**Feedback to CEA**

Draft Electricity Plan on Generation for the period 2017 - 2027

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**Abstract**: CEA deserves congratulations for having taken a rational and bold stand that no coal-based power capacity addition is required until 2027. It is also a matter of solace that the govt. of India has the target of 175,000 MW of renewable energy (RE) capacity by 2022 and the target share of non-fossil based installed capacity of 56.5% by the end of 2026-27, which is considerably better than the target stated in INDC. The CEA draft plan also has taken a welcome approach of the beginning of a holistic view of the demand/supply of electricity by focusing on energy efficiency, conservation, and demand-side management (DSM) issues, which should be vigorously pursued against any odds.  Whereas it is a welcome step that CEA’s draft plan has started to consider the impact of power sector on the environmental issues in general and GHG emissions, in particular, a lot more commitment in minimising such impacts on a long term basis has become critical from the overall welfare perspective of the nation. Whereas  the recognition of facts such as (i) the demand for electricity by 2022 and 2027 will be less than that projected in the 18th EPS, (ii) very many impediments in setting up additional conventional technology power plants, and (iii) the RE sources can take a much higher share of total power generation capacity is appreciated, it will be in the larger interest of our society if the overall approach of the power sector takes into diligent consideration the economic decision-making tools “Options Analysis” and “Cost Benefit Analysis (CBA)” in deploying any technology and before embarking on any project.  A diligent approach to the generation planning will reveal that additional coal power capacity in particular, and conventional technology power plants in general, will not be needed in future years also if all the other available options are optimally used. The careful deployment of distributed type of RE sources enabled with micro/smart grids need to be given adequate focus in order to minimise the deleterious impacts of conventional technology electricity sources, and to ensure electricity for all sections on a sustainable basis and at acceptable costs.  In all such planning processes, the effective consultation with the stakeholder groups such as domain experts, civil society organisations, and concerned individuals should become an avowed norm than an exception.

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1. **Introduction**

The subject of electricity has acquired huge significance due to many reasons: (i) availability of adequate quantity and quality of electricity has come to be associated with the development of a community; (ii) global projections for 2050 and beyond indicate that more than 60% of total energy consumption will be in the form electricity due to the convenience of usage; (iii) production and usage of electricity has become a major contributor to global warming. For a densely populated and resources constrained country like India, which has about 25% of its population still without access to electricity, the importance of electricity should become obvious to all sections.

The generation plan prepared by CEA can be seen as crucial in the context of overall development of the power sector because the same is intended to be used by prospective generating companies, transmission utilities and transmission/ distribution licensees as a reference document. Since the omissions and commissions in the power sector have huge impact on the overall welfare of our thickly populated and poor communities, the generation plan by CEA must be seen as one relevant to all sections of our society.

At a time when the Indian power sector is witnessing an unfortunate scenario where about 25% of the population has no access to electricity even after nearly 7 decades of independence while many of the thermal power plants are idling due to want of power purchasers, the criticality of a realistic and diligently prepared generation plan for the country cannot be emphasised enough. Such an unfortunate scenario should be seen as an indication of a clear mismatch between planning, implementation and the true needs of the society. It is even more unfortunate that a committee was constituted by the power ministry in September last year to suggest innovative schemes for raising power demand. In view of the unassailable fact that consumption of unlimited quantities of electricity/energy will have huge implications on our natural resources, and hence not sustainable, there should have been concerted efforts to reduce the electricity demand instead of looking for innovative schemes for raising the demand. This approach by the power ministry may indicate a poor understanding of the ecological implications of a high electricity demand. Unless such efforts are intended to rationalise the tariff and to reduce the energy cost to critical manufacturing sectors so as to benefit the overall economy, such an approach to raising power demand artificially across non-productive sectors is against the true interest of our society.

In this context CEA’s discussion of demand side management (DSM) in the draft plan document is a welcome step, and hence it is hoped that the DSM measures recommended in the draft plan will be able to correct the ministry’s approach.

In order to make electricity generation planning highly relevant to the overall welfare of the country the task of generation plan has to be objectively viewed in the context of the relevant mandate to CEA under various Acts of the parliament and relevant policies of the Union government. Such a mandate includes the salient features such as efficiency, economy, responsible use of natural resources, consumer interest protection, reliable supply of electricity and protection of environment. When we look at the performance of the power sector since independence from the perspective of what the conventional power plants have achieved in the past, it is difficult to notice the true compliance of the letter and spirit of Indian Electricity Act 2003, and National Electricity Policy as far as salient features are concerned.

Whereas the draft plan has referred to Electricity Act 2003, National Electricity Policy 2005 and Tariff Policy 2016, the importance of having proper perspective of the other relevant Acts and policies need not be emphasised keeping in view the impact of power sector on other sectors of our economy. In this context the following Acts and policies can be cited as of high priority.

*Energy Conservation act 2001, mandates all the necessary measures for efficient use of energy and its conservation.*

*Environmental Protection Act, the Forest Conservation Act and the Wild Life Protection Act, all emphasizes the critical need to protect the natural resources, flora and fauna.*

*The National Forest Policy recommends that 33% of the land mass should be covered by forests and trees for a healthy environment.*

*The main objectives of National Action Plan on Climate Change (NAPCC):*

* *Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to Climate Change.*
* *Achieving the national growth objectives through a qualitative change in a direction that enhances the ecological sustainability, leading to further mitigation of greenhouse gas emissions.*
* *Devising efficient and cost- effective strategies for end use Demand Side management.*
* *Deploying appropriate technologies for both adaptation and mitigation of green house gas emissions extensively as well as at an accelerated pace.*

**As per the sections 48 (a) and 51 (a) (g) of our Constitution it is the duty of the STATE and every citizen to make honest efforts to protect and improve our environment by protecting and improving rivers, lakes, forests and living beings.**

India, claiming to be a responsible member of the international community, also has many international obligations which need to be kept in proper perspective while planning for additional electricity generation capacity. The threat of Global Warming and the associated need to drastically reduce the burning of fossil fuels should never be out of our focus.

