Is Pursuing Nuclear Energy in India's Strategic Interest?

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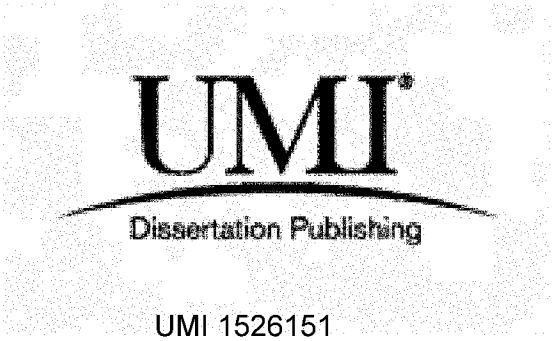

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Approved

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Abstract

As a developing country with the second largest population in the world, India's energy needs will continue to grow steadily in the coming decades. A significant proportion of India's oil, coal and natural gas are imported because of a dearth of indigenous energy resources. This creates a situation of energy dependence and is a potential national security issue. As a result, the government is embarking on an ambitious plan to have nuclear power generate 25% of electricity in 2050 – up from 3.7% in 2012. The aim is to be running on thorium fast-breeder reactors, that are currently in development, by that time. India's vast reserves of thorium would mean that this would improve energy security, while also improving access to energy for the large part of its population that remains without it.

However, nuclear energy is controversial. Issues of safety and viability must be addressed adequately if nuclear energy is to be pursued. Civil-society concerns about the displacement of people and the degradation or changes in environment around plants and its consequences must also be appropriately addressed. The aim of this paper is to ascertain if it is indeed in India's strategic interest to invest in nuclear energy. Within a theoretical framework of energy security the paper will seek to identify what changes should be made in the sector to guide and manage the process of expanding nuclear-power generation is also important if prescribing this course of action.

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Key Definitions

Term	Definitions
AERB	Atomic Energy Regulatory Board
CSC	Convention on Supplementary Compensation for Nuclear Damage (1997)
EIA	US Energy Information Administration
EPA	U.S Environmental Protection Agency
EPR	European Pressurized Reactor
EU	European Union
GW	'GigaWatt' - A measure of electricity- 1000 MW makes a GW
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IMF	International Monetary Fund
JNPP	Jaitapur Nuclear Park Project
MW	'MegaWatt' - A measure of electricity
NPCIL	Nuclear Power Corporation of India Ltd
NPT	Treaty on the Non-proliferation of Nuclear Weapons (1970)
NTPC	National Thermal Power Corporation
Planning Commission	The Planning Commission is an institution in the Government of India, which formulates India's Five-Year Plans, among other functions.
Social Justice	Social justice is the ability people have to realize their potential in the society where they live
Supply Shock	An unexpected event that changes the supply of a product or commodity, resulting in a sudden change in its price.
Utilitarianism	Utilitarianism is a theory in normative ethics holding that the proper course of action is the one that maximizes utility, usually defined as maximizing total benefit and reducing suffering or the negatives
WCA	World Coal Association
WNA	World Nuclear Association

List of Illustrations

Thesis Statement

This paper will seek to establish that making nuclear energy a growing and central part of the energy matrix of the country is in India's strategic interest. This will be done by first laying out all the information deemed necessary for analysis. Energy security theory will be the framework employed to structure the argument. Then the analysis will look at whether energy security is enhanced by pursuing nuclear energy. The issue of safety and the ability of the country to implement reforms in regulation and adequately provide for those adversely affected in keeping with their human rights and norms of social justice will also be elaborated.

Literature Review

Looking at empirical sources was necessary to gain a holistic picture of India and its energy sector. As a starting point, the CIA Factbook's (2014) and the World Bank's (2014) country pages for India were used for basic statistical information – primarily demographic but a general overview of India's energy situation was provided by both. The Planning Commission of India's (2012) five year plan for energy called 'Integrated Energy Policy - 2012' was used to garner more detailed statistical information and also establish the direction India was taking with its future policy. The Planning Commission's constitutionally sanctioned role at the time of establishing five year plans that would shape state policy make it uniquely placed as a reliable source of information showing

especially the government's perspective on the issue. Their statistical information is considered to be of sound standing.

Various other sources for empirical data were used. Among them, news sources such as The Times of India, BBC, CNN and The Hindu were used for statements and information about relevant events. Care was taken to only use publications of repute and even then the information taken was strictly factual. Arguments by journalists were deliberately not used as corroboration to the arguments in the narrative. They were used to show the nature civil-society and media opinions where it was relevant to the argument.

The World Coal Association online resources (2014) were used for information about making coal more efficient and its viability. The Association is a global industry association comprised of various coal producers and stakeholders and is a credible source of information on matters relating to coal. Their information on clean-coal technology and how it can improve efficiency was important to know since India, even if it invests in nuclear energy in a big way, will still use coal to generate the majority of its electricity as far ahead as 2050.

The World Nuclear Association (2014), similar to the World Coal Association, is an association comprising experts in the field whose mandate is to "provide a global forum for sharing knowledge and insight on evolving industry developments strengthen industry operational capabilities by advancing best-practice internationally" (WNAc, 2014). The nature of the WNA would make it biased towards supporting nuclear energy, however, the statistical information it

provides is credible and this is what the website was used for. The website is cited repeatedly in certain sections of the text that may be perceived as a weakness. However, it is not cited in a way in which the arguments are being borrowed. Most of the citations are specific information, statistical or factual, that are relevant to the paper for which the WNA is an ideal source given its expert capacity.

. The online resources of the International Atomic Energy Agency too was a major source of information on nuclear energy especially its self-published 'Convention on Supplementary Compensation on Nuclear Damage' that is the international agreement on compensation if there is any damage as a result of nuclear energy (IAEA, 1997).

Venkataraman's (1991) book '*Bhabha and His Magnificent Obsessions*' was used as to illustrate the vision of the architect of India's nuclear power program through the three stages culminating with the third that involves power-generation with Thorium fast-breeder reactors. This is relevant because the Indian state is still using his vision half a century later to shape the trajectory of growth of nuclear-power generation in the country.

Economic and International Relations theory was used over the course of the paper to enhance understanding. The theory of externalities that was used to illustrate the hidden costs of fossil-fuel consumption was found on the website of the IMF (2014). The theory was also applied to assert, qualitatively, the positive externalities of nuclear energy because of the impact it has on the environment by cutting green-house gas emissions.

Subhash Mallah (2010) writes about nuclear energy, sustainable development and energy security from an economic standpoint. He outlines India's current energy situation and explains the growing pressure from the international community to cut greenhouse gas emissions. He corroborates the idea that nuclear energy is sustainable and has a positive externality on the environment. Mallah asserts that it in the interest of energy security and the environment, India should pursue nuclear energy.

The discussion on Chernobyl and the implications of a nuclear disaster was sourced primarily from information from The Green Facts Initiative (2014). The Green Facts Initiative (2014) is an institution who's "mission is to bring the factual content of complex scientific consensus reports on health and the environment to the reach of non-specialists." They use reports from the WHO, FAO, IARC, UNEP, and the European Commission to generate concise and more readily comprehensible material. It is an ideal source for factual information about Chernobyl to inform thinking on the argument of this paper. They portrayed the enormous damages caused by the Chernobyl crisis – enough to assert that another crisis of this kind is unacceptable.

Richard Tanter's (2013) article from the journal 'Asian Perspective' entitled 'After Fukushima: A Survey of Corruption in the Global Nuclear Power Industry' explains the presence of regulatory capture and corruption and its dangers citing Chernobyl and Fukushima as examples. Tanter's argument underlines an important area for the state in India to work on to improve its own nuclear-power generation program.

Jeff Kingston's (2012) chapter titled 'Japan's Nuclear Village' from his book 'Critical Issues in Contemporary Japan' outlines the structure of the nuclear sector in Japan. He corroborates Tanter's argument about the hazards of regulatory capture by showing how this process operates in the Japanese nuclear regulatory mechanism. Much like Tanter's, Kingston's work highlights the needs for reform in India's regulatory apparatus if the nuclear power generation is to minimize the chance of human or mechanical error program is to be as safe as it can be.

Levi and Ferguson's (2006) article entitled 'US-India Nuclear Cooperation: A Strategy for Moving Forward' contained information on the transition of the relationship of India's civilian nuclear sector with the world's. The agreements made by the Indian Government with the US, France and Russia were explained in detail. The idea that the opening up of the sector to international scrutiny, supervision and monitoring will improve regulation domestically and also create a safer program was found here. Mistry (2014) outlines many of the same details and corroborates the idea that improvements will be seen in the monitoring and regulation of India's nuclear program.

Ramana and Rao (2010) in 'the environmental impact assessment process for nuclear facilities: An examination of the Indian experience' explain in detail the deficiencies in the current regulatory mechanisms emphasizing the lack of transparency and suspicion of vested interests. They propose many changes to the process and include a suggestion for how the government can meaningfully engage civil-society participation in coming up with strategies to move forward

with plans for nuclear energy. They imply that increase in transparency levels would make civil society opposition more constructive and that India can learn from the U.S system of regulation in the nuclear sector.

Bidwai's (2011) piece on the Jaitapur plant was used as a source to understand more about the civil society concerns in the immediate surroundings of the plant. His research sensitively portrays the fears and the uncertain futures facing the communities around the plant's site who face relocation or a loss of livelihood. He is also a voice of dissent against the nuclear program in India – and his argument that 'there is no global renaissance' and that India should abandon its nuclear program is used as a foil to the argument put forth in this narrative. Chopra (2011) too writes informatively about the issues surrounding the Jaitapur plant and is sensitive to the plight of the surrounding communities.

The models in Graham Alison's (1971) seminal work '*The Essence of Decision*' that explain the different forms of decision-making by governments was used to see what kind of decision-making has been seen in the state's decisions on nuclear energy. This was done with a view of predicting whether the reforms that are necessary in the sector will be forthcoming given the government's decision-making style. The conclusion was that it is safe to be cautiously optimistic about the government's role in perpetrating reform.

Andrei Belyi's (2007) work on energy security and positive and negative dependency in 'International Energy Security Viewed by Russia' was applied to understand the interplay of the national and energy security spheres in India. His

work indicates that India is indeed in a vulnerable position and should act to remedy its weakness.

The definition of 'Human Security' adopted at 2005 World Summit (UN World Summit, 2005) was used as the measure for ascertaining whether nuclear energy would enhance or diminish the well-being of people in India. Taking the arguments made in the analysis section as a whole, and looking at the magnitude of people that would benefit from nuclear energy, it is asserted that pursuing nuclear energy is indeed in the interest of human security.

