An overview of nuclear power in the context of additional capacity to Kaiga NPP

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Abstract: The decision by the govt. of India in May 2017 to commission ten nuclear reactors of the type PHWR of 700 MW capacity each, and the other proposal to add four more reactors of the type VVER of 1,000 MW capacity each at Kudankulam NPP, has given rise to serious concerns to the communities around these projects, and to the concerned civil society groups in the country. In this background it is in the overall interest of our communities to diligently review the true relevance of nuclear power to India in the context of fast changing scenario, not only within the country but globally too. In this background the scenario around Kaiga NPP in Karnataka is considered for the related discussions in the overall context of India.

Key terms: Nuclear reactor; transmission line; right of way; tropical forests; Western Ghats; ecology; environment; efficiency improvement; demand side management (DSM); electricity demand; nuclear waste; nuclear accident; nuclear waste.

1.0 Introduction

The decision by the govt. of India in May 2017 to commission ten nuclear power reactors of the type PHWR of 700 MW capacity each in different parts of the country, and the proposal to add four more reactors of the type VVER of 1,000 MW capacity each at Kudankulam Nuclear Power Project (NPP), has given rise to many serious concerns to the communities around these projects, and to the concerned civil society groups in the country. Whereas the massive opposition to the Kudankulam NPP in Tamil Nadu few years ago, the consequent social unrest in that area, and the opposition to the same by the civil society groups (CSO) from around the country are still fresh in memory, the decision by the govt. to commission more nuclear reactors may have initiated another wave of anti-nuclear movement across the country. Whereas it has been made public that two of the ten PHWR type reactors are proposed at Kaiga NPP, in Uttara Kannada district of Karnataka state, the proposed location of the other eight PHWR reactors is not known at this stage.

In order to have a clarity between the claims of the govt. that the nuclear power is safe, economical and essential to India's developmental paradigm on one hand and very serious concerns of the CSOs on the true relevance of nuclear power to India, a rational debate at the national level has become urgent and critical for the overall welfare of our society.

In this context an overview of the related issues in respect of Kaiga NPP, Karnataka state, keeping in view the national scenario may help to provide the necessary knowledge background, and may also help in a rational debate at the national level on the country's nuclear power policy. It is hoped that the discussion in this paper will help to create an effective knowledge/information base on which informed discussions can be held between the concerned authorities and the CSOs so that a rational and societal level decision on the concerned policy is taken at an early date.

2.0 The case of Kaiga NPP

The societal level discussions on Kaiga NPP cannot become objective without considering the nature of the terrain around the Kaiga NPP. That terrain is made of undulating hills covered with thick forests as an important part of the Western Ghats (WGs) on the west coast of India. The forests around Kaiga NPP are considered to be some of the best tropical forests in the world with very high ecological value, rich tropical bio-diversity and many kinds of unique species (Report of the WGEEP, Ministry of Environment & Forests, Govt. of India, 2011). These forests are also considered to be among the main contributors to the World Heritage title to the WGs. They are also within one of the eight hottest of bio-diversity hotspots worldwide. The hill ranges of WGs, of which these forests are critical parts, are also considered as the backbone of the ecology and economy of south India, and are also considered as very good carbon sequestration systems in addition to being the water fountains of peninsular India.

The addition of two reactors of 700 MW capacity each (a total of 1,400 MW of capacity) will increase Kaiga NPP's overall capacity from 880 MW (4 reactors of 220 MW each at present) to 2,280 MW (an increase of about 2.6 times). In view of the fact that the existing transmission lines (4 lines of 400 kV rating) to evacuate power from Kaiga NPP will not be adequate for the new capacity, there will be a need for additional transmission lines to evacuate the additionally generated electricity. Whereas the details of the additional transmission line planning are not known at this stage, it may be 3 or 4 of line of 400 kV rating OR two lines of 765 kV rating.