* *Cocoyoc declaration of 1974 at Mexico, as part of UN Conference, has defined the sustainable ways of human development. This definition has to be at the core of our developmental planning.*
* *World Charter for Nature was adopted by consensus by UN General Assembly in 1982, according to which it will be a wise policy to apply Precautionary Principle and take necessary action to conserve Bio-diversity before components of it are permanently lost.*
* *Convention on Biological Diversity which was signed by 156 states in 1992, has the objectives of the conservation of various components of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisataion of genetic resources.*
* *The Ramsar Convention on Wetlands seeks commitment from signatory countries to protect the wetlands due to their huge significance to aquatic bio-diversity.*
* *Whereas IV Assessment Report of* *Inter Governmental Panel on Climate Change (IPCC) has highlighted the critical need to protect our forests, V Assessment Report has unambiguously identified the need to keep 80% of all fossil fuels in the ground.*

When we view the huge inefficiency prevailing within the electric power sector with a holistic perspective of the overall welfare of our society, the efficacy of plans for large addition to conventional power generating capacity in the country (and the consequences on our natural resources, environment and the vulnerable sections of society) becomes fundamentally questionable.

1. **Demand Projections for Electricity**

A credible electricity demand projection for the next 10 to 20 years is a critical part of the electricity generation plan, and hence it should be linked to a realistic appraisal of legitimate needs of our society at all levels, which will in turn lead to a responsible management of the power sector.

**2.1 The critical need for a realistic demand projection**

The basic need for a realistic demand forecast is that it must objectively take into account the social, economic, and environmental issues such as the changing consumption pattern across different sectors of our economy; limited natural resources; global warming potential of energy consumption; and our obligations to the future generations. A carefully thought out strategy consisting of responsible demand side management and sustainable energy supply options has become imminent for the long term welfare of our communities, and hence should be a critical part of the generation planning process. Instead of projecting future electricity demand with the GDP maximizing paradigm, which has been the practice all these years with devastating effects as reported by the World Bank itself, the country must aim at determining the least amount of electricity required to eradicate poverty.

**2.2 The issues with high demand projection**

The social, economic, environmental, and health impacts on our densely populated communities of huge addition in the form of conventional power plants will not be inconsiderable. All these years a large number of power plants are being proposed without due diligent studies about their true need, and without objectively considering the impacts on our densely populated communities. High demand projections have led to an unfortunate scenario recently where many of the thermal power plants are either idling or operating at low levels because of the lack of so called demand, and the average load factor of the power plants is coming down.

The big question is: whether our society can afford a huge additional demand on the grid, because all of such additional demand may not contribute to the economic development or may not lead to true welfare of our masses. Most importantly the social, economic and environmental impacts of such a huge additional demand will certainly be enormous, and may even defeat the very purpose of high GDP growth, which is the all round welfare of all sections of our society. Hence there is a need to keep the overall power demand within manageable limits keeping our geographical and environmental constraints in proper perspective.

**2.3 Need for reducing the effective grid demand**

Additions to conventional technology power generation capacity and the expansion of the integrated grid network are associated with considerable social, environmental and economic concerns. Also, from the perspective of global warming there is clearly a critical need to reduce the GHG emissions from the sector, which is possible only if the generating capacity of the conventional power plants is kept minimum.

Section 1.0 of the draft plan provides a relevant set of data to drive home the need for minimising the effective grid demand. It says: (i) the installed capacity of power plants has increased to about 3,02,088 MW as on 31.3.2016 from a meagre 1,713 MW in 1950, (ii) the electricity generation has increased from about 5.1 Billion units in 1950 to 1,107 BU, (iii) the per capita consumption of electricity in the country has also increased from 15 kWh in 1950 to about 1,010 kWh. Despite such massive increase in capacities, it is a glaring fact that about 25% of our population is without access to electricity, which is a clear indication of the serious issue of inefficiency in the sector. It becomes obvious, hence, that massive additions to the generating capacities alone will not be able to address the inequity in the availability of electricity in the country.

Section 2.8 of the draft plan has listed major reasons for the slippage of generation projects in the 12th plan period. Keeping in view the growing population and shrinking natural resource base, it is not unrealistic to project that these reasons will only get acute in the future making it hugely costly to implement additional power projects which may require land, water and other natural resources..

While the Indian power sector is witnessing a scenario where about 25% of the population has no access to electricity even after nearly 7 decades of independence while many of the thermal power plants are idling due to want of power purchasers, it is even more unfortunate that a committee was constituted by the power ministry in September last year to suggest innovative schemes for raising power demand. This development shows the criticality of realistic demand forecast and concerted efforts to minimise the grid electricity demand and deploy all feasible options to minimise the need for conventional power plants and the expansion of the grid network.

Instead of looking to raising the electricity demand artificially, only to make use of the already commissioned thermal power plants, the efforts should be to consider using the so called surplus electricity to bring on to the road more electric vehicles for public service in order to reduce the pollution associated with petrol/diesel.

Our power sector’s planning approach should be to determine and provide only that much of electrical energy in such a way and at such costs so as to assist the poor and vulnerable in our society to come out of the clutches of poverty. This should be the primary objective.

