IN THE NAME OF SUSTAINABLE DEVELOPMENT: SOCIO-LEGAL CHALLENGES OF NUCLEAR ENERGY AND SPENT FUEL MANAGEMENT

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Abstract

The spent fuel management of nuclear power reactor has two major concerns regarding storage and disposal. Law should comment specifically on the maximum duration of storage of spent fuel and it should ensure that no extended storages will deemed to be de facto disposal. The radioactive waste has potential to extend over several thousand years, it's always better to have sound spent fuel management schemes so that the future generations won't be burden by the debts of our generation. Retrieving spent fuel as a further resource will address issues associated with its disposal and security. Majority of laws have future applicability but while drafting nuclear energy/ radioactivity related laws we should provide a clause giving a window for applying technical and safety related advances with retrospective effect to the past activities. Or we should come up with legal principles which are retroactive (retroactive here would like to propose as those incidences which happened in past and still continue to do the same actively)[1] . Due to this new development in the spent fuel management, radioactive waste management will be applicable to the old storage, disposal or mining sites to have new outlook. Regulatory authorities should not only focus on present and future prospects but also required to do reviews of their past operating experiences and lessons learned through their policies. Better risk management is beneficial for shaping public perceptions, supporting spent fuel sites and its acceptance. Improved spent fuel management will not only beneficial for present population but it will also protect the rights of third and fourth generations. This paper also comments on the socio legal requirements across the back end of the fuel cycle. It also comments on necessary improvements in waste management from recycling activities, accident tolerant fuels, and political conflicts among the drivers.

1. INTRODUCTION

The growth of nuclear energy is always associated with the concerns of spent fuel management and nuclear waste management. For next few decades sustainable development through nuclear energy is going to be major area for public law and policy framing. Major policy arguments and disagreements are based on the conceptualizing various rights and duties of the governments, national and international organizations. Even after defining these roles and responsibilities, to get it legitimacy and approval from all corner of the domain at the local, regional, national and international level is another challenge. There was time when whole world was enthusiastic on having nuclear technology but very soon world leaders recognized that just power/supremacy won't suffice the purpose. It's now globally accepted truth that sustainable development is ultimate goal and nuclear energy can contribute to achieve it significantly. By the end of 2016 there were 448 reactors around the world[1] [1] and as of 1st July 2017, a total of 403 nuclear reactors are operating in 31 countries [3]. Director General of World Nuclear Association, in World Nuclear Performance Report 2017 said, "The world's nuclear power plants have performed well this year (2017), making a significant contribution to meeting the need for clean, reliable and affordable electricity. But more will need to be done to ensure this contribution grows as it will need to over the coming decades in order to meet the Harmony goal of supplying 25% of the world's electricity by 2050". The problem of energy crises needs to be answered considering common benefit and environmental philosophies. With increase in the population the demand for electricity grows faster than ever. For sustainable development nuclear energy is the perfect answer as compare to other forms of energy. The use of fossil fuels for electricity and energy generation has assaulted on air quality. To

[1] Retroactive law is a law that operates to make criminal or punishable or in any way expressly affects an act done prior to the passing of the law. (https://www.merriam-webster.com/dictionary/retroactive%20law)

improve urban air quality and reduce greenhouse gas emissions China is marching towards developing more nuclear power. Sustainable development can be achieved by having peace and using science. While educating about peace and sustainable development ignorance of science and technology may lead to aggression, exploitation, hatred and disaster. The ninth Secretary General of the United Nations, His Excellency Antonio Guterres has rightly pointed out that, "It's widely recognized that there is no peace without development and no development without peace; it is also true that there is no peace and sustainable development without respect for human rights [4]".