The definition used by the National Defense College of India (1996) for national security was used as part of the analysis. In International Relations theory there is no universally agreed upon definition for the concept of national security. The definition of the National Defense College, in this regard, is useful because it is reasonable to assume that it is the same definition, or is at least very close to, the definition used by the Government of India. This provides a window into attempting to understand how pursuing nuclear energy is viewed in the context of national security by the Indian state.

Cherp and Jewell's (2011) framework for understanding the problem of energy security will be the framework that supports the argument of the paper. Cherp and Jewell argue that the old manner of answering questions about energy security which involved asking a specific questioning like 'do we need to reduce dependency from oil and answering them is ineffective when tackling the energy problems of today. The way they propose to address the question of energy security is finding an integrated solution to a complex situation and not in

isolating variables that are not isolated when it comes to their behavior. Applying their theory to India's energy situation, the case for a pursuit of nuclear energy becomes strong.

Research Methodologies and Limitations

The aim of this research paper is to ascertain whether it is in India's strategic interest to invest in nuclear energy. In a bid to do this, reliable sources of empirical information were used to paint a picture of India's demographics and energy situation. Some of these sources are the World Bank, the International Atomic Energy Agency and India's Planning Commission. Information on energy was gleaned from sources such as the World Coal Association and World Nuclear Association. Even though these organizations are deeply vested in their interests, the statistical and factual information they provide can be considered reliable. An array of sources including newspaper articles and opinions from civil society were used to gain more knowledge about events, updates and opinions on the issue. The opinions from these sources were used strictly as indicators of opinions about the issue – not as authoritative arguments made by academics. Scholarly articles were used to explain concepts such as energy security, environmental sustainability regulatory capture and the nature of India's regulation sector etc. They strengthen analysis in appropriate areas.

For the analysis, a theory of energy security was employed to provide a framework in understanding the issue and reaching a conclusion. The modern concepts of human rights and social justice were employed to complement this classical theory that addressed these issues but in a manner very different from what is construed today.

An obvious limitation of the paper is an inability to go to a nuclear plant in India or a site at which the plant is being constructed. This would have been good

for research but proved impractical to implement. Though an attempt was made to meet someone from the Department of Atomic Energy, this proved not feasible as well. The person I contacted and told that this would provide me with whatever answers I sought guided me to the website of the Department of Atomic Energy. A meeting with someone from the department would have given a unique perspective on the government's view on nuclear energy. An approach with arguments backed more by quantitative analyses could possibly have resulted in more concrete courses of action for the government to take. An in-depth discussion on renewable sources and their potential may also have helped in strengthening the argument.

However, the variety of renewable sources such as hydroelectric, solar, wind and tidal would require a detailed examination of the benefits, current feasibility and projected future technological advances to do justice to the broaching of this topic. The general consensus, however, among academics, is that renewable sources don't have the potential today and most likely will not even in future of to meet the energy demands on the scale that is required for a developing India. This consensus was accepted to make the argument more focused and compact. This is still a limitation and must be acknowledged as such. There were many articles that were two or sometimes three decades old. The topic of nuclear-power generation in India is lacking in scholarship but has many opinions from the state, the media and civil society which are not as credible – this forced me to build my argument from the raw data and factual information I

had available. The argument may have been more nuanced with more scholarship to go by.

Narrative

Thesis Introduction

India, in broad but sweeping terms, can be described today as a large and developing country. India has a large land mass and a population of nearly 1.3 billion people, that is projected to rise to 1.6 billion in the near future, thereby surpassing China (CIA Factbook, 2014). India is portrayed as a logistical giant because of this. India's growth rate has varied in the last decades going from as high as 8% to as low as 3-4% over the past decade (CIA Factbook, 2014). It is projected that India will continue to grow at a minimum at moderate rates in the future. Given India's status as a developing country and its large population size, it is projected that there will be a significant need for energy in the future (Hiscock, 2014). To this affect, Hiscock (2014), who authored 'Earth Wars : The Battle for Global Resources' titles his article 'Securing India's energy a major challenge for new Prime Minister Modi' in anticipation of Modi beginning his tenure as the Prime Minister of India.

Providing energy to citizens who do not have access to it is imperative and it is also equally important to ensure that energy will be available to meet the demands placed by growth. India is comparable to China in its potential need for energy even though it does not currently have China's financial resources and political clout worldwide to secure energy supplies. Brazil is another country that has similar demographic challenges, but as an energy producer the dynamics are different. Russia and the United States, as the other two comparably large countries are on different levels in the development scale and are also energy

suppliers. In this context India finds itself in a vulnerable position when it comes to energy security.

India's primary source of electricity production is coal. The online database of economic indicators, 'Trading Economics', takes data from the World Bank and shows that in 2011 68% of India's electricity came from coal (Trading Economics, 2014). 20 % of this coal is imported and the percentage of imports may grow given logistical and environmental challenges in indigenous production (Economic Times, 2014). Oil too is mostly imported with very little domestic supply. However, it is used widely but not in a clean manner. Natural gas is cleaner but it too is imported. India, in conclusion, is an energy dependent country.

Coal and oil being used in a manner that is not optimizing their potential to be used cleanly are causing grievous harm to the environment in India. Half of the 20 most polluted cities in the world are in India (Park, 2014). The health costs of this are already being felt by people suffering from various ailments but will also be felt by the State in the future if this issue is not addressed.

Additionally, even though India has large deposits of coal, the reserves are not vast enough to sustain India's development into the future (Das, 2014). Coal as the fuel to power development is also an issue given the high costs to people and the state from the burning off fossil fuels. Oil is imported and India is dependent on the world for almost all of its supply. For natural gas as well, India is largely dependent on supplies from abroad. (World Bank, 2014).

Energy independence, at least to a degree, is essential for any nation aspiring to be a global economic and political power. Energy independence is an issue that should be understood in terms of national security for India and will become even more pronounced in the future.

The Planning Commission of India (2014), the Indian Government's policy making arm, explains on its website that "some 600 million Indians do not have access to electricity and about 700 million Indians use biomass as their primary energy resource for cooking. Ensuring life line supply of clean energy to all is essential for nurturing inclusive growth, meeting the Millennium Development Goals and raising India's human development index that compares poorly with several countries that are currently below India's level of development."

The excerpt from the Planning Commission's 5 Year Plan shows the commitment of the Indian state to provide energy to its people. On the other hand, the fact that 600 million Indians do not have electricity implies that growth, which if it is to be as inclusive as the State intends, will bring more and more people into the cycle of energy consumption. For the people already in the cycle, growth would bring many opportunities but it would also bring a rise in demand for energy. As such, 'energy security' is a very pressing concern for India. Balancing demand with supply and aspiring towards some sort of independence or at least sustainability in dependence is of great importance.

The definition used by the Planning Commission for 'energy security' provides a starting point in understanding the domestic debate over the issue from possibly the most significant local decision-making body in the field. The Commission notes, "Energy security is defined in terms of reasonable assurance of access to energy and relevant technologies at all times with an ability to cope with sudden shocks. Energy security does not mean complete energy independence, it only means an ability to meet reasonable requirements with reasonable assurance of stable supply or an ability to pay for import needs" (Planning Commission, 2014).

It is apparent from this definition that the Commission does not see energy independence in the simplest sense for India in the near future. India is an energy importer when it comes to oil and gas – and approaches levels of independence only when it comes to coal (World Bank, 2014). India is projected to become even less independent not just in oil and gas sectors but even with coal. By 2031, it is projected that the supply of energy will need to quintuple to meet domestic needs (Planning Commission, 2012).

The same source provides a statistical estimate of India's energy needs projected in the future:

> "India needs, at the very least, to increase its primary energy supply by 3 to 4 times and, its electricity generation capacity/supply by 5 to 6 times of their 2003-04 levels. With 2003- 04 as the base, India's commercial energy supply would need to grow from 5.2% to 6.1% per annum while its total

> primary energy supply would need to grow at 4.3% to 5.1% annually. By 2031-32 power generation capacity must increase to nearly 800,000 MW from the current capacity of around 160,000 MW inclusive of all captive plants." (Planning Commission, 2012)"

The statistics are quite stark – energy supply must grow significantly to keep up with growth in the country. Also, the 'growth' of the economy does not account for all of the 600 million currently living without proper access to energy who, as the Planning Commission has acknowledged, are all entitled to energy as citizens of the State. The Commission does intend to ensure that these citizens too can enjoy the benefits of energy in the future. Access to energy is a key factor in improving the prospects of upward mobility of those who are poor. Furthermore, access to energy allows for more efficient and productive living standards, improves access to healthcare and other important spheres of life, such as education and gives the energy consumer a greater possibility of living in accordance with their human rights. In a developing country that aspires to be a global power, the provision of energy to its citizens should definitely be an important issue and is considered as such in India.

In light of all this, nuclear energy as an alternative source of energy becomes an interesting proposition. It is sustainable and clean and capable of supplying large swathes of population that is something renewable sources may only be able to do in time. As of now, they are too expensive and scaling up is

difficult. An India that uses more nuclear energy to power itself would be more energy independent and cleaner from an environmental standpoint as well making the country more secure. However, there are drawbacks such as ensuring safety and the presence of popular support that is important in a democratic country.

This paper will explore the debate around nuclear energy in India. The hypothesis will be that it is in India's interest to invest in it strategically. Theories of national security and government functioning will be employed to better understand the issue and the challenges posed to the State if it pursues the nuclear path in its bid to ensure energy security.

Framework of Energy Security

Questions of energy security, according to Cherp and Jewell (2011) can not be broken down into isolated problems. Doing so may make analysis simpler, but the analysis will not be as fruitful unless the complexity and interdependence of different parts of the system are accounted for. They say, "the need to take into account vulnerabilities of complex technical systems, the global limits, and the role of markets and investments brought natural science, engineering, and economics in the orbit of energy security discourses."

Speaking about the evolution of the energy security discourse, they write "at the same time, the most notable idea in the energy security community in the last decade has been that these diverse challenges to energy security, which had historically been tackled separately, have recently become increasingly entangled."