These additional transmission lines may require the clearance of about 75 meter wide corridor for more than 100 kM for the right of way. This means the destruction of many sq. kM area of thick tropical forest of very high ecological value not only for the WGs, the state of Karnataka, and the country, but to the global environment itself because of the good Carbon sequestration capability of the thick forests in the tropics. The total cost (both direct and indirect costs) of such a destruction of tropical forests will be incalculable from the ecological perspective to India, whereas the benefits of the additional electricity from the expanded project will be negligible from the country's projected power sector capability by 2030 (year by which the two reactors may get commissioned).

The Uttara Kannada district in Karnataka, where the Kaiga NPP project is located, is known to have some of the best tropical forest wealth, and is known as one of the best forest cover districts in the whole country. The forest cover in the district has come down from a high of about 70% of the land area in 1950s to about 40% now due to very many 'development projects' such as Konkan railway, Sea - Bird naval base, National Highways, industries, many dam based hydel projects, and the Kaiga NPP since year 2000. As against the National Forest Policy (adopted in 1980s) target of 33% land cover by forests & trees, Karnataka's forest & tree cover at present is less than 20% for which the forests of Uttara Kannada district are major contributors. Any further loss of such rich forests in WGs can spell doom not only to the drought prone state of Karnataka, but to the entire peninsular India, for which the WGs are considered as water fountains.

As per Inter Governmental Panel on Climate Change - IV Assessment Report, "the emissions from deforestation are very significant – they are estimated to represent more than 18% of global emissions". It also says, "Curbing deforestation is a highly cost-effective way of reducing greenhouse gas emissions." At a time when the mitigation aspects of Climate Change phenomenon have occupied the minds of global leaders, it is a moot point to consider how rational it will be to loose many sq. kM of thick tropical forest around Kaiga NPP for the sake of a technology, for which there are many suitable alternatives. While the nationwide efforts to plant tree saplings are laudable, the same cannot replace the rich original tropical forests. The loss of many sq. kM of tropical rain forests, at this juncture in the fight against Climate Change, can be viewed by the global scientific community as unacceptably destructive.

The increase in nuclear power capacity by 2.6 times at Kaiga NPP should also mean an additional fresh water demand on Kali river, which is flowing adjacent to the project, by a similar magnitude. If this also leads to an increase in the temperature of the discharged water from the project back to the river, it should be a matter of concern from the perspective of the creatures dependent on that river. Due to the increased volume of the used-water discharge from the project, the pollution level of the river water downstream of the project is likely to go up, despite the claims of project authorities on water purification processes to be deployed. It is a moot point as to what impact will this distorted quality of river will have on the concerned stakeholders. It is impossible to imagine that it will be beneficial from any perspective.

The impact of the vastly increased radiation density (because of the 2.6 times increase in nuclear reactor activity?) on the bio-diversity and the people working and living in the project area cannot be anything but negative. Additionally, the risk of any unfortunate nuclear accident can only multiply because of the need to store on site the vastly additional quantity of highly radioactive spent fuel for hundreds of years (India has no policy as yet to store the spent nuclear fuel and other associated wastes away from the nuclear reactor site).

3.0 Relative economics of nuclear power w.r.t other sources

Whereas the levelised cost of solar and wind energy have fallen beyond all expectations since 2010, and are projected to continue to fall further (as at the end of May 2017), the cost of nuclear energy has been continuously increasing and can only go up further in order to incorporate additional safety features, which are becoming mandatory subsequent to Fukushima nuclear disaster. Although the cost of electricity from the proposed 700 MW type PHWR reactors may not be known yet (this type and size of nuclear reactors are not in operation as of now), it may not be unrealistic to project it to be not below Rs. 5.00 per kWH, when we consider the cost projected for the massive Jaitapur NPP. Due to many hidden costs, subsidies, and the type of tariff determination model deployed in the case of nuclear power in India (where, as per some reports, the cost of capital finance during the construction is not fully accounted for), the true cost to the society of nuclear power can be said to be much more than that is published. In contrast, through international bidding process the solar power has already been contracted below Rs. 2.5 kWH per unit for 25 years, and the wind power below Rs. 3.00 per kWH.

