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Public Understanding of Science: The Case of Kudankulam Nuclear Controversy.

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Abstract

The paper tries to investigate how different public(s) are involved in the Kudankulam nuclear issue. How different public(s) conceptualize the tenor of nuclear technology and what should be the immediate course of action to deal with the same. This paper intends to highlight three kinds of public like, youth, media and the inhabitants around the Kudankulam nuclear power plant and their narratives on the ongoing nuclear standoff. The paper captures how Kudankulam as a site of contestation can be explored through the prism of Public Understanding of Science (PUS)

Introdyction

In the wake of Fukushima disaster, nuclear industry throughout the world faced a new kind of challenge: public protest escalated throughout the different parts of the world. Countries loaded with nuclear expertise decided to detract from nuclear path, others decided to review existing nuclear establishments. However, the case of India was a bit parochial and bizarre as well. India decided to proceed with its ambitious nuclear project despite a stormy wave of public resentment.

Nuclear power stations are expensive, polluting sitting ducks—static time bombs" (Greenpeace, 2005). Such a debate has further broadened in the wake of Fukushima disaster. Nuclear power plants are considered inherently risky and expensive business. Nuclear power is also associated with negative connotations and imagery (accidents, destruction, contamination, mushroom cloud, child cancers) often linked with such technologies (Solvic et al 1990; Boholm 1998). Moreover, other factors like risk inherent to nuclear technology, design defaults and decommissioning have also become tumult issues after the Japan tragedy.

In the wake of dominant public controversies, constructing a substantial scientific advice is always a question mark. In a huge cloud of public distrust proclaims of safety and pronouncement of watershed proof is further scrutinized and questioned by media non-governmental organizations, branches of government and concerned members of the public (Stilgoe, 2005). Most scientific projects are always top-down exercise, wherein social scientists, scientific experts, and others are always responsible for organizing and facilitating them in almost all aspects. Thus lay–people rely on others for information access and mobilization, somehow find top- down approaches as unavoidable (Powel, Colin 2008).It is also interesting to find the source of information for the public on which they largely base their protest or discontent in the purview of technological controversies .

In the context of India, sites like Jaitapure, Kudankulam and Hirapur have emerged as new locations of public protestation. Indian nuclear regime faced fervent public protest and the commissioning of the Kudankulam Nuclear power plant was almost stalled. What seems to be case of public-state conflict needs to be debunked from public understanding of science perspective. Factors like risk perception, autonomy within the various scientific institutions, politics of public engagement, nuclear policy and its execution needs to be revisited and reconstructed as well.

Public understanding of science as a theoretical tool can be deployed to understand the whole grammar of the current Kudankulam nuclear protest and further, on deliberating as, how different shades of public understand and conceptualize the nuclear technology?

Public understanding of science (PUS) is not only young and emerging discipline, but a modern movement which tries to rejuvenate sense of trust among ordinary citizens[1] (Finkelstein, 1996). In order to counteract or simply contest the trust deficit and misconceptions pertaining to scientific institutions, innovations, newer technologies, scientific applications and actions, Public understanding of science has a broader role to play in (Boykof, Roberts, 2007). Public understanding has been enunciated as studies woven in fabric of “science and society” (Michael 2009) or popularization of science (Hilgartne, 2009).While, others have defined it, movement to bridge the gap of knowledge between the institutions of science and the rest of the society (Fayard et al,. 2004). (Rader et al,. 2011) expresses it as a kind of activism, which tries to generate public opinion and simultaneously ensure their participation in diverse scientific ventures. More interestingly, (Durant, 2003) suggests that PUS now focuses of dialogue model rather than deficit model [2]

Before getting down to necessitate the understanding of different public(s) in the context of Kudankulam, it would be imperative to explore what public really stands for?

Every individual member of the society can be rightly termed as public. Moreover, it is heterogeneous and multifaceted group. Scientist, decision makers, mediators, general public, attentive public and interested public are all part of this group. Further, they may be classified as lay public or scientific community (Burns et al,. 2003).

Brannen and Susane (2010) believes that landscape is populated by four major construction of publics -

(a)The general public

(b)The pure public

(c)The affected public

(d)The partisan public [3]

Mike Michael has classified two broad rhetorical categories of public identified as public in general and publics in particular. Michael (2009) believes, attention is to be paid to the ways, assumption are built into the techniques of public participation, or engagement, and how these can be read as media of governmentality which resources participants as particular type of public, and indeed particular type of (Scientific) citizen.

Michael (2009) asserts that, the term "public" is used heuristically, as it covers wide range of similar terms such as citizen, collectivities, lay groups, communities and movements. The purpose is not only to define public, but to trace out some of the dynamic by which such "publics" endorses themselves or emerge through the processes of expressing themselves against other such publics. In our study, given that there are variety of public available, we have identified three type of publics like

a) Youth

b) Habitants of Kudankulam

c) Media and Government responses.

1.Youth as one of the public

An interview schedule was administered to a sample of 150 youth and the universe of study was national capital Delhi. In order to make the sample size more inclusive, a kind of 'mixed bag' response, data was collected from various universities like IIT, JMI, DU, call centers, private schools, NGO's and pedestrians too. Respondents of different age groups between 18 and 35 were given questionnaires.

The opinion of the youth becomes highly pertinent in context like India whose current population comprises of 40% of the youth and in the years to follow; this population would be half of the total population of the country. Youth is also valuable human resource, who is deeply linked with the present and futuristic plans of national development (2012 India, Tribune).

A crucial study was carried by National energy institute US (Bisconti, 2011). In the public survey, it was found that 73% of American's say nuclear energy/technology is safe. Similarly, in other exhaustive survey, carried by international atomic agency in year 2005, across 18 countries, it was noticed that, in India 33% of respondents believe that nuclear technology is safe and other 22 % holds opposite opinion. In yet another survey, titled, *Canadian Nuclear Attitude*, initiated by Canadian nuclear association (CAN 2011), it was observed that 74% of the respondents assume that, safety of nuclear plants is of primary importance and 19% suggest that nuclear safety is not an issue of anxiety.

However, in the current study it was found that91(60%) out of the total 150 respondents advocate that nuclear power plants are not safe at all.(see table 1), (57)38% of the respondents support the argument that Nuclear power plants are completely safe. While the number who support the theory that nuclear power plants are not safe, is almost double to the one who favour it. Interestingly, in another question respondents were offered five (5) options and asked to choose the one they think is most appropriate. The question comprised of the options like, very important, somewhat important, not important at all, not too important and can't say.128 (85.3%) believed that much importance should be given to management of safety and risk, 10 (6.7%) opted for the option of somewhat important, 4(2.7%) chose not important at all and very fewer preferred can't say is most appropriate for them. (see figure 1.)

Responses; whether Nuclear power plant is safe or not?)