The correlation between sustainable development, technology and peace is not the modern discovery. All legal theories and philosophies of the world are backed by the ethics and values, and ultimately reach to sustainable development and welfare of mankind. For example, Indian legendry mythological text 'Bhagavad-Gita', deals with philosophical/ metaphysical thought and action with respect to sciences for peace and sustainable development through its small 700 verses. Bhagavad-Gita many a times referred as a poem of socio-political crisis. 'Bhagavad-Gita' is the same literature which was referred by J. Robert Oppenheimer when he witnessed the world's first nuclear explosion and saw the fireball glowing over the New Mexico desert at the Trinity test site on 16 July 1945 [5]. Robert Oppenheimer upon witnessing the explosion and imagining possible military application of the nuclear technology recalled the passage from the Bhagavad Gita, which says 'I am become death, the destroyer of worlds [6]'. Apart from national and international agencies the UNESCO under its ambit observes 'World Science Day' for Peace and Sustainable Development on 10thNovember every year. This celebration is nothing but the acknowledgment of the contribution of the science for achieving sustainable development to build peace and harmony in global society as a whole [7].

2. SUSTAINABLEDEVELOPMENT & NUCLEAR ENERGY

All UN members adopted a development agenda with 17 Sustainable Development Goals (SDGs) for the next 15 years from 2015 to 2030. The social, economic, developmental and environmental dimensions of the SDGs are leading to energy supply and with this aspect nuclear power becomes a key performer for sustainable development. Countries choose nuclear energy as a part of sustainable energy strategy because it broadens the resource base, expands electricity supply; avoid air pollution and greenhouse gas emissions [8]. The sustainable development is development that meets the needs of the present without compromising the ability of future generation to meet their own needs [9]. This widely accepted definition of sustainable development focuses on needs of present generation and the ability of the future generations, considering peace, development and environment.

The Johannesburg Declaration listed three pillars of sustainable development, namely economic pillar, environmental pillar and social pillar [7]. The 17 SDGs are aiming to eradicate poverty and achieve sustainable development. The Economic pillars of sustainable development are related to the maintenance, accumulation and use of different categories of capital (e.g. in natural category: mineral resources, forests, clean air and water). Relating nuclear energy to the economic pillar, it is observed that Uranium resources are vastly available than other forms of energy, the electricity generation cost and health damage cost are minimum with exploration of nuclear energy as compare to other forms of energy; though the cost invested in nuclear power plants construction can't be recover in shorter time but it is worth looking at the related benefits of availing nuclear power. The environmental pillar deals with the preservation on of natural resources, biodiversity, the protection of habitats and ecosystems and also makes sure that the carrying capacity of ecosystems is not depleted. The environmental dimension of use of nuclear energy for sustainable development primary seen as a decarburizing power system, the waste generated through nuclear power program is comparatively low than the other fossil fuel options and their side effects. The social pillar encompasses 'needs' as defined under the definition of the sustainable development and it includes food, water, energy, shelter and health, and can also extended to the areas of education, leisure, culture, political activities, good governance, social justice [7].

We can correlate these three pillars of sustainable development and nuclear energy with the 17 SDGs. Out of all 17 SDGs we can directly relates the 'SDG Goal-7: Ensure access to affordable, reliable, sustainable and modern energy for all' with the Economic pillar, the 'SDG Goal-9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation' can relate with social pillar and 'SDG Goal-13: Take urgent

action to combat climate change and its impacts' can be associated with environmental pillar. SDG Goal-7 of energy and SDG Goal-13 on environment are interlinked. The adequacy of resources is applicable to SDG Goal-9 (e.g. uranium resource adequacy).Reduction in waste generation will significantly contribute in complete utilization of resource. We can also relate and interlink SDG Goal-9 with SDG Goal-12 'ensure sustainable consumption and production patterns', the proper management of fuel cycle and waste management options result into sustainable consumption of uranium as a resource.

3. CHALLENGES OF NUCLEAR ENERGY AT NATIONAL LEVEL

Though nuclear energy is major player for sustainable development but this view is debatable as there is constant fear of risk of accident. Also there are radioactive waste management issues concerning environment and health. But the analysis says, total human health damage from nuclear power remains relatively low and comparable to the damage caused by most renewable energy sources and natural gas CCGT (combined cycle gas turbine) plants. Nuclear power can contribute to the mitigation of human toxicity and air pollution effects [12]. Opponents of nuclear energy raises question about its economic feasibility. The full cost of nuclear power needs to be examined. The direct costs of generating electricity across the lifetime of the nuclear power plant plus the related system costs of the plant need to be calculated. Environmentalists with above perception believe that nuclear energy is not economic option to adhere for sustainable energy source.

