Page 1486 - 1500 **DOI:** *https://doij.org/10.10000/IJLMH.114546*

INTERNATIONAL JOURNAL OF LAW MANAGEMENT & HUMANITIES

[ISSN 2581-5369]

Volume 6 | Issue 2

2023

Nuclear Energy: Enviro-Legal Implications and India's Goal of Energy Independence

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ABSTRACT

For any profit driven and developing nation-state, the desire to improve industrially and economically has always been the top objective for the nation's growth. A balance between the right to growth and the right to a clean environment should exist, even if there is no formally recognised right to development. A clean environment is a right that is routinely ignored and it is relevant for nuclear energy industry too. Although nuclear power plants are a dependable source of energy, their operators must take great care to protect the environment. The majority of the material handled by nuclear power plants is radioactive which in case of an adversity may lead to accidents like the Three Mile Island incident, the Chernobyl disaster and the Fukushima disaster and hence they possess a potential to cause catastrophic damage to the people and the environment. This paper discusses nuclear energy, its potential impact on the environment and the enviro-legal implications in India. Over the years, while furthering its quest for energy independence, India has made efforts to adhere to the international safety standards and policies. However, the extent to which these policies prioritise the environment over the economy and the well-being of citizens is still up for intense debate. It must be acknowledged that people and environment come first and responsibility of the State is immediately behind it. The paper further takes associated factors like nuclear waste disposal, state responsibility, potential harm and extent of liability into consideration. The authors attempt to examine whether the existing laws and judgments make way to create a balance between environmental conservation and India's goal of becoming energy independent by 2047.

Keywords: *energy, goal, environment, management, liability.*

I. INTRODUCTION

Burning fossil fuels is one of the primary drivers of human greenhouse gas emissions, despite the fact that reliable access to energy is essential for economic progress. For minimising environmental impact and the hazards associated with climate change, emissions related to energy must be reduced. As a consequence, countries that largely depend on conventional fuel sources must dramatically lower their percentage of fossil fuels. There is evidence that nuclear

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energy can take the place of clean energy. Many consider it to be both a remedy and a response to climate change. For instance, nuclear energy may help cut greenhouse gas emissions, and several countries are pushing it as a viable alternative to meet the world's growing need for power. Long-term uses of nuclear energy might include the production of heat, drinking water, and hydrogen in addition to electrical output. This would significantly boost nuclear energy's ability to lower GHG emissions.

The emergence of nuclear energy as an alternative to common fuel sources like coal and hydropower has raised worries about both the environment and safety since the risk factor is significant and sometimes irreversible. There have only been a few of significant nuclear reactor accidents to date, which resulted in the loss of human life and environmental harm. The Chernobyl disaster, the Three Mile Island tragedy, and the Fukushima disaster all continued to be catastrophic. In the past, concerns about the spread of nuclear weapons and nuclear plant accidents helped to mould public opinion against nuclear power[3]. Nevertheless, advancing technology, the need for additional power, and the expanding involvement of international organisations in overseeing and regulating the nuclear business are swaying public opinion in favour of the expansion of the sector. The rising energy costs brought on by the rising cost of crude oil are also influencing public opinion in favour of nuclear power in many of the emerging nations that are reliant on oil imports, such as India[4].

However, there are arguments against such narratives, particularly when abuse is a possibility and worries about environmental deterioration are raised. How policymakers would approach ways to justify responsibility may be placed on potential defaulters against damages produced by nuclear reactors is one aspect of such a polarised worldview. There are currently very few disorganised legal and normative systems in India that deal with the responsibility problem. However, the Indian goal of reaching energy independence by the 100th anniversary of its independence has not been discouraged, and stands strong, notwithstanding this reality.

II. VIABILITY OF NUCLEAR ENERGY IN INDIA

In India, the Ministry of Power's data as of 30 September 2022 shows that the installed generation capacity (fuel wise) came out to be occupied by fossil fuels to an extent of 57.9% and Clean Energy or Non-fossil fuels to an extent of 42.1%; which included a minimal portion of Nuclear Energy at 1.7% and from which it is evident that there is only a minimal contribution

[3] Gamson William and Andre Modigliani, *Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach*, AMERICAN JOURNAL OF SOCIOLOGY 95, NO. 1 1–37 (1989).

[4] INDIA ENERGY OUTLOOK, 2021, https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf (last accessed on 15 Dec, 2022).