**2.4 The vast scope for reducing the effective grid electricity demand**

Keeping in view the huge potential in efficiency improvement & conservation measures, and the demand side management measures, and the technological maturity of distributed electricity sources such as roof top solar systems and community based bio-mass plants etc. it is not inconceivable that through the existing techno-economically viable means it is feasible to drastically reduce the effective demand on the grid based electricity network.

Chapter 3 of the draft plan has effectively discussed the huge scope for demand reduction. It has highlighted the effectiveness of DSM, energy efficiency and conservation measures that would modify or reduce end-user’s energy demand. Whereas table 3.2 has estimated the avoided generation capacity as 36,323 MW between 2006 -2014, it also says that “the benefits reported by BEE, have been mainly concentrated in one or two schemes i.e. appliance and industry programs. Therefore, there is lot of scope in other schemes and larger penetration opportunities of energy efficiency in different stages and types of end users.” The draft plan has done well in it that it has listed various options available reduce the demand in Chapter 3.

As per tables 3.3(a) & (b) of the draft plan report, the projected savings in electrical energy due to the efficiency improvement and DSM measures for the period 2017-2027 is estimated as 2,503 Billion Units (BU). At the end of this period, i.e by 2027, the projected figure for the avoided peak power is 13,225 MW. While these figures for the avoided power capacity additions in themselves are considerable, the true potential for reducing the effective demand on the grid is vastly more if we take into account the gross inefficiency prevailing in various segments of the power sector. Some credible reports had estimated that the demand reduction potential can be as high as 40% in 2010. Factoring in the efficiency improvements, which have been implemented since then, it may not be an exaggeration that the demand reduction potential can be as high as 30% as at present. Further, if effective measures are taken to shift many of the smaller and/or remote loads on to isolated distributed RE sources, the demand reduction potential becomes even larger.

**2.5 Realistic demand forecast options**

As per the highlights listed in the beginning of the draft plan report “The projected Peak Demand is 235 GW and Energy requirement is 1,611 BU (after considering DSM measures) at the end of year 2021- 22 which is around 17% and 15.4 % lower than the corresponding projections made by 18th Electric Power Survey (EPS) report. The projected Peak Demand is 317 GW and Energy requirement is 2,132 BU at the end of year 2026-27 which is around 20.7% and 21.3% lower than the corresponding projections made by 18th EPS report.” This set of data indicates the inaccuracy of the demand projection methods deployed in the past and the potential available for demand reduction.

A salient and common feature of CEA’s demand projection in its generation plans seems to be its linkage to GDP growth rate. As has been observed all over the world there is a clear trend of electricity consumption growth getting increasingly delinked from the GDP growth rates. In the case of India, in view of the fact that the contribution of services sector is continuously growing, such delinking become obvious. Also, in view of the fact that there is a steep decline in CAGR of electricity consumption from 6.87% in the 30-year period (between 1974-5 and 2004-05) to 4.30 % in the recent 5 year period (between 1999-2000 and 2004-05), and taking into account the huge potential with efficiency improvement measures to reduce demand, it can be credibly argued that not more than 4% of CAGR of electricity generation for next 20-25 years may be required. More importantly, it appears feasible to restrict the actual electricity demand growth to this level without compromising the welfare of our communities.

Since there is also a dire need necessary to minimise the additional conventional power capacities because of the social and environmental concerns, all feasible measures to minimise the demand must be deployed. Keeping in view that all such measures will be deployed effectively, the projected demand by 2026 - 2027 should be considerably less than that projected in section 4.4 of the draft plan, which are 317,674 MW of peak power and 21,31,987 MU of annual energy.

**2.6 Credible electricity demand projection for 2027**

The country is witnessing an unfortunate scenario where about 25% of the population has no access to electricity even after nearly 7 decades of independence while many of the thermal power plants are idling due to want of power purchasers. Such an unfortunate scenario should be seen as an indication of a clear mismatch between planning, implementation and the true needs of the society. CEA has the onerous role to project a credible electricity demand such that the country’s meagre resources are put to optimum use through careful planning of generation capacity.

A high level analysis of the power scenario in the country throws up an interesting picture, and may point towards a viable solution to the power sector woes. A different approach as compared to the conventional thinking in demand projection may provide an interesting perspective. For the sake of such an analysis the power sector data for the year 2014-15, for which latest authentic CEA data is available, can be considered.

* Installed Generation Capacity (as on 31-3-2015) was 271,722 MW with 235,945 MW of conventional power including hydro power and 35,777 MW of renewable power excluding hydro power capacity (refer CEA website).
* The peak power and annual energy demand for year 2014-15 was 148,166 MW and 1,068,923 GWH (refer CEA Annual report/website). When this peak power demand is compared to the conventional power capacity available in the system, it allows a spare capacity of about 87,780 MW of conventional power capacity alone. Allowing for 10% outages and 10% spinning reserve (a total reserve capacity of about 30,000 MW) to meet the peak demand, the system seems to have surplus of about 57,780 MW installed generating capacity without taking into account the renewable power capacity.
* The actual/deemed peak demand on the grid of 148,166 MW during 2014-15 (CEA website), when viewed from the perspective of gross inefficiency prevailing in the sector means that in real term it was much less. CEA itself admits, in its previous generation plan, that there is a saving potential of about 15% in the end use. The T&D loss reduction of 10% (from the present level of about 20 %) is techno-economically feasible during the period 2017 -2027 if adequate emphasis is provided. Through concerted DSM measures the actual peak demand on the grid can be brought down further.
* Even assuming the demand reduction potential of only 25% (15% from end uses PLUS 10% from T&D losses), the true demand on the grid as on 31.3.15 could have been only about 111,125 MW of peak power, and 801,682 GWH of annual energy during 2014-15.
* From the base figure of 148,166 MW and 1,068,923 GWH for peak demand and annual energy as on 31.3.15, and at an assumed CAGR of 4% demand growth, the power demand in the country can be projected as about 237,220 MW of peak hour demand and 1,711,380 GWH of annual energy by 2027.