Preferences	No. of Respondents	Percentage %
Very important	128	85.3%
Somewhat important	10	6.7%
Not too important	4	2.7%
Not important at all	2	1.3%
Can't say	6	4%
Total	150	100

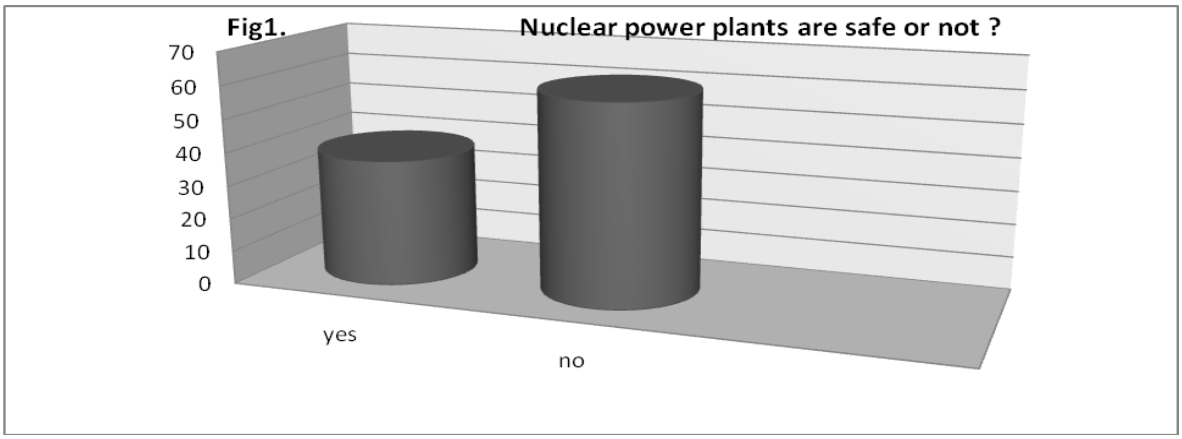


Table 1. Public perception on the management of safety and risk

Conceptualization of risk in post- Fukushima era.

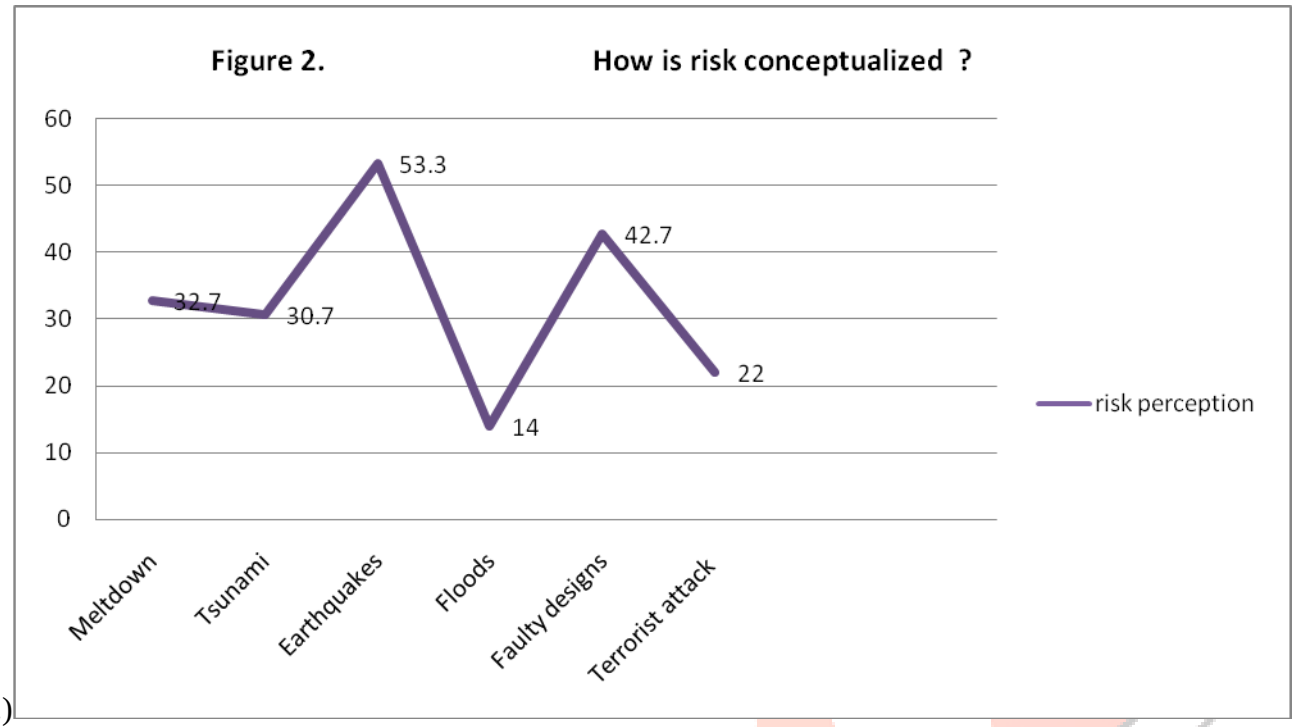
Defining, identifying and classifying risk is always a complex process. Risk cannot be same, thus need to be contextualized differently at different locations (EMO, 2012). One of the classical narrations of risk is that, "risk is measurable objective function of the probability event and magnitude event"[4]. However, the alternative perception is that, risk is not a measurable entity but a social construction. (Solvic, 2001)

Psychologist, Paul Slovic was among the first to identify the risk perception. Slovic observed that people exercise expert rationality only in the knowledge domains which they are aware of. In unfamiliar circumstances even scientists and engineers perception of risk through lay rationality (Wilkins and Patterson, 1991). Moreover, he concluded that people conceptualize risk on the basis of consequence of events and term the outcome as individual human error, rather than the result of social, political or mechanical errors (Wilkinson and Patterson, 1987).

In a very extensive and critical study of post Fukushima nuclear crises, (Kingston, 2012) in his article, *managing risk and Fukushima nuclear crises*, mentions that, safety measures have improved from the onset of previous nuclear episodes (TMI, Chernobyl) . Paradoxically, despite so much of assurance, Japan could not avert nuclear tragedy of this magnitude .Thus, Fukushima episode has further deepened crises and enhanced skepticism regarding safety and risk free theories. Poor safety measures and mismanagement of various sort of risks like seismic (earthquake), Tsunamic, huge disposition of radiations, poor designs of nuclear plants, risk of acquiring safe food and livelihood, has altogether raised suspicion on the whole risk outlook (Kingston, 2012).

In our current study, it was observed that 80 (53.3%) of respondents share the opinion that, Nuclear power plants in India are prone to threat of earth quakes and thus seismic sensitivity is top precedence for the safety of nuclear power plants. 64 (42.7%) respondents voted for the option of faulty design. The next option, for which we got maximum number of response, after earthquakes and faulty design, was meltdown. 49(32.7%) of respondents think nuclear power plants are not safe and massively dangerous because of the risk of meltdown[5].

In the study carried by IEA (2005), majority, 54%, of respondents surveyed, vouched that, the risk of terrorism is high. In the case of India, it was observed that, 40 % of Indians consider terrorism as primary risk for safety of nuclear power plants. However, in the present study it was found that only 33(22%) of respondents conjure up terrorism or terrorist attacks as primary danger for the nuclear power plants. Only, 21 (14%) of respondents, support flood as the potential risk for Indian nuclear power plants.(See figure 2.)



