Electricity Governance in India

IIM Kozhikode Society & Management Review
3(2) 109–122

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Abstract

Electricity governance and planning ought to have been two important areas of administration in India right since Independence, but unabated growth in demand, chronic power cuts, nature's limits and global warming implications all have now made them *critical* to the all-round development of our communities on a sustainable basis. A rational analysis at how the Electricity sector in the country has performed since independence provides a disappointing picture: there is indifference to the consumers' needs, inequity of access, financial mismanagement, lack of professionalism and frequent non-compliance with relevant laws. These conditions indicate the need for a paradigm shift in the way the sector is governed. Electricity planning seems to be based on archaic principles, insensitive to changing customer needs and the global warming context. This article recommends that both in governance and planning, effective stakeholder participation and regular consultations with the domain experts will help to address the major issues. System-wide measures such as efficiency improvement, demand side management (DSM), energy conservation and effective use of distributed renewable energy sources (REs), supported by micro grids and smart grids, should be the way forward. A number of national and international reports focusing on Power sector reforms have advocated this approach.

Keywords

Policy, constitution, environment, efficiency, conservation, tariff, resources, micro grid, smart grid, costs and benefits, DSM, global warming, regulation, cost-to-serve, sustainability

Introduction

Governance in general can be defined as a set of administrative or policy initiatives aimed at true welfare of all sections of the society keeping in proper perspective the real needs of the people, nature's limits, sustainability, laws of the land and so forth. It can be seen largely as management of a given sector in an efficient way suitable to the needs of a society. In the Indian context effective electricity governance shall mean the following:

- Compliance in letter and spirit of the Indian Constitution, Indian Electricity Act (IE Act) 2003, National Electricity Policy, Energy Conservation Act 2001 and The Electricity Regulatory Commissions Act, 1998. These Acts and Policy stipulate the highest possible efficiency in harnessing the natural resources, financial viability of electricity supply companies, equity in access to electricity, customer satisfaction and sustainability of the associated policies.
- Since Electricity sector is known to impact the nation's biodiversity, natural resources and the general environment, there is also the critical need to comply with the letter and spirit of the Environment Protection Act, Forest Conservation Act and Wildlife Protection Act.
- Ensure the common man's access to clean air, water and food; the right not to be forcibly displaced from one's chosen habitat and legitimate access to natural resources.
- Mitigate and adapt to the threat of global warming consistent with the global imperative and to fulfil obligations towards the future generations.

  Ensure equity, quality and reliability in the supply of electricity to all sections of society at realistic prices.

An overview of the performance of electricity governance in the country since independence in general, and during last 10 years in particular, gives rise to significant concerns in respect of legal, technical, economic, social and environmental compliances.

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Legal Issues

As per 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. The impact on our environment due to the vast additions of coal and hydro power capacities since independence are continuing to be ignored by the states and the centre, despite the past experiences, such as court cases and national and international reports, such as assessment reports of Inter Governmental Panel on Climate Change (IPCC, Fourth and Fifth Assessment Reports). The large numbers of conventional power plants, which are continuing to be planned and implemented, are reducing the nation's forest cover, severely interfering in the natural flow of rivers, polluting land, air and water, and destroying or hastening the extinction of many species and in general reducing the rich biodiversity. This is continuing despite clear knowledge of major inefficiencies prevailing in the system (National Electricity Policy of 2005). This article argues that if the inefficiencies in the generation and distribution system were adequately addressed, as recommended by National Electricity Policy, the real need for conventional power project scan be reduced by a vast margin.

Energy Conservation Act, 2001 focuses on promoting efficient use of energy and its conservation. The performance of the Electricity sector as at the end of 2013 can indicate a huge scope for improvement in all areas of the Electricity sector. Integrated Energy Policy (IEP) of the Planning Commission itself had admitted in 2006: 'India's conventional energy reserves are limited and we must develop all available and economic alternatives. … Clearly over the next 25 years energy efficiency and conservation are the most important virtual energy supply sources that India possesses'. It also has advocated: '… relentlessly pursue energy efficiency and energy conservation as the most important virtual source of domestic energy'. The inefficiency prevailing in the end use of energy in the country is so much that the IEP has estimated that the energy intensity of our economy can be reduced by 25 per cent by 2031–2032, and that the cost effective saving potential is at least 15 per cent of total generation through demand side management (DSM). Agricultural sector alone, which consumes about 22 per cent of the total electricity, is known to be wasting about 50 per cent of that energy due to technical losses, which of course can be drastically reduced by simple measures (Planning Commission of India).