**The rationale for 4% CAGR**

A brief note about GDP centred growth paradigm, which has a traditional correlation to electricity demand, would be useful here. At 6% constant CAGR the electricity demand will double in 13 years, treble in 20 years, and quadruple in 25 years. At 8% constant CAGR the electricity demand will double in 10 years, treble in 15 years, and quadruple in 19 years. While the implications of demand for electricity at such high rate should be well known, the high CAGR of GDP growth of our economy should also become clear.

A high GDP growth rate, year after year, will mean the manufacture of products and provision of services at an unprecedented pace leading to: setting up of more factories/manufacturing facilities; consumption of large quantities of raw materials; unsustainably increasing demand for natural resources such as water, minerals, timber etc.; acute pressure on the govt. to divert agricultural/forest lands for other purposes; huge demand for energy; clamour for more of airports, airlines, hotels, shopping malls, private vehicles, express highways etc. Vast increase in each of these activities, while increasing the total demand for electricity will also lead to higher GHG emissions, and will also reduce the ability of natural carbon sinks such as forests to absorb GHG emissions.

In view of the fact that India has already achieved a good level of industrial and commercial development, as evidenced by the size of its economy, efforts in future should focus on inclusive economic growth at much lower CAGR. This can be achieved by putting focus on less energy intensive growth sectors, which will also reduce the demand for electricity/energy. Also in view of the fact that there has been a steep decline in CAGR of electricity consumption from 6.87% in the 30-year period (between 1974-75 and 2004-05) to 4.30 % in the recent 5 year period (between 1999-2000 and 2004-05), and taking into account the huge potential with efficiency improvement measures to reduce demand, it can be credibly argued that not more than 4% of CAGR of electricity generation for next 20-25 years may be required.

While it is recognised that economic policy is not the domain of the Power Ministry, CEA being the supervisor/custodian of the interest of the power sector should take a diligent view of the above discussion, and should recommend accordingly to the Union govt. Since it is in the overall interest of the society to restrict the electricity demand, all possible efforts should deployed to restrict the demand growth to less than 4% CAGR. Hence CEA’s consideration of 6.34%, 7.34% and 8.34% CAGR of demand growth (refer section 5.11.3) needs a diligent review. As a welfare society we cannot be silent spectators of annihilation of our natural resources, and consequent harm to our communities.

* If we apply the total of 25% reduction potential associated with T&D Loss and end use efficiency, the true demand figures may be 177,900 MW and 1,283,535 GWH by 2027.
* As compared to the demand projection figures by 2027 in CEA’s draft plan of 317,674 MW and 21,31,987 GWH, these figures are less by about 46% and 40% respectively.
* Allowing for 20% reserve margin (10% spinning reserve and 10% outage) the required generation capacity figures of 213,900 MW by 2027 can be stated as below the installed conventional capacity of 235,945 MW as on 31.3.2015. If we also take into account the RE capacity (some percentage of which can provide peak hour support also), it appears that the installed capacity as at the end of 2014-15 may be able to meet the peak demand of 2027, if due diligence is followed in power management.
* As on 30.11.2016 the total installed capacity had increased to 308,834 MW with 45,900 MW of non-hydro RE capacity. This should mean that there may not be a need for additional generation capacity till 2027.
* Basically what this analysis means is that the power sector may not need a lot of additional capacity if the existing infrastructure is put to use optimally. But it requires concerted efforts not to allow the true demand on the grid to escalate without diligent checks and to increase the efficiency at all levels/segments of the power sector.
* As compared to the huge logistical and societal problems associated with the planned capacity additions, this approach can bring huge benefits to the society while avoiding humongous costs.
* In view of the huge potential existing in the distributed type renewable energy sources such as roof top SPVs and community bio-energy plants, the additional annual energy requirements by 2027 and beyond should be met by them as far as possible, by shifting all smaller loads from the grid to these distributed power sources.
* The huge solar power potential should be made use of to meet the additional peak demand also in future by installing CSPs of 10 to 15 MW capacity at suitable locations (such as each taluka places) to feed to the grid.
* Such diligent discussions should lead the nation to a realisation that in view of the serious social, environmental and economic issues associated with the conventional power plants, these plants should be phased out at an early date and should be replaced by RE sources for which there is huge potential.

It need not be an exaggeration to state that the country has enough base load generation capacity (or what is termed as despatchable capacity) and all the additional demand for electricity can be met by a combination of effective DSM measures and diligent deployment of RE sources. This should basically mean that the power sector should seriously consider preparing a time line to gradually phase out fossil fuel and nuclear power plants. Shutting down the old and inefficient coal power plants and the nuclear power plants (which are contributing almost negligibly to the overall capacity) should be the priority in this context. This approach has many good examples to emulate from around the world.

[Reference: The book “Integrated Power Policy”, <http://mitramaadhyama.co.in/archives/2791>]

CEA plan should consider this approach seriously starting from the present plan period itself.

1. **Global warming and environmental considerations**

The power sector in India produces about half of all CO2 emissions in the country (805.4 million tonnes) while coal is the most polluting of all power sources, As per the draft plan. Considering the huge contribution of the conventional power plants to GHG emissions, it is impossible to imagine how India’s total GHG emissions can be less in the future as compared to that in Y2016, unless definitive and appropriate measures are taken with concerted efforts by all segments. Additionally, it should also be kept in mind that those activities in our society which will result in GHG emissions will also have impact on the pollution of land, water, and air; on accelerated depletion of natural resources such as forests and fresh water sources; on food & agricultural products; on the access to natural resources for the sake of livelihood of vulnerable sections etc. Hence, the total GHG emissions of the country should be a huge concern from the all-round welfare perspective of our people even if we stake claim in the international forum to burn more fossil fuels in view of the low per capita emissions.