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from nuclear power to the country's overall primary energy consumption from commercial sources.[5] Despite its relatively little contribution at the moment, nuclear power has the potential to provide India "energy independence" beyond 2050[6]; for this reason, the advancement of nuclear power is seen as being of utmost importance. But although there are modest concentrations of poor-quality uranium ores in India, the country is endowed with vast volumes of thorium ores[7]. There are additional ores of thorium. India's nuclear-generation programme is thus built on a three-stage strategy that consists of a) Pressurized Heavy Water Reactors, b) Fast Breeder Reactors, and c) Reactors based on the Uranium 233-Thorium 232 cycles.[8]

Each stage of the plan calls for a different kind of nuclear reactor, with the ultimate objective being to use the nation's enormous thorium supplies. However, due to international sanctions imposed on India as a result of its failure to ratify the Nuclear Non-Proliferation Treaty (NPT) and its conduct of nuclear tests in both 1974 and 1998, it is difficult for the nation to get nuclear components and technology from other nations[9]. The growth of India's nuclear power sector over the next decades will depend on its involvement in the international community's peaceful nuclear commerce. The major goal of the International Atomic Energy Agency (IAEA) since its establishment in 1956 has been to encourage and assist the spread of nuclear energy[10]. It was widely believed that the development of nuclear power would contribute to world peace, health, and riches. According to the International Atomic Energy Agency's (IAEA) objectives, health and environmental risks would be handled by the various legal systems themselves via the creation of laws and regulations that take the IAEA's recommendations on safety measures into account[11].

While having international assistance and working with intergovernmental organisations are necessary for a nation to grow its nuclear business, aspects like safety and security for nuclear plants are heavily reliant on the environment of the nation in which they are situated. In terms

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[5] Ministry of Power, *Power Sector at a Glance: All India*, *available at* < https://powermin.gov.in/en/content/power-sector-glance-all-india> (last accessed on 15 Dec, 2022).

[6] Naveen Chandra Sharma and Prakash Sharma, *Atomic Energy in India: Legal Framework*, I HPNLU LAW JOURNAL 165-181 (2020).

[7] R. Gupta, *Emerging Trend of Uranium Mining: The Indian Scenario*, E IAEA SYMPOSIUM ON "URANIUM PRODUCTION AND RAW MATERIALS FOR THE NUCLEAR FUEL CYCLE- SUPPLY AND DEMAND, ECONOMICS, THE ENVIRONMENT AND ENERGY SECURITY", VIENNA; JUN. 20-24, (2005).

[8] Department of Atomic Energy, Government of India, *Shaping the Third Stage of Indian Nuclear Power Programme*, available at < https://dae.gov.in/node/sites/default/files/3rdstage.pdf> (last accessed on 15 Dec, 2022)

[9] Pramit Pal Chaudhuri, *India's Complex Nuclear Policy*, https://rhg.com/research/indias-complex-nuclear-policy/ (last accessed on 15 Dec, 2022).

[10] Y.A. Sokolov, *The IAEA's Role in Nuclear Energy - Past, Present and Future*, THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA), VIENNA, AUSTRIA, IAEA-CN-114/P1-3.

[11] Legal Framework for IAEA Safeguards, Vienna: International Atomic Energy Agency, (2013) STI/PUB/1608 ISBN 978–92–0–141810–4.

 [ISSN 2581-5369]

of safety and security, internal difficulties are thus more important than external ones, which are often of a legal or political nature. This is due to the possibility that domestic concerns may have a bigger effect on how efficiently nuclear reactors run. To ensure that nuclear facilities can run without incident, it is crucial for countries that generate nuclear electricity to enhance their management of community safety and environmental security.[12]

As a consequence of industrialisation and the rising concern about climate change, India and other developing countries have been put in a special situation. To guarantee that their futures are both economically and ecologically sustainable, these countries will need to compromise between environmental sustainability and economic progress. One of the biggest challenges India would confront is altering its current coal-heavy energy balance to make room for a greater proportion of cleaner and more sustainable energy sources. In India, civilian nuclear technology has a strong basis, and the government's main goal is to develop the nation's nuclear sector and increase the amount of electricity generated by nuclear reactors. To do this, it is essential to run the existing power plants at full efficiency and build new reactors to increase the overall quantity of energy generated. A continual supply of nuclear fuel for the reactors as well as the construction of new power plants are required to satisfy this demand. This, however, suggests that pressing concerns, such as those regarding the environment and waste management, as well as the potential for damage to communities and political responsibility, cannot be put on hold in favour of industrialization and development.