Preamble of the IE Act, 2003 states it as 'An Act to… promotion of efficient and environmentally benign policies'. Section 3(1) of the Act requires the Central Electricity Authority (CEA) to advise the Central Government on 'optimal utilization of resources'. As per Section 8(1) of the same Act the CEA is required to examine that any proposed river works will lead to the 'best ultimate development of the river or its tributaries for power generation, consistent with the requirements of drinking water, irrigation, navigation, flood-control, or other public purposes'. The word 'ultimate' in this section points to the necessity of assessing long-term sustainability of river and other related resources. It is almost impossible to notice the compliance of the letter and spirit of IE Act 2003, and National Electricity Policy as far as salient features such as efficiency, economy, responsible use of natural resources, consumer interest protection, reliable supply of electricity and protection of environment are concerned.

The National Electricity Policy had said in 2005:

> It would have to be clearly recognized that Power Sector will remain unviable until transmission and distribution (T&D) losses are brought down significantly and rapidly. Many states in the country have been reporting losses of over 40% in the recent years. By any standards, these are unsustainable and imply a steady decline of power sector operations. Continuation of the present level of losses would not only pose a threat to the power sector operations but also jeopardize the growth prospects of the economy as a whole. No reforms can succeed in the midst of such large pilferages on a continuing basis.

It speaks volumes about the electricity governance in the country that even after nearly six decades of independence the national policy has to record its concerns on such fundamental issues of governance. Not much action to improve the situation is evident since then.

As per a study report by Prayas Energy Group, Pune the usage of energy efficient models of common house hold appliances such as lamps, refrigerators, fans, TVs, radios etc. can result in about 30 per cent energy savings in households annually. This may correspond to an avoided additional generating capacity of about 25,000 MW (Prayas Energy Group).

The efficiency in the Power sector is known to be so low that the potential for improvement is estimated to be 35–40 per cent of the peak demand met as indicated in Table 1.

The Electricity Regulatory Commissions Act, 1998 aims at rationalization of electricity tariff, transparent policies regarding subsidies, promotion of efficient and environmentally benign policies. It says in its statement of

Table 1. Power Sector Efficiency in India

Power Sector Area	Prevailing Level of Efficiency/Loss in India (in %)	Potential for Improvement/Savings (Percentage of Total Annual Energy)
Generating capacity utilization	50–60	5–10
Aggregate Technical and Commercial losses (AT&C)	35–40	15–20
End use efficiency in agriculture	45–50	15–20
End use efficiency in industries and commerce	50–60	5–10
End use efficiency in other areas (domestic, street lights and others)	40–50	5–10
Demand Side Management	Potential to reduce the effective demand by more than 20	

Source: Estimates based on many reports and articles on the Indian Power sector.

objects and reasons: 'It is essential that the Government implement significant reforms by focusing on the fundamental issues facing the Power sector, namely, the lack of rational retail tariffs, the high level of cross-subsidies, poor planning and operation, inadequate capacity, the neglect of the consumer …'.

Environment Protection Act, Forest Conservation Act and Wildlife Protection Act, and national forest policy have all emphasized and/or mandated the need to preserve a healthy environment, adequate quality and extent of forests, and to protect biodiversity in the country. A report by the Ministry of Environment and Forests (MoEF) 'Achieving 2010 Biodiversity Target: India's contributions' has copiously described the rich bio diversity in the country and the threats to it. As per State of Environment Report 2009 by MoEF India is a mega biodiversity country with only a 2.4 per cent of land area of the Globe but accounting for 7–8 per cent of the recorded species of the world. It is the home for 11.8 per cent of the plant species documented so far. Since the Electricity sector has been known to have considerable impact on various aspects of the nature, the relevant provisions under these Acts also need to be looked into the while discussing the effectiveness of governance.

It is hard to see satisfactory compliance of various provisions under these Acts and Policies in the Electricity sector.

Social and Environmental Issues

The conventional power plants have been throwing up many serious concerns to our communities since independence. These issues have impacted the social, economic, environmental and intergenerational issues. Forced displacement of the project affected families is a common but credible threat to our communities because of each of the conventional power generation technologies. Loss of livelihood; denial of access to stretches of forests, rivers and oceans; inadequate or nil compensation; destruction of habitats etc. have impacted the lives of millions of people from such projects since independence.