Coal power plants are established as the most polluting of all the electricity sources. The term clean coal technology is a misnomer, since any form of coal burning will result in CO2 emission, which is the major GHG. Carbon capture & sequestration (CCS) cannot ensure that the captured CO2 will be kept out of the atmosphere for ever. The Super critical and Ultra Supercritical technologies can only reduce the amount of CO2 emission by a small margin, but cannot altogether stop GHG emission. Even if all the future coal power plants are to be based on these technologies, the total GHG emission can only be more than what it is now, although CO2 emission per unit of electricity produced may be slightly less.

In the case of India additional coal power plants, even if all of them are to be based on Super critical and Ultra Supercritical technologies will pose severe problems to the local environment because of the need for the diversion of lands, the destruction of forest cover below which are the coal mines located, vast quantities of fresh water, and pollution of land, water and air. The densely populated and resources constrained country has already been facing acute problems because of these reasons, and is not in a position to take further pollution related burdens.

No welfare society can afford to ignore the coal burning related air pollution impacts on its people, as is being reported form different parts of the world. Whereas China has been witnessing an unacceptable level of air pollution in regions heavy with coal power plants, such as Beijing, India has started experiencing the same as in Delhi, Varanasi, Faridabad etc.

The draft plan itself recognises the pollution impacts form fossil fuel power plants. In chapter 12 it says: “Generation of power by use of fossil fuel like coal, oil and gas pollutes the atmosphere in many ways. Emission of particulate matter and generation of fly ash from coal based power stations are local health hazard. Gaseous emissions from fossil fuel based power generation like CO2, SOx, NOx and Mercury etc. affect the local as well as global climate.” Section 12.1.2 of the draft plan lists various water pollution sources and impacts.

If the advocates of coal power ignore all other factors, the increasing scarcity of fresh water to run coal power plants cannot be ignored. Already a water deficit country with one of the lowest per capita availability record, India cannot afford to ignore the competing demand for fresh water from its human usage, agriculture and industry. Adequate action has become critical not to allow coal power plants to idle due to want of fresh water for the operation. There have been such incidence already in some parts of the country, and there should be no surprise if more coal power plants are affected adversely. The number of coal power plants cannot go increasing indefinitely.

When all these factors are objectively considered from the welfare perspective of our society, neither coal power nor any of the fossil fuels can be seen as an option to meet our electricity needs even in the medium term. Hence it is in the overall interest of our society to aim at eliminating these fuels from the power sector, if not altogether from our economy. Since recent global experiences indicate that it is techno-economically feasible to meet almost all electricity demand through RE sources, this generation plan should at the least discuss the possible year by which coal can be phased out completely.

The vexatious issues of land diversion, forced displacement of local population, forest cover destruction, additional lands for setting up transmission lines, inadequate compensation for the affected families, R&R etc. are all common to each of the conventional technology power plants. Whereas hydro power is propagated by its advocates as clean & green power, the Methane (CH4) emission from tropical hydel power plants is a major concern from Climate Change perspective. The destruction of forests in reservoir waters, in constructing the plant buildings, roads and transmission lines all will contribute negatively to the global warming implications. However, the future may need pumped storage plant as an energy storage option to supplement Solar and Wind power capacities. In such cases where pumped storage plant technology is considered essential, the social and environmental issues must be attended to with all the seriousness they deserve.

Nuclear power plants have their own intractable problems such as huge cost and time over-runs, radiation risks, Chernobyl-Fukushima kind of nuclear accidents, nuclear waste disposal etc. The fact that despite massive financial and political support by successive governments the nuclear power capacity has remained below 3% in India is a testimony of its irrelevance. In view of the fact that India imports much of its natural gas, and the fact that many gas based power plants are idling because of the lack of supply of natural gas (with an average PLF of 20.93 in 2015), the gas based power plants cannot be seen as a substantial part of future electricity supply source.

India, having recognised the existential threats to its densely populated and vulnerable communities from the fast evolving phenomenon of Climate Change would be failing in its Constitutional obligations if it refuses to phase out the conventional technology power plants in the near future.

**All these factors and the well-known difference in magnitude of the order of 30 - 180 times in life cycle CO2 emissions between conventional power plants and renewable energy sources should clearly dictate the electricity generation planning strategy for India.**

1. **Credible generation Planning**

In view of the critical role of the power sector for our society and the environment, while a credible projection of electricity demand for next 10 or 20 years is essential in generation planning, the long term perspective of the society’s overall welfare, the sustainability of the technologies deployed, global warming impacts, the true cost & benefits to the society of these technologies, the concerns of the project affected population are all even more important. Without such objective considerations, CEA’s generation plan has the risk of being termed as irrelevant form the civil society’s perspective.

* 1. **A holistic approach through Options Analysis and Costs & Benefits Analysis (CBA)**

A common problem with the past generation planning documents has been the complete absence of calculating the true costs and benefits of the conventional technology electricity sources to our communities, and objective consideration of all the available alternatives to bridge the gap between demand and supply.

Without determining the relative costs and benefits of a given technology and without comparing them with other alternatives, it would be unwise to consider any given power generation technology as the most beneficial. The alternatives available in individual states or the regions in the form of efficiency improvement measures or renewable energy sources may be able to provide equivalent amount of virtual capacity addition at much less overall costs and with many more benefits. For a resource constrained, densely populated and poor country the continued practice of proposing large size and costly power plants without an objective CBA and without effective public consultation is a huge concern to the communities.