Alternative sources of Energy

In the wake of Fukushima disaster, search for alternative sources of energy and renewable sources of energy have assumed considerable significance the world over. In India also there seems to be renewed and more focused attention given to renewable and clean energy sources. Nuclear technology is not only considered 'dreaded and catastrophic' by public, but it also conceived a technology with minimum acquired benefits (Pidgeon et al : 1992; Solvic et al 1980).There is greater emphasizes by experts, environmental activists and common masses that renewable sources of energy should be given much more preference in the post –Fukushima era.

The severe meltdown in Fukushima has located international energy policies at cross roads. Nuclear energy was perceived as Co_2free, safe, secure, cheap and reliable resolution in the last decade. However, Fukushima disaster has made us to look at other alternative sources of energy. In the backdrop of increased depletion of resources and immense hike in oil and gas prices, energy policies throughout the world should be revisited. Renewable energy validates wide benefits and makes it unlikely large scale 'nuclear renaissance' would materialize (Ramana, 2011). It should

meet certain goals like economic viability, energy security, ecological sustainability and social compatibility. All this is possible only, when there is complete transit to renewable options of energy and need to expand alternative sources of energy is realized (Netzer and Steinhilber, 2011).

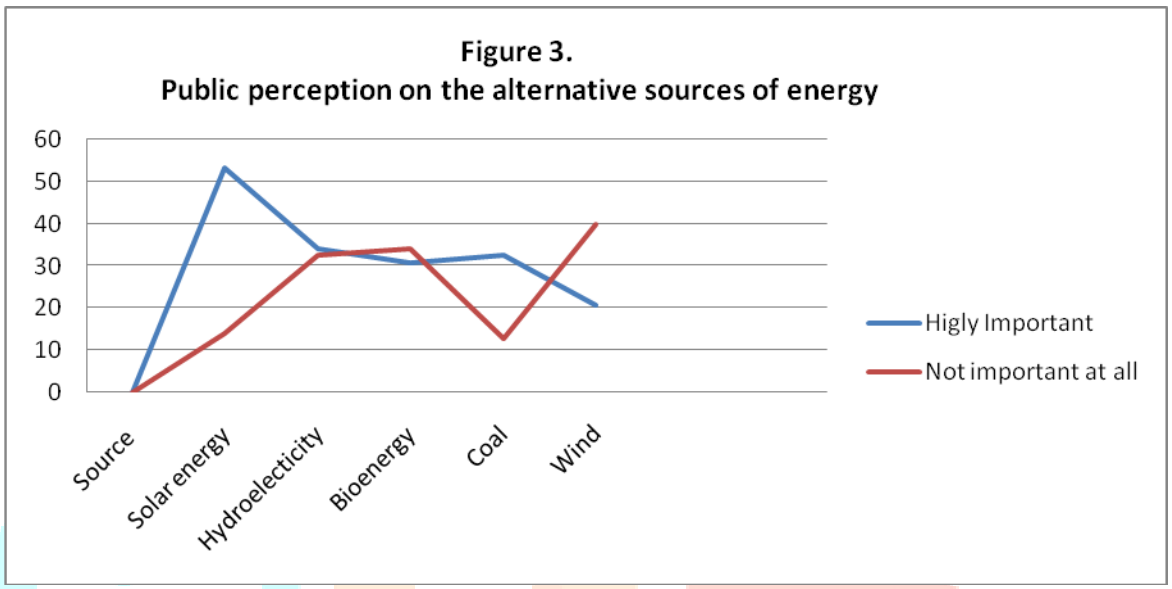
(Grossman, 2011), while referring to *scientific American*, most conservative scientific publication, in a major story 2009, mentions that for a sustainable future renewable occupy a place of centrality. Interestingly water, wind and solar technologies can provide 100 % of the world's energy, eradicating all fossil fuels.

In a very important study (CAN, 2011), it was observed that 76% of the respondent claim that, they strongly favour solar energy as most reliable and effective source of energy in contrast to the nuclear energy. Also, 64% of the surveyed public strongly favoured wind as the most reliable choice of energy in post–Fukushima era. 55% of the respondents vouch for hydroelectric option and surprisingly a very meager proportion of people suggest coal as their strongly selected energy alternative. A Washington post ABC–poll conducted in April 2011 found that 64% of the Americans opposed the construction of new nuclear power plants (Ramana, 2011, Craighill and Cohen, 2011). Support for nuclear power plants has also declined in countries as varied as Chile (12%), Thiland (16.6%), Austraila (34%) and United Kingdom (35%)(Ramana, 2011; Flower 2011; Greeen, 2011; van der Zee,:2011)

(Prabhu, 2012) proposes that, it is imperative, in the light of Fukushima, that country (India) generates clean and green energy. This is only possible, when country retracts from nuclear path completely and promotes use of renewable resources of energy. India as a country has got tremendous potential for solar energy, almost; all the parts of India receive sunlight for more than 300 days of year. Wind energy is also valid alternative for risk prone nuclear energy. Hydro followed by Biomass can generate considerable amount of energy.

In our study we found that, 80(53.3%) respondents say solar energy is highly important and simultaneously most reliable option of energy, while 21(14%) of respondents believe that solar energy is not that important. Hydroelectricity is the second most reliable option of energy and 51(34%) claim hydroelectricity is highly important, while 32% of the respondents hold opposite opinion. 48(32.05%) of the people questioned , replied that , they believe coal is highly important and other 19(12.7%) ,think other way, assume coal is not important at all. Bio energy as a highly important option was chose by 40(30.7%) respondents and interestingly a higher number of respondents, 50(34.3%), denied out rightly its importance. 31(20.7%) conceive that wind could be the alternative for nuclear energy and almost double of the respondents 60(40) denies the claim that wind is highly important and reliable option of energy.)(See figure 3.)

When a separate but almost similar question was posed to respondents that, "do you think renewable technologies (wind solar bio-energy) can become a major alternative to nuclear energy in coming decade or two? Majority of the respondents,117(78%), replied that, yes , renewable technologies have all the capacity to become major alternative to nuclear technology in coming decades, while as very less portion,33(22%) refuted their claim .