If India wants to expedite the pace of its economy's progress while simultaneously helping to minimise the effects of climate change, it must diversify its existing energy mix, which is mostly dependent on coal[13]. Only then will it be able to meet both of these goals. Because of this, it is crucial for India to reduce its reliance on coal and other fossil fuels and to look into alternative energy sources that don't contribute as much to greenhouse gas emissions as fossil fuels do. India must simultaneously ensure that it employs renewable energy sources that won't endanger its ability to provide itself with energy and, therefore, its ability to advance economically. The country finds itself in a position where it must constantly trade-off between preserving economic growth and reducing the quantity of carbon emissions it generates.[14]

Therefore, given that it is a technology that has been tested and proved, as well as the fact that

[12] Carlton Stoiber, Abdelmadjid Cherf, et.al., *Handbook on Nuclear Law: Implementing Legislation*, INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 2010.
[13] Pravakar Sahoo, *India's Energy Mix and the Pathways to Sustainable Development*, ESSAY FROM ASIA EDGE, MARCH 5, 2021.
[14] M.P. Ram Mohan and R. Rajesh Babu, *Nuclear Energy Law and Decision Making in India* 17, ISSUE 1 JRR 1-6 (2014).

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India has developed nuclear technology through the years and has a burgeoning nuclear industry, nuclear energy is an option that merits consideration. As a consequence, nuclear energy is a sustainable source of energy, and India's use of it would significantly lower the nation's total carbon emissions. The practicality of this option, nuclear power in this example, depends on it posing the least threat to the environment and having the least detrimental consequences on the general populace.

III. NUCLEAR ENERGY: THE EMERGENCE OF ENVIRONMENTAL AND SOCIAL CONCERNS

Low-enriched and naturally occurring uranium is the primary fuel used in nuclear power reactors. This fuel performs a fission chain reaction that releases heat while also producing radioactive fission products, plutonium, and other transuranic elements. The heat is utilised to create steam, which powers turbines that generate electricity. When the number of chain-reacting isotopes reaches a certain level, the fuel is deemed "spent," and new fuel must be used in its stead. In order to reduce heat and radiation levels, the spent nuclear fuel from power reactors is discharged into a water-filled pool right next to the reactor. It stays in this pool for lengths of time ranging from a few years to decades. After cooling, the fuel may be moved into massive air-cooled dry casks for on-site or centralised storage.[15]

The nuclear fuel cycle, operations, and consequences of nuclear accidents all have an influence on the environment. It is generally acknowledged that spent nuclear fuel, high-level reprocessing wastes, and plutonium wastes need carefully planned storage for durations ranging from tens of thousands to a million years, in order to limit emissions of the stored radioactivity into the environment.

a) Potent and Carcinogenic High Level Liquid Waste

The overall quantity of reprocessing done that year determines how much garbage is produced. The wasted fuel is being reprocessed continually. Since it is against Indian national policy, the plutonium inventory cannot be disclosed. More than 100 radioactive isotopes that can cause cancer, including strontium-90, iodine-131, and caesium-137, are present in spent nuclear fuel from nuclear reactions involving uranium-235 and plutonium-239. It also contains some of the most stable transuranic elements, including americium-241 and isotopes of plutonium.[16] The broad use of nuclear energy is severely limited by the safety and health risks connected with

[15] Spent Nuclear Fuel Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges, REPORT TO CONGRESSIONAL REQUESTERS, GAO – 12 -797, (AUGUST 2012).
[16] Legal Framework For IAEA Safeguards, Vienna: International Atomic Energy Agency, 21 CM, (2013). STI/PUB/1608 ISBN 978–92–0–141810–4.

nuclear waste. Nuclear waste must be kept or treated with extreme caution due to its radioactivity and very dangerous characteristics. The lengthy half-lives of the radioactive components in nuclear waste make storage and reprocessing even more challenging.[17]

b) Future Disposal Plans Seem Uncertain

Currently, it is thought that the best course of action is to dispose of these pollutants in specially designed repositories buried deep under acceptable geologic formations. But when the liquid waste has been de-radicalized for 30 to 40 years, this demand won't materialise. However, there are still a lot of worries about this geologic disposal method since the buried nuclear waste might escape into the environment if any significant tectonic changes take say a seismic activity. Furthermore, since radioactive waste has such lengthy half-lives, even a very little leak or migration might produce a major catastrophe.