* 1. **A different paradigm for generation planning**

There is a clear need for CEA to adopt the least cost planning process in an objective sense by diligently adopting an integrated resource management approach. While doing so the total cost (both the direct and indirect costs) to the society should be the criteria instead of only the financial cost to the project developer. One such diligent approach can be as follows:

* + 1. For each additional MW of demand various alternatives available within the existing power infrastructure should be the **priority 1**: efficiency improvement measures such as T&D loss reduction, DSM, agricultural pumping loss reduction, PLF improvement, R&M of power plants etc.
		2. A substantial portion of the proposed investments and efforts in generation sector should be diverted to these measures including that of replacing incandescent lamps and CFLs by LED.
		3. **Priority 2** could be to transfer as many loads as possible to roof top solar or community based hybrids such as solar/wind/bio-mass power systems. All possible efforts should be deployed to utilize the large roof top surfaces available in residences, schools & other educational institutions, offices, factories, hospitals, hotels, hostels, shops, warehouses etc. to install SPV systems and solar water heater systems. Additionally, the CSP systems of suitable size should be installed in smaller towns/cities to provide adequate power during the absence of sun shine hours.
		4. **Priority 3** could be to energise every IP set through locally installed SPV system with or without provision for grid connection. The total load from this segment is estimated to be about 30%, and transferring it away from the grid will provide a huge relief.
		5. **Priority 4** could be to replace old and inefficient coal power plants with efficient super critical plants at the same site after due diligence for its appropriateness. Land available at an old coal power plant of 4 or 6 of 210 MW units may be adequate for 2 or 4 of 800 MW plants.
		6. **Priority 5** could be to set up micro hydro and mini hydro power plants where minimum disruption to local environment can be ensured.
		7. This process should be employed to determine the order of costs and deploy the most economical option to the society. It is important that CBA, as a decision making tool, is deployed objectively in every step/project.
		8. In this approach the conventional power plants should be the last resort: mini/micro hydro, gas power, coal power, and nuclear power in that order. It is not difficult to appreciate the fact that an objective consideration of all the technical, economic, social and environmental issues will reveal that nuclear power projects score the least.
	1. **Planning for peak coal power consumption**

Integrated Energy Policy of the erstwhile Planning Commission had indicated in 2006 that the total extractable coal reserves (including proven, indicated and inferred) in the country will run out in about 45 years. Since then a large number of additional mines are being permitted to feed the huge number of coal power plants, and hence the coal reserve may not last beyond another 25 years. In this context there is clearly a need for the country to look beyond coal. It is therefore necessary to have a definitive plan to phase out coal power plants (so also other conventional power plants) in the next 15-20 years.

Global opposition to the coal power plants is accelerating because of the environmental, economic and social issues. In many geographical locations the renewable energy sources have become less costly than coal power plants. Many countries such as UK have taken conscious decision to phase out coal power by 2025. Many countries have taken conscious decision to phase out fossil fuel power plants in the next few decades. Even the traditionally coal reliant countries such as China, Australia and South Africa have taken conscious decision to reduce such reliance in the near future. Many proposals for coal power plants aggregating to more than 150,000 MW have been cancelled in US due to a combination of environmental and economic reasons.

At the same time there have been very many instances of RE sources becoming the preferred option across the globe. Countries like Germany, Holland, Norway, UK, Portugal have recorded more than 50% of their electricity demand met by RE sources alone for short durations. Recently, Portugal has recorded reliable electricity supply to meet 100% of its demand for more than 3 days continuously with RE sources alone, establishing the techno-economic feasibility of meeting electricity needs without fossil fuel power plants. In recent years the global level investment on RE sources is reported to be more than on fossil fuel sources. Major financial and banking institutions have taken policy decision not to support fossil fuel investments. There are many globally credible simulation reports to indicate that the electricity needs can be reliably met by 100% RE sources even in large and diverse countries like US. In view of all these factors coal power should not be viewed as a credible source of electricity in future, and hence even many of the power plants under construction should be considered for cancellation to minimise the number of stranded assets. An early year should be identified for complete phase out of coal power, which can only be in the larger interest of the society.

* 1. **The critical role of renewable energy (RE) sources**

A welcome approach by CEA to generation planning this time is its dedication of one whole chapter to RE sources. It is a good beginning that the attention is being given to the experiences from all over the world and for a study of grid integration of RE sources.

On the basis of an objective consideration of many national and international reports, it appears safe to state that the energy future of our country depends on how effectively our society will be able to harness the huge renewable energy potential within the country. The Annexure 6.1 of the draft plan indicates huge potential (about 8,96,602 MW)of RE sources in India. When we consider the roof top potential of solar power the total RE potential can be said to be many times more than this figure. Such RE potential, if harnessed diligently, can eliminate the need for all other forms of conventional technology power plants. There has been a spate of international reports in recent years, including the one from IPCC, expressing credible confidence in and advocating for a definitive shift towards renewable energy sources.

An integrated energy resource management approach, with a carefully designed combination of centralized and decentralised renewable energy sources, is absolutely needed to avail energy security for our masses. Due to modular nature of RE sources, their role in meeting the future electricity demand becomes even more crucial.

Whereas CEA’s draft plan has focused on solar, wind, biomass and small hydro power sources, the potential for ocean energy in India with over 6,000 kM of coastline should not be ignored. Similarly, geothermal potential requires close scrutiny. These two sources should get adequate focus in R&D efforts.