2. Responses from Kudankulam

People of Koodamkulam (local dialect for Kudankulam) are well aware about the nuclear incident that has happened in the past. They not only remember the dates, but they offer sufficient details about the nuclear tragedies that have happened in the course of history like Chernobyl, Three Mile Island and now Fukushima. They profoundly borrow from historical accidents, when asked, what is their understanding of nuclear technology? In a sense they historicize the nuclear episodes, while framing their understanding of risk and safety pertaining to nuclear technology. People borrow from past legacies when they have to frame their perception on nuclear episode or genetically modified food (PST international conference Barcelona 2004)

People refer to historical nuclear tragedies including Hiroshima and Nagasaki. They talk about Bhopal gas tragedy and Kalpakkam nuclear incident. They argue that children still are born with innumerable deformities; they are still suffering from cancer and other diseases, severe genetic disorders and on the top of that effected people are yet to receive compensations, which simply speaks callous attitude of concerned state governments. Nuclear power plant is not a matter of one single year, it is about future generations. People not only from Koodamkulam, but other villages share the same content that "we cannot live in persistent fear, fear of massive explosion, pervasive radiations and unbelievable aftermaths. Nobody knows what is going to happen in future, so how they (NPCIL)

can assure that our life and future is protected."[6].The perceptions about the various problems like pollution, toxic chemicals or nuclear power plants are largely influenced by broad worldwide relationships between humans, environment, prior beliefs about risk (Douglas, and Wildavsky 1993,Vaughan and Nordenstam , 1991 ; Dake 1991) . cultural contexts in which risk discourse is generated as well as framed cannot be ignored. Understanding of risk has strong underpinnings with the cultural world views (Irwin, 2001)

When people talk about nuclear technology, they base their assumptions or speculations largely on the basis of risk and safety issues. People refer to array of safety and risk issues which make them to be more skeptical about the nuclear technology. It is interesting to note that, risk issues are connected to public concerns and that science often fails to consider the public concerns that certain issues may cause to arise (Irwin and Michael, 2003; Marres, 2007). People have innumerable arguments, which defy the expansion as well as construction of new nuclear plants. People who comprises of women folk, men, children, students and leaders almost have some common apprehensions regarding the nuclear technology, but it would big blunder to assume that they base their protest on mere myths and lack scientific knowledge all together. People argue that, huge deposits of uranium would be dumped in the near vicinity.[7] It would be nothing but a dumping ground, which by all measures is a point of concern, grave issue and a matter of protest. They comprehend KKPP requires huge amount of water, which would be de-salinated and then consumed for cooling purposes.[8] In exchange, almost 7. 2 billion liters of hot water would be discharged every day from every single nuclear plant, such a great quantity would ultimately depreciate water texture and water contamination would be gruesome matter for marine ecology. Power and radioactive waste facilities show a very complex set of relationships between the technology (real or proposed) and geography (the aspects of a community's physical, social, and psychological make-up) (Pidgeon et al. 2012). Tamil Naidu is facing enormous water scarcity and states like Kerala and Karnataka are not in any compromise of sharing water with Tamil Naidu, thus nuclear power plant would lead to huge water shortage, which would result in a drought or famine situation.[9]

People argue that there have been several cancer cases especially because of radiation. Cancer cases in Tamil Naidu are higher than the rest of the country.[10] In the U belt of the state (i.e. Tutukudi and Cochin), radium is available in abundance in the sand, which is point of contention. People thus conceptualize the presence of nuclear power plant as threat to life and existence. They identify nuclear power plants are innately dangerous and their presence means further increase and widespread emission of radiations, which poses challenge to entire mankind and coming generations too. The public is not homogeneous, and different individuals oppose nuclear power for different reasons.

People believe Tamil Naidu is self sufficient, when it comes to electricity consumption. Tamil Naidu can sustain if it is able to construct solar roofs throughout the entire region. Tamil

Naidu gets sunlight for more than 320-340 days, so confessedly Tamil Naidu has a huge potential for solar energy, unlike northern India. One must understand nuclear power industry, which has one of the biggest and most lavish programmes and expensive projects aimed at public understanding (Stain, 2003) Moreover, maintenance cost in case of solar energy is not that high, when we compare with nuclear energy. In case of nuclear energy, uranium is purchased from other countries. Nuclear energy requires huge economic investment, large labor force and vast infrastructure; still there is no assurance of electricity. Ironically, the share of nuclear energy is less than 3% of the total energy, which is by any comparison, is dismal and a sorry picture. Factors like no radiation, cheap, clean, non-pollutive and no more enslavement towards other countries make non – renewable sources of energy more productive and reliable than the horrendous nuclear technology. Unlike with nuclear power, most people, when considering renewables as abstract idea, view renewable sources positively as a clean and natural resource that will not run out (Demski, 2009)

In post Fukushima period, it is important to understand how advanced countries can built high technology, renewable energy systems can be constructed (Pidegon et.al 2009). Germany, Italy, Switzerland like countries are retracting nuclear path and unfortunately India is on an expansionist mission, which simply beats the human wisdom.[11] Moreover, countries like Germany, China have tremendously strengthened their solar energy system, then why India hesitates?[12] In addition to solar, wind is another important source of energy, nearly 3000Mwt of energy is generated from wind energy only, and it could be further enhanced, if government facilitates wind technology and taps it properly. In post Fukushima renewable sources call for greater attention to gain public trust again. The heavy transition toward future large scale renewable energy sources, there is more scope for understanding, siting, perceived risk, and trust (Pidegeon and Dimiski ;2012). Tamil Naidu has this distinction, that it witnesses high monsoon winds; wind is prospective resource to meet growing energy demands. Kanayakumari, Tirunelveli, Coimbatore, and Triupur are the four vital districts where wind energy could be easily tapped.

. Wind is seen as reliable and productive alternative source of energy

Moreover, Nayveli thermal power plant is already established in the district of Cuddalore and it has a capacity of more than 2500 Mwts, Kalapakkam nuclear power plant is already commissioned, which is

maintained by MAPS (Madras Atomic Power Station) approximately 440 Mwts of energy. In totality, Tamil Naidu requires 11000 Mwts of energy. Tamil Naidu is self sufficient.[13]

Construction of huge lofty structures is nothing but an economic burden. People are being sacrificed for power (electricity) but it should have been other way round "electricity for people."[14] People conceive there is always a huge cloud of secrecy around the nuclear power projects and people are abstained from indulging in any discourse. Historically veiled in secrecy, the nuclear power industry has maintained close institutional links with the government and the military, making it difficult for proper public debate to occur (Irwin et al., 2000). Central government has always been indifferent towards Tamils. Thus there is great alienation, alienation of masses by Delhi (central government). People who have waged war against the government are actually asking for basic right, Right to life which is a fundamental right of every individual. Common residents perceive that, everything produces radiations, but the radiations emitted by nuclear power plants are tremendously dangerous and the life of radioactive material is more than 20,000 years. Radioactive radiations would cause cancers in the local populace, entire marine life would be contaminated, vegetation would be washed away, ground water would be unsafe, cattle would be diseased and surprisingly more than 46 villages are dependent on fish economy. The nuclear power plant site falls in the seismic zone, and there are volcanoes inside the ocean, which can erupt at any point of time and lead to nuclear disaster. Decommissioning is an enduring process and would take double the expenditures it takes in commissioning,[15] thus in entirety, it is not mere a struggle against nuclear expansion, but a struggle to live and struggle for life. Opposition to the nuclear power at local level stems out of various reasons like generic distrust, poor transparency, weak public collaboration, and public doubt on developmental projects, threat to local community's autonomy, identity and life (Pidegeon et al., 2009)