Many countries don't have complete independent national nuclear regulatory authority, which is creating doubt in public mind. Countries should build human resource conditions which are mutually acceptable to the suppliers also while doing contract. To avoid public protest it is desirable to have a viable tariff regime and all inclusive approach for site selection. Such public protest lead matter to the court of law causing delay in power generation. It is been observed that, the courts are optimistic and believes that, if all regulatory compliances are made and when national and international standards are also adhered in a power plant project then, there is very little possibility of a nuclear accident. It is evident that lack of transparency and awareness is reason for civil societies distrust in the nuclear power programme.

For building trust it is essential to take strong actions for educating the stakeholders. The fear of nuclear accident and its ill effects is the reason for public outrage and civil societies distrust. The inadequate liability structure and ambiguity in interpretation of certain legal provisions makes the problem more complex for the nuclear industry as well as for the beneficiaries. For the safety of nuclear industry at international level there are many soft law principles in place. But the only problem is that, they are just advisories. Such provisions are merely suggestions and are not mandatory for the state governments. Many a times implementation of such guiding principles is time consuming and it can increase the economic burden on the state. There is need to have strong regulatory as well as economic/financial global cooperative institution offered by nuclear industry for the welfare of the nuclear power sector itself. Such institution will help to promote universal financial and experts support and it will promote common safety culture.

There are many soft law principles relevant for national and international safety and security conduct. With respect to nuclear energy it is needed to have certain mechanism which will encourage implementation of such soft law principles. Though we have international forums to discuss national level innovations and share the experiences, still the best practices are not shared and encouraged with the immediate effect. Another national level challenge for the nuclear energy sector is public and stakeholders involvement. Along with interactive activities in nearby vicinity of nuclear power plant (NPP) site, it is suggested here to establish a knowledge management hub. This knowledge management hub will educate students of the neighbourhood, potentially engage local public, spread awareness and conduct small training sessions for livelihood and safety and security while coexisting with NPP. Such hub/ centre will promote belongingness, encourage trust building and will increase self-reliance of local population. This will help to overcome psychological fear of having NPP at neighbourhood. Such public engagements will prepare the public even for any kind of emergency.

Plant sites which are facing protest for commissioning of NPP should handle this issue with democratic way. Though delay in scheduled nuclear plant site causes economic loss but the mutual trust of local public in NPP is

prime concern. So in such protests, operation of activities associated with NPP should be halted for some time. In that time period, public should be given an opportunity to study and express opinion on the reports like Site Evaluation Report (SER), Environmental Impact Assessment (EIA) and the Safety Analysis Report (SAR). There should be an open scientific discussion on already submitted reports between the public and concerned authorities. Concern experts who prepared such reports should be allowed to participate in such dialogue. While addressing protest, government agencies should frame issues in consultation with stakeholders. Government agencies should show commitment to respect options generated together, priority should be given to resolve the dispute sooner, so that the associated cost with respect to developmental projects should not become burden further.

With following suggestions some of the national level challenges can be addressed. There should be two-way information exchange while resolving the dispute. Details of policy and programme of NPP should be clearly revealed. All the relevant parties should unanimously decide the criteria for involvement of stakeholders in consultation. Such opportunity of dialogue between public and administration will make stakeholders aware about the safety of NPP from all angles. At each NPP site there should be 'Local information committee'; and 'Publication of periodic assessments of facility performance report' made available to general public. Public consultation &involvement should be encouraged. It should be a continuous activity. Public hearings for matters relating to safety and emergency measures need to be carried out periodically. The reports of Onsite and Off-site emergency plans, mock drills need to be released to the local newspapers having potential number of readers. Though there is digitalization but still majority of the population is not techno savvy or E-literate, considering this, comments and reviews on such drills need to be released on printed newspapers. There should be separate social policies and supportive government programmes to provide cost effective electricity to poor masses. In developing countries it is general practice to provide electricity with some subsidy to particular class of marginalised population. When low cost electricity provided to the public then the burden should be bare by the particular host country and not by the investor/ supplier or by the Energy Company. The economic compromises and the financial burden should not be linked to the investment decisions and managerial practices of energy companies and their CSR activities.