Their model for understanding an energy system and its challenges is presented in the figure below;

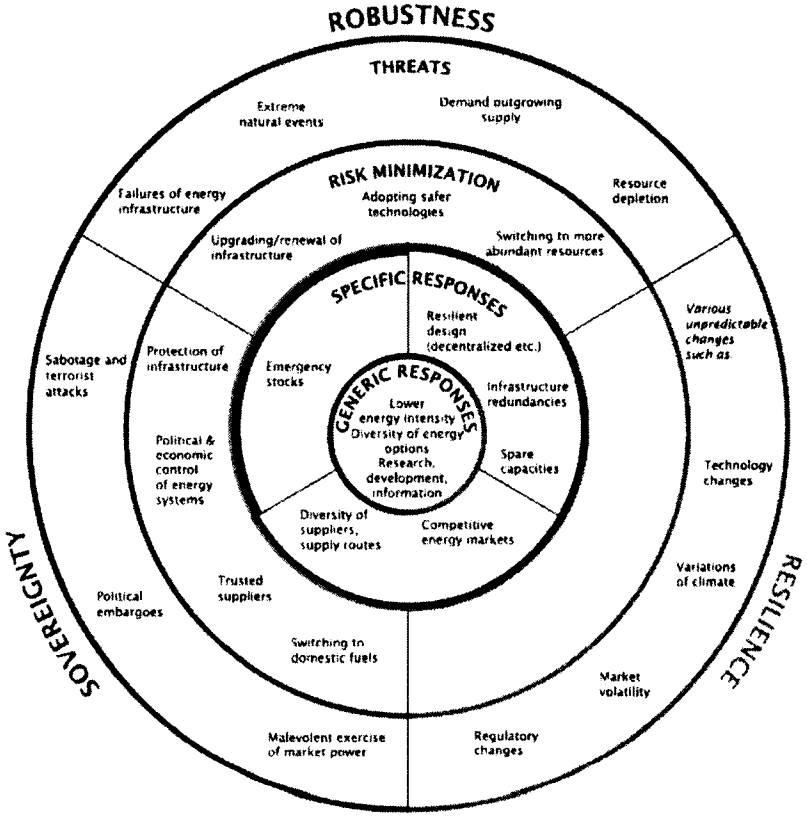

Figure 1 – Cherp and Jewell's Energy Security Framework

Applying this framework to the Indian case, we can draw some quick conclusions. In the realm of 'sovereignty', India has issues that come from being an importing country. A reduced dependence on imports would improve 'sovereignty'. In the realm of 'resilience', India is susceptible to market volatility and should protect itself from that. Market volatility and 'resilience' tie in with the concerns over sovereignty. Regulatory change, another factor in the 'resilience' realm, can be a tool to improve energy security. Currently, the regulation of the sector for coal is poor. And also, as will be discussed later, enhanced regulatory mechanisms can create better outcomes in the nuclear energy sphere as well – indeed, they are necessary to safely pursue nuclear energy. In the 'robustness' realm, the

shortcomings of coal become apparent. Coal is harmful, in the manner it is currently processed and the reserves of its supply are already being outstripped with demand. An increase in the dependence of nuclear energy, and a decrease in dependence on coal would improve 'robustness'. The decrease in emissions that would result from a move toward nuclear energy would also have significant environmental outcomes. This enhances 'robustness' as well. A gradual shift to thorium as a fuel would also improve 'robustness' further since thorium is widely available in India where uranium would have to be imported.

The short application of the framework will be what is elaborated on over the course of the narrative to make a case for the pursuing of nuclear energy and making it a greater part of India's energy matrix in the future from an energy security perspective.

The Externalities of Fossil Fuel Consumption

India, as mentioned earlier, plans to increase its number of coal-fired power plants as a part of its strategy in trying to provide energy in its bid for growth and inclusive development. (Planning Commission, 2012). The reason that coal is fashioned as the bedrock of the strategy to the energy issue is that is readily available, both domestically and from abroad, is simple to process, and is 'cheap'. This makes it more suited the task than nuclear energy that requires a higher investment and a high level of expertise to manufacture, or renewable sources that are similarly expensive and not scaled up so readily given existing technology.

However, the argument that coal is 'cheap' is simplistic. It is more accurate to say that the 'private cost' of coal is cheap. The theory of 'externalities' can be applied here to establish that the 'societal cost' is far higher than what the market rate would suggest. The glossary of the OECD (2014) defines externalities as;

> "Externalities refer to situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided."

Externalities are of two kinds – positive and negative. The building of a road is an example of a positive externality. The actual cost of building a road for

the builder is often smaller than the benefit to society – the people whose lives are improved because of the road. Pollution is the oft-cited example of a negative externality. The price of pollution to the seller and buyer does not account for the substantial costs to society of the consumption of the fossil-fuel in question. In this case, air pollution caused by the burning of coal is a negative externality with a great cost to society.

'Resources for the Future', an organization that seeks to improve environmental and natural resource policy planning through scientific research explains, in an article titled, 'The Hidden Costs of Power'

> "Air pollution produced by coal-fired power plants has been linked to premature deaths from lung cancer, respiratory illness, and heart disease. Studies have found air pollution to increase the incidence of diseases such as chronic bronchitis and asthma, as well as heart attacks and strokes."

A Greenpeace report on coal use in India estimated that in 2011-2012 between 80,000 and 115,000 people died prematurely from coal pollution. Another 20 million people developed asthma over the same period because of exposure to particle matter that was a direct result of emissions from coal. The study also estimated that the health cost to Indian society of coal use was upwards of 3.3 to 4.4 billion USD. The study quantified the cost of hospital stays, lost workdays, and effects of bad health on life. The World Bank in a 2005 study (World Bank, 2005) estimated that around 460,000 people die every year

from air pollution in the country as a whole. The figure is larger because it includes emissions from the burning of oil and other sources of air pollution as well. Oil, as mentioned is another source of fossil-fuel energy that is subject to similar arguments when it comes to energy security and India's national security as coal.

The value of lives lost and the impact on people affected by the death of loved ones who may even be the primary bread-winners for a family is not quantifiable but hugely significant and must be kept in mind as well.

In what was a troubling observation from the data, Greenpeace (2014a) noted;

> "Demographically, adverse impacts are especially severe for the elderly, children, and those with respiratory disease. In addition, the poor, minority groups, and people who live in areas downwind of multiple power plants are likely to be disproportionately exposed to the health risks and costs of fine particle pollution."

Given the magnitude of the deaths, and the greater magnitude of people with health concerns because of pollution, a perceived sense of injustice by the poor or the minorities could be a cause for national security concern for India if these communities choose to organize around this issue. The Indian state is already dealing with a plethora of issues such as a Maoist insurgency, an intermittent insurgency in Kashmir and more traditional minority and poverty issues that are tied to economic well-being and opportunity.

Pollution, depending on the severity of the issue as time goes by, could be another flash-point for community organization against the state. To call it an issue of national security would not be doing justice to the disenfranchised people with a valid grievance. It is better to say that it is the state's responsibility to ensure that the burden and costs of pollution do not fall disproportionally on the poor and the marginalized communities of the country. The injustice of their plight is compounded by the fact that they are most likely to not even be a part of the majority that has access to some forms of modern energy.

The scale of the issue of pollution from coal is likely to deepen in the future. At 210000 MW, India has the fifth-highest coal power generation in the world. Based on information from the Planning Commission the use of coal as a fuel source is likely to deepen over time with 76000 MW slated to be added in the latest plan (The Twelfth Five Year Plan - 2012-2017) and 93000 MW is estimated to be the target for the next (The Thirteenth Five Year Plan 2018-2023). This nearly doubles the amount of coal being burned. As things stand the amount of emissions would double as well and the detrimental effects of that would not be proportional.

This demonstrates that resilience, sovereignty and robustness in energy security will all be enhanced by decreasing a dependence on coal.

Technology exists that can make the processing and use of coal a cleaner process. Similar technology exists for oil as well. However, incorporating this technology into production would require political will and significant investment that the government does not seem to be willing to make in its push for breakneck

inclusive development. Though the will to modernize is laudable, the calculations that go into the cost-benefit analysis at the time of policy planning do not appear to include the social cost of the negative externality of production.

The IMF (2014) explains why the government has an important role to play in tackling the issue of pollution externalities;

> "Externalities pose fundamental economic policy problems when individuals, households, and firms do not internalize the indirect costs of or the benefits from their economic transactions. The resulting wedges between social and private costs or returns lead to inefficient market outcomes... Although there is room for market-based corrective solutions, government intervention is often required to ensure that benefits and costs are fully internalized."

There is almost no probability of weaning the country away from coal and oil in a short period of time. Cleaner coal is a possibility but increasing the proportion of renewable energy is a potential solution as well. However, as mentioned earlier, given current technology, meeting the energy needs of 600 million people who still live without electricity is not possible today. In view of all this, the case for nuclear energy that is more sustainable for the environment and for society becomes stronger. The government has an important role to play by making decisions to facilitate a better outcome for society. Nuclear energy is

already a part of the energy matrix – and its use in generating electricity is set to increase as a proportion. As Mallah (2011) explains 'the advanced nuclear energy with conservation potential scenario shows that huge amounts of CO2 can be reduced in the year 2045'. A more concerted effort to accelerate the process or increase its weight in the matrix may be in the country's strategic interest – environmentally, socially and economically.

Increasing Efficiency in Coal and Oil-Use in India

Coal is the primary source of energy for India. According to the Planning Commission (2012) and the IEA (2012), coal will continue to be the most important source of energy for the next 30 years and probably longer. In 2009, it was 40% of India's matrix, 56% of installed power capacity and 70% of India's generated electricity. Even though the percentage share of coal in the matrix might decline over time, India's increase in demand for energy would mean that the volume of coal being burned would still be growing. As such, the development and use of clean-coal technology should be and is being considered very seriously as part of the country's energy strategy.

The World Coal Association explains;

> "Improving the efficiency of the oldest and most inefficient coal-fired plants would reduce CO_2 emissions from coal use by almost 27% representing nearly a 7% reduction in global CO_2 emissions. These significant emissions reductions can be achieved by the replacement

> of plants < 300 MW capacity and older than 25 years, with larger and significantly more efficient plants and where technically and economically appropriate the replacement or repowering of larger inefficient plants with high-efficient plants of >40%." (World Coal, 2014)

Referring solely to India, the Planning Commission writes in its 2012-2017 Plan (Planning Commission, 2012) that 50% of additional production of coal would be channeled through Super-Critical plants that have an efficiency of 40%. This is 4% higher efficiency than that of the traditional Sub-Critical plants which is around 36%. As of now the average efficiency of the entire fleet stands at about 29%. There is a recommendation by the commission to invest more into research on Ultra-Super Critical plants that have an efficiency of 46%.

Strategically, the commission notes,

> "To put it simply, faster adoption of USC and SC technology can save as much coal as would be saved by installation of ten times the solar power capacity. While from a long term perspective we need the solar option, from a medium term perspective, development of USC and SC technology should be pursued vigorously." (Planning Commission, 2012)

Also, coal gasification, another technology that makes for cleaner coal may enable India to achieve better efficiency out of its existing coal and would also

increase the volume of available coal. This is because gasification can tap into deeper deposits of coal that would not be possible to mine conventionally and would allow for safe mining in environmentally fragile regions. India would need sustained investment in this area to reach a stage where the technology could be used liberally.

