Articles

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Spanners in India's Energy Ambitions: Negative Perception & Non-Committal Government

Abstract

There is no denying the fact that developing countries, like India, would need energy to feed its development, while at the same time trying to keep in check its carbon emissions. If India intends to increase the living standard of its people, attain increased level of industrialisation and pursue the projects of national importance nuclear energy is an extremely reliable de-carbonised source of energy. The Indian Nuclear energy capacity, however, has not augmented even after the Indo-US nuclear deal. Also, the sluggish growth of the nuclear energy prior to the inking of the landmark Indo-US nuclear deal was attributed to the lack of adequate of financing, technological denial regimes, continued non-availability of uranium at low cost, the limitations of the Indian manufacturing industry and negative public perceptions about nuclear energy.

This paper attempts to look into the two main challenges faced by Indian civil nuclear power programme. It attempts to compile various reasons as to why despite the nuclear energy being projected as one of the main energy sources since the inception of the Indian nuclear programme, the rise of nuclear energy has lacked progress.

Introduction

The commercial generation of nuclear power has a global history of over six decades (Obninsk – First Nuclear Plant to Produce Commercial Electricity in 1954, 2019). But, the fear of it has been a critical impediment towards its acceptance by countries across the globe, even though the world today has 450 nuclear reactors operating. India too has 22 nuclear reactors operational in the country and decades of successfully operating nuclear power plants, but the ambivalence of the Indian Government and the negative public opinion against the atomic power is the reason that the ambitions of the country vis-à-vis nuclear power are from its reach.

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According to the statistics of the Ministry of Power (Government of India), as on January 2019, the total installed power capacity of India is just 367,281 MWs. Out of this a whopping 62.8 per cent comes from fossil fuels like coal, lignite, gas, diesel. Renewable energy like wind and solar comes next at 23.1 per cent. Then is the hydro power at 12.4 per cent. The lowest share is that of the nuclear energy at a meagre 1.9 per cent (that is 6,780 MW) generated by its 22 nuclear reactors (India, 2019). According to the International Atomic Energy Agency (IAEA), India ranks 27th as per its share of nuclear energy in the total energy matrix.

In 2004, the Nuclear Power Corporation of India Limited (NPCIL) set an ambitious target of generating 20,000 MW by the year 2020 (Subramanian) and 64,000 MW by 2032 (Sharma, 2019). This target was further confirmed in 2010 and in 2011 the eyes were set to achieve a nuclear power generation of 63 GW by 2011 (Khan, 2019). In fact, Prime Minister Manmohan Singh termed the goals as 'modest' in 2007, and asserted that India was capable of generating 'double' the current targets by opening to the international cooperation. Prime Minister Narendra Modi's government in July 2014 also asked the Department of Atomic Energy to recalibrate its nuclear power goal to 17 GW by 2024. In March 2017, answering a parliamentary question the government said that the 14.6 GW target of nuclear capacity by 2024 was achievable (Sharma, 2019).

The sluggish growth of the nuclear energy prior to the inking of the landmark Indo-US nuclear deal was attributed to the lack of adequate of financing, technological denial regimes, continued non-availability of uranium at low cost, the limitations of the Indian manufacturing industry and negative public perceptions about nuclear energy. The historic Indo-US nuclear deal did build up the expectations about the growth of the Indian Nuclear Power sector and as did the ensuing civil nuclear cooperation agreement with France, Russia, Canada, Australia, United Kingdom and Japan. Buoyed by this the Department of Atomic Energy (DAE) projected the 2052 nuclear power generation to 470 GW by 2052 (Khan, 2019).

The Indian Nuclear energy capacity, however, has not augmented exponentially even after the Indo-US nuclear deal. The Nuclear Power Plants planned to be set up jointly with foreign vendors like the US and France who have long gestation periods. The US nuclear cooperation Westinghouse and the French Areva, now owned by EDF; has been undergoing negotiations with the Nuclear Power Corporation of India Limited (NPCIL) over tariff of the power units and the modalities of the construction of the power plants at Jaitapur (Gadgil, 2015) (Dipanjan Roy Chaudhury, 2018).