c) Concerns of the Local Community

The social stigma of using nuclear disposal methods is a similar worry to the environmental issue. In India, the closed fuel cycle option—which entails processing and recycling used fuel—has been embraced. Only 2 to 3 percent of the used fuel is wasted during reprocessing; the remainder is recycled. Through a process known as vitrification, this 2-3% waste, also known as high level liquid waste (HLW), is transformed into glass. The vetrifications are performed at a specific place, and the vitrified waste must be held for 30 to 40 years to cool.[18] In order to focus the emissions of such sectors that may harm a particular community, nation-states often choose a certain area. Nevertheless, a lot of towns do not want to host a nuclear waste deposit because they are worried about their town turning into a de facto dump for waste for a very long time, the health and environmental effects of an accident, and declining property values[19]. Thus, one of the key factors in choosing a location is the public's engagement and the involvement of the surrounding communities.[20]

d) Environment-related externalities Uranium Mining was the cause

Similar to mining for other commodities and processing them afterwards, enriching uranium and processing it may all seriously impact the nearby ecosystems and waterways. Additionally, there are unfavourable environmental externalities throughout the life cycle's functioning

[17] Gurmeat Kaval, *India Nuclear Force Structure*, STRATEGIC ANALYSIS, VOL.XXIV, NO.6, PG.240.
[18] Technical Reports Series No. 339, *Design and Operation of High-Level Waste Vitrification and Storage Facilities*, INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1992.
[19] Benjamin K. Sovacool, *Contesting the Future of Nuclear Power: A Critical Global Assessment of Atomic Energy*, WORLD SCIENTIFIC, P. 144, (2011).
[20] Benjamin K. Sovacool, *Contesting the Future of Nuclear Power: A Critical Global Assessment of Atomic Energy*, WORLD SCIENTIFIC, P. 144, (2011).

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period, which is equivalent to the cycle's start. Nuclear power plants are generally often built next to large bodies of water like lakes, rivers, and oceans since running a nuclear reactor needs a sizeable amount of cooling water to cool down the equipment and absorb extra heat waste. A typical nuclear power reactor that generates 1 GW of electricity uses around 477,000 gallons of water per minute for cooling.[21] This warmer water is subsequently released back into the surrounding environment, where it has a negative impact on the aquatic species due to thermal pollution.

e) Increased Build-up of Spent Nuclear Fuel

The truth is that all of the major nuclear-power nations, including India, have enormous inventories of fuel that has not been processed. Unless the tonnes of yearly capacity anticipated are completely put into use and operational efficiency reaches substantially higher levels than those yet attained by reprocessing facilities, a backlog will become much greater. The accumulation of used fuel backlogs may eventually cause both economic hardship and public humiliation. What shape the waste should take is a crucial subject that many nations have yet to address. Reprocessing capacity for the foreseeable future won't be enough to stop a significant backlog of spent light water reactor fuel from accumulating. Undoubtedly, the Swedes have chosen to dispose of their used fuel directly in the earth's crust.[22] Although they are formally committed to reprocessing, the Germans have not disqualified direct disposal. However, they are now planning shut the reactors down.[23] Both India and France have a strong commitment to reprocessing.[24] By the end of the century, reprocessing as a commercial industry is likely to be gone, and the expected spillouts will have a significant environmental impact if recycling and reprocessing plutonium in light water reactors continue to be as economically unfavourable as they now seem to be.[25]

f) Can Nuclear Energy It Really Reduce Carbon Emissions?

Calculating how much CO_2 the nuclear system as a whole emits in comparison to other energy sources will help us understand how nuclear power may help combat global warming. Even if a nuclear reactor produces almost little carbon dioxide during operation, the nuclear power