Lastly, it is pointed out in a paper titled 'Tariff-based incentives for improving coal-power-plant efficiencies in India' (Chikkatur, Sagar, 2007) that the recent restructuring of the Indian electricity sector offers an important route to improving power plant efficiency, through regulatory mechanisms that allow for an independent tariff setting process for bulk purchases of electricity from generators.

In summary, given that coal will remain the primary source of energy for the coming decades, there are points of action that if pursued can increase the indigenous supply of coal, efficiency in energy in production and distribution and a marked decrease in emissions intensity. The externalities of coal consumption and issues around supply security could well be addressed to a degree by cleaner technologies that improve efficiency. This is worth keeping in mind when engaging in a discussion on strategic interest in India's energy policy.

With respect to oil, there is not much that can be done to significantly improve efficiency domestically. Since India is mostly an oil importer, any advancements or innovations in refinement or distribution would have to be external. That is, India is dependent on the international system for increases in

efficiencies for oil. Even technologies to increase efficiencies in consumption would have to be imported, given no real need for the investment in the science of oil as a whole. A reduction in the dependence of oil is the only course that remains open to India. This strengthens the case for investment in nuclear energy.

Nuclear Energy

Introduction

There are two ways to release nuclear energy from atoms- nuclear fission and nuclear fusion. Nuclear fission is the current way of generating electricity. 'Fission' involves the splitting apart of atoms to smaller atoms and harnessing the significant amounts of thermonuclear energy released during the process. The sun creates energy using this process. The feasibility and merits of using 'fusion' to create energy are still debated by scientists today. At the moment technology does not exist that can make the harnessing of energy from fusion a reality – it may never be possible. (Nuclear Energy Institute, 2014)

Nuclear fission is powered by uranium. Although uranium is a metal that is quite commonly found worldwide, however, Uranium-235[1], a special kind of uranium that lends itself to the process of fission, is quite scarce. Uranium-235 is only mined in about 20 countries worldwide. Most of the uranium in the world today, some 82%, comes from 10 mines in only six countries- Canada, Australia, Niger, Kazakhstan, Russia and Namibia. This percentage will go down in time however, with newer mines contributing to 48% of annual output. (WNA, 2014d).

In this way, Uranium-235 is also subject to some of the same geopolitical security issues and market forces that make oil and coal risky propositions for importing countries like India. However, the imports of fossil fuels and gas have a far greater impact in the short term in the event of disruption because of the need for constant supply.

[1] The number 235 refers to the atomic structure of Uranium 235

Benefits of Nuclear Energy

The World Nuclear Association explains some of the benefits of nuclear energy on its website (WNA, 2014c);

> "Fuel is a low proportion of power cost, giving power price stability, its fuel is on site (not depending on continuous delivery), it is dispatchable on demand, it has fairly quick ramp-up, it contributes to clean air and low-CO2 objectives, it gives good voltage support for grid stability. These attributes are mostly not monetised in merchant markets."

Environmentally, nuclear power is as clean as renewable sources provided there are no accidents Also, nuclear fuel, does not need to be constantly imported like fossil fuels or natural gas. This means it is less susceptible to supply shocks or geopolitical coercive politics than fossil fuels for which supply is necessary

What stands out here is the fact that nuclear power is cost-efficient in the long run even when compared to fossil fuels. It is also just as effective, if not more, at providing power and scaling up. Also, the reliability of nuclear energy and the less-threatening nature of the dynamics of uranium's supply reduces the degree and danger of the dependence on external sources that come with fossil fuel imports.

The positive attributes of nuclear power are not monetized on the market- that is, there is no monetary value assigned to the positive benefits (or positive externalities) of nuclear power which are manifold. This is in contrast to the

negative externalities or costs of fossil that are not monetized fully on the market. A considerable reduction of greenhouses gases that would result with an investment in nuclear energy is significant. Mallah (2011) who established several scenarios for India's energy matrix and greenhouse gas immissions in the future concluded that a scenario with advanced nuclear power generation would result in 52% greenhouse gases than the 'business as usual' scenario. This would help India meet its environmental sustainability goals.

Nuclear Energy Worldwide

The first nuclear reactors began operations in the 1950s in the United States. As of today, 430 nuclear power plants are being used worldwide in 31 countries with a total capacity of 370,000 MW. Regional grids, however, make the number of countries that use nuclear energy for electricity higher still. (WNA, 2014c)

Eleven per cent of all the world's electricity comes from nuclear fission generated thermonuclear energy. An interesting statistic is that this 11% as a volume equals all the electricity produced in the world from all sources in 1960. There are 70 reactors under construction with over 160 firmly planned. If the 70 reactors go online as planned, the capacity of nuclear-power generated electricity would rise by 20% - if the firmly planned ones are executed as well, power generation would rise by 50%.

France meets almost 3/4 of its electricity needs with nuclear energy. Including France, 16 countries rely on nuclear energy for at least a quarter of their needs. Some of these are Switzerland, Bulgaria, Hungary, South Korea and Sweden. Italy and Denmark get 10% of their power from nuclear energy.

Japan, before the Fukushima meltdowns in 2011, used nuclear power for 30% of its energy needs. Immediately in the aftermath of the Fukushima disaster the government at the time announced its intention to phase out nuclear energy completely. However, in the early part of 2014, the government led by Shinzo Abe announced a reversal from that plan. Toshimitsu Motegi, the Minister of Industry and Trade, announced at the time that "Japan had to opt for an energy supply system that was "realistic, pragmatic and well balanced"". (BBC, 2014) Two reactors were given preliminary approval in July 2014 after passing the new test of new standards introduced after Fukushima. It is likely that nuclear energy will regain its place as an integral part of Japan's energy matrix in the future.

Expansion of Nuclear Power Worldwide

Nuclear reactors provide power in 31 countries in the world. They meet a total of 11% of the world's electricity needs. There are over 430 reactors involved in production and that number is slated to increase. (WNA, 2014c)

China is investing heavily in nuclear energy. It is projected that by 2020 it will increase its generating capacity to 58,000 MW with 30000 MW more under construction. In the eleven years from 2002-13, China has brought eleven new reactors online and 30 more will be under construction by the end of 2014.

China's R&D on nuclear technology is pioneering and it is now beginning to export its own largely indigenous technology. Previously, the export of reactor technology was largely the domain of the United States, France and Russia.

India will be discussed in more depth in the next section. However, the most significant part of India's nuclear program is its emphasis on the development of thorium-based reactors. Thorium is another element that is conducive to the production of nuclear energy and India has reserves of it in abundance. India's program may be 'ambitious' but there is reason to be optimistic of India's ability to eventually power its nuclear plants with fast-breeder Thorium reactors. This has profound political implications for energy security in India.

Europe too is seeing a renewal in investment in nuclear energy. France and Finland are intending to increase the number of power plants. The UK in 2006 endorsed a decision to replace the nation's old plants with newer French units by 2023. Sweden had planned to decommission its nuclear power program but has since reneged on its decision and is in the process of upgrading its plants with newer technology. The United States has 5 reactors under construction with 4 incorporating some of the latest technology. Also, upgrades to existing plants in the last 15 years have resulted in an increased yield equivalent to new 191,000 MW plants. (WNA, 2014c)

South Africa intends to grow its nuclear power program with the addition of new reactors. South Korea is acting towards the same goal while working intensively on R&D to improve its competitiveness in exporting nuclear plant

design technologies. Countries such as Vietnam, Bangladesh, Lithuania and others have had talks with the IAEA and will most likely develop nuclear power programs with IAEA support (IAEA, 2014).

Germany is the one exception. It had earlier made plans to decommission its nuclear power program and then went back on it. However, after Fukushima, Germany is once again taking steps to shut down its nuclear program. Interestingly, Germany is a world-leader in renewable energy generation and it was expected that it would replace its nuclear power with renewable sources. However, the quest for energy security and economic competiveness may be moving it once again in the directions of fossil fuel consumption.

In July, 2014, Günther Oettinger, the EU's Energy Commissioner was quoted referring to a proposal made by two German Cabinet ministers that Germany should consider fracking as a viable option to contribute to Europe's effort for greater energy security. The UK and Poland were willing to explore this route and this is considered reason enough to give the move serious thought in light of security issues and economic pressures posed on German industry with declining costs in the US (because of fracking there) (Heller, 2014)

Germany has made a strong commitment in the recent past to pursue a path of sustainability in its energy use – the possibility of beginning fracking now, with its environmental costs, shows the pressure it feels in domestic and regional energy security. Russia's annexation of Crimea and the knowledge of the immense power Russia wields because of its near monopoly over natural gas in

the region is the main dilemma when it comes to energy security in the EU – of which Germany is an integral part.

Overall, with the exception of Germany, nuclear power use is expanding where it exists and programs are being initiated in other countries all over the world. Nuclear power generation is endorsed by scientists and exports and credible institutions like the IAEA that also serves as a regulator for its use.

However, nuclear power generation comes with hazards. The issue of safety and an appreciation of the potential hazards are an important part of any discussion over potentially investing in nuclear power. Safety will be discussed first generally and then in detail in the context of India in the section of nuclear power in India.

Environmental Impacts in Normal Circumstances

There are environmental impacts to nuclear power generation. These can be broadly classified into air, land, water and radioactive wastes as per a classification drawn up by the U.S Environmental Protection Agency (EPA, 2014).

The functioning of nuclear plants do not involve the release of carbon dioxide, sulfur dioxide and nitrogen dioxide – the gases considered the most common of the polluting greenhouse gases.

Nuclear plants require large amounts of water for the cooling of fuel and other processes involved in power generation. This involves the drawing of large amounts of water from proximate sources that may affect aquatic life. The water,

too, must be disposed of appropriately as it can contaminate water sources and have dangerous outcomes for those exposed. Mostly, countries involved in this process have their own laws and regulations governing disposal.

A certain amount of radioactive waste is generated at any nuclear power plant that is then shipped off to be disposed off in a stringent manner in licensed disposal sites.

However, this is a brief overview of environmental impacts of nuclear power generation in normal circumstances. The environmental impacts of a nuclear disaster merit a separate discussion.

Nuclear Disaster Impacts

The environmental impacts of a nuclear disaster are so grave that they warrant a discussion independent of the issues of impacts in times when plants are running smoothly. Even though the probability of disasters is low and the statistical probability decreases with advancement in technology, the disaster at Fukushima in 2011 has shown that the possibility must be acknowledged and addressed if a pursuit of nuclear energy is being considered seriously.