Few of the agitators conceive nuclear power plants as any other developmental project, which results in displacement of locals and asks for their permanent rehabilitation. People believe that, in the name of electricity, these nuclear power plants are nothing but property of elite class, which is burgeoned by national and multinational companies (MNC'S). Imagine after so much of budgetary diversion in the name of nuclear energy, more than 60% of the villages are yet to be electrified.[16] It costs around 15, 000 crores to construct a single nuclear power plant and almost 10% commission goes to nuclear elites, who strongly lobby for nuclear expansion. India has become a big market. Simply there exists a nuclear mafia, which enhances nuclear agreements between India and other countries like Canada, Russia, France and America.[17] Such projects are strong foundation of urban development, rural India is further plunged into vicious poverty; unfortunately this widens the already existing big gap between rich and poor. Science and technology should cater to the needs of public rather being tool in the hands of few elites (Burns

et.al 2003) And the electricity they talk about is meant for huge industries and factories, which parochially belongs to the rich and 'shining India'. Nuclear power plants constructed in sensitive rural sites or locations, where the local population, living in the vicinity of huge nuclear power structures, does not benfit from energy generating facility, itself (Pidegeon and Dimiski ;2012). Poor people are simply sacrificed and made scapegoats for the vested interests on Indian elites.[18]

Women placing less value on social dominance (Caricati, 2007), more value on social intimacy over financial success (Sheldon, 2007), and less value on scientific inquiry (Trankina, 1993) than their male counterparts. Most studies that investigate gender differences in attitudes toward science conclude that men are more supportive of science than women (e.g., Barke et al., 1997; Fox and Firebaugh, 1992; Pifer, 1996; Trankina, 1993). This gender difference in science attitudes exists whether considering substantive issues such as nuclear technology (National Science Board, 1988) and biotechnology (Hallman et al., 2001, 2003; National Science Board, 2000; Qin and Brown, 2007), or attitudes about science in general (Hayes and Tariq, 2000; von Roten, 2004).From the feministic point of view, one can conceptualize nuclear protest more thoroughly. Joint family would never remain intact, because it would be displaced if the nuclear power plants are commissioned. This is what felt by some in the region. It is the women who experience a lot of dilemma, if the children are born with deformities, it would be the female members who need to run from one doctor to another to get their children cured. Such exisiting perceptions make nuclear energy more freighting among the women folk. Sea is more than body of blue water for them. It is simply life and whole cultural and religious attributes circles around it. If fishermen are relocated, they simply would get unemployed, which would lead to starvation of entire family. Women do consider it a social problem, so are vigorously participating in the whole phenomenon of protest.[19]

Converse perspective. "It is unfortunate that innocent fishermen are being misled. One should be on guard against attempts to rouse the passion of the people and designs of certain sections of the society to make India abandon its nuclear energy facilities. Such fringe movements are all over the World." **M.R. Srinivasan.**[20]

Despite strong opposition to nuclear technology, there persists alternative outlook as well. Scientific community has entirely a different version to talk about; NPCIL has a different story to offer. There is strong accusation against the PMANE, and they are out rightly blamed for the recent stir. Not only that they are held guilty of instigating ignorant masses, school children, and but also making church hostage for their personal means[21]. An uninformed public is very vulnerable to misleading ideas. Ignorance of elementary science makes them to doubt various scientific projects and phenomenons. To decide between the competing claims of vocal interested groups concerened about various technological controversies particularly nuclear technology, individual need to know

some of the factual backgrounds and should be able to assess the quality of evidence presented (Royal society 1985)

They claim PMANE people especially the frontrunner S.P Udaykumar is 'misleading' ignorant villagers and use coercive approach to ensure participation of 'masses'. Idintakaria is dictating the terms for other adjacent villages including the hot bedrock location, Kudankulam. Therefore according to them, protest is outsourced from Idinthakaria to the local vicinity[22]. Idinathakaria people are involved in the illegal practice of country made bombs, "they don't capture the fish but, fish is being bombed."[23] That is why, Idintakaria fish has low market price. Fisherman travels a distance to sell their fishes in other areas due to the fear that it might be contaminated (Ramana, 2011)

NPCIL authorities reject the theories, which extensively talk about harmful radiations. They argue, radiation originates in nature, thus radiation emission is a natural phenomenon .People should not fear it with such a great degree, radiations are present everywhere, sun, water, moon, everything emits radiations. Medical examinations like x-ray, MRI and CT scan everything exposes us to enormous radiations, but that does not mean one should denounce these kinds of technologies. Nuclear technology, especially the Kudankulam is one of the safest and most sophisticated technologies in the entire world. Thus by and large people are protesting on the basis of false or incomplete information. The public's grasp of scientific knowledge in particular is anomalous. Metaphorically at least, scientific issues that manage to break through the veil of ignorance are akin to beacons that spark obsessive interests or distress signals (Ungar, 2009)

NPCIL authorities are putting their own set of theories, in order to prop up the establishment of Kudankulam nuclear project. They claim KKNPP is all safe to face any kind of adversity, whether natural or mankind .They are of the opinion that water discharged from nuclear power plants is safe and would not impinge on the marine life, the water which is used for cooling purposes in the condenser, never comes in contact with the radioactive material, as perceived by dissenters. (Nuclear energy, NPCIL 2012). Moreover, they nullify the public claims that nuclear power plants is located in a highly seismic zone, according to them Kudankulam nuclear power plant site is in a very low seismic zone. "KKNPP is located in Indian Seismic Zone II, which is the least seismic potential region of our country. However, for designing of the plant, detailed studies were conducted to conservatively estimate the extent of ground motion applicable to the specific site with reference to seismo- tectonic and geological conditions around it so that the nuclear plant was designed for a level earthquake which has a very low probability of being exceeded. The plant's seismic sensors safely shut down the reactor in case the seismicity exceeds the preset value"(Kasinath Balaji, S.V. Jinna, The Hindu 11March 2012)Also, Kudankulam plant has been constructed at an elevated level of 7.5m above the sea level, which denies chance for flooding due to any reason, including tsunami.

Defending the nuclear energy in contrary to other options, to meet future energy demands, nuclear energy is the sole options at hands.[24] NPCIL assumes thermal power plants require huge quantity of coal or gas or oil fuels, stocks of which are limited worldwide. However, India is enormously

rich and has huge reserves of nuclear fuel in the form of thorium. Similarly, there are huge transportation costs in case of thermal power as compared to nuclear energy. Land required for establishing a windmill of 1000Mw and hydro electric power plant of 1000mw requires 50-100Sq.km and 50-75 Sq. km respectively, while as in case of nuclear power plant of 1000mw requires only 2-5 Sq .km of land. Moreover the tariff of electricity produced would be 0.90 paisa per unit, which is comparatively very meager to the electricity costs produced through other alternatives. Nuclear energy is, in many places, competitive with fossil fuels for electricity generation, despite relatively high capital costs and the need to internalize all waste disposal and decommissioning costs. If the social, health and environmental costs of fossil fuels are also taken into account, the economics of nuclear power are outstanding.(WNA, 2012) Thus NPCIL puts all the theories to nullify public claims that Koodamkulam nuclear power plant is unsafe and a matter of nervousness. Nuclear industry has resorted to various strategies to persuade public to accept nuclear power. None of these have been very successful. One of the common strategy is to publish numerous 'fact sheets', a constant theme in such publications is that risk from nuclear power is less in quantitative terms (Ramana, 2011).