4. SOCIO-LEGAL CHALLENGES OF SPENT FUEL MANAGEMENT AT NATIONAL LEVEL

Regarding nuclear energy one of the astonishing things is that as compare to other available energy sources, it is comparatively safest and environmentally approachable energy source and still it is considered to be most risky energy alternative by majority. There are international rules and regulations to direct national legal framework for nuclear energy and spent fuel management. Despite of settled international legal principles and guidelines countries adopt laws and policies which are suitable for their conditions and socioeconomic goals. Efficient handling of nuclear waste or spent fuel since start reflects comprehensive regulatory practices in a country. For sound regulatory practices it is not sufficient to have just administrative and executive planning but along with this it requires social and political will for excellence and common wellbeing. For sustainable development nuclear energy as a green energy is possible only if certain operational, technological and developmental issues are addressed. Spent fuel management requires techno economic innovations, best knowledge management and multinational collaborations to address prospective challenges associated with its transport and recycling.

Accountable spent fuel management has some challenges, particularly in a country which is destabilised or where country fails to be a responsible state due to dominance of non-state actors. It is real challenge to hold state accountable for any security breaks. In such circumstances it's difficult to expect legitimate national regulation [13]. World leaders are convinced that radioactive waste should be buried in geological repositories as a safe option. Whatever will be the sustainable development benefits nuclear power may have country can't avail it without local public support. Along with this, the management of spent or disused radioactive sources, including legacy sources and recovered orphan sources, continues to be a challenge in many countries [7].

Public involvement while formulating national and regional spent fuel storage /disposal policies, resources sharing, waste acceptance criteria, etc. will facilitate regulator as well as operator. Stakeholder's engagement since site selection till its closure and post-closure activities will certainly contribute for public acceptance of nuclear power plant. With changing time the safeguarding dimensions must change. The Ipsos Social Research Institutes

reports says that, 'the impact on global opinion is variable between countries and is does not appear to be lasting' [7]. Which means global impact of international standards on spent fuel management will differ between countries and there national stand will not be the final stand. It will vary time to time. This in a way justify of having different perspectives of countries towards spent fuel management and its safety and security. Experts are convinced that there are linkages between psychological factor, perceived risk and benefits received and all these factors support in building public perception. Immediately after accidents public opposition to nuclear power plants increases but after years of safe record with no accident dilutes the opposition. Also Studies indicate that 'lay people exhibit higher perceptions of risks involved with nuclear power compared to experts' [16]. Public sensitizing series at local and regional level about benefits and risk of nuclear program will result positively. All propositions about public awareness plans are proven to be true with the Swedish case. The extensive information programmes in four municipalities of Sweden has resulted into larger public acceptance of a local radioactive waste repository.

At national and international level important issue concerning nuclear energy is spent nuclear fuel and its management (SFM). Spent nuclear fuel can be recycled and many countries are positive for recycling of it. The reprocessing procedure separates the Spent Nuclear Fuel into 95% reusable uranium, 1% plutonium, and 4% highly radioactive waste product [17]. But such recycling of spent fuel was not promoted due to possibility of getting producing weapon grade plutonium which will risk the nuclear non-proliferation program. But the disadvantage of this approach leaded to huge amount of nuclear waste. While dealing with spent fuel and its recycling two possibilities are there: 1) recycles the spent nuclear fuel and get ample of reusable uranium along with possibly 1% plutonium, and 4% highly radioactive waste product; but this choice has possibility of violating and challenging non-proliferation measures. 2) Escape the recycling of spent fuel to adhere non-proliferation regime and to avoid production of small amount of weapon grade plutonium; but this second possibility of not reprocessing/non-recycling creates problem for storage and management of larger amount of spent fuel. For the definitive management of spent fuel, three options are being considered by nuclear power producing State, 1) The one-through cycle (the direct disposal of the spent fuel in the geologic repository); 2) The closed cycle, (the reprocessing of the spent fuel, recycling of the reprocessed plutonium and uranium, and disposal of the wastes from the reprocessing operations, 3) The 'wait and see' policy, which means first storing the fuel and deciding at a later stage on reprocessing or disposal. The major reasons for choosing reprocessing is it been the efficient utilization of uranium resources, appropriate conditioning of nuclear waste and further decreases waste volume and radio-toxicity. Even India's approach towards spent fuel management is to recycle it, as spent fuel is not considered to be waste.