There have been two major nuclear disasters since the advent of nuclear power generation. The first disaster occurred in 1986 in Chernobyl in the erstwhile Soviet Union or in the modern state of Ukraine. The second occurred, as mentioned earlier, in Fukushima, Japan in 2011. The first was arguably the result of human error as the core overheated and exploded because of bad construction and crisis-management and the second can be said to be a result of negligence

compounded over time that was brought to light because of the Tsunami after the earthquake. It is considered a case of negligence because the plant should have been able to withstand the shock of the tsunami if maintenance regulations had been followed.

The consequences of the meltdown of the Chernobyl reactor were severe. The Green Facts Initiative, an organization dedicated to making the content of complex scientific consensuses on health and environment accessible to the public, reports that after the explosion people across Europe were exposed to radioactive material through dispersal by air and by a gradual contamination through the ground. 28 emergency workers died as a result of acute-radiation syndrome and fifteen patients died of thyroid cancer. Fifteen people died of thyroid cancer induced directly by the fallout. (Green Facts, 2014)

An estimated 4000 of the 600,000 people exposed most severely are believed to have died of radiation induced cancer. However, so far, there is no conclusive evidence to link the Chernobyl disaster with a decrease in fertility or leukemia – a condition and a disease linked with exposure to radiation levels. However, there were psychological consequences for the 330,000 people who lived closest to the disaster and were evacuated or relocated. Being portrayed as victims and relocating from their homes led to a higher prevalence of post-traumatic stress disorder, depression and anxiety among the 'survivors'.

The environmental impacts of the disaster were great with the damage felt most severely in modern day Ukraine, Russia and Belarus. Biodiversity in a 30 km radius around the site suffered from lower fertility and higher mortality that is

associated with populations suffering from radiation exposure. Crops and water sources much further away were contaminated with reports of reindeer meat containing dangerous levels of radiation as far away as Scandinavia. A huge upheaval of economic and social practices of the affected region was the result and the impacts of the crisis are seen on the land and present in society even today.

Social benefits programs were started which are still being run in Ukraine, Belarus and Russia today. Around 7 million people receive benefits under a system that is necessary but unsustainable given the economic realities of especially Ukraine and Belarus. The Green Facts Initiative breaks down the costs of the fallout as follows;

Costs include:

- "direct damage caused by the accident.
- expenditures related to sealing off the reactor, treating the Exclusion Zone and other affected areas, resettling people, providing health care and social protection for those affected, monitoring radiation, and disposing of radioactive waste
- indirect costs linked to restrictions in the use of agricultural land and forests, and to the closure of industrial and agricultural facilities
- increased energy costs resulting from the closure of the Chernobyl plant and the cancellation of Belarus's nuclear power program." (Green Facts, 2014)

A total estimate to the Soviet Union, modern day Ukraine, Belarus and Russia and other affected areas runs into hundreds of billions of dollars.

Fukushima was a smaller disaster in terms of scale and no deaths are believed to have occurred because of radiation. 300,000 people were relocated as a result of the crisis and 1600 died because of the evacuation conditions. The evacuation conditions though were significantly impacted by the earthquake and the tsunami that precipitated the crisis in the first place. Contaminated food and water supplies are a reality Japan has to confront for some time yet and there are fears of the negative impacts of the spillover in the Pacific.

Green Facts (2014) explains that Chernobyl was a result of a faulty reactor and negligent management on part of the plant managers. Richard Tanter (2013) in a paper titled 'After Fukushima: A Survey of Corruption in the Global Nuclear Power Industry' found that "investigations of the Fukushima nuclear power accident sequence revealed the man-made character of the catastrophe and its roots in regulatory capture effected by a network of corruption, collusion, and nepotism". There was an alarming level of negligence on the part of the Japanese regulators and the crisis could easily have avoided had established processes been followed and issued directives been acted upon. Civil-society support is important for a venture such as nuclear energy. And as Tanter points out, "Widespread corruption of the nuclear industry has profound social and political consequences resulting from the corrosion of public trust in companies, governments, and energy systems themselves."

Jeff Kingston, writing in the Asia-Pacific journal argues that the nuclear industry in Japan and in other nuclear technology exporting countries such as France, China and the United States showed signs of 'Regulatory Capture' (Kingston, 2012). An extract from Kingston's article, titled 'Japan's Nuclear Village' explains the concept as follows;

> "Regulatory capture refers to the situation where regulators charged with promoting the public interest defer to the wishes and advance the agenda of the industry or sector they ostensibly regulate. Those with a vested interest in specific policy or regulatory outcomes lobby regulators and influence their choices and actions."

Though generalizations are difficult to make, India has a long history with corruption that may be a hindrance when it comes to the strict implementation of due process. These are issues that must be dealt with if nuclear energy is to be pursued in a concerted manner in the country. The lesson is clear, with inefficient or corrupt regulation, disasters are a possibility and this can make the nuclear path a dangerous road to tread.

A fact to consider is that Ukraine and Russia still have nuclear power generation programs that are a significant part of the energy plans and projections going into the future. Belarus has shut down its program. Japan, as mentioned in an earlier section, made a decision to abandon nuclear power-generation but has since backtracked under the Abe government and now intends to resume power

generation but reduce its dependence. As per latest statements from the government, nuclear power figures long into the future energy plans of the country and two reactors were approved for resumption under new standards in July, 2014. (BBC, 2014)

Nuclear Energy in India

India's nuclear program is largely indigenous given India's isolation in the international nuclear community for its pursuit of nuclear weapons capability. India adopted a three stage vision articulated by an eminent nuclear scientist Homi Bhabha in 1952. The first two stages of the vision can be excerpted in his own words as follows:

> "The first generation of atomic power stations based on natural uranium can only be used to start off an atomic power programme... The plutonium produced by the first generation power stations can be used in a second generation of power stations designed to produce electric power and convert thorium into U-233, or depleted uranium into more plutonium with breeding gain... The second generation of power stations may be regarded as an intermediate step for the breeder power stations of the third generation all of which would produce more U-233 than they burn in the course of producing power." (Venkataraman, 1994)

The goal was to begin producing power using nuclear energy while maintaining a long term focus on the developing of the capability of powering reactors with Thorium – thorium is a fuel that is found in abundance in India. 25% of all known reserves are in India This is in contrast to Uranium-235 that is quite scarce and needs to be imported.

Bhabha explained Thorium's place in stage three of India's nuclear vision as below;

> "The total reserves of thorium in India amount to over 500,000 tons in the readily extractable form, while the known reserves of uranium are less than a tenth of this. The aim of long range atomic power programme in India must therefore be to base the nuclear power generation as soon as possible on thorium rather than uranium..." (Venkataraman, 1991)

However, the first of the fast-breeder reactors are not expected to come online till the end of the present decade. To keep up with current economic growth and meet its target of producing 14,600 MW of nuclear energy India would have to import uranium.

India plans on sourcing 25% of its energy needs from nuclear power in 2050– up from 3.7% in 2012. India's energy pie would grow significantly in that period so 25% of the future will be a far greater volume than what 25% of today's pie would be." (Nuclear Engineering International, 2012). There is will be a growing demand for reliable energy from both those who don't have access to electricity and those who already do.

Specifics of Nuclear Sector in India

India's civil nuclear program has been geared since 1970 for complete independence in the fuel cycle. This was a direct result of India's exclusion from

the NPT (non-proliferation treaty) that was signed in 1970 because of India's nuclear weapons program. The independence had a cost in the form of some of the world's lowest capacity reactors. However, the capacity rose impressively from 60% to 85% from 1996 to 2002 until a shortage of uranium forced a slowdown in power generation. (Department of Atomic Energy, 2000)

An illustration of the growth of nuclear power generation is shown in the graph below;

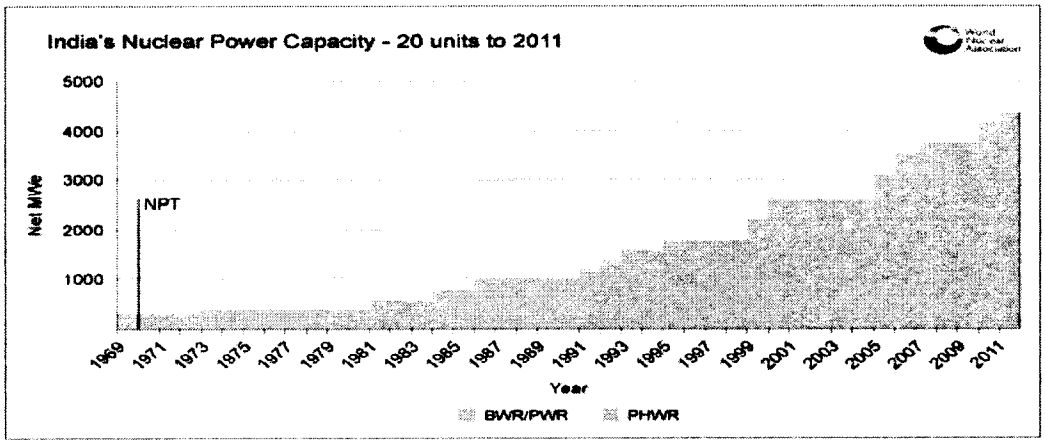

Figure 1 - Source : World Nuclear Association (2014a)

The sector is comprised of the Nuclear Power Corporation of India Ltd (NPCIL) whose objective is to operate power plants and implement the nuclear projects for generation of electricity in accordance to the policy directives of the Indian Government. This is done under the Atomic Energy Act In 2010, the NPCIL said it had enough funding available for increasing power generation by another 10,000 MW. (NPCIL, 2014)

The National Thermal Power Corporation (NTPC) is a larger organization than the NPCIL. The NTPC is a government enterprise. Its main responsibility is to maintain the grid and effectively distribute electricity.

The investment in the sector is also restricted according to the '1962 Atomic Energy Act'. The Act forbids private ownership of nuclear power plants though small levels of investment are permissible. In 2010, the government made it possible for the percentage share of private investment to be greater to help create funds for the sector. (WNA, 2014a)

Currently, India has 20 nuclear reactors operating in 6 power plants in operation all over the country with plans made for the establishing for at least 6 more in the near future.