The Kudankulam Nuclear Power Plant in Tamil Nadu, constructed under Indo-Russian cooperation, is the only successful example of a joint venture in the field. But the fact remains that the construction began in 2001 and it was scheduled to be completed in 2007. However, the construction of the first unit was completed in December 2011 and that of the second unit in December 2012. According to the Comptroller and Auditor General (CAG) of India's 2017 report, the missing of the original deadline was caused because of "delayed completion of different activities, of which many were attributable to the M/s Atomstroyexport (ASE), a company responsible for undertaking the Russian scope of work (General, 2017). There was also vehement opposition from the nearby villages under the banner of People's Movement against Nuclear Energy (PMANE) further scuttling the construction.

Domestically, the Indian government sought to fast track the nuclear power industry by approving the construction of 10 indigenous developed Pressurised Heavy Water Reactors (PHWR) with a total capacity of 7,000 MW. In its announcement, the Government enumerated the advantages of nuclear power – how it can ensure "long-term base load requirement for the nation's industrialisation" and is in sync with its sustainable development goals (Boost to transform domestic nuclear industry, 2017). To be inducted in fleet mode, the 10 PHWRs do give the Indian industry a lease of life, albeit a short one.

This paper intends to look into the two main challenges faced by Indian civil nuclear power programme. The quest is to compile reasons as to why despite the nuclear energy being projected as one of the main energy sources since the inception of the Indian Nuclear Programme, the rise of nuclear energy has lacked progress in other sector.

Global Scenario

Countries arrive at their power mix taking into account their overall energy scenario – that involves availability of fuel sources, projection of power demand and the political compulsions of the government. The world has been talking about 'nuclear renaissance' – a term for the revival of the global nuclear industry, when over 250 earthquake tremors and ensuing Tsunami in Japan, presented nuclear power its biggest challenge in the form of Fukushima Daiichi nuclear accident (Fukushima Daiichi Accident, 2018).

The accident created a political panic across the world governments, even though as per the World Nuclear Association, no deaths were reported due to the radiation from the nuclear reactor. As a result many developed countries, particularly Germany, announced roll back of their nuclear programme (Dohmen,

Jung, Schultz, & Traufetter, 2019). The German experiment of "exceptionalism" in nuclear policy has been termed "Energiewende" (literally translating to energy transition) and entails the European country phasing out nuclear power in a decade (Beveridge & Kern, 2013). The entire world is closely following the developments in the "Modell Deutschland" and if successful, is likely to be replicated around the world.

The German distrust of nuclear energy is riding on the premise of it being inherently unsafe. Despite, the German public's unanimous opposition to nuclear energy, the 'Energiewende' as programme has little to show in terms of results as the largest economy in Europe continues to fall short of its sustainability goals (Pflugmann, Ritzenhofen, Stockhausen, & Vahlenkamp, 2019). The phasing out of nuclear power has made Germany more dependent on coal. In 2017, the share of coal-generate power in Germany's energy mix is the same as it was in 2000.

German experts are waking up to its perils and enlisting problems of intermittency, grid and stability of distribution, market distortion, storage problems and its damaging effects on bio-diversity to build a case against 'Energiewende'. Fritz Vahrenholt, who has served in several public positions with environmental agencies such as the Federal Environment Ministry and Deputy Environment Minister and Senator of the City of Hamburg, gave a presentation titled 'Germany's Energiewende: A disaster in the making at the House of Commons in 2017. Owing to the heavy subsidies given by the German government to push its 'Energiewende' programme, the energy prices in Germany are the second highest in the Europe (Vahrenholt, 2017).

The US is also leaning towards increasing the use of natural gas with massive reserves being discovered. In US, the proven reserves of natural gas have marked an increase of over 80 per cent to approximately 430 trillion cubic feet. Already the largest oil and gas producer, the US is aiming to increase its share of global oil production to 17 per cent and of gas to 23 per cent. In the 2020s, the US is set to supply over 60 per cent of new oil and gas (Clemente, 2019).