5. CHALLENGES OF NUCLEAR ENERGY AND SPENT FUEL MANAGEMENT AT INTERNATIONAL LEVEL

The climate change not only affect food and water supply but results in to irreversible transformation of earth and which will hamper next generation's fundamental rights. Nuclear energy and low carbon technologies are potential options for energy security and environmental protection. International legal framework has always impacted positively on the national law and policy framing.

For a defined period of time it is safe and secure to store spent nuclear fuel in reactor pools and in interim storage. Many countries are recycling the spent fuel and there are also States in need to find out final disposal options. It is also clear by now that the spent fuel will have to be stored for longer periods than initially intended. Storage times of spent fuel may extend up to decades of years and beyond and that again increases the responsibility and liability regarding the safety and security of storage over such long period time. To have licensed storage facilities or to have jointly invested common storage facilities can be good option to share the burden [7]. Reprocessing of spent fuel will contribute in reducing environmental burden and promote sustainable use of nuclear energy. Spent fuel treatment may be difficult depending upon the type of the nuclear reactor. Reprocessing has become settled practice in some countries with considerable experience in this field. Country like India and China has ambitious nuclear power programme. It is require for economic development of the region.

IAEA's Ministerial Conference on Nuclear Safety (June 2011) resulted into Nuclear Safety (the Action Plan). Out of suggested 12 key areas under worldwide action plan, which are applicable to the sustainable development of the nuclear energy and the spent fuel management facilities are laid down here:

Undertake assessment of the safety vulnerabilities of nuclear power plants in the light of lessons learned to date from the accident, strengthen emergency preparedness and response, Strengthen the effectiveness of operating organizations with respect to nuclear safety, Improve the effectiveness of the International legal framework, Facilitate the development of the infrastructure necessary for Member States embarking on a nuclear power programme, Ensure the on-going protection of people and the environment from ionizing radiation following a nuclear emergency, Effectively utilize research and development, Each country running nuclear power program and those countries which are also looking forward for having common or joint repositories or spent fuel facilities must work on above guidelines suggested by IAEA.

6. SUGGESTION

At national level State have to have continuous evaluation of their safety and security plans for spent fuel and for the overall nuclear power program. It is State's own duty to learn and upgrade from their past evaluation reports and act presently to overcome those deficiencies. Definitely International safeguards/ guidelines and cooperation's are going to assist State's to have tried and tested standards but for the future advancements country has to look introspectively towards their own national goals/objective and international commitments for sustainability. Each State's implementation of safeguard should be recorded regularly and further cooperation should be stopped effectively until and unless requisite are fulfilled. If governments and policy makers convince people about contributing for sustainable development through nuclear energy then it might reduce the public resistance. Wider approach while having public interactions might ease the task. International organizations should prepare the fundamentals of socially sustainable radioactive waste and spent fuel management and global policy for the accountable management at national level. Physically safe, technically stable and socio-economically sustainable management of spent nuclear fuel should top the agenda for international conferences and seminars.

Whether direct disposal or reprocessing is involved, multinational nuclear power companies can be expected to minimize the costs associated with their responsibility for the final phases of the nuclear fuel cycle. If one or more countries are able to set up functional repositories then both governments and nuclear power companies are likely to regard them as attractive. In other words, a relatively small number of financially robust multinational corporations may eventually be able to fund the management of spent nuclear fuel in many countries.