A map of existing plants and the plants under construction is shown below;

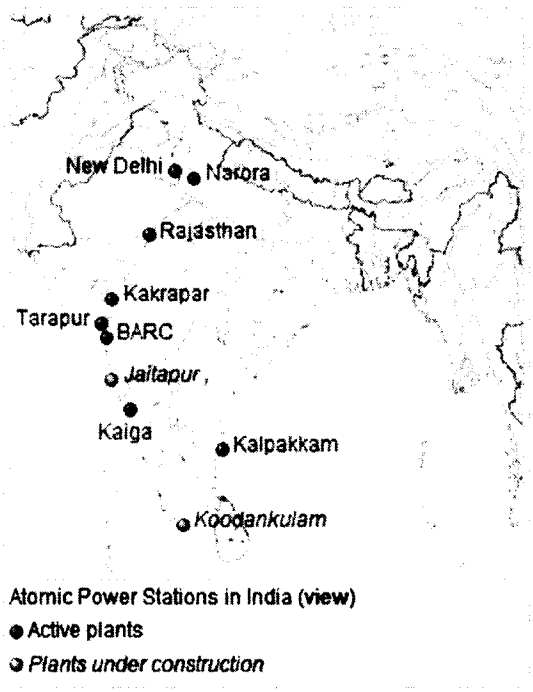

Figure 2- Source : World Nuclear Association (2014a)

As per a statement from the NPCIL, India had planned in 2010 to increase its nuclear power generation capacity to 63,000 MW from the current 4760 MW being generated today. However, after the Fukushima crisis in 2011, protests have sprung about around the two sites proposed as plants in Jaitapur and Kalpakkam. The state government in West Bengal also denied the centre the permission to build a plant at Haripur. In the state of Haryana as well farmers have come together to voice their concerns about the prospect of a plant in the region.

Safety is the primary cause of concern for these protests and refusals. There is also a concern among locals about state land acquisition rates and inadequate rehabilitation schemes. Srivastava (2014) quotes S P Udhayakumar, a prominent anti-nuclear activist who founded and still leads the 'People's Movement Against Nuclear Energy' says, "All over the world people are phasing

out or canceling nuclear power plants. Electricity should be for the people. It cannot be at the cost of the people."

There is a factual inaccuracy in the activist's claims. As mentioned earlier in the section on 'Nuclear Energy Worldwide' countries, with the sole exception of Germany, are consolidating their nuclear power generation plans. Others are on track to begin the process of nuclear power generation. Japan is reducing dependence, but is showing that it intends to persist with nuclear power in a meaningful way.

However, the activist's voice carries resonance for the cause he is championing. The issue of safety is important in India today. It is something the government will have to learn from meaningfully and address appropriately if it is to pursue nuclear energy in a democratic manner.

The Structure of India's Nuclear Sector and Regulatory Implications

The structure of India's nuclear sector is illustrated below;

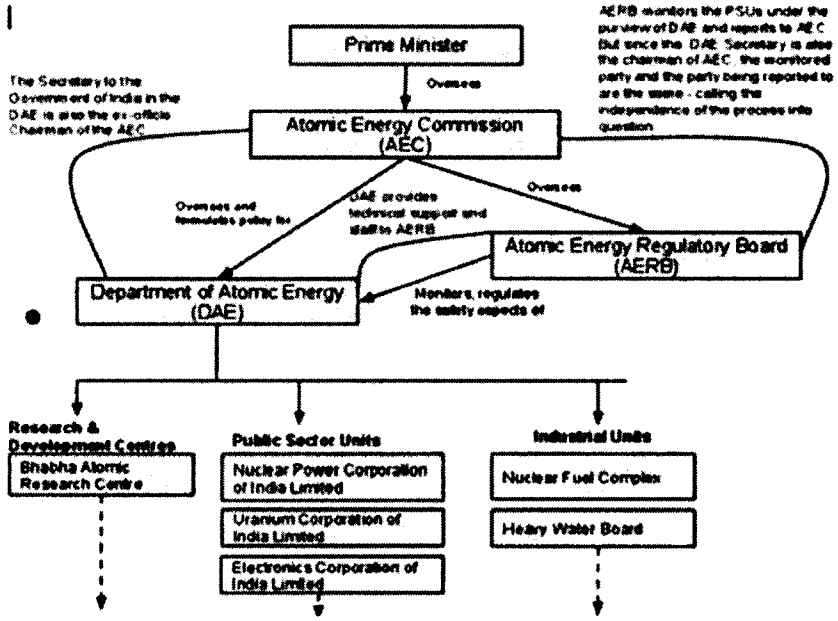

Figure 3 - Source : World Nuclear Association (2014a)

This diagram shows that almost the entire sector comes under the administration of the central government under the prime minister. Of this, the most worrying fact is the Atomic Energy Regulatory Board's (AERB) status as a dependent and subsidiary of the central government. A parliamentary report by the Comptroller and Auditor General (CAG) stated "the legal status of AERB continued to be that of an authority subordinate to the central government, with powers delegated to it by the latter." It went on to elaborate that this was in direct conflict with India's subscribing to international norms and standards as expressed by international experts and knowledge of best practices.

As for the actual performance of the AERB in recent history, the WNA (2014a) explains that the AERB has not as yet prepared an overarching safety

planning policy for nuclear radiation as had been required in 1983. It had also not been able to establish radiation safety directorates in administrative areas where they had been deemed necessary by a Supreme Court Order in 2001. When it came to inspections, it had only achieved a completion of 15% of the recommended level at required sites relative to IAEA norms. Safe disposal is a priority for the country but there is no detailed inventory of radioactive sources to assist in this and no mechanism to check on disposed waste.

The IAEA is the international body mandated with regulating and setting guidelines for countries to follow on matters relating to nuclear technology. Its mandate, as defined on its website is "work with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies".(IAEA, 2014) However, its authority is not universal. When the international community sanctioned India for breaching the terms of the nuclear Non-Proliferation Treaty by pursuing nuclear arms, India pursued its own program independent of international supervision.

The performance of India's regulatory body has been less than satisfactory in the last few decades for a country with an ambitious nuclear power program. It is essential for the civilian nuclear space to open up to international scrutiny and influence to improve.

Greenpeace India (2014a) also, in its capacity as a civil-society opponent of India's nuclear program, shares some of the same concerns;

> The inherent risks of nuclear power are made greater in India by the structure of the country's nuclear establishment. The

> organization in charge of safety in all nuclear facilities, the Atomic Energy Regulatory Board, shares staff and is provided funds with the organizations it is supposed to be regulating. This compromises its ability to act independently and enforce vigorous safety regulations. (Greenpeace, 2014a)

Greenpeace also points out that the line between India's military and civil nuclear program is blurred with ultimate decision-making authority resting with the Prime Minister and government bureaucracy. This allows for the civilian nuclear industry to not disclose information in a transparent manner because the issue is considered by the government to be one of national interest – thereby warranting a certain level of operational secrecy.

The possible merits and demerits of strong and somewhat opaque centralized decision-making for a developing country can be debated in general terms but the quality and quantity of regulation in the civilian nuclear sector is an area of legitimate concern for India. However, regulation practices may improve with the introduction of international monitoring mechanisms into the Indian nuclear sector. This process has begun but it remains to be seen if the change will be far-reaching and quick.

Recent Changes in the Indian Nuclear Power Sector

In 2005, the UK, US, France and Canada relaxed their stance on nuclear trade with India because its weapons-program was not considered a proliferation threat. France even expressed an agreement to set up a bilateral cooperation

agreement with India. The US Congress passed legislation in 2006 allowing the US to engage in nuclear trade with India. This was followed by a landmark bilateral agreement allowing trade in nuclear fuel and other technology with India. The agreement also paved the way for additional IAEA involvement in India's civilian nuclear sector. The 14 reactors classified as 'unambiguously civilian' were to come under the IAEA's supervision. A decision was also made to create a new reactor to process nuclear fuel that would also be under the IAEA's supervision. (Grover, 2010) (WNAa, 2012))

India then began engaging with the IAEA in 2008 to set up a 'safeguards agreement' that would put into place many of the requirements set forth by the US in the bilateral agreement. This process took place in 2008 and the agreement was signed in 2009.

At the same time, the US Congress reviewed and ratified the agreement and France and Russia had established their own agreement with India (Levi, Ferguson, 2006). In 2009, the Nuclear Supplier Group agreed to exempt India from the sanctions traditionally imposed on parties that had violated the NPT. The goal was to give India the same responsibilities and opportunities as China in the civilian-nuclear space. However, India would have to accept a greater level of international controls on all its nuclear activity.

These processes ended India's global isolation in the civilian nuclear space. It also laid the groundwork for an improvement in the monitoring and regulating mechanisms operating in the structure. However, the completion of the

process of adopting international standards and supervision is gradual and will continue to take time.

It is only recently, on June 23, 2014, after the election of the Modi government, that the government has expressed a willingness to approve the IAEA's additional protocol to the safeguards agreement. A spokesman for the foreign ministry said, "I can confirm that we are ratifying the additional protocol to the IAEA Safeguards Agreement". (Times of India, 2014)

The Arms Control Association (Arms Control, 2014) summarizes the key ideas of the optional protocol;

> "The essence of the Additional Protocol is to reshape the IAEA's safeguards regime from a quantitative system focused on accounting for known quantities of materials and monitoring declared activities to a qualitative system aimed at gathering a comprehensive picture of a state's nuclear and nuclear-related activities, including all nuclear-related imports and exports. The Additional Protocol also substantially expands the IAEA's ability to check for clandestine nuclear facilities by providing the agency with authority to visit any facility, declared or not, to investigate questions about or inconsistencies in a state's nuclear declarations. NPT states-parties are not required to adopt an additional protocol, although the IAEA is urging all to do so."

As of today, the full extent of India's nuclear power program is not open to international supervision.

India's Nuclear Liability Law

India, in 2010, after sustained efforts by civilian society organizations and political opposition signed a Nuclear Liability Law. Greenpeace in India was one of the spearheads of the campaign in support of the law. This law is unique in the world in that it holds suppliers accountable. Total liability is limited to $450 million or higher if the central government considers a greater amount appropriate. Operator liability is limited to $285 million or higher if the central government deems this appropriate.

What is unique about the bill is a clause that includes supplier liability. In the event of any damage, a special clause in the bill, clause 17(b) lets the operator have the right to recourse to supplier for 80 years if, as an Indian court ruled, "nuclear incident has resulted as a consequence of an act of supplier or his employee, which includes supply of equipment or material with patent or latent defects or sub-standard services." (Patil, 2014)

The clause is in opposition to internationally established norms as laid down in the CSC (IAEA, 1997)

Even though the Department of Atomic Energy asserts that suppliers can not be sued for amounts greater than what the operators liable, the terms of the bill are still a major concern for the companies and administrations of the country that

India plans on doing business with. France, the US and Russia especially are most concerned. This would slow down India's growth plans as these countries and the companies are now waiting for a resolution of this issue before proceeding with engagement.