The developed countries have their own political and economic compulsions to pass over the option of nuclear power, but reports have time and again underscored the importance of nuclear energy. A 2018 interdisciplinary study done by Massachusetts Institute of Technology (MIT) titled 'The Future of Nuclear Energy in a Carbon Constrained World' has unequivocally underlined that nuclear power has to be part of the energy mix in any pathway to a 1.5 degree Celsius future. The report expressed concerns at the 'dim' prospects for the expansion of nuclear energy in many parts of the world. "The fundamental

problem is cost. Other generation technologies have become cheaper in recent decades, while new nuclear plants have only become costlier. This disturbing trend undermines nuclear energy's potential contribution and increases the cost of achieving deep de-carbonisation," the reports contend while calling on the world governments to provide a level playing field to nuclear power vis-à-vis other renewable sources of energy (The Future of Nuclear Energy in a Carbon-Constrained World, 2018).

The downside of the Great German Energy Experiment is that the anti-nuclear panic amongst German population has forced the government to shut down itself to any technological advancement in making the nuclear power safer. The scientists in other parts of the world are working to find if it is possible to run power plants on radioactive waste – which would be a two pronged solution to manage the nuclear waste better; to make the nuclear energy technology better and safer.

Developing countries like India and China need energy pathways that lead to a destination with greater share of nuclear energy in their overall energy matrix. Numerous studies charting out scenarios of India's Energy pathways indicate a greater share of nuclear energy if the country wants to meet its future energy requirements while at the same time keeping its greenhouse emissions low (Mohan, 2016) (Gambhir & Anandarajah, 2013) (TERI, 2013). In October 2012, Avoiding Dangerous Climate Change (AVOID), a UK funded research programme of the Department of Energy and Climate Change (DECC), published a study on India's energy pathways to 2050. The study while outlining the ways to reduce greenhouse emissions and to minimise the costs to the energy system, found that irrespective of the scenarios the nuclear power in India requires fresh impetus (Gambhir & Anandarajah, 2013).

Challenges to Nuclear Energy Pathways

The political and public panic ensuing post Fukushima disaster had scuttled the growth of the global nuclear energy sector. Since the disaster in 2011, it has only been in 2019 that the nuclear power generation showed an upward trend. The World Nuclear Association (WNA), the international organisation representing the nuclear industry, released the 18th edition of the biennial 'Nuclear Fuel Report: Global Scenarios for Demand and Supply Availability 2019-2040'. The Upper and Reference Scenarios show global nuclear power capacities growing over the period up to 2040 at a faster rate since 1990, "increasing mainly due to extensive reactor building programmes in China, India and other countries in Asia" (World Nuclear Association sees upturn in uranium demand, 2019).

Secretary DAE and Chairman of Atomic Energy Commission KN Vyas enumerated the challenges encountered in the capacity addition programme. "These include delays in land acquisition and related research and development, obtaining statutory clearances and difficulties faced by Indian industries in timely manufacturing and delivery of equipment or components. In respect of projects to be set up with foreign cooperation, the techno-commercial discussions to arrive at project proposals have been long drawn as they involve complex techno-commercial, legal and regulatory issues," Vyas added (Vyas, 2019).

Negative Perception

Since its inception in 1950s, the Indian Nuclear Programme has matured without any nuclear accidents. However, the negative perception around nuclear power, especially among those living close to a Nuclear Power Plant, remains one of the biggest challenge that civil nuclear programme up against (Malhotra, 2016) and the Indian government has not done much to dispel the misinformation around nuclear technologies.

The Kudankulam Nuclear Power Plant has faced a vociferous opposition from the population residing around the nuclear plant resulting in much delay. The Nuclear Power Plant was even a pivotal issue of the Tamil Nadu elections since 2011. As India plans more nuclear power plants across the country, the opposition would become more noticeable. The Planning Commission's report on "India's Low Carbon Strategies for Inclusive Growth", also indicated that the future capacity addition in nuclear energy sector also depends on public acceptance. The report reflects that "nuclear accident in Japan has raised public concerns about the safety of nuclear power as an energy source" (Low Carbon Strategies for Inclusive Growth, 2011).

The Bharatiya Janta Party-led government at the Centre has now woken up to the pitfalls of public anxiety about nuclear energy. Union Minister of State for Atomic Energy and Space Dr. Jitendra Singh said at the Indian Energy Forum 11th Nuclear Energy Conclave in 2019 that awareness needs to be created among the public to bust the myths associated with the use of nuclear energy. "I have been trying to sensitise states about nuclear energy, making them aware of its diverse benefits," Singh said during the Conclave (Bureau, 2019). The Minister's statement is, albeit, not backed with a concrete strategy.