Such major concerns can be listed as in the Table 2. While the negative impacts of coal Power sector have been

Table 2. Major Issues with Conventional Technology Power Sources

	Fossil Fuels (Coal, Gas and Diesel)	Dam Based Hydro	Nuclear Power
Economic Issues	Huge pressure on natural resources such as land, water and minerals; reduced agricultural production; ever-increasing capital and operating costs; fast depleting fossil fuels	Demands large tracts of forests and agricultural land; water logging; impacts fishing income	Demands large tracts of forests and agricultural lands; huge capital costs; long-term waste management costs; vast requirements of fuels and technology
Social Issues	Peoples' displacement and health; denial of access to natural resources for the poor	Peoples' displacement and Health; denial of access to natural resources for the poor	Peoples' displacement and health; denial of access to natural resources for the poor
Environmental Issues	Global warming; pollution of land and water and air; large quantity of ash; radiation from ash	Methane emission, submersion and fragmentation of forests	Mining related pollution; radiation emission; GHG emission in the overall life cycle

Source: Author's compilation from various sources.

reported widely, the impacts from dam based hydel as well as nuclear power plants also are huge (Chapters 4 and 5 of Integrated Power Policy). Effective governance was expected to strive hard to minimize such impacts through due diligence in policy making, planning and implementation processes, but sadly that has not been the case since independence (Integrated Power Policy).

As per IPCC, the Global increase in CO_2 concentration, which is the most important anthropogenic green house gas (GHG) leading to global warming, are due primarily to fossil fuel burning and land use change. Large conventional power plants (coal, gas, dam based hydro and nuclear), are all closely associated with fossil fuel use and land use change. Accelerated depletion of natural resources such as forests and rivers; unmanageable pressure on agricultural land and fresh water; unacceptable level of pollution of air, water and soil; and never ending displacement of poor people from their natural habitat, for which Electricity sector is a major contributor, have all been resulting in massive socio-environmental problems, and in drastically reducing what should have been massive contribution of rural areas to the overall wealth of the country (IPCC).

The fourth assessment report of IPCC has indicated that emission of the greenhouse gases must fall by 2050 by 50–85 per cent globally compared to the emissions of the year 2000, and that the global emissions must peak well before the year 2020, with a substantial decline after that. As per this report 'Emissions from deforestation are very significant—they are estimated to represent more than 18 per cent of global emissions'; 'Curbing deforestation is a highly cost-effective way of reducing greenhouse gas emissions'. The planning process in the Electricity sector does not indicate any drop in the proposed addition to coal power plants in the near future. Large additions to conventional power plants will not only add massively to the already high GHG emissions in the atmosphere but will also reduce the thick natural forest cover, which are natural sinks for CO_2.

The fifth assessment report of IPCC, which was released in April, 2014, has made unambiguous recommendations to move ways from the overreliance on fossil fuels. It says that globally 2000–2010 was the decade of coal with almost 80 per cent of the GHG emissions growth during this period having been caused by fossil fuel combustion, and in particular burning of coal. It says that in order to have decent chance of keeping the global warming from running away situation more than 80 per cent of the identified fossil fuel reserves must remain below ground.

In view of the serious concerns on global warming implications, including the 'existential threat' to the human race, which have been known for more than 20 years, and to which Electricity sector is a major contributor, the criticality of a highly responsible governance of the sector need no special emphasis. In this context India's continued choice of coal as the primary source of energy/electricity for the future cannot be termed as responsible governance.

Forest defragmentation and degradation due to various activities in Electricity sector such as coal mining and construction of hydro power dams and transmission lines, as experienced since independence, should be of huge concern. Whereas the National Forest Policy recommends that 33 per cent of the land mass should be covered by forests and trees for a healthy environment, our practice of continuing to divert forest lands for vast number of large size power projects will bring this percentage much below even the present low level of about 20 per cent in the country. A statement by MoEF few years ago has indicated that about 35 per cent of the coal reserve belts in the country are in 'No Go' areas because of the strong environmental reasons. But subsequently due to massive lobbying to permit coal mining in such sensitive areas too, the policy of 'Go' and 'No Go' areas was ignored.