The financial/economic concerns on nuclear power from the Indian perspective remain more or less the same whether the technology under consideration is imported or indigenous. Hence, the implied decision of the Union govt. to shift the focus on to indigenous technology does not seem to change the relevance of nuclear power to the Indian context. The lessons to be learnt from the recent bankruptcy experience of two large size global nuclear power companies (Westinghouse of US and Areva of France) should not be ignored by India's policy makers, w.r.t Nuclear Power Corporation (NPCIL) .

Dr. M V Ramana, a Physicist at Princeton University, has argued with reasonable amount of certainty that the real cost of a modern nuclear power station is clearly higher than that of a comparable size coal based power station, through comparison of cost of similar size power generators at Kaiga NPP and Raichur thermal power station in Karnataka. If we also take into objective account the cost of long term storage of spent nuclear fuels and other contaminated wastes, insurance costs, government subsidies and all the associated environmental and health costs, the nuclear power can only be costlier than other conventional power sources. Subsequent to Fukushima disaster, the requirement for additional safety features has become stringent enough to make the cost of nuclear power even higher than the pre-Fukushima costs. So, even the cost advantage of nuclear energy is not there anymore. The electricity from nuclear power reactor was considered suitable to a rich society with high per capita consumption because of these reasons and also due to its base load nature. In the case of India, which is experiencing more of a continuous increase in peak hour power demand than on the annual energy front, it will be hard to find nuclear power economical to the poor population. Now that even rich societies have decided to move away from nuclear power to renewable power sources because of cost and nuclear accident considerations, the question that needs to be addressed is whether there are any substantial local reasons for a resource-constrained society like India to continue to pursue this costly and risky power source.

The Australian Power Generation Technology Report (Nov. 2015) – a collaborative effort from more than 40 organisations, including the CSIRO, ARENA, the federal government's Department of Industry and Science and the Office of the Chief Economist – has demonstrated that solar and wind will be the cheapest low carbon technologies in Australia ahead of nuclear and coal even though it has large coal and nuclear fuel reserves. As per a Stanford University study of 2009 referred to in an article titled "A path to Sustainable energy by 2030", in Scientific American in November 2009, the authors have referred to a ranked energy systems according to their impacts on global warming, pollution, water supply, land use, wildlife and other concerns. The very best options were wind, solar, geothermal, tidal and hydroelectric power— all of which are driven by wind, water or sunlight. It was found in this analysis that the nuclear power and coal with carbon capture were all poorer options.

The Integrated Energy Policy of the then Planning Commission in 2008, had indicated that the known Uranium reserve in India can support only 10,000 MW of nuclear power capacity. The same document had projected nuclear power capacity by 2032 as 63,000 MW and there was not much of a discussion as to how this much of nuclear power capacity will get its fuel from. The obvious implications of the need to import the nuclear fuel/technology need to be taken into account while planning for a large nuclear power capacity base.

As per a news article in Wall Street Journal of 12 May 2017, there are about 450 nuclear power plants worldwide, more than half of which are nearing the end of their planned lives. The massive task of dismantling them will require years of risky work and tens of billions of dollars. It is estimated that dismantling just one of them may cost upto $1.5 Billion. This eventuality also brings in to question whether the projected cost of such dismantling and safe storage of the nuclear wastes associated with the large number of nuclear reactors planned for the country have been objectively included in the overall cost of the plant while determining the price of its electricity in India.

4.0 The role of nuclear power at the national level

When we consider all the direct/indirect costs to the society from the addition of 1,400 MW of PHWR capacity at Kaiga NPP, 5,600 MW of PHWR at other yet unidentified places, and 4,000 MW of VVER capacity at Kudankulam NPP, the true benefit to the power sector of the state, south India, and the nation needs to be put under proper perspective. Whereas the nuclear power as at present is about 2% of the total capacity at the national level, the same has rarely, if ever, exceeded 3% of the total capacity.