In the government to government financing for nuclear projects, the financing government on the very primary level should insists to the receiving government to have strong regulatory framework on safety and security as well as make sure that the safeguards/ non-proliferation aspects of spent fuel & radioactive waste management are well in place. Internationally it should be made mandatory for the financing government to make sure fulfilment of these conditions before engaging in contract. Cases where it is technically not possible to make it happen, then the financing government should be ready to share the joint responsibility for any lapses in these conditions resulting in to any kind of damage. Internationally there are examples of certain countries engaged in the government to government financing for nuclear projects (e.g. Russian Federation in a number of countries, including Bangladesh, Belarus, India, Viet Nam, Nigeria and another e.g. is China in Pakistan) [19]. Financing and cost issues have changed the perspective to look at the management of spent fuel and nuclear radioactive waste. Country's having involvement of private industry partners and who don't have complete government ownership on the nuclear program are facing problems matching private sector's benefits and public policy. The conflict between private profit and national/international policy framing may intensify depending on the chosen options and mechanisms for spent fuel management. Chosen method for spent fuel management is not only under scrutiny of local interested parties but also has an eye from international NGOs and civil societies like Greenpeace International. We can also apply Respondent Superior principle which says, 'let the superior be liable'. We can refer this in cases where one State finances to the other State and the financing State when fail make it a point to monitor adherence of international guidelines in the respective state.

The first use of nuclear energy was for the military application and the reminiscences of Hiroshima and Nagasaki are still so strong. The deterrent effect of nuclear weapons is constantly discussed in the global and regional public domain. All these factors negatively hamper the acceptance of nuclear energy even for civilian purpose and for sustainability. The non-proliferation of nuclear weapons and the existence of nuclear weapons on the other hand, both in the present situation have lost their credibility. We are forced to believe this proposition that; the deterrent effect of nuclear weapons is of no use when it comes to the terrorist attacks and state sponsored terrorist activities. Both of these global realities creating chaos at the local level making it difficult for the operator's and regulators to have public support for nuclear power program. Apart from this the another hurdle for public acceptance is political leadership, which now and then remind of ill effects of the nuclear weapons if being used against the neighbouring country. And the vicious cycle of blame game in the international geopolitical domain start, again resulting in to doubts for acceptance of nuclear power. The psychological warfare mechanisms might be helpful form defence perspective but they are negatively impacting civilian nuclear programs acceptance. So, the hype and the glorified discussions of the military/defence applications of the nuclear energy should be control/limited then it might be in real sense permit IAEA to achieve its actual objects. Once public is convinced for nuclear power project, then it won't be that difficult to implement spent nuclear fuel management guidelines.

7. CONCLUSION

Management of spent nuclear fuel and radioactive is always a matter of national responsibility. The legitimacy of the representative government, as a national democratic government plays important role when it comes to formulation and implementation of the robust legal and policy framework. This legitimacy includes legal as well as moral principles in its policy framing and in execution. Such management will be needed until nuclear power has been replaced by other types of energy and radioactive waste has been reprocessed and/or stored on an interim basis and placed in a final repository. If uses are found for the spent nuclear fuel, then it will take little more time for final disposal. Providing energy security to all nations and regions is a major challenge, and to achieve it with the help of nuclear energy is a sustainable option.

Each generation must manage its own spent nuclear fuel, for this we can very much apply environmental law and sustainability principles. The way spent fuel is generated it should be dispose of. Dumping can't be a sustainable option. Deep geological storage and transmutation of the spent fuel can be treated as an assault for future generations, violating third and fourth generation of Human rights. 'Eodem modo quo quid constituitur, eodem modo destruitur [20]' which mean, 'in the same manner by which a thing is constituted, it is destroyed'. If the solution for spent fuel management will be like above maxim then there won't be any difficulty for public acceptance. Whatever is the spent fuel generated it is the responsibility of the producer. If this is to be followed, then spent fuel management issue will be resolved shortly.

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