'Over 8,000 projects, involving a diversion of 200,000 hectares of forest land, have been cleared by the central government in four years between 2007 and 2011, and this was double the clearances given in three previous decades', according to Director of CSE and environmentalist Sunita Narain as reported in Business Line in January 2014. Power projects are known to have considerable share in such forest land diversion.

In addition to huge contributions to GHG emissions, the conventional power plants have many other implications in the global warming context; they result in diversion of forest and agricultural lands for mines, power plants, transmission lines, dams, coal storage and ash ponds etc.; they also consume large quantities of water, and produce huge quantities of pollutants. Coal plants also emit other pollutants such as ash, heavy metals, sulphur dioxide, nitrogen oxides and mercury that contribute to smog and affect human health.

As per a report from the MoEF (Second National Communication to the UNFCCC) the Energy sector emitted 67 per cent of the total GHG emissions in the country during 2000. In another report of 2010 (India: Greenhouse Gas Emissions 2007) MoEF has indicated that about 38 per cent of all GHG emissions in our country is associated

with electric Power sector. CEA's draft plan for 12th and 13th plan periods admits: 'The Indian power sector has immense potential of reducing carbon dioxide emission by way of Renovation and Modernization schemes as some of the plants are old and are operating at a low efficiency'.

While GHG emissions from coal power plants is highest amongst all conventional power plants, the methane gas (CH_4, which is about 24 times more potent than CO_2) emissions from the dam based hydro power plants, and the GHG emissions associated with the life cycle of nuclear fuels are not inconsiderable. The campaign by the nuclear power lobbies, that nuclear power is environmentally friendly just because the GHG emissions from an operating nuclear reactor is tiny, has no credibility because the GHG emissions associated with a nuclear power plant whether it is from mining, fuel processing, construction of nuclear reactors, the operation of the same, and the safe storage of spent fuel for hundreds of years can be huge.

The coal power plants also are known to consume huge quantities of fresh water, which is already a highly stressed commodity in our densely populated country. In this regards lack of due diligence becomes abundantly clear when we see that many coal power plants have been set up (and continued to be set up) in water stressed areas such as Rajasthan, Vidarbha and north Karnataka. In addition, coal power plants are being planned in other ecologically sensitive areas such as wetlands, coastal areas and foot hills of the Western Ghats. As per the survey report by Prayas Energy Group ('Thermal Power Plants on the Anvil: Implications and Need for Rationalisation'), if 700,000 MW of additional coal and gas power plants are to be set up as per the projections, fresh water requirement of a huge quantity (about 4.6 billion cubic meters per year) can be expected. The gravity of the situation becomes clear when we also realize that this much of fresh water can meet the drinking water needs of about 7 per cent of the population in India, or can provide irrigation to more than 900,000 hectares of land. In a country having serious crises of fresh water the rationality of such large additions to thermal power plants becomes highly questionable.

Agitation by locals against coal power plants from a fear of displacement has been a common phenomenon in recent years. Health impacts due to coal burning and radiation hazards associated with nuclear mineral mining and power plants also are serious concerns.

Additionally, it should also be kept in mind that those activities 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 the food and agricultural products; on the access to natural resources for livelihood of vulnerable sections etc. Hence, every activity leading to additional GHG emission in the country should be of concern from the all-round welfare perspective of our people.

The impact on the health and livelihood issues of people because of Coal Power sector has been well recorded in many reports of Greenpeace India. A study report 'Coal Kills' has found out that in 2011–2012, emissions from Indian coal plants resulted in 80,000 to 115,000 premature deaths and more than 20 million asthma cases from exposure to the associated pollution. As per a report by the Chinese Centre for Disease Control and Prevention 'The True Cost of Coal—Air Pollution and Public Health', coal combustion in China is the source of 70 percentage of the country's soot emissions; 85 per cent of its sulphur dioxide emissions; 67 per cent of its nitrogen oxide emissions; and 80 per cent of its carbon dioxide emissions.

Physicians for Social Responsibility have prepared a report titled, 'Coal's Assault on Human Health' (2009). This report refers to coal combustion emissions such as sulphur dioxide, particulate matter (PM), nitric oxides, mercury, and a number of other hazardous substances, which damage the respiratory, cardiovascular and nervous systems of the human body. A number of similar reports from around the world have highlighted the social, health and environmental impacts of coal industry, and have strongly recommended the global community to move away from the over reliance on coal power.