All the above mentioned capacity additions (7,000 MW of PHWR type and 4,000 MW of VVER type, if and when are commissioned) may not result in the nuclear capacity of the nation not exceeding 1 or 2% of the total electricity capacity. This is because of the fact that there are plans to increase the capacity of other sources of electricity in the country by massive levels by 2032 (a total electricity capacity of 800,000 MW as per Integrated Energy Policy, 2008 and about 700,000 MW by the draft National Electricity Plan, Volume I (Generation) by Central Electricity Authority (CEA), 2016).

As on 30 May 2017, the installed electricity generating capacity of the country was as in Table I below.

Table I: Installed Electricity Generation Capacity in India (as on 20.5 2017)

(Source: Ministry of Power, Govt. of India)

Generation technology	**Capacity in MW**	**Percentage of the total Capacity**
Thermal (Coal, gas & diesel)	221,626	67
Nuclear	6,780	2
Hydro	44,594	13.5
Renewable	57,260	17.5
Grand Total	**330,260**	

Whereas the nuclear power capacity seems to be struggling to go beyond 2% of the total capacity even after five decades of massive budgetary support by the successive governments, the renewable energy capacity (other than hydro power) has already gone beyond 13% of the total capacity in less than 15 years. The renewable energy capacity, especially the solar power and wind power capacity, itself is expected to grow beyond 300,000 MW by 2030 as compared to 6,780 MW of nuclear power capacity as on date (India's INDC to UNFCCC). Even assuming that Units 3 to 6 at Kudankualm NPP (4 of 1,000 MW each), and the ten of 700 MW each are commissioned by 2030, the nuclear power capacity as a percentage of total electricity capacity at the national level cannot be much more than

2%. Looking at the past experience of Indian nuclear reactors getting commissioned within the budgeted cost & time, it seems unlikely that the nuclear power capacity in the country will be even 1% of the total capacity by 2030. The two PHWR type reactors of 700 MW each under construction in Rajastan have already registered cost and time over-run.

In this context, the question that should be objectively addressed is the simple economic rationality of costs and benefits of nuclear power w.r.t the other sources of electricity available to India, while taking into account all the direct and indirect costs and benefits to the society.

5.0 The Climate Change perspective

Faced with the negative connotation of the economics of nuclear power in the 21st century, the nuclear power industry got an opportunity to see the relevance from the perspective of Climate Change. Whereas the nuclear power plants are generally not associated with any GHG emissions during their operation, the life cycle GHG emissions (which are linked to various stages from nuclear ore mining till the spent nuclear fuels/wastes are safely disposed of after thousands of years) cannot be inconsiderable. The energy related cost of keeping the spent nuclear fuel safe for hundreds of years, if not for thousands of years, cannot be inconsiderable and can be seen as unjust burden on the future generations, because all the associated benefits of nuclear power would have come to the present generation alone. Taking all these direct and indirect costs and GHG emissions into objective account the nuclear power technology has been ranked by credible analysis as one of the least beneficial to human kind among various sources of electricity.

As per Nuclear Energy Institute (NEI), the nuclear power plants provided 11 % of the world's electricity production in 2014, which could have only come down since then due to massive additions to renewable energy. One global estimate indicates that in order to have any discernible benefit from the Climate Change perspective, nuclear power needs to be about 33% of the total installed power capacity at the global level. This estimate also indicates that about 2,500 nuclear reactors of average capacity of 1,000 MW would be required, and nearly four new reactors would have to begin construction each month until 2075. If nuclear power were to play more than a marginal role in combating global warming then some nuclear-power reactors would have to be operated even in those countries, where there is no nuclear power as of now. Looking at the past experience of slow electricity demand growth, the increasing public opposition, the safety issues, and the threat of nuclear terrorism etc. such a huge addition of installed capacity is impossible. Since India's nuclear power capacity is unlikely to reach even 5 % of the total in the foreseeable future, the rationality of even considering the Climate Change perspective of nuclear power should come under scrutiny.