In 2017 the government had to shift a proposed 6000 Megawatt nuclear power plant from Mithivirdi in the Bhavnagar district of Gujarat to Kovvada, Andhra Pradesh following a decade long resistance from the local populace. This would have been the first nuclear power plant under the Indo-US civil

nuclear pact 2008 and as a joint venture between state-owned Nuclear Power Corporation of India Ltd (NPCIL) and the now bankrupt Westinghouse Electric Company. The resistance against the atomic power station saw protests with rallying cries like '*maut nu karkhano band karo*' (shut down factory of death), '*anu bijli sasti nathi salamat nathi*' (electricity generated from atomic energy is neither cheap nor safe), 'we will give our lives not land' and 'not here not in our land' that were heard on that day became part of the movement till the end (Dhar, 2017).

Watchers of the Nuclear energy in India says that the resistance faced by the nuclear power plant in Mithivirdi and delay in land acquisition in Kovvada due to strong public opposition as "merely a PR disaster" rather than anything scientific. So far, the scholars working on the topic has not been able to chronicle any instance of "wholehearted support" for nuclear energy projects (Mishra, 2012). This negative perception has been the reason for the long gestation periods for setting up nuclear plants. Since Chernobyl, nuclear power plant construction has come a long way and the reduction in construction time has been noticeable (Sethi, 2012).

Experts in the field of Nuclear Energy have time and again pointed out that there are no sources of energy generation that are completely risk free. Even oil industry face environmental disaster as was seen after about 3.19 million barrels of oil spilled into the Gulf of Mexico – resulting in the largest accidental ocean spill in human history (Team, 2010). Despite the huge damage to the marine life, contend the experts, there were no calls for boycotting oil as energy source. Rather, research studies were conducted to improve safety in the sector (Mishra, Fukushima Disaster: A Breakdown of Events, 2012).

Contrary to this in the history of civil nuclear power three major reactor accidents have been observed/witnessed – Three Mile Island, Chernobyl and Fukushima. The World Nuclear Association website reads: "One was contained without harm to anyone, the next involved an intense fire without provision for containment, and the third severely tested the containment, allowing some release of radioactivity." These are the only three big accidents in over 17,000 cumulative reactor-years of commercial nuclear power operation (Safety of Nuclear Power Reactors, 2019). Out of these three accidents – Chernobyl and Fukushima, had received a level 7 (the maximum classification) on the International Nuclear Event Scale.

In the case of Chernobyl, 31 people died due to direct exposure to the radiation released following the accident and the estimate of the long term deaths resulting from low level radiation exposure ranges from 16,000- 60,000. The

Fukushima Disaster in 2011 is reported to have resulted in injury of 40-50 people at the nuclear facility but the number of direct deaths from the incident are said to be zero. Around 1600 people, however, are said to have died to due to evacuation procedures (Ritchie, 2017). The casualty in two incidents nearly 25 years apart indicate the strides that nuclear reactor safety has taken and it is a "unique feat" compared to any other fuel used for electricity production (Sethi, 2012).

The DAE has been aware of the opposition that nuclear energy evokes. "Scare caused by Fukushima accident and public, at large, going in overdrive and failing to understand the differences between Fukushima and Indian scenario in terms of the types of reactors, environmental conditions, etc," Secretary DAE KN Vyas says (Vyas, 2019).

Anil Markandya and Paul Wilkinson published a comparative analysis of the death rates in major ways of energy generation. The duo while expressing concern about the piling nuclear waste, a matter that the scientists are also seized of, established that nuclear energy resulted in the least amount of deaths when compared to coal, oil and gas (Markandya & Wilkinson, 2007).

The study concluded that fossil fuels have killed more people than nuclear energy, but the negative public opinion stemming from imagined catastrophic accidents continues to be the hurdle in the Government's commitment to nuclear power. This indicates the next challenge in the growth of Indian Nuclear Energy sector at desired pace.

Non-committal Government towards Nuclear Power

Nuclear Energy was not adopted as the general policy to combat global warming at the 2015 Climate Change Conference in Paris, owing to the concerns around its safety. The Indian Government, despite its stated ambitions with respect to nuclear energy, has not committed to nuclear energy in the same manner as it has to other renewables. The nuclear energy requires a policy intervention from the government to compete with other carbon emissions free renewables like solar and wind.