To achieve the target of 175,000 MW of RE by 2022, India must add 130.76 GW of [renewable](http://energy.economictimes.indiatimes.com/tag/renewable) energy over the next six years, an average of 21.7 GW per year or, three times the capacity it added in 2016. This requires a massive effort from various segments of the society. While this target appears very ambitious, it is needed in order to minimise the threat of ecological disaster unfolding fast due to the addition of conventional power plants. The biggest impediment will be the financing required to achieve this target. This financing (about $100 Billion as per some estimates) cannot be met by the govt. alone. If we take the case of 40,000 MW target for the roof top SPV sector, unless domestic, commercial, industrial and agricultural consumers (for IP sets) are encouraged/mandated to participate, in however small capacity, it is difficult to imagine how the target can be realised in next 5 years. As happened in the case of solar roof top water heaters in Bengaluru, which is called solar water heater capital of India, if the consumers are encouraged to participate and influenced by the usefulness of the same we can expect massive addition to the capacity. To this extent well thought out strategy and financial incentives should be announced soon by the state and union governments. As of now, the approach of the distribution companies to the enquiries by the residential consumers to set up roof top SPVs to export excessive energy to the grid, is at best discouraging even in those states where there is a feed –in-tariff policy. This must change immediately.

It must also be emphasised that containing the demand for electricity within the nature’s limits will be necessary even with the deployment of RE sources for meeting 100% of electricity. The impact on the natural resources, even in case of RE sources will be considerable if due diligence is not adhered to in demand side management. The land, materials and energy required to manufacture/install the solar panels, wind turbines, support structures, the electronic accessories, battery banks etc. will be enormous which can have deleterious impact on the nature, and also can contribute to GHG emissions considerably.

**4.5 Huge relevance of distributed type of RE sources**

The conventional technology power plants are considered as most economical in large Unit sizes and need complex integrated grid network. Such integrated grid networks are becoming hugely complex and costly with the passing of each year. Ultra high voltages, HVDC systems, SVCs, FACTSs, condensers etc. are not only making the system hugely complex but also highly susceptible for cascade tripping. The biggest outage of an integrated grid occurred in North Indian system in 2012 when more than 600 Million people were estimated as to have been affected for hours due to two different outages on two consecutive days. In USA the grid outage incidences are reported to have increased in recent decades. There have been such grid outages affecting millions of people for house together from other parts of the world also. It is being increasingly recognised that the total cost to the society of such integrated HV grid system will continue to go up while the outages cannot be completely eliminated.

As compared to this scenario, the RE sources are generally found to be most effective and economically attractive at small unit sizes. In view of the fact that such distributed RE sources will not need much land (no land diversion needed in roof top SPV systems) and no additional evacuation system (they can be located/ connected to the existing network) they are of huge relevance to our densely populated and resource constrained communities. Injecting kVARs at thousands of distribution nodes, leading to good voltage profile will be a major advantage. One high level calculation as below may drive home the point.

**Huge potential of roof top SPV systems**

Of the 35 Crore odd households expected by 2032 in India, 10 Crore houses can be assumed to be strong enough to support SPV systems. Assuming an average of 1,000 Sq. ft of roof surface area for each of these houses, the total potential for installing SPV systems on this surface can be about 1,000,000 MW @ 1 kW per 100 Sq. ft of roof surface. Additionally, even if only 10% of roof top surfaces in each of the other categories of building are considered for this purpose, the total solar power potential is enormous; running to millions of MW. Such a policy can transform our power sector scenario, and ideally eliminate the need for any conventional electricity sources in the near future.

A high level calculation indicates that the roof top surfaces on the Indian Railways’ plat-forms and other associated buildings can accommodate more than 15,000 MW of SPV systems. Such an approach may make the IR self-sufficient in electricity and even make it a net exporter of electricity to the grid fetching good revenue.

Such an approach can make many govt. departments/agencies as net exporters of electricity to the grid fetching good revenue.

Distributed RE sources such as roof top SPV systems, community based bio-mass or wind turbines when deployed with careful planning at distribution voltage levels can go a long way in addressing some of the acute problems in the power sector such as power cuts, voltage instability, distribution losses, diversion of land for additional distribution lines, urban/rural divide etc. Adequate deployment of distributed RE sources will also assist in minimising the capital investment costs associated with the extension/strengthening of HV transmission schemes, which would be necessary if large size conventional technology power plants were to be added.

In this context the preference by the govt. for solar and wind power parks should be diligently reviewed. Such large RE source sites need vast tracts of land and dedicated transmission lines, which have the same trappings of conventional power projects. Such dedicated transmission lines would be idle for considerable part of a year due to non-availability of power from these sources. For example, in the case of a solar power park a dedicated transmission line will be utilised only for less than 10 hrs a day on an average, which is a grossly inefficient asset. Additionally, such large power sites will create uncertainty in the integrated grid if a cloud cover passes over it or if the wind dies down suddenly. Whereas the argument in favour of large site RE power is the so called economics, these problems will more than negate the economic benefits. On the contrary, distributed RE sources eliminate these problems.

* 1. **Micro/Smart grids to enhance the role of RE sources**

Distributed RE sources can perform optimally in a micro-grid mode. A federation of such micro-grids, which are connected to adjacent micro-grids and/or to the national grid, will enable optimal utilisation of RE potential while providing effective local controls, and also the provision of isolated operation, if necessary, at the time of grid emergencies. Smart grids enabled by suitable IT, communication and protection technologies will vastly assist in efficient management of the demand/supply of electrical energy through micro-grids.