India has the world's most toxic air, as reported in two successive studies by Yale and Columbia universities. India scored 3.73 out of a possible 100 points in an analysis in 2011, and ranked among lowest five countries in air quality in Environmental Performance Index 2014 that assessed 178 nations. Coal power plants are known to be major contributors to this problem.

Experts are of the opinion that thousands of lives can be saved every year in India if India tightens its particulate emissions standards, introduces emission limits for pollutants such as sulphur dioxide, nitrogen oxides and mercury, and institutes mandatory monitoring of emissions at plant stacks, and making the data publicly available in real time. The question is: since alternatives are available, how to stop people from getting exposed to all the health impacts of coal power?

The cumulative impact of large number of coal based, dam based, and nuclear based power plants, already commissioned and also planned to be commissioned in next

15–20 years on densely populated communities, ecologically sensitive areas, and the already polluted regions will be massive. The large number of such power plants defeats the very purpose of producing electricity, which is the welfare of all sections of the society.

In view of the credible threat to the true welfare of communities and to the environment, there is a need for minimizing the number of large conventional power projects, and not to increase them as recommended by IEP. CEA's generation plan to add about 79,000 MW in each of the 12th and 13th plan periods would not have been projected under diligent electricity governance.

A number of conventions and reports have urged extreme precaution while harnessing natural resources in order to minimise the damage to the nature. The Precautionary Principle is the essence of these conventions. Such conventions and report include:

1. UN Framework Convention on Climate Change (UNFCCC).
2. World Charter for Nature by UN General Assembly in 1982.
3. Cocoyoc declaration of 1974 at Mexico, as part of UN Conference.
4. UN Convention on Biological Diversity in 1992.
5. The Ramsar Convention on Wetlands.
6. A report 'Biodiversity impacts of large dams' prepared for UNEP and IUCN.
7. Reducing emissions from deforestation and forest degradation (REDD).

In this regard, it is sad but inevitable to come to the conclusion that the Electricity sector in India has failed to exercise precautionary principle, and hence the effective governance has been sorely missing.

Technical and Technological Issues

Despite massive investments and increase in the total installed capacity of conventional power plants by about 220 times since independence, the fact that about 35 per cent of the population has no access to electricity should raise serious questions about the very goals of India's electricity governance. The country's Electricity sector has been associated with the one of the worst levels of efficiencies at the global level. Much of the inefficiency noticed in the sector can be attributed to technical issues. The choice of best technology available in the market, diligent design considerations, careful implementation of various projects, and responsible operation and maintenance of the sector could have resulted in much less energy and financial losses. While the overall efficiency of coal power generation technology (from coal mining till it is put to use as an electricity application) is known to be of the order of 10 per cent or less in most coal power plants in the country, even the best technology cannot take it beyond 25 per cent because of the theoretical limits of the technology. While the reliability of coal supply—quantity and quality—to the existing power plants has been an issue, the clamour for increased import of coal is fraught with cost escalation and energy security concerns. In this context, it is irrational to continue to rely heavily on coal power, as India's planning agencies do.

A crucial aspect of Power sector management is the realistic forecast of power demand for the next hour, day, week, month and year, as also the demand forecast for next 10–25 years. Exaggerated demand projection seems to be the prime reason for a large number of conventional power plants being planned and implemented in recent decades. IEP itself has projected an increase in electricity generating capacity from about 153,000 MW in 2006 to 778,000 MW by 2031–2032. A survey report by Prayas Energy Group released in 2011 has estimated that there are more than 700,000 MW of coal and gas plants waiting to be built in the coming years. This is in addition to about 60,000 MW of nuclear power and about 120,000 MW of hydel power by 2031–2032 as projected by IEP. When compared against a total power production capacity of about 225,000 MW built in 66 years of independence, the enormity of problems associated with the project related issues to the society of the proposed addition of more than 550,000 MW in next 20 years may become clear. Though there is no guarantee that all these proposed power plants may get built, even 50 per cent of them can have huge consequences on social, economic and environmental aspects. There can be no doubt that this large number of power plants is being proposed without due diligent studies about their true need (Prayas Energy Group).

