those reactors which are under IAEA safeguard. THE growing dependency on imported fuel could be the cause for concern in future as imports are contingent on international sentiments. Currently NSG has made the exception for India, through there are regular voices of disclosure due to this, for instance, both Australia and Japan have expressed reservations about India's position on CTBT and NPT, with several within countries demanding for more stringent controls on Indian nuclear programme. While current administrations in two countries are more interested to fix the deal with India (uranium exports from Australia and technology from Japan), negotiations have been protected. Strategic considerations also become important while considering uranium imports.

xi. Land-related Issues

Difficulties in acquiring land and issues faced in commencing work in previously acquired land are some of crucial issues stalling development of new power plants, as well as opening up of new mines. Public protests have been seen in Jaitapur, Kudankulum, and in Domiasiat in Meghalaya. Protest against large-scale infrastructure projects has been faced in several other sectors as well. While some of reasons for these protests are systematic-insufficient compensation, bad implementation of rehabilitation and resettlement, no social impact assessments are carried out to gauge impact of resettlement of people, insufficient consultation with public etc. in case of nuclear these larger systemic issues are also back-grounded with public perception against nuclear. There is need to develop more robust and exclusive programme for all sectors to address concerns of public around large infrastructure facilities.[75]

[75] Ravindra Tomar, *The Indian Nuclear Power Program: Myths and Mirages*, 20 ASIAN SURVEY. 517, 517-31 (1980).

xii. Public Acceptance

Expanded deployment of nuclear power requires public acceptance of this energy source. Nuclear in India, due to international isolation, hitherto, had been the subject removed away from public eye. There seemed to be very little information coming out of administration or government about programmes. There have been very little efforts in part of nuclear establishment to engage with public at large. Nonetheless, globally as well, post Fukushima accident, people's opinion about nuclear energy was on the decline, with increasing safety concerns about nuclear. Reflection of this trend was seen in India as well, with the growing discontent against nuclear projects. THE strong negative public perception regarding nuclear power and its effects has stalled development of new sites at several places.

India today is recognized as the country with advanced nuclear technologies. Comprehensive indigenous capabilities have been developed in all aspects of nuclear power and associated fuel cycles. It has the large R&D base, qualified human resource and facilities for continual development of human resource, industrial capability and capacity as well as robust regulatory framework. Performance of Indian nuclear power stations and implementation of projects have been comparable to international benchmarks technologies for several complex in-core operations have been established and deployed successfully.