[21] Office of Nuclear Energy, *Infographic: How Much Power Does A Nuclear Reactor Produce?* MARCH 31, 2021.
[22] The Government approves SKB's final repository system, 2022-01-27, https://www.skb.com/news/the-government-approves-skbs-final-repository-system/ (last accessed on 15 Dec, 2022).
[23] Caroline Jorant, *The Implications of Fukushima: The European Perspective,* BULLETIN OF THE ATOMIC SCIENTISTS. 67 (4): 15, (JULY 2011).
[24] Kanwar Raj, *Commissioning and Operation of High Level Radioactive Waste Vitrification And Storage Facilities: The Indian Experience*, INTERNATIONAL JOURNAL OF NUCLEAR ENERGY SCIENCE AND TECHNOLOGY, VOL. 1, NO. 2-3, (2005), PP 148-163.
[25] C.D. Ferguson, *Nuclear Energy: Balancing Benefits and Risks*; COUNCIL OF FOREIGN RELATIONS: NEW YORK, NY, USA; CRS NO. 28. (2007).

system as a whole does not. Contrary to popular belief, nuclear power really emits a lot more carbon dioxide (CO_2) than is typical. What's more, CO_2 emissions from nuclear power will rise with time. The quality of the uranium ore and the operating lifespan, which is often lengthy and desirable, are the two key factors that affect CO_2 emissions. Nuclear power utilising the typical ore grade of 0.15% today would release around 30% CO_2 if we assume a gas-fired power plant produces 100% CO_2. The CO_2 emissions rise as the grade of the ore decreases. Nuclear power produces CO_2 emissions that are equivalent to those of a gas-fired power station at ore grades of between 0.01 and 0.02% U_3O_8.[26]

g) The Takeaways from Prior Disasters

1. Three Mile Island Nuclear Accident

At Middletown, Pennsylvania, on March 28, 1979, a partial meltdown took place at the Three Mile Island Unit 2 (TMI-2) reactor. This location is in close proximity to Middletown. During an unplanned shutdown that caused significant damage to the core, the relief valve broke, which led to the worst nuclear power plant accident in the history of the United States. Fortunately, there were no injuries or obvious health effects. Better equipment, training programmes, and public education would have greatly improved the situation.[27]

2. The Nuclear Disaster at Chernobyl

The worst nuclear accident to date is regarded as having occurred at Chernobyl. It happened on April 26, 1986, when an unexpected voltage spike while testing the reactor systems caused an explosion and fire that completely destroyed Unit 4. Workers neglected to warn operators about the hazards associated with the electrical test or take proper safety procedures. The operators' lack of awareness caused them to take activities that were contrary to safety protocols. Large quantities of radioactivity leaked out and spread over western Europe and the Soviet Union[28].

3. Nuclear Disaster from the Windscale Fire

The Windscale, Cumberland (now Sellafield, Cumbria) Unit 1 nuclear reactor had a three-day core fire on October 10, 1957. It is believed that traces of the isotope iodine-131 may have contributed to several hundred cancer diagnoses after the Level 5 catastrophe spread radioactive pollution over Europe. During the British atomic bomb programme, Windscale's two piles had

[26] J.W. Storm van Leeuwen, *Contemporary CO_2 Emissions of Advanced Nuclear Power*, INDEPENDENT CONSULTANT MEMBER OF THE NUCLEAR CONSULTING GROUP, (SEPTEMBER 2019).
[27] Sue Sturgis, *Startling Revelations about Three Mile Island (Nuclear) Disaster*, FACING SOUTH, APRIL 3, 2009.
[28] Amalie Henden, *Chernobyl disaster: What caused the Chernobyl explosion? Who was to blame*?, EXPRESS, JULY 10, 2019.

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been hurriedly constructed. It was the worst nuclear disaster in UK history. [29]

4. The Nuclear Disaster at Fukushima

The 9.0-magnitude Great East Japan Earthquake that struck on March 11, 2011, knocked out the power and sparked three reactor meltdowns at the Fukushima Daiichi facility. The tsunami was 15 metres high. According to official statistics, a process of evacuation that resulted in the displacement of more than 100,000 individuals may have resulted in over 1,000 fatalities. According to later assessments, the infrastructure and risk forecasts weren't ready for such a terrible natural catastrophe. It was only the second accident in history to obtain the Level 7 classification, the most serious.[30]

5. Nuclear Disaster of Kyshtym

As part of the Soviet Union's effort to catch up to the US in terms of weapons-grade plutonium production, the covert Mayak facility, close to the Russian town of Kyshtym, saw the third-most catastrophic nuclear disaster in history. Rising temperatures caused an explosion with the equivalent force of 70–100 tonnes of TNT after a defective cooling system was allowed to deteriorate. Due to the secret nature of the facility, 10,000 villagers were only evacuated from the region a week after the nuclear fallout reached a distance of more than 300 kilometres.[31]