The other renewable sources of energy – wind and solar, are carbon emissions free, but they are not base load source of energy. Recently, a task force headed by former chairman of the Atomic Energy Commission Dr. Anil Kakodkar, examined the Indian nuclear energy eco-system and found that the Government's incentives to the Renewable Energy Sources have tilted the odds against the nuclear energy. The report titled 'Nuclear Power: India's Development Imperative' said: "In any comparison with coal, emission costs must be factored

in.... Without factoring grid/system costs of renewables, nuclear tariff may appear high. A well-designed financing and pricing policy should, therefore, be put in place at the earliest. (Nuclear Power: India's Development Imperative, 2019)"

Making a case for nuclear power, the task force said that "low emission" and "grid stability" are its two chief attributes. Both, as per the report, are the public good for which "no mechanism exists to ensure due compensation to the nuclear power producer". A report released by Independent Power Producers Association of India, by the end of 2022, India will have installed capacity of 100 GW of solar power and 60 GW of wind power. But, these renewable energy resources will not come without their socio-ecological impact, as they are the most land hungry energy-generation resources. According to experts, to replace the power generated by one typical coal-fired power station with renewable energy requires an area of around 500 km square. And, in India land is one of the scarcest resources considering its population (Sharma R., 2017).

The Indian Government's preferential treatment towards renewables meant that early on they were given feed-in tariff and they are still given incentives like Accelerated Depreciation and Renewables Purchase Agreement. Feed-in tariffs (FIT) are fixed electricity prices that are paid to renewable energy (RE) producers for each unit of energy produced and injected into the electricity grid. The accelerated depreciation benefit allows the commercial and industrial users of solar power in India to depreciate their investment in a Solar Power Plant at a much higher rate than general fixed assets. This in return allows the user to claim tax benefits on the value depreciated in a given year.

The Renewable Purchase Agreement means that the large power consumers have to ensure certain percentage of the energy mix comes from renewables such as wind and solar and is likely to increase to 21 per cent by 2022 (UN, 2018). This obligation is akin to a subsidy impetus to the renewable sector and helps in generating demand for the sector. The 2016-17 Economic Survey pegged the social cost of producing renewable energy to three times that of coal-based electricity at Rs. 11/- per kilowatt-hour (kWh). The Economic Survey reported that though solar and wind power tariffs dipped to Rs.2.44/- per kWh and Rs.3.30/- per kWh, respectively, making renewable energy cheaper than coal-fuelled electricity; these low tariffs do not reflect the "costs of integration with the grid, and other costs such as those of stranded assets and land opportunity costs" (Economic Survey 2016-17, 2017). The survey cautioned that the push to renewable energy could worsen the bad loan woes of the banks.

Despite the lack of desired government support, atomic power plant operator Nuclear Power Corporation of India Limited (NPCIL) has been self-sustaining

for all these years without relying on government subsidies and loan guarantees. In the year 2017-18, the NPCIL delivered a profit of Rs. 4622 crore before taxes and its net worth was also up by 4 per cent (31st Annual Report 2017-18, 2018).

The Anil Kakodkar-led task force takes these concessions given to renewable energy and seeks a zero emission credit on the patter of the United States to nuclear power as well. The task force report made a point that unlike coal, nuclear power cannot be backed down. Nuclear power plants, therefore, need to be given 'must run' status. The Indian government has to ensure, says the report, a long-term power purchase agreement with bulk buyers (Nuclear Power: India's Development Imperative, 2019).

Presently, the Department of Atomic Energy (DAE) has been deciding the tariff of nuclear power under the Atomic Energy Act. The DAE is also seeking government support till the nuclear energy, which is a "more sustainable" option, comes at par with other renewable energy resources (PTI, 2019). The Kakodkar report says that for achieving this target, there has to be effort put in by various stakeholders. The provision of Rs. 3,000 crore per annum falls short of the equity of Rs. 20,000 crore needed per annum to achieve the target. It recommended that several Public Sector Units form joint ventures with Nuclear Power Corporation of India Limited (NPCIL). The government might also have to amend the Atomic Energy Act if we are trying out a model where foreign vendors are allowed to invest in the plant and operate it for large periods. The Indian Government has, in fact, allowed Foreign Direct Investment (FDI) in the field of Nuclear Energy in January 2020.