The IAEA (2014) has drawn up a Convention on Supplementary Compensation for Nuclear Damage (CSC) that India is stipulated to ratify as per the US-Indo Nuclear agreement 2008. As per this convention, suppliers are not liable to sued in their home country. In 2010 India signed the convention but has not yet ratified it. The US Secretary for State, Hillary Clinton, said about the issue and the CSC that, "we would encourage engagement with the International Atomic Energy Agency to ensure that the liability regime that India adopts by law fully conforms to the international requirements under the convention." (Chaudhury, 2012)

Though the Civilian Nuclear Liability Act is considered a hindrance to the plans for expanding nuclear power generation, the spotlight cast on the regulation and maintenance component of nuclear power generation may have positive consequences. Supplier liability of some sort may actually go toward a greater international scrutiny of the Indian nuclear program which might make it better run. Coupled with the opening up of India's civilian nuclear space global scrutiny and monitoring, regulation in the sector is likely to improve.

As of July 2014, a new plant at Kudankulam in 2014 came online. There were controversies surrounding its start-up. However, another nuclear plant is

being built at Jaitapur in Maharashtra. This project has attracted the most controversy. The following section will be a case study of the Jaitapur Nuclear Park program. The aim is that this section will illustrate in more detail the issues that are present in the pursuit of the nuclear power generation program in India. The view of civil society organizations opposing the project will be reviewed as well.

Jaitapur Nuclear Park Project

The Jaitapur Nuclear Park Project (JNPP) is expected to be the world's biggest nuclear power station once it comes online. The area is 970 hectares and the plant is intended to produce 9900 MW of electricity (Center for Science and Environment, 2014). Chopra (2011) points out that at full capacity this plant would trump the Kashiwazaki-Kariwa which produces 8200 MW of electricity to become the biggest nuclear power project in the world by a wide margin.

Bidwai (2011) estimates some 40,000 people would be directly affected in 5 villages in the area which is to be used to start the project. These people would need to be relocated. There is significant local opposition over a broad range of issues surrounding the JNNP's inception. The importance of these issues changes over time but the plant remains controversial even today.

One of the civil society concerns around the issue centers around the new EPR reactor (European Pressurized Rector) that is expected to be the main source of energy for the plant. This reactor is essentially a more powerful version of the

most powerful reactors currently in existence. However, it has never been tested in a civilian-nuclear scenario.

A former chairman of the AERB, Dr. Gopalakrishnan, who is a voice of dissent against the JNPP notes, ""Why should the people of Jaitapur be subjected to the high risk of proving out an unknown reactor in their backyard?" (Gopalakrishnan, 2011). Gopalakrishnan's voice carries added weight as an expert and as someone who in the past who would have been the individual with ultimate decision-making authority over approval of such a project and regulating the manner of its construction and operation. C.B Jain, the project director of the JNPP from NCPIL calls it one of the world's 'safest reactors'.

Dr. Gopalakrishnan's suggestion was to use indigenously build 'Pressurized Heavy Water Reactors' which would be cheaper than the EPR and have a track record of being successfully used. However Dr. Gopalakrishnan's position could also be borne out a vested interest. Given the structure of India's nuclear sector and the established practice of staff sharing across organizations (WNA, 2013a) there is a also a possibility that Dr. Gopalakrishnan would want to promote indigenous technology that would benefit the sector he has worked in. Though he is right about the higher cost, the internationally built EPR's are more efficient and have a greater capacity. The returns of an investment in the EPR would only be seen over an extended period of time.

Activists and opposition claim that information of this nature that is crucial to informing the public is not readily available and plans of the JNPP

appear shrouded in secrecy. There are calls from some that an ombudsman should be appointed by the NPCIL to deal solely with the concerns of those seeking to be informed. The added transparency would benefit the project and allay public fears if, indeed the activists argue, all is as well as it should be in the plans for the JNPP. (Chopra, 2011)

Another concern is that the government may secretly sign a contract with Areva, the supplier of the reactors, to circumvent the Nuclear Liability Act that is one of the biggest hurdles to overcome from the government's point of view in getting the project going. Though this is a possibility, there is no evidence to suggest that this is actually happening. However, the NPCIL has not confirmed or denied the reports – an act that further fuels speculation.

Ramana and Rao (2010), writing for the journal 'Environmental Impact Assessment Review' note that given the AERB's lack of experience in regulating reactors of this kind, there is legitimate concern about their ability to do so. He argues that the NPCIL should try and adopt the transparency model used by the US Nuclear Regulatory Commission. The US Nuclear Regulator makes all license applications for reactors available on the internet for civil society perusal. Chopra (2011) notes "these applications run into hundreds of pages and include minute technical details that are subject to unrestricted inspection. Citizens can raise questions about any aspect and NRC makes it mandatory for companies to respond to each one of them."

Ramana and Rao (2010) also point out that important members of the nuclear sector are present in all the Environmental Impact Assessment process. This is something that could lead to biased outcomes and is indeed a cause of worry for civil-society and observers of the sector. It is likely though, that, with the opening up of India's nuclear sector to international scrutiny and supervision, such discrepancies in these processes would be weeded out. It is up to the government for now to determine whether this will happen eventually.

There is also a question about whether the JNPP will meet the energy requirements of the state as is estimated by the authorities. The state of Maharashtra has an installed power capacity of 15000 MW and faces a perennial shortfall of 4000 MW. The estimated power generating capacity of JNPP, estimated at 9900 MW is heralded by the state and central government as a solution to the energy crisis of the state. It is also meant to meet some of the energy demands of neighboring states which face a similar energy shortfall.

However, Ashwini Chitnis, a senior research Associate of the Prayas Energy Group NGO (an NGO that specializes in studying national energy related issues), is skeptical of these claims. She says that given Maharashtra's tendency to double its demand for energy, the JNPP would only go part of the way in meeting the demand in ten years time. Even then, when the plant becomes operational in 7-8 years as per present estimates it will only run at a third of its capacity, around 3300 MW that severely undermines the claim that it will solve the energy concerns of the region (Chopra, 2011).

Though Chitnis is critical of the project, there is another way to view this observation. If the observation is valid, it does not provide a solution to the rapidly increasing demand. Chitnis argues that the JNPP will not solve the energy problem the government claims. But an additional 9900 MW of power generating capacity for the region would go a long way in improving energy access and reliability. There is no easy solution to the problem of India's energy needs. An argument that propounds that the JNPP is not viable because it will not provide the solution that the JNPP planners claim ignores that those energy concerns would probably be greater in the absence of the JNPP. Coal, as mentioned earlier, has its problems and renewable energy is an alternative though arguably its viability to provide additionally at this scale is even more suspect as of now than nuclear energy's potential.

There are also questions raised about the viability of the site for nuclear activity. The site is located at an elevation to reduce vulnerability to tsunamis. However, the area is located in a Seismic Zone four region on a scale with five being the highest. One earthquake of magnitude 6 on the Richter scale was recorded in this region in 1985-2005. Greenpeace India (2014b) notes with concern that in contradiction to the Jaitapur Environmental Impact Assessment of 2010, the NPCIL stated that the site was classified as zone three, which corresponds to a lower risk. The organization has also recently begun to respond to public pressure on the plant by stating that the Jaitapur site is a "mere zone three." The state government and the NPCIL consistently maintain the site is safe.

Another review may be required to ascertain with certainty the viability of the site and at the very least, to allay public fears.

There were concerns about the community that has to be relocated as a result of JNPP. There were initial concerns about the compensation for land acquisition being inadequate. In January 2010, only 33 out of 2335 villagers who were land holders in the slated area had accepted the compensation deal. In time, by February 2014 compensation had been accepted by the 2336 that held land in the area at the time. A significant increase in the compensation package after negotiation is the reason for this change. (The Hindu, 2014)

There are concerns for the extended community as well. The JNPP project, located in Ratnagiri on the Konkan coast is a biodiversity hotspot. In 2003, as Bidwai (2011) explains, the Maharashtra government designated the region as a 'Horticulture District'. Mango is one of the major crops produced in the region and a major source of income for locals. There are approximately 15,233 hectares under cultivation and annual turnover is approximately $ 3.6 million. Given the mango crop's tendency to be adversely sensitive to any change in soil or temperature, there is a very real fear that the crop yield may suffer when the plant comes online.

The JNPP is also expected to draw and dump 52,000 million liters of hot water into the sea everyday. This is enough to change the behavior of fish populations in the region and fishing is an important part of the livelihood for the people. Fish populations also changed when the neighboring Tarapur plant,

India's first nuclear plant , came online. Fishing in the region suffered. Bidwai (2011) estimates that 15,000 people depend on the local fishing economy to sustain themselves and they are at risk of losing their livelihoods.

Bidwai (2011) concludes with the argument "India's super ambitious nuclear plans are based on the rosy assumption that a global nuclear renaissance is underway and that nuclear power is the best solution to both the climate change crisis and to the national energy security question. But there is no nuclear renaissance." What such a claim does not address is the reality that about six hundred million Indians live without access to electricity (Planning Commission, 2012) and about 300 million live in conditions of absolute poverty. (Biswas, 2012)

A 1 MW solar plant was commissioned in 2010 and it produces enough electricity to power a thousand homes in Delhi (2010). If the ratio of 1 MW: 1000 homes (a MW of electricity provides the same amount of energy no matter what the source) is used as an approximate a 9900 MW plant will power almost 10 million homes. At a third of the capacity, at which JNPP is expected to begin, the plant will power 3.4 million homes at a reasonable cost. Such a massive positive outcome is almost always written off by critics of nuclear energy. It is not even discussed.

Civil society activists seem to play blind to the tremendous positive benefits of installing nuclear energy citing immediate costs of relocating existing societies at planned nuclear sites. However, the fact remains that this single

nuclear plant could power almost 10 million homes. By being myopic in their views concerning short term costs, critics of nuclear energy are ignoring the benefits of powering millions of homes efficiently and cheaply.

Those affected adversely in the short term should be compensated and rehabilitated. But the loss of livelihood for 15,000 people involved in fishing and $3.6 million a year lost in revenues from export of mangoes does not measure up to benefits of electricity in millions of homes. Adding the ripple-effect developmental benefits of having access to energy into the cost-benefit analysis will make the argument for the plant even stronger from a utilitarian standpoint.

The issue of safety is one that must be considered very seriously for the costs of a meltdown are immense. The issue of environmental degradation though complex in its specificity can be viewed in a simple way. Is the greater good for the greater number an acceptable way of making policy? What place does the environment have if preservation is in direct conflict with creating conditions for the better enjoyment of human rights for the citizens of India. These are the choices for the state in India. With 600 million people lacking energy the state is obligated to provide energy to its disenfranchised citizens in accordance with their human rights. This goal is difficult to achieve without degradation and some loss of the environment. This creates a conflict with goals for environmental preservation and sustainability. What costs are acceptable are difficult decisions to make with choices such as these. Finding the right balance is the key for the

Indian state. This will be discussed in more detail in the analysis section that follows.