NPCIL claims Koodamkulam case is special, because the way it has been constructed, it can withstand any adverse situation. The reactor of the nuclear power plant is placed inside a cylindrical structure with dome top called primary containment "primary containment has a wall thickness of 1.20 meters and is made of reinforced pre-stressed concrete. It is lined with leak proof steel plates on the inner surface. Moreover, primary containment is in turn placed inside one more structure called secondary containment" it is made of reinforced concrete and has wall thickness of 0.60 meters."P16 Thus all efforts have been made particularly in the wake of Fukushima, that there is no leakage of radioactive material. These structures would protect nuclear plant from any sort of damage, even in the extreme cases like Tsunami, Earthquake, explosion, or even the aero plane crash (Nuclear energy, NPCIL 2012).

NPCIL has initiated a literary movement of their own in order to sensitize and educate masses and also counteract anti-nuclear demonstrations. They have published lot of literary material, pamphlets, small booklets, T.V advertisements, moving screening, public awareness programmes etc. Even they are organizing college seminars, science museums are being promoted to counter the protests and generate more confidence among masses towards pro- nuclear energy movement that would help commissioning of Kudankulam nuclear power plant.[25]Scientific community involves people in various scientific projects in order to build rapport with the local population and also counteract any negative public perception (Eden, 1996)

3. Governments response through lenses of media .

Media influences public perception, particularly newspaper reading can shape generalized public perception on science and technology (Nisbet et al, 2002). Any attempt to understand social representation of science __ that is, how science is captured in the public imagination___ would be undermined without analyzing the media representation of science (Farr, 1993). (Weingarten, 2005) used the term "medilization", it refers to wide coverage of media's scientific issue and it is believed that media has extensified its role in science related controversies. Science coverage has become more "egalitarian" (Weingarten2005, p23) and diversified (Maasen 2002, p 12).

However , the other flip of the story is that, the press, radio, television are often accused of giving platform for scaremongers and mavericks leading to irrational shifts in public behavior. Media is often blamed and termed as risk junkies , searching out even more fantastic and doom laden scenario which appeals already terrifying audiences, after all 'good news is no news'(Freudenberg et al,. 1996). Media always give space to terrifying episodes and thus significantly attracts audiences. Moreover, media is blamed of sensationalism which rather than clarifying the process of coverage obscures the whole phenomenon (Kitzenger, 1999).

Fukushima nuclear disaster, as in the case of other countries, has raised a fundamental question on the expansion and future of nuclear industry. India's response to Fukushima nuclear disaster was no different. It was believed that, the implementation of new nuclear plants would certainly take a back seat, eventually; Indian nuclear expansion plan would be severely dampened. It would be difficult to sell the nuclear dream to Indian masses by political parties or scientific institutions. Few of the sites earmarked for constructing nuclear projects faced strong public protest (Schneider, 2011). In the backdrop of the catastrophe in Japan, India's nuclear regime rushed to assure frightened citizens that the country's existing and planned reactors were completely safe, constructed in seismic zones where earthquakes as strong as Japan's temblor, which cleared 8.9 on the Richter scale, have never occurred, and, therefore, could not possibly ever happen (Kadamar, 2011). "The safety of people and environment has always been the priority of the nuclear industry. All existing and upcoming plants had undergone the international peer view process by the World Association of Nuclear Operators. Plant operations in India have not changed the natural radiation status at the surrounding sites. Nuclear power plants in the country strictly followed the theme of safe engineering and greener tomorrow"(Balaji. 2012, 24 Febuary, The Hindu)

Fukushima put a speed bump on the road to the nuclear renaissance,[26] but despite this India's response seems quite strange and surprising. Immediately after Fukushima, government of India came into action and tried to assure its citizens that, there was no threat to India from radiation leaks from the quake-hit nuclear plant in Fukushima in Japan. Just two days after the disaster Nuclear Corporation of India Limited (NPCIL) made a public statement "We cannot be complacent and therefore we are closely observing the experiences of

the rarest event that is taking place in Japan where nuclear plants in the Northeast part are affected following the severe and devastating earthquake and tsunami. Despite a major earthquake in Bhuj on January 26, 2001, the Kakrapar Atomic Power Station near Surat in Gujarat continued to operate safely. Similarly, during the tsunami in Tamil Nadu in December 2004, the Madras Atomic Power Station (MAPS) was safely shut down without any radiological consequences. The plant was restarted in a matter of days after regulatory review" (NPCIL. 2011, March 14. The Hindu)

When the discourse rekindled on the safety and future of nuclear power plants in India in the wake of devastating earthquake and tsunami that triggered a nuclear crisis in Japan, nuclear regime relentlessly tried its best to assure public about the feasibility and safety of nuclear power plants. Only four days after disaster, Minister of State for Science & Technology, Ashwani Kumar, told media "I would like to assure the nation that on the basis of information received till date there is no danger to India from the radiation leaks in Fukushima, The radiation, we are told, is travelling eastwards and we are on the opposite direction from Japan. The distance between India and Fukushima is more than 6,500 km," (Kumar. 2011, March 16. The Hindu). However, such securities against the nuclear technology did not last too long. The theories of safe nuclear energy, propounded by nuclear establishment, failed miserably and people resorted to unprecedented protest in various parts of India. "While the State Experts' Panel has refused to meet our people and certified that the KKNPP reactors had several safety features, nuclear experts from the Atomic Energy Regulatory Board (AERB) and the International Atomic Energy Agency (IAEA) are inspecting the reactors. It clearly shows that the Nuclear Power Corporation of India Limited (NPCIL) is carrying out all related works for the early commissioning of the plant, ignoring the State Cabinet's resolution. Hence, the KKNPP administration is clandestinely making the preliminary arrangements for the commissioning of the plant."(PMANE, 2012) It was in the wake of strong public resentment, Tamil Naidu government was pressurized to establish an expert committee headed by former Atomic Energy Commission Chairman M R Srinivasan to asses afresh safety of nuclear plants[27]. However, to the utter surprise expert committee gave clean chit to the Kudankulam nuclear power plant and described that public agitations were exhaustively scrutinized (2012. 19 March, The Hind). Later, on the 19th of March 2012, Tamil Naidu CM, Jayalilata, also gave green signal to the controversial nuclear plant. State government strongly pronounced that the public fear was heavily scrutinized, denied public apprehensions of existence of earthquake or tsunami and advocated nuclear power plants are safe from every aspect [28](2012, 19 March. The Hindu). The central experts group appointed by the Department of Atomic Energy, also allied public fear, by vouching for the safety of Kudankulam nuclear power plant calling it most advanced and safest nuclear power plant (2012,Deccan Herald). Interestingly, in September 2011, state government asked central government to freeze further work in Kudankulam, until and unless the public discontent is severely dispelled and addressed.

The message from Japan disasters stand out in serious contemplation, particularly the fact that, when nuclear tragedy of such massive magnitude can happen in Japan, country which is " one of the world's most advanced industrial nations, an acknowledged leader in the technologies of the twentieth century, with several

decades of experience in handling nuclear matters in all its varied aspects. Japan is a world leader in the design of earthquake-resistant structures" (Jayaraman. 2011, 20March). It literally beats the human wisdom that when a country like Japan, could not avert nuclear tragedy of such a magnitude, then it clearly defies tall claims of DAE, Who lack culture of safety, known for poor management, severe accidents, routine exposure of workers, can have efficient and safe nuclear power plants, thus completely deny Fukushima like disaster can take place in Indian territory (Bidwai, 2011).