IV. EXAMINING THE LEGAL FRAMEWORK FOR NUCLEAR ENERGY CURRENTLY IN PLACE

The roots of energy law may be found in environmental law, which is also strongly related to development law. We have a well-established set of nuclear weapons laws under international law. Every state owes it to its citizens to organise its nuclear laws in accordance with the fundamentals of international law, including both treaty and customary norms. The demands of development and ecological requirements must be balanced with human aspirations. In light of this, a critical analysis of Indian nuclear legislation has been conducted.[32]

India must establish a more adaptable, viable, and effective domestic legal system in order to facilitate nuclear commerce without jeopardising public concerns about safety, the environment, and liability. This is in addition to accepting and accommodating these

[29] Process Industry Forum, *The Five Worst Nuclear Disasters in History*, available at https://www.processindustryforum.com/energy/five-worst-nuclear-disasters-history (last accessed on – 15 Dec, 2022).
[30] *Ibid.*
[31] *Ibid.*
[32] M. P. Ram Mohan, *Nuclear Liability Law of India: An Appraisal of Extent of Liability, Right of Recourse and Transboundary Applicability*, 17 JRR 115-131 (2014).

international obligations resulting from bilateral to multilateral agreements and arrangements. We look at the specifics of the domestic legal and regulatory framework that India may need in light of the massive expansion of the civil nuclear energy sector that is anticipated, along with the potential infusion of enormous investments as a result of the conclusion of extensive bilateral nuclear cooperation agreements and arrangements. Private sector involvement is conceivable to some extent. According to some, in order to achieve the technical and managerial criteria intended to safeguard the public's health, safety, and environment, a sound legislative framework is required.[33]

a. The Atomic Energy Act of 1962 has to be updated

The 1962 Act[34] was developed in the backdrop of India's effort to achieve nuclear energy independence. In that regard, the 1962 Act was a repressive law that only had a few narrowly defined areas to control. It hadn't considered large-scale nuclear energy trading at the time (or even later), nor had it considered private involvement in the advancement of nuclear energy. The 1962 law's scope and goals were consequently constrained, despite the fact that it was clearly stated in the preamble that it was intended to promote the development, regulation, and peaceful use of atomic energy for the benefit of the Indian people.[35] The law, in reality, makes no mention of what is intended by "peaceful purposes" and makes no connection between nuclear energy and environmental concerns or the need for society to conserve it as a resource.[36]

b. Inadequate Transparency Requirements

Even though it is acknowledged that the need for complete transparency is detrimental to the country's security, it is assumed that privatising nuclear energy's use for civil electricity production and attracting potential foreign investment to the market will necessitate some level of operational transparency in order to determine future liability should these changes materialise. Once private engagement in the civil nuclear energy industry takes hold, the prior perception of nuclear energy as a whole being secretive will need to change. While the strategic and military applications of atomic energy may continue under the current rules, the civil nuclear energy industry need to be made public. Naturally, security issues would be a significant exception. India should define some of these policy challenges in more precise legal terms given the country's expanding prominence in the global context and the increased transparency

[33] A. Vinod Kumar, *India's Nuclear Energy Renaissance: Stuck in the Middle,* 17 JRR 43-60 (2014).
[34] The Atomic Energy Act, 1962, Act No. 33 of 1962 [India].
[35] *Ibid.*
[36] IDSA Task Force, *Development of Nuclear Energy Sector in India,* INSTITUTE FOR DEFENCE STUDIES AND ANALYSES, GOVERNMENT OF INDIA, (NOVEMBER, 2010).

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standards that have been implemented on the domestic legal front.[37] Affected parties will be able to seek out the proper corrective actions thanks to the legal articulation of these straightforward policy principles. Any international duty resulting from any nuclear energy-related agreements would continue to be implemented ineffectively and haphazardly in the absence of sufficient legal articulation of these policy actions.

c. Goals and Environment Must Coexist in Harmony.