In view of the fact that it is officially stated that the prime reason for about 25% of the population not having access to electricity is the economics of extending the grid to these areas, suitably planned micro/mini grids are the best options to electrify such areas. Since these micro/mini grids can optimally make use of the locally available RE sources, such as solar, wind, bio-mass, micro-hydro etc. their overall costs will be minimum while the benefits to the local communities will be maximum. In the initial stages such micro/mini grids can be of simple design to reduce the cost and to provide confidence to the local populations. Gradually they can be made stronger and sophisticated with financial contribution form the enhanced local economy. Such micro/mini grids when enabled by suitable IT, communication and protection technologies are called as smart grids, and can be deployed for the overall benefits of the society even in urban areas, which are already being served by the grid. Many such examples are reported from across the world, and can be of high relevance in many of the Indian scenarios.

In the context of ever increasing cost and the complexity of the integrated High Voltage grid the micro, mini and smart grids powered by distributed RE sources, which can be seen as a regional level or national level federation of micro grids, should be seen as our long term goal to address the vexatious issues of the High Voltage grids. Initial steps in this regard should be taken by opting for mini/micro grids powered by RE sources for those communities not having access to electricity in order to achieve the targets of electrification program.

The generation planning should provide adequate focus on RE enabled micro/smart grids for better management of the power demand/supply in the medium/long term.

[Reference: The book “A Roadmap to Tamil Nadu's Electricity Demand/Supply – 2050”,

http://www.indiaenvironmentportal.org.in/files/file/Tamil%20Nadu%E2%80%99s%20Electricity%20Demand-Supply%202050%20FINAL.pdf ]

* 1. **Low Carbon Growth Strategy for Indian Power sector**

Various measures discussed in CEA’s plan, as a part of low carbon growth strategy for the Indian power sector, will be negated by the huge additional GHG emissions resulting from the large number of conventional power plants planned to be added. Hence, a complete paradigm shift in the way we look at the demand/supply of electricity in future has become a dire necessity by charting out a time-bound plan to move away from the conventional technology power plant based and centrally controlled grid system to a federation of micro/mini/smart grids enabled by RE sources, while at the same time making all possible efforts to minimise the overall electricity demand within the nature’s limits.

**5.** **Discussion on the salient points of the draft plan**

Keeping all the above listed discussions in proper perspective, it should become obvious that the national electricity plan (volume I) generation is prepared from a holistic societal welfare perspective. But a quick reading of the draft generation plan indicates that the letter and spirit of many of the associated Acts, rules, policies, and international obligations cannot be complied with various projections/proposals in the plan. Since the sole objective of generating electricity is the overall welfare of our communities, the time has come to rationally consider the power sector as a whole from the true perspective of the societal development, which is inextricably linked to a sustainable ecological health of our natural resources.

1. **Recommended action plan**

A set of action plans is recommended in this regard.

1. Because of the huge inefficiency prevailing in the country’s power sector, the highest priority is needed to take the overall efficiency to the international best practice levels; this approach is known to cost least amongst various options to meet the legitimate demand for electricity of all sections of our society; it will also have the shortest gestation periods and many associated benefits.
2. In view of the huge impact on our society, including the all important environment, the use of conventional energy sources, such as dam based hydro, coal, natural gas and nuclear, should be minimised in the short term, and discontinued at the earliest; their usage should peak early, and gradually eliminated latest by 2050.
3. In view of the inevitability of harnessing the renewable energy sources on a sustainable basis, all out efforts should be made to develop them early to meet our entire electricity needs before the middle of this century; this should include adequate focus on R&D, fiscal incentives if necessary, suitable policy interventions, necessary regulatory measures etc..
4. **Conclusions**

CEA’s generation plan has many welcome features such as the recognition of the need for no additional coal power plants, discussion on environmental issues, emission from power sector, and consideration of grid-interaction of RE sources etc. This move towards a holistic view of the overall welfare of our communities is a very good beginning towards a sustainable life style.

In view of the huge implications of additional conventional electricity generation plants on our society’s social, environmental and economic aspects and the huge relevance and potential of RE sources no more nuclear, gas based and dam based hydro power plants also should be considered as necessary for the future.

Carefully designed micro-grid/smart grid based distributed RE sources have the potential to meet all the legitimate electricity needs of the country at acceptable costs and on a sustainable basis. There is a growing body of simulation studies and practical experiences from around the world to establish the feasibility of 100% RE enabled electric power system in the near future for which concerted efforts, starting with the enabling policy framework by the union government have become urgent. This vast potential of RE sources should be harnessed optimally through effective inclusion of various stakeholder groups in planning and execution of the future power sector projects.

The overall approach of the demand projection and generation planning should be to determine and provide the minimum quantum of electricity which will eliminate the poverty instead of the aim to assist in maximising the GNP. Whereas RE sources have almost unlimited power generation potential, the limits of the nature even with them cannot be kept out of our focus.

Keeping in view the huge costs of expanding the integrated grid, its ever increasing complexity and the major grid outage probability, the necessity of such complex grid for conventional power projects cannot be ignored. In this context the micro, mini and smart grids powered by distributed RE sources, which can be seen as a regional level or national level federation of micro grids, should be seen as our long term goal to address the vexatious issues of the High Voltage grids. Initial steps in this regard by opting for mini/micro grids powered by RE sources for those communities not having access to electricity should become a priority for accelerated electrification program.

The electricity generation plan has a close relation to sustainable welfare of our communities, and hence a diligently developed/implementable plan and policy to provide the legitimate quantum and quality of electricity to all sections on a sustainable basis, while taking adequate precautions not to allow our natural resources to degrade, is a critical task for the entire society.

It is sincerely hoped that CEA’s electricity generation plan will be suitably modified so as to live up to the true needs of our communities.

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