In one of its documented report *lessons from Fukushima*, Green Peace has highlighted that all the tragic episode of Fukushima happened because of institutional failures. These institutional failures are visible in all countries that generate nuclear energy. And ironically governments have been engrossed in promoting public education in nuclear power, rather than building environment for public debate about nuclear safety (Naidoo, 2012).

The Fukushima disaster has further fostered the already ongoing debate on autonomy of regulators from plant operators. AERB is being vehemently criticized for its subordinate role and suppression by DAE. "After Fukushima, the establishment of a truly independent regulator has been promised. Currently, institutional deficiencies are structurally inbuilt and hard to eliminate. If they remain, the credibility and autonomy of the regulator cannot be ensured. Historically, nuclear policymaking in India was not transparent and involved only a handful of people in the government."(Srinivasan et al,. 2012 Hindu).

In the light of growing pressure from civil society and common masses, government of India, in a surprising move, appointed Anil Kakodkar as chairman of National Solar Mission, which clearly depicts unwarranted public policy making. Noteably, Kakodkar appointed as the head of the solar mission symbolizes conflict of interests because Kakodkar has been the former head of controversial Indian nuclear programme and has always projected nuclear energy as inevitable and indispensable option.[29]

Indian scientists are also accused of fudging the causalities of Chernobyl and other nuclear disasters. Indian scientist portrays nuclear tragedies as minor accidents. Thus people have become skeptical about their work and their assurances. One can argue that Indian scientists don't carry a clean image in front of common Indian masses. (Jain 2012**,** 22 April. The Hindu). In case of Fukushima, an area of around 200km has been contaminated and in case of an accident of Fukushima magnitude occurs, whole Tamil Naidu state would be affected[30].Thus it is government's underestimation and formulating of forged reports of nuclear accidents that really agitates the common masses of this land (2012, 22April. The Hindu). Moreover, Indian nuclear programme has faced fervent protest because when the most developed nations are denouncing the nuclear path such as Germany, India is determinant to embark on commissioning more nuclear power plants and ardent to switch on to other modes of energy[31].Though Indian government admits the fact that the 'legitimate and understandable concerns'[32]emerged in the backdrop of Fukushima disaster need to be addressed, but at the same time vouches to pursue nuclear energy in order to enhance energy security.

The Prime Minister, Dr. Manmohan Singh has given the reliability or the impetus required to gather momentum, when he referred that foreign NGOs, especially from the US, were instigating the current

agitation and were responsible for derailing the Kudankulam nuclear power plant being set up by the Russians. But ironically in the guise of foreign hand theory, government failed to recognize that how in Post-Fukushima era, the fisherman community in Tamil Nadu, local leadership, church and people of all walks of life have become more critical and skeptical about nuclear technology (Somashekhar, 2012) Kudankulam protest has been applauded for being non violent and peaceful in nature. Government has been strongly condemned for its relentless efforts to criminalize the whole nuclear protest and making no modification in legal provisions.[37] Government has also been lambasted for its acquisition of punitive measures against anti-nuclear protesters and to repress democratic protest against nuclear policies and nuclear establishments.[38]

Conclusion

Around the world support for nuclear power plants has decreased tremendously. Though, public support for nuclear power was never so unpopular. After nuclear episodes like Three Mile Island and Chernobyl, majority of the population consistently opposed nuclear power (Rosa, Dunlap, 1994; Bolsen and Cook, 2008) (Ramana, 2011).

From India's point of view, Post Fukushima period calls for greater autonomy within the various atomic energy departments. Fukushima episode has deepened the ongoing debate, which call for true autonomy to the Atomic energy regulatory board of India (AERB). In the past AERB has been subservient and subordinate to DAE, such an arrangement has been debatable even before Japan disaster, however such an equation has faced fervent criticism and continuously ask for immediate separation of powers. In case of Kudankulam, the established norms set up by AERB were violated by none other than scientific institutions like NPCIL, construction of KKPP unit 1 at a distance of two (2) kms from the village which houses a population of more than 20,000 is a nasty violation and suppression too. Even the current political leadership promised for the separation of different atomic energy departments and in the light of Fukushima episode, all important Nuclear Safety Regulatory Authority Bill, 2011, resurfaced within the corridors of parliament, but however such a dream is still unrealized and unfulfilled one.

Moreover, main stream media should play a positive and constructive role in building public perception towards contested nuclear technology. Media should help in formulating a true picture of nuclear episodes, rather than romanticizing, exaggerating and sensitizing the projection of catastrophic nuclear events .Media really has pertinent role to play in structuring and generating genuine public opinion, decisive for technological acceptance and public engagement. Mass media provide the lenses through which citizens look at these processes (Hagendijk, 2004).

Severe criticism by the deficit model has given more currency to people's participation or dialogue model. Dialogue model, PUS approach, has led to more 'democratic turn' towards

participatory and deliberative approaches to ensure egalitarian and upstream engagement (Kurath and Gisler, 2009) Above all, PUS has a much bigger role to play in Kudankulam controversy. PUS as a discipline ensures local attitudes, framing of concepts, behavioral tendencies, opinions are respected before making any final decision .PUS and participation model in particular, has a broader and efficient significance in the whole course of Kudankulam conflict. Participation model stress on the fact, that a proper mechanism should be built, wherein all the stake holders, agencies, actors, like PMANE, Fishing community, Student Community, Farmers, Chruch, Political parties are mutually interacting with each other and are able to reach unanimously on some concrete decision .Participation model also termed as dialogue model favors genuine deliberations, discussions, respects local socio-political milieu, knowledge , attitudes and belief patterns among all the stakeholders, in order to resolve the conflict between science and society. It is imperative for governments and industry mangers, to listen carefully to community voices, by doing so they understand emotional attachment to, and meaning of, a place as well as how physical and symbolic expression of a place contribute to the collective identity (Devine-Wright, 2011; Mclachan, 2010) PUS as a discipline promotes awareness of scientific ventures and initiatives, but participation model builds up a common mechanism, where multiple actors can work together to resolve their disagreements. However, ultimately it should be the decision of all stakeholders to decide the fate of technology, to reject or chose should be collective decision, rather than being rubric and elitistic in nature. Public engagement model is an effort to transfer scientific knowledge from science elites to common man. Thus, it is an effort to challenge the hegemony of science but simultaneously, advocacy for democratization of scientific knowledge and technology (Sclove, 1995). PUS also stresses on reframing the argument and dangers of imposing what we call ‘elite’ categories in defining or interpretating lay reasoning (Gamson and Madgolini, 1989) In Post Fukushima period, Kudankulam, dialogue model calls for inclusion of dominative (Public) voices, grievances of various stakeholders, should be taken seriously, and ought not to be treated in a condensing way (Hagendijk, 2004). Participation or dialogue models stresses upon various local social factors like knowledge, religion, public attitude etc. PUS, thus essientializes the need to give due respect to lay _knowledge. In fact, Lay Knowledge, as a kind of alternative knowledge system seems more productive and functional as well. Lay knowledge is generally more sensitive towards the pre-occupation of the public, thus scientists, experts and science policy makers need to be more aware of lay knowledge, while framing any science policy or project (Dolby, 1982)