As per a less known Department of Atomic Energy (DAE) document of 2008 "A Strategy for the Growth of Electricity in India" the plan was to increase the nuclear power capacity in the country to about 275,000 MW by 2050. Even if we were to accept this highly unrealistic plan, it will require about 390 nuclear reactors of average capacity of 700 MW. The enormity of the task of constructing 368 reactors in the next 33 years should become evident when we compare the fact that only 22 nuclear reactors, which are in operation, were constructed in duration of about 50 years. Keeping in view the enormous quantities of water required for these reactors it is most likely that the future reactors will be on the coast. Even assuming that 4 reactors of 700 MW of capacity each will form a single nuclear project, the country's 6,000 kM coastline will have to be dotted with a nuclear power project at every 60 kM. Though this stupendously ambitious plan (may mean adding on an average 8,000 MW of nuclear power capacity every year during next 33 years) sound hilarious to say the least, looking at what has happened in the last 50 years, it should be a matter of grave concern to our society because it indicates the determination of DAE to seek huge budgetary support to try and expand nuclear power capacity exponentially, and the scope for the denial of adequate financial resources to develop renewable energy sources which are the sustainable sources.

Allowing for an average of 1.5 sq. kM area around each reactor as safety zone, 390 reactors may require a minimum of about 585 sq. KM area as a whole in addition to the vast stretches of land for dedicated transmission lines. The affordability of diverting such a vast land area for nuclear power sector in a densely populated country should be another matter of concern requiring diligent approach.

6.0 The safety concerns in India

Whereas the Chernobyl accident in 1975 was a grim reminder of the reality of the dangers associated with nuclear power, the Fukushima accident in 2011 shook the world from its stupor. Since then many countries (Germany, Japan, Italy, and Switzerland) have announced the plans to move away from nuclear power. France, US and South Korea have announced plans to drastically cut the share of nuclear power.

The credible risk perception of any unfortunate nuclear accident should be a matter of great concern to any community close to a nuclear power project. A cursory look at the social and environmental impacts of two nuclear reactor disasters in human history at Chernobyl and Fukushima should be enough to indicate the grave risk facing the communities around Kaiga NPP (and of course the other nuclear power projects in the country). It is reported that due to the nuclear accident an area of about 650,000 acres around Chernobyl has become unfit for human habitation even after a lapse of 30 years. It will be a horror even to imagine the consequences of an unfortunate nuclear accident on a densely populated country like India, which is already facing serious issues of land availability. Addition of two nuclear reactors at Kaiga NPP will only increase the probability of such an accident, the consequent cost of which can never be calculated and recovered. Since the communities around Kaiga NPP are distributed over a large forested and hilly area, the evacuation of them in case of a nuclear emergency will be very difficult. A diligent study of this scenario by the National Disaster Management Authority may throw up many challenges. This may be true in many other existing or planned project locations too in India.

In view of the increased probability of a nuclear mishap at Kaiga NPP, consequent to the proposed additional capacity, and in many other project locations in the country, it is essential to take note of what Dr A Gopalakrishnan, former Chairman of Atomic Energy Regulatory Board (AERB) has to say on safe practices in nuclear industry in India: "Japan (*which could not prevent the Fukushima disaster*) is a country that has a superb disaster management organisation throughout their nation, and an oftenrehearsed working team to handle such emergencies. In contrast, in India, we are most disorganised and unprepared for the handling of emergencies of any kind of even much less severity. The Atomic Energy Regulatory Board's (AERB's) disaster preparedness oversight is mostly on paper and the drills they once in a while conduct are half-hearted efforts which amount more to a sham."

An insightful article, "The missing safety audits" by Dr A Gopalakrishnan poses many serious concerns on the safety aspects in the nuclear establishment of the country. What Dr. A. Gopalakrishnan has recommended as safe operating practices for Indian nuclear industry may be seen as real concerns to the existing nuclear reactor sites, on the apprehension that these recommendations might not have been implemented. He has recommended that the nuclear power policy of the government should be thoroughly debated in parliament and openly discussed with energy specialists in the country. "It should be preceded by a re-look of the overall energy policy of our country to assess whether all viable non-nuclear electricity generation schemes have been given their due priority, before we jump-start an extensive nuclear power programme."