Analysis

Given the shortfall of energy access in India and with the large increases expected in energy demand as India develops, a range of issues arise which have been touched upon in previous sections. Given the facts, a decision on whether India should invest can be may be taken after breaking down the issue in the following broad categories:

- **Energy Security- 'Sovereignty'**
- **Energy Security – 'Robustness' and 'Resilience' Domestically**
- **Safety** - Is investing heavily in nuclear power generation viable? Can proficient regulation, safety and maintenance be assured to allow for a nuclear program that is as safe as can be?
- **Capability to Implement Necessary Reforms** - Is the government capable of the reform necessary to achieve better outcomes in the sector?
- **Justice for those Adversely Affected** - Will those who are affected adversely by the implementation of a program be justly treated in accordance with their human rights and as citizens of a democratic nation?

Though there are significant overlaps in these areas they will be analyzed in isolation in attempt to reach a conclusion with clarity.

Energy Security – 'Sovereignty'

The IEA (2014) defines energy security "as the uninterrupted availability of energy sources at an affordable price. Energy security has many aspects: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs. On the other hand, short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance."

The potential of a supply shock to the system for an importing country is one cause of energy security. The view of the IEA can be classified as liberal with the importance it places on economic forces and its implicit faith on institutions such as itself to improve energy security worldwide. However, power politics is an important part of energy relations worldwide. There is an element of anarchism in the system that is best understood through the lens of realism.

Dependency on another state can be a source of vulnerability for a country. In Cherp and Jewell's (2011) framework, this is an issue of sovereignty. Andrei Belyi, affiliated scholar at the Centre for EU-Russia Studies (CEURUS) (2007) explains it in more depth;

> "Factors that define the energy security complexes are the historical *amity* and *enmity* patterns that have an influence on how the energy dependency is perceived. Each energy dependency case can be perceived in varying degree either as a mutually beneficial interdependency (*positive*

dependency) or as an unequal and threatening dependency (*negative dependency*)."

India, as reported by the Planning Commission (2012), imports 80% of its crude oil and 25% of natural gas and 20% coal. With each year, with energy demand and supply rising, the volume of energy used by the country is growing. Given a dearth of local resources, the percentage share of imports is also steadily increasing year by year. There is positive dependency.

Even though India does not have any 'enemies' in the countries it imports energy from currently (for example, Iran, Kazakhstan or Indonesia to name a few) the international system is such that this may easily change leading to threatening negative dependencies.

It can be argued on this basis that India is already a country suffering from negative dependency from another perspective. India is the fourth larger consumer of energy worldwide, with a high dependency on large volume imports of oil and coal. This is an increasing dependency that increases year by year for commodities for which supply must be assured. It places India in a very vulnerable position.

In light of this, it can be asserted from a standpoint of energy security, investment in nuclear energy is in the strategic interest of the country. A dependence on uranium imports is not as severe in terms of threat as it is for fossil fuels and gas because uranium only needs to be renewed about once every 5

years. The market for uranium is also far less prone to supply shocks than oil and gas.

> In the long run, if India is able to transition to stage 3 of the nuclear scientist's Homi Bhabha's vision of having thorium fueled fast-breeder reactors, India's vast domestic sources of the fuel would further strengthen its energy security.

Also, increase in access to energy for the citizens of the country would go towards and improve the robustness and resilience of the economy by developing human resources, the economy and industrial base. The use of thorium would be a prudent use of natural resources otherwise not utilized that would reduce energy dependency that would also enhance robustness.

Energy Security – 'Robustness' and 'Resilience'

Access to energy would also help in bridging social and economic inequalities. Inequities are a cause of dissatisfaction with the state and major cause of political unrest. Improved energy access, and the development that will come with it, would ease some of the tensions that lead to the perpetuation of the Maoist insurgencies and separatist movements in parts of the country.

. In the World Summit Outcome of the UN in 2005, the heads of state agreed that "the right of all people to live in freedom and dignity, free from poverty and despair", and recognized that "all individuals, in particular vulnerable people, are entitled to freedom from fear and freedom from want, with

an equal opportunity to enjoy all their rights and fully develop their human potential". (UN World Summit Outcome, 2005)

In light of this, the substantial increase in access to energy would substantially improve human security in the state. By 2032, the state plans to increase installed nuclear-power capacity to 60,000 MW (Mistry, 2014) which is an increase of 55,270 MW. This would mean as per a rough estimate that 58 million additional homes could be powered at that time at current levels of energy consumption. The current level of energy consumption per home is projected to increase but the figure, 58 million homes, gives some perspective of the scale at which the investment into nuclear energy could go to improving human security.

A study from Georgia Tech on 'Energy and Quality of Life' worldwide (Pasten and Santamarina, 2011) provides some insights that are important when talking about human security;

- "Energy consumption is inherently coupled to quality of life and population growth.
- Limiting overconsumption [Ensuring that the small percentage of people who consume the largest share of all energy do not continue to 'overconsume'] can keep 2040 energy consumption at 2010 levels.
- Restricting population growth has a minor effect on future energy demand.
- Social inequality reduction increases quality of life with a minor energy use.

- Increasing energy-for-life efficiency can keep 2040 energy use at 2010 levels."

What is also relevant to India from these observations is that providing energy to people who have less access to it will not place an overwhelming burden on the state. Of course, the idea that energy use can be limited by efficient use is relevant as well – this idea will be touched on in the context of the discussion on energy independence and national security going forward.

The effect of the negative externalities from fossil fuels would also be reduced and goals of environmental sustainability will be more easily attained with nuclear energy given that is a low-emission form of energy. A 100,000 people died prematurely from coal-related emissions in 2012 as per the World Bank (2012) – the number is increasing every year as well. None would die of such emissions from a well-managed nuclear power generation program. As Mallah (2010) argues "So there is an urgent need to install centralized [nuclear] power plants for long-term energy supply and reduce environmental externalities."

Security would improve drastically with a well-run nuclear program at a relatively low cost to the state. Improvements in energy efficiency, which is an area the government is focusing on, would also increase the impact of the additional energy on human security.

Safety

The issue of safety of nuclear power plants divides opinion sharply. For some, one Chernobyl is enough reason to never pursue nuclear energy. For others, a Chernobyl coupled with the reminder provided by Fukushima, was more than enough to say that nuclear energy should be abandoned. For others, nuclear energy remains a valid source of energy. Its sustainability and potential benefits outweigh the costs and the heavy risks.

At Chernobyl and Fukushima, as established in the section on 'Nuclear Safety', human error and faulty regulatory practices facilitated the crisis. Both disasters would have been averted if even existing processes had been implemented properly and consistently. Importantly, as was also established earlier, both Russia and Ukraine still have thriving nuclear programs that are expanding. Japan, though it intends to reduce its dependency on nuclear energy, still intends on resuming power generation in its plants and persisting with it for the foreseeable future.

The question for India is whether the nation's apparatus for ensuring safety can ensure that the potential for disasters is mitigated. As of now, because of the structure of the regulatory mechanism, with staff being shared across different organizations in the civilian-nuclear sector, the incentives in the apparatus are not ideal and it is susceptible to corruption. However, the opening up of the sector after decades of isolation to the international civilian-nuclear sector with its norms, agreements and governing bodies has begun the process of the reform. The government would still have a large role to play in ensuring the

sector reaches a point where regulation is up to standard or even better than the leading countries involved in production and consumption of thermonuclear energy.

Ability to Implement Reforms

Manmohan Singh, the previous prime minister, who was leading India's push for the deal the US in 2008 to exempt India from global sanctions for its pursuit of a nuclear-weapons program, was quite persuasive on this issue. He has been criticized for being weak and easily obstructed and influenced in other areas of policy-making, but when it came to nuclear energy he made strong decisions.

The current Prime Minister Modi, arguably, has more charisma and therefore holds more influence than Manmohan Singh at the end of the tenure. His intentions are important in understanding if India is capable of reform. The expression of willingness to sign the IAEA's Additional Protocol by an official from Modi's government shows Modi's intention of continuing the process of opening up India's civilian nuclear sector to international scrutiny. This would lead to an improvement in regulation in the long term that is important if India is to pursue nuclear energy in a big way. It is on the right track today – though the process of opening up must be expedited.

An improvement in regulation would enhance resilience in the sphere and this would have better outcomes in terms of energy security. The mitigation of the

risk of hazards or catastrophic events that comes with better regulation is also an improvement of robustness and resilience. Also, even though regulation of the nuclear sector is under the scanner, improved regulation in the heavily state-monopolized sector for coal would also create better energy security outcomes for the country.

Justice for Those Adversely Affected

People are affected by the building and running of plants. Livelihoods are inevitably lost. However, the impact of investing in nuclear energy for the country as a whole can be said to outweigh the concerns of the few. 15,000 people dependent on fishing stand to lose their livelihood if the plant is built at Jaitapur. $3.6 million USD of income from mango cultivation and other trades in the region would suffer. However, the possibility of providing electricity access to 10 million homes that is what the plant would provide eventually is a massive benefit.

Jeremy Bentham, the founder of Utilitarianism, writes in his Essay on the First Principle of Government (1768) that the "greatest happiness of the greatest number is the foundation of morals and legislation". The implication is that a policy that benefits a greater number of people should be undertaken when all the choices before the government involve trade-offs that invariably and adversely affect some people or the other. From a utilitarian standpoint, the benefits of the nuclear power plant far outweigh the costs of it.

However, modern political thought, with its emphasis on human rights and social justice must also be kept in mind by the state in its pursuit of nuclear power energy. The concerns of affected people (those who lose livelihoods or are relocated) must be adequately understood, compensation should be appropriate and rehabilitation should be given importance. The Indian government can make great improvements in this way by improving transparency and being less 'heavy-handed' as many civil society organizations like Greenpeace India argue. (Greenpeace, 2014)

Conclusion

From this standpoint of energy security, nuclear energy can be pursued but the manner in which it is pursued should uphold the human rights and right to justice of the people adversely affected. For India, an investment into nuclear energy thereby increasing its share in the energy matrix would have a significant positive impact on the nation's energy security by enhancing robustness, resilience and sovereignty in the energy sector. The ability of reforming the regulatory mechanism in the sector is of utmost importance and must be undertaken to support the expansion in nuclear-energy production. However, the fact that coal is and will remain the primary source of electricity in the country means that pursuing strategies to improve efficiency and sustainability in its production and use is also a high priority. Nuclear energy is not a panacea for India's worries, but it can go a long way in alleviating some of the pressures on the nation.

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