A crucial aspect of demand projection for the next 25–30 years will be the anticipated growth in demand for electricity by the rapidly increasing middle class, and the 400 odd million people who are without access to electricity. Assuming that the total electricity demand, say by 2040, will be much higher than the present demand (even if it is two or three times more), it becomes imperative that we also plan how such a demand can be minimized to legitimate needs, and how to meet it satisfactorily

on a sustainable basis. The limits of the nature to meet all such electricity demand through conventional electricity sources, and even through the renewable energy sources (REs) should be carefully understood. There can be no doubt that the conventional electricity sources, due to reasons discussed in the earlier sections, cannot meet such a projected demand on a sustainable basis.

Hence, there is an inevitable need to determine the minimum quantum of electricity that is required to eliminate poverty, how to obtain the same at lowest overall cost to the society on a sustainable basis, and how to ensure equitable distribution to all sections of the society. One cannot observe such a rational approach in any of the official policies and/or planning process. Considering various issues besetting the Electricity sector all these years, it seems more likely that distributed type of REs, either connected to the grid or operating off grid, will be needed in the future. Hence, blind addition to the conventional electricity generating capacity in the name of meeting the huge demand of the future cannot not be said to be in the true interest of the society.

Plant load factor (PLF), which is a measure of the utilization of a coal power plant's installed capacity, is reported to be less than 30 per cent at many older power plants in the country, as against 90 per cent of many NTPC power plants (CEA) generation plan for 12th and 13th Plan periods). Such old coal power plants with low PLF, which are not only a huge drain on the natural resources and our economy but also huge polluters, should have been retired and replaced by efficient plants many years ago, but our planning process has failed to act accordingly. In this context it is perplexing that CEA has projected addition of 66,600 MW and 49,000 MW of new coal power capacity respectively in 12th and 13th plans periods, instead of focusing to improve the PLF/efficiency of the existing coal power plants. Keeping in view various issues such as inadequate supply of coal to existing power plants, various risks associated with the imported coal, additional requirement of land and water, people's displacement and environmental concerns the real need for additional coal power plants should have been ascertained objectively, but the various policy/planning documents do not indicate such an approach.

As indicated in Table 1, the potential for virtual additional power capacity through efficiency improvement measures can be in the range of 35–40 per cent of the peak demand met. This works out to about 45,000–50,000 MW, which is comparable to the additional coal power capacity planned for the 13th plan period. The enormity of the problem may become clear if we also consider the huge social–environmental costs associated with setting up of so many additional coal power plants.

Lack of professionalism is a chronic problem besetting the Electricity sector. M.G. Devasahayam, a former Chairman of Haryana State Electricity Board, and a keen observer of the Electricity sector in the country, says in an article ('Reforming India's Power sector'), ' …ill-trained workforce, poor reliability, high line losses, low voltage profiles, overloading of transformers, poor maintenance, absence of conservation measures, power theft, haphazard layouts, whimsical load connection, inadequate safety clearance, …' are the major ills. He notes, '… Any increase in generation capacity is more than offset by inefficiencies and wastage at every stage—production, transmission, distribution and delivery. Without fixing these inefficiencies and wastage, increasing generation capacity and production is like filling a bucket full of holes!' He proposes that three action plans should be a part of better governance: (i) determining the consumption profile in each utility such as shift-based industries, continuous process industries and industries having independent feeders; (ii) designing a state-of-the-art distribution system and (iii) streamline delivery mechanism to meet the specific needs of each consumer category. It is extremely disappointing that even after six decades of independence, many fundamental issues of governance, such as, the absence of accurate data bases, an asset register, asset maintenance practice and policies, and adherence to safety practices, have not be addressed effectively.

The Bureau of Energy Efficiency (under Ministry of Power) has estimated that at the current costs of additional energy generation, it costs a fourth to save a unit of electrical energy than to produce it with new generating capacity. As per the Planning Commission's IEP, '… Clearly over the next 25 years energy efficiency and conservation are the most important virtual energy supply sources that India possesses'. Instead of focusing on such efficiency improvement measures, which can bring many benefits to the society at much lower costs, our authorities seem to be keen only in hugely costly new projects.