The leaders of Russia and Japan, who were at the helm of affairs at the time of nuclear disasters at Chernobyl and Fukushima, have expressed similar concerns about the safety of nuclear power technology and have also cautioned the global communities to be extra careful before investing in nuclear power technology.

As welfare oriented society with a dense population, India cannot afford not to take cognizance of such concerns by a former Chairman, AERB, and many other civil society leaders. We cannot expect the civil society either to be rest assured until all the concerns raised by such experts are addressed satisfactorily before we consider building more nuclear reactors.

7.0 Are there better options than nuclear power?

For decades, the state of Karnataka and the country as a whole have been witnessing very low efficiency in generation, transmission, distribution and utilisation of electricity. It has been acknowledged in many credible reports, including the National Electricity Policy of 2005 and Integrated Energy Policy of 2008, that it is vastly economical and sustainable to invest on measures such as efficiency improvement than investing heavily in additional capacity projects when there are such opportunities. The inefficiency in the Indian power sector is so abysmal that when efficiency improvement measures are combined with the other enabling measures such as demand side management (DSM) and energy conservation, the true demand on the national electricity grid itself can be brought down by as much as 25-30 % at much lower capital cost and vastly lower economic cost to the society.

During the year 2016-17 the peak electricity demand of the country was 1,59,542 MW and the annual of electrical energy demand was 11,42,929 Million Units (Ministry of Power, Govt. of India) as in Table II. On the basis of this data, it may be stated that the effective reduction of grid demand through efficiency improvement measures, as stated above, can save as high as 40,000 MW of avoided generation capacity, which is many times more than the proposed nuclear capacity addition. It should be noted that this much of savings can come at vastly lower capital costs and can also result in many other direct/indirect benefits to the power system while avoiding the diversion of land and forests. If the proposed expenditure of Rs. 70,000 Crores for the ten PHWR reactors is diligently spent on the these efficiency improvement measures over the next 10-12 years to reduce the grid demand, the benefit to the society will be vast, and will result in avoiding the associated diversion of lands and forests, and the contamination of land and water bodies.

Table II: Power Supply Scenario in India (year 2016-17)
(Source: Ministry of Power, Govt. of India)

Peak Power Demand (MW)			Annual Energy Demand (MU)		
Demand	Availability	Deficit	Demand	Availability	Deficit
1,59,542	1,56,934	2,608	11,42,929	11,35,334	7,595

When we consider various kinds of electrical energy losses in the prevailing grid based system, the net benefit to Karnataka from the additional capacity at Kaiga NPP may be very small. Assuming a share of 50% for Karnataka from this additional capacity, and accounting for a transmission and distribution (T&D) loss of about 20%, and the auxiliary consumption of 10%, Karnataka may get a maximum of 450 MW if both the reactors run at full capacity. Since utilisation factor of a nuclear power plant is generally not more than 80% in India (and can be even much less when the share of renewable energy sources goes much higher by 2030) the benefit to the state on an annual basis may not be much more than 400 MW.

The net annual electricity benefits to the country from the proposed 11,000 MW capacity addition of nuclear power of the type PHWR and VVER can be similarly determined only as about 60% of the installed capacity.

Such potential benefit to the state of Karnataka, the south Indian states and the country as a whole from the addition of 11,000 MW of capacity can be more than compensated by simple efficiency improvement measures in T& D system, agricultural pump sets, lighting in homes, commercial & industrial sites, and street lights at vastly lower capital costs.

In view of that fact that these efficiency improvement measures also bring many other benefits such as vastly improved voltage profile across the grid and increased reliability, the rationality in investing vast sums of money and other scarce resources such as diverting land and forests in the proposed addition of 7,000 MW in type PHWR reactors and 4,000 MW in type VVER (at Kudankulam NPP) deserves a lot more diligence in the fast changing scenario in the country while taking into account developments around the world.