Techniques like public hearing, public meetings, consensus conferences, science shops, science museums all can be worked on to make public participation a reality. (Hamlett, 2002), (Wachelder, 2003), (International Science Shop Network, 2003). It is quite clear that Kudankulam has become a site of strong brawl between state, science, scientific

institutions and the common masses. It is also evident that, in the case of Kudandkulam 'storm' there is wider scope for public understanding of science. However, simultaneously Government should engage the local leadership in more sincere and mature dialogue, rather than criminalizing their democratic and peaceful protest. People have all the right to raise questions on government policies and programmes including the all scared nuclear technology and in return, it is the responsibility of government to address and satisfy the curiosity of its citizens, rather than penalizing them under punitive and draconian laws. Government resorts to various tactful measures/strategies to defy pubic protest and criticism (Ramana 2011) citizen participation should be ensured to support technological and scientific developments at hand rather than blaming agitators as ignorant masses. Various institutions with vested interests may not engage citizens to have their share in decision making or policy implementation, but paradoxically suppress the public resistance for technological acceptance (Irwin, 2006; Petersen, Anderson, Wilkinson, & Stuart, 2007)

Indian nuclear regime has faced severe criticism, which reflects upon aggravate public discontent and protest at various nuclear facilities. Nuclear industry is thus facing severe public distrust, which impedes to push forward nuclear programme as envisioned by nuclear regime of India. It is always an uphill task to regain public trust, a phenomenon that has been termed as 'asymmetric principle' (Solvic, 1993). It is deficit of trust, which Indian nuclear establishment is facing at the moment. Public (Nuclear) policy should predominately think of 'public' to whom they are ultimately responsible and try to incorporate them through the medium of scientific discourse. Moreover, scientific community should be willing to narrate various aspects of science and technology and their ramification to the public (Royal Society, 1985)

Moreover, there is nothing black and white, but simply different shades of public opinion, in the whole contested project of Kudankulam. People in the post-Fukushima era prefer renewable sources of energy over all controversial and contemptuous nuclear energy. Nuclear technology as a dear dream has crystallized in the wake of Japan disaster and other past nuclear accidents. Scientific community and nuclear regime of India have failed time again and again to live upto the public expectation or for that matter fulfill the promises made to the common masses. Unkept promises and denial to participate have made people to resort to 'spate of protest'. Above all, one thing which stands in deep contemplation is that, public understanding of science (including nuclear technology) calls for earliest attention, recognition and acceptance to settle down scores in Kudankulam nuclear controversy.

Notes

1. Here the word ordinary means non – scientific community.
2 Schafer, S. Mike.(2009) From public understanding to public engagement, *Science communication volume* 30. No4 . Sage publications, p476.
3 I.bid.

5. Agumya, A., & Hunter, G. J. (1999). A risk-based approach to assessing the 'Fitness for Use'of spatial data. *Urisa Journal*, *11*(1), 33-44.

9.The notion that experts perceive risk differently as compared to the lay man, who has no scientific expertise and limited life experience

10 Melt down is phenomenon that takes place in a nuclear reactor in which the fuel overheats and melts the reactor core or shielding.

11.Talking to a group of villagers, it is quite reflective that they have lot of fear regarding nuclear power plants

12 It refers to the area nearer to Koodamkuam nuclear power plant.

13 Cooling purposes is a process of maintain a required set of temperature for nuclear rods in order to ensure there is no melt down or exposure of radioactive material in surrounding water .

14 All this was highlighted, while having a detailed discussion with some of the prominent leaders of PMANE

15 It is believed that people, particularly women in the states of Kerala, Karnataka, and Tamil Naidu are prone to thyroid cancer. Thyroid cancer is caused because of human exposure to radioactive material.

16 Commoners have reflected when the researcher interacted with them.

17 Seemi Mohan, is a staunch supporter of solar energy. From the last two decades he has been persistently advocating for green and clean environment, conspicuously started tea plantation movement.

18 People believe Tamil Naidu is self sufficient in itself and there is no need for construction of horrendous nuclear power plants, who pose great threat to life and property.
19 Udaykumar, believes people has been made hostage to electricity .people are being sacrificed for elitistic projects.

20 Mohan Lal (SCIENTIST) takes a strong stand on decommissioning process; he argues it is again an expensive affair.

21. Group of students, who fervently deny that there protest is based on mere emotional contents .they believe they are well versed with intricacies of nuclear technology.

22. India has signed bilateral deals on civilian nuclear energy technology cooperation with several other countries, including France, the United States, the United Kingdom, Canada and South Korea

23.Dr. Lal Mohan is one of the prominent and former principle scientist of government of India, but he dares to highlight the negative repercussions of nuclear technology

24. Lidwin , while answering how family relations would be altered by displacement of inhabitants
.
25.In an exclusive interview to The Hindu, he opined that the stand of anti-KKNPP was unreasonable

26.While talking to the NPCIL authorities researcher got to know about the same

27.Adjacent area who are proactive in the ongoing protest

28. Country made bombs are exploded in water, so that fish(dead) is easily acquired from water, rather than capturing it alive

29. NPCIL authorities seemed to be confident about the future of nuclear technology. They believed nuclear energy is the only option India has to embark for robust growth, and the same was reviled to researcher while having interview with NPCIL authorities.

30. NPCIL authorities accept there has been good number of lacunas from their side to address the public discontent, which has become now grave issue.

31. The expansion of nuclear power plants in India and the proposed plan to build more in the coming years is often pronounced as nuclear renaissance

32 T. N. SrinivasanT. S. Gopi Rethinaraj Surya Sethi, How Fukushima is relevant to Kudankulam, 2012, 8 March. The Hindu.

33. Jayalalithaa gave go-ahead for Kudankulam project after the state expert committee endorsed the face that Koodamkulam nuclear power plant is safest in the world. 2012, 9 March.

34. PM Manmohan Singh appoints nuclear scientist Anil Kakodakar as national solar commission head. 2012, 6 Jan.

35. Neeraj Jain, president, Lokayut mentioned that koodamkulam nuclear power plant would not resolve the power crises for Tamil Naidu,KKNPP will not solve power crisis, 2012, 22 April.The Hindu

36.Supreme Court lawyer and anti-corruption crusader Prasanth Bhushan has accused Tamil Nadu Chief Minister Jayalalithaa of letting down the agitation against Koodankulam Nuclear Power Project,Jayalalithaahas let down anti-nuke protesters, 2012,2 April .The Hindu.

37.Prime Minister Manmohan Singh promised to address the legitimate concerns of the protesters but he also clearly indicated that kudankulam project would start commissioning, Kudankulam will go forward. 2011,7 October.The Hindu.

38.Don't lose the plot now. 2012.6 April .The Hindu.

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