The objective of achieving energy independence and environmental preservation should be balanced by the legal system. With the development of additional reactors employing both domestic and foreign technologies, India is already aiming to triple its nuclear energy output. The current pace of this procedure has to be accelerated. One of the main obstacles preventing India from being recognised as a responsible nuclear power internationally is the fact that it is not a signatory to the NPT. Following the Supreme Court ruling on the Bhopal Gas[38] catastrophe, India has seen significant internal opposition to the construction of nuclear reactors. Additionally, permissions required by the Ministry of Home Affairs, Ministry of Defense, environmental laws, and coastal zone rules act as barriers to the participation of new parties in the industry[39].

d. Independent Governing Body

A fundamental principle of nuclear power regulation, as advocated by the International Atomic Energy Agency (IAEA) and implemented in the majority of nations, is that the safety regulator, in India's case the Atomic Energy Regulatory Board (AERB), must be impartial toward business and the executive branch. Then, free from political or economic intervention, it may make choices on its own that are solely focused on maintaining the right degree of care for public safety within a legal policy framework. The AERB should be more closely involved in emergency drills that take place on-site at nuclear power facilities, and the government should establish clear deadlines for NPCIL to draught and get permission for decommissioning plans. Regarding radiation and waste disposal, there are a few regulations and directives in place that were introduced in 2020–21. However, in light of political and social circumstances, it would be interesting to see how far and independently these directives would be followed in the years to come.[40]

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[37] Vishnu Konorayar, *Atomic Energy Law In India: An Analysis*, KLRI JOURNAL OF LAW AND LEGISLATION, VOLUME 1, (2011).
[38] Union Carbide Corporation vs Union of India, 1989 SCC (2) 540 [India].
[39] S.S. Bajaj, *Regulatory Practices for Nuclear Power Plants In India*, SADHANA, INDIAN ACADEMY OF SCIENCES, VOL. 38, PART 5, (OCTOBER 2013).
[40] Ajay Singh & Nalnish Singha, *Environmental Impact Of Nuclear Power: Law And Policy Measures In India*,

V. SUGGESTIONS FOR INDIAN NUCLEAR SECTOR

The Indian economy is expected to develop at steady and sustained high rates in the next decades, similar to the growth seen in the previous decade, which indicates that the world's need for energy would rise quickly. India's energy mix has to be more diverse in order to meet these demands while also taking into account the shifting patterns of fuel use throughout the globe and the unpredictability of future hydrocarbon availability and pricing. The present, very low proportion of nuclear energy in India's overall energy supply and the most recent revisions to the international regulations regulating nuclear commerce suggest that the proportion of nuclear energy in India's future mix of energy sources may increase quickly.[41]

Given the nation's very low natural uranium stocks and the highly developed fast reactor science and technology in the nation, it is important to hasten the Fast Breeder Reactors [FBRs] operationalization. Once created and operational, further FBRs must be built and put into service as soon as feasible. This will facilitate the reprocessing of spent fuel in India and have a multiplier effect, advancing the nation's civil nuclear energy production.

Further, the country's quick and accelerated nuclear energy growth necessitates significant adjustments to the way nuclear sciences and technology have been organised and promoted in the nation. Private money must enter the market, particularly if nuclear power output is expanded and a significant amount of additional cash is needed. Since the conditions in which the Indian civil nuclear programme is meant to be developed have altered, The Atomic Energy Act of 1962 needs to be modified appropriately. On the regulation front, before issuing any licence for operations, the licencing authority and regulatory agencies must make sure that all potential nuclear power plant operators have assurance of fuel supply for the life cycle of the plants. This is due to the country's limited domestic uranium reserves and the urgent need to increase the availability of reliable sources of energy.

VI. CONCLUSION

India has a proven track record of upholding strict security and safety measures in the context of nuclear technology and materials. India is among the top nations in the world for nuclear research and technology. In India, the private sector is anticipated to take the lead in the production of nuclear energy in the next years. The necessity for India to establish stringent

HUMANITIES & SOCIAL SCIENCES REVIEWS VOL 4, NO. 2, PG 88-95, (NOVEMBER, 2016).

[41] Harihar Shankar, and Sunjoy Joshi, *Development, Energy Security and Climate Security: India's Converging Goals*, (2010), available at http://globalenergyobservatory.org/docs/analysis_papers/Gupta_ORF_Conf_final(v10).pdf (last accessed on 16 Dec, 2022).

rules and regulations for stringent export restrictions on nuclear commerce and trade is shown by growing worldwide worries about non-state actors acquiring access to nuclear material and technology for illegal purposes. The safeguards that will be used on nuclear facilities and nuclear material in civilian nuclear operations must also be transparent and administered properly and rigorously.

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 [ISSN 2581-5369]

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 [ISSN 2581-5369]