As per Karnataka Renewable Energy Development Ltd., the state's potential in renewable energy sources is about 28,000 MW (only medium and large size capacity suitable for grid connection are considered) of which only about 7,200 MW of installed capacity has been commissioned as on April 2017. If we also consider the vast potential of roof top on various kinds of buildings such as residential, commercial, educational, industrial etc. for installing the solar power systems in the state, the possibilities are immense. A high level estimate indicates that if on an average 1,000 Sq, ft of roof top in each of the 20% of the total households in the state (those houses which are structurally and economically strong) are used to set up solar photo voltaic panels a total solar power capacity of about 20,000 MW can be achieved with virtually nil GHG emission addition, nil water requirement and nil displacements of people. Such roof top solar photo voltaic panels will drastically reduce the energy lost in transmission and distribution, and if connected to the existing grid network can eliminate the need for many additional conventional power plants. If the roof tops of various types of other buildings in the state such as schools, colleges, industries, offices, ware house etc. also are effectively used the total solar capacity which can be realized will be enormous. Similarly, the agricultural pump sets of our farmers, which require electricity during the day time mostly in summer months, and which are officially accounted for about 30% of the total annual electricity consumption in the state, are ideally suited for solar PV systems.

The relevant potential of renewable energy systems, especially the solar and wind energy, at the national level are similarly huge, and are estimated to be more than adequate to meet the legitimate electricity needs of the country on a sustainable basis, if suitable policy interventions are taken by the union and state governments.

Whereas the intermittency and the so called lack of reliability of renewable energy sources may appear as impediments, the continuously improving energy storage technologies such as storage batteries, concentrated solar power (CSP), electric vehicles, pumped storage plants, peak hour demand response measures are being increasingly accepted / deployed as suitable measures to overcome these impediments. What is needed is a resolute effort by various stake holder groups (such as the Union and state governments, energy companies, research institutes, CSOs) to invest in the associated R&D efforts to fine tune the commercially available technologies for renewable energy systems to Indian scenario and encourage the usage of the same.

Two different studies analyzing the electricity demand-supply scenario at the national level and for the state of Tamil Nadu, as in the links below, can indicate how a combination of efficiency improvement measures, demand side management (DSM) and renewable energy sources can meet the legitimate demand for electricity by 2032 and 2050 respectively without the over-reliance on the conventional technology sources such as coal power and nuclear power.

(1) "Integrated Power Policy", Sept. 2012; http://freebookculture.com/?p=172

(2) "Power Sector Road Map for Tamil Nadu – 2050"; April 2016; http://mitramaadhyama.co.in/archives/2791

In this context a diligently conducted "Costs and Benefits Analysis" (CBA) and "Options Analysis" for each of the electricity generation technology and for every large size project, by objectively taking into account all the direct and indirect costs and benefits to our society, should be considered as essential economic decision making tools for the power sector in the country.

8.0 Summary

From the above discussions it appears that the state of Karnataka, and the nation as a whole, do not require nuclear power for its development; that the risks and cost of nuclear power are unacceptably high; and that there are very many benign alternatives to meet the legitimate demand for electricity of the state and the country on a sustainable basis.

In view of the multifarious problems associated with nuclear power plants and its small projected contribution to the overall power scenario in India even by 2030, and in view of credible concerns by very responsible leaders, our society should thoroughly review whether the resources made available for nuclear power sector is well spent on other suitable alternatives, such as developing the new & renewable energy sources, which can eliminate all the thorny issues associated with nuclear power sector and provide reliable and sustainable electricity for the future.

In a democratic scenario it is but natural that the larger civil society is taken into confidence before committing the society for huge investments and long term policy implications. The trust deficit between the CSOs and establishment, and the veil of secrecy prevailing in the nuclear establishment of the country should be addressed early so that the active cooperation of the local communities can be sought for every project once they are convinced of the need for nuclear power projects.

It would be in the overall welfare perspective of the country that a rational debate on all the related issues are urgently held at the national level through effective involvement of various stakeholders, so as to assist the Union govt. to arrive at the suitable policy framework, before the massive investments are committed to additional nuclear power capacity.

Such a rational debate can also help to address the concerns of the Civil Society Groups, which is essential for the overall development of the society.