Even as India is dithering to be assertive when it comes to nuclear power, European Council has maintained that it is eligible for 'green' financing. Because of this nuclear power projects will be eligible for finances allocated by European countries to curb carbon emissions (Valero, 2019).

Conclusion

There is no denying the fact that developing countries, like India, would need energy to feed its development, while at the same time trying to keep in check its carbon emissions. If India intends to increase the living standard of its people, attain increased level of industrialisation and pursue the projects of national importance like lift irrigation or river linking, nuclear energy is an extremely reliable de-carbonised source of energy.

The Indian Government's push to the country's nuclear power programme in the form of the 10 indigenous Pressurised Heavy Water Reactors (PHWRs) has come at the right time. But, in commensuration what is required is a strategy

to dispel the misconception surrounding nuclear power and a clear strategy on part of the Indian Government to put its money where its mouth is, if it wants the nuclear energy to stand a chance against other renewables.

References

1. *31st Annual Report 2017-18.* Mumbai: Nuclear Power Corporation of India Limited.
2. Beveridge, R., & Kern, K. (2013). The 'Energiewende' in Germany: Background, Development and Future Challenges. *Renewable Energy Law and Policy Review*, pp. 03-12.
3. *Boost to transform domestic nuclear industry.* (17 May 2017). Retrieved from Press Information Bureau: https://pib.gov.in/newsite/PrintRelease.aspx?relid=161865
4. Bureau, F. (2019, October 19). *Myths linked to nuclear energy should be busted: MoS Jitendra Singh*. Retrieved from The Financial Express: https://www.financialexpress.com/industry/myths-linked-to-nuclear-energy-should-be-busted-mos-jitendra-singh/1740042/
5. Clemente, J. (2019, December 8). The U.S. dominates New Oil and Gas Production. *Forbes*. Retrieved from https://www.forbes.com/sites/judeclemente/2019/12/08/the-us-dominates-new-oil-and-gas-production/#78ed3bfa1cce
6. Dhar, D. (2017, June 30). *Economy*. Retrieved from The Wire: https://thewire.in/economy/mithivirdi-movement-gujarat
7. Dipanjan Roy Chaudhury. (2018, February 06). *Westinghouse to hold talks for 6 N-reactors in Andhra Pradesh*. Retrieved January 15, 2020, from The Economic Times: https://economictimes.indiatimes.com/industry/energy/power/westinghouse-to-hold-talks-for-6-n-reactors-in-andhra-pradesh/articleshow/62799169.cms?from=mdr
8. Dohmen, F., Jung, A., Schultz, S., & Traufetter, G. (2019, May 13). *German Failure on the Road to a Renewable Future*. Retrieved January 2020, from Der Spiegel: https://www.spiegel.de/international/germany/german-failure-on-the-road-to-a-renewable-future-a-1266586.html
9. *Economic Survey 2016-17.* New Delh: Government of India, 2017.
10. *Fukushima Daiichi Accident*. (2018, October). Retrieved from World Nuclear Association: https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-accident.aspx
11. Gadgil, M. (2015, March 10). *Areva may source locally for Jaitapur nuclear project*. Retrieved Jan 15, 2020, from Livemint: https://www.livemint.com/Industry/P0hR5tsvGYv9uPsUL6pKzL/Areva-may-source-locally-for-Jaitapur-nuclear-project.html
12. Gambhir, A., & Anandarajah, D. G. (2013). *India's CO2 Emissions Pathways to 2050.* London: Grantham Institute for Climate Change.
13. General, C. a. (2017). *Report of the Comptroller and Auditor General of India on Kudankulam Nuclear Power Project, Units I and II.* Department of Atomic Energy.
14. India, G. o. (2019, January 14). Power Sector at a Glance - All India. *Ministry of Power*. Government of India. Retrieved Jan 14 2020, from https://powermin.nic.in/en/content/power-sector-glance-all-india
15. Khan, A. (2019). India Needs to Wake up from its Nuclear Fantasy. *Economic and Political Weekly,* 54 (41).
16. *Low Carbon Strategies for Inclusive Growth.* New Delhi: Planning Commission, 2011.
17. Malhotra, A. (2016). Assessing Indian Nuclear Attitudes. *A Visiting Fellow Working Paper*. Washington DC: Stimson Center.

18. Markandya, A., & Wilkinson, P. (2007). Energy and Public Health. *The Lancet*.
19. Mishra, S. (2012). Fukushima Disaster: A Breakdown of Events. In Manpreet Sethi ed., *Nuclear Power in the Wake of Fukushima* (pp. 11-26). New Delhi: Centre for Air Power Studies and KW Publishers.
20. Mishra, S. (2012). Nuclear Energy in India: Changing Dynamics of Public Opposition and Social Acceptance. *Air Power, 7*(3), 55-82.
21. Mohan, A. (2016, August). The Future of Nuclear Energy in India. *ORF Occasional Paper*. Observer Research Foundation.
22. *Nuclear Power: India's Development Imperative.* (2019). New Delhi: Vivekananda International Foundation.
23. Obninsk – First Nuclear Plant to Produce Commercial Electricity in 1954. (2019, February 23). Energy Global News. Retrieved January 15, 2020, from http://www.energyglobalnews.com/1954-obninsk-nuclear-plant-produces-worlds-first-commercial-electricity/
24. Pflugmann, F., Ritzenhofen, I., Stockhausen, F., & Vahlenkamp, T. (2019). *Germany Energy Transition at a Crossroads.* McKinsey and Company.
25. PTI. (30 October 2019). *Energy*. Retrieved from The Economic Times: https://energy.economictimes.indiatimes.com/news/power/dae-seeks-preferential-treatment-to-ensure-energy-security/71821802
26. Ritchie, H. (24 July 2017). *What was the death toll from Chernobyl and Fukushima?* Retrieved from Our World in Data: https://ourworldindata.org/what-was-the-death-toll-from-chernobyl-and-fukushima
27. *Safety of Nuclear Power Reactors*. (2019, June). Retrieved from World Nuclear Association: https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/safety-of-nuclear-power-reactors.aspx
28. Sethi, M. (2012). In the Wake of Fukushima: Implications and Lessons for India. In E. b. Sethi, *Nuclear Power in the Wake of Fukushima* (pp. 43-64). New Delhi: Centre for Air Power Studies.
29. Sharma, A. (2019). *India's Pursuit of Energy Security: Domestic Measures, Foreign Policy and Geopolitics.* Hosur, Tamil Nadu: Sage Publications.
30. Sharma, R. (2017, October 20). *Views* . Retrieved from Nuclear Asia: https://www.nuclearasia.com/views/experts-raise-concern-energiewende-failure-germany-bangladesh-india-need-draw-lessons-right/1259/
31. Subramanian, T. (n.d.). Nuclear Electricity is the Answer. *Frontline, 21*(4). Retrieved January 2, 2020, from https://frontline.thehindu.com/static/html/fl2104/stories/20040227005811400.htm
32. Team, T. O. (2010). *Introduction*. Retrieved February 2020, from Ocean: https://ocean.si.edu/conservation/pollution/gulf-oil-spill
33. TERI. (2013). *100 per cent Renewable Energy by 2050.* New Delhi: WWF-India.
34. *The Future of Nuclear Energy in a Carbon-Constrained World.* Massachusets Institute of Technology, 2018.
35. UN, S. (18 June 2018). *India*. Retrieved from Quartz India: https://qz.com/india/1307648/india-is-forcing-large-power-consumers-to-use-more-renewable-energy/
36. Vahrenholt, F. (2017). *Germany's Energiewende: A disaster in the making.* The Global Warming Policy Foundation.
37. Valero, J. (2019, September 25). *Energy & Environment*. Retrieved from Euractiv: https://www.euractiv.com/section/energy-environment/news/council-maintains-nuclear-as-eligible-for-green-finance/

38. Vyas, K. (21 November2019). DAE Working on Small Modular Reactors: KN Vyas. (R. Sharma, Interviewer)
39. *World Nuclear Association sees upturn in uranium demand*. (05 September 2019). Retrieved from World Nuclear News: https://www.world-nuclear-news.org/Articles/Nuclear-fuel-report-sees-upward-trend.