As compared to international best practices of 4 per cent losses in transmission and distribution (T&D), the average loss at the national level is about 25 per cent (as per CEA's Annual report 2012), which is a clear indication of huge inefficiency. Despite repeated warnings on the implications of such inefficiency on our economy since mid 1980s, the country has not focused to bring it to an acceptable level. Some of the states are recording T&D losses of more than

Table 3. T&D Losses (2009–2010)

Region	Losses (%)
Northern Region	27 (Range from 20 to 64)
Western Region	26 (Range from 13 to 35)
Southern Region	19 (Range from 14 to 20)
Eastern Region	27 (Range from 21 to 42)
N E Region	34 (Range from 29 to 64)
All India	25

Source: CEA, Agenda for 18th EPS Report.

50 per cent even in 2012; a clear failure of governance (Table 3).

Similarly, the losses in electricity utilization are very high indicating a huge potential in savings. As indicated in Table 1 there is a huge scope for energy efficiency, DSM and conservation. IEP has also clearly acknowledged that the coal reserves may not for more than few decades, and that uranium reserve available in the country can support the nuclear capacity of only about 10,000 MW.IEP's projected increase in total electricity generating capacity from about 153,000 MW in 2006 to 778,000 MW by 2031–2032 should be viewed in the background of these concerns, and from a responsible governance perspective. The projected increase of thermal power from about 80,000 MW, to about 480,000 MW; hydro power from about 30,000 MW to about 150,000 MW; and nuclear power from about 4,000 to 60,000 MW between 2006 and 2031, when seen from the perspective of overall welfare our communities and the implications of global warming, should clearly indicate the failure of governance.

Since most of the technical losses are in distribution segment, it is worthy of mentioning that ensuring good voltage profile at all points in the system, especially at consumer's premises (which is any way a requirement under IE Act 2003), will minimize these losses. Much lower ratio of the length of low tension lines to high tension lines in the distribution system will enable this mandate of the Act. It is another case of the failure of governance to comply with the mandate of IE Act 2003 to ensure adequate voltage at the consumer's premises for more than six decades since independence.

By adopting international best practices in design, implementation and operational areas the losses in the system can be reduced to an acceptable level, which will be associated with huge benefits to the society. Deployment of effective DSM measures and efficient appliances in end use, and optimal conservation measures have the potential to bring down the effective demand on the grid by a considerable margin, and also can address many of the chronic ills of the sector. All these system improvement measures are like low hanging fruits, which will accrue to our society at about 25 per cent of the cost of green site power plants.

Table 4. New and Renewable Energy Potential in India

	Potential (Grid Interactive Power Only)
1. Wind energy	50,000 MW (Onshore only)/(100,000 MW as per WISE)/ 748,000 to 976,000 MW as per a recent study in 2011)
2. Small hydro	15,000 MW
3. Solar	Over 5,000 trillion kWH/year potential (estimated to be many times more than the total energy needs of the country)/(200,000 MW of CSP as per WISE)
4. Bio-mass	> 50,000 MW
5. Ocean-based Energy	With about 7,000 kM of coastal line it should be huge, but no estimates available
6. Geo-thermal	Estimated to be considerable

Source: MNRE, Government of India.

Whereas many international agencies including the World Bank, the European Bank as well as the US government have taken policy decision to discourage funding to the coal industry because of the global warming implications, many international reports, including the one from IPCC ('Special Report Renewable Energy Sources (SRREN)'), have unambiguously projected critical role for renewable energy (RE). India being a tropical country has huge potential in RE as indicated in Table 4.

Two major grid collapses on two consecutive days of 30th and 31st July 2012 in the northern parts of the country when more than 650 million people in 18 states and two Union Territories (termed as the largest known blackout in history in terms of the population affected) were reported as directly affected for hours together; the not so infrequent grid collapses in the previous years; and the chronic power cuts impacting most parts of the country, all clearly indicate the failure of polices, planning and implementation in the case all agencies in the sector. The relevance of responsible governance through a holistic approach to the overall welfare of the society becomes very obvious in this context (Prayas Energy Group).

Economic Issues

The Electricity sector in India has huge impact on various segments of our economy, and a well managed sector

would result in vast economic and social benefits. The floundering Electricity sector since last few decades has not only become a major drain on the nation's economy, but also has impacted the economics of individual families. As per the report of the 13th finance commission of the Parliament, unless the public utilities engaged in (T&D) of electricity take urgent measures to improve the overall efficiency of operations the combined losses at the national level may increase from ₹ 68,643 crores in 2010–2011 to ₹ 116,089 cores by 2014–2015. Yet the business media has already reported that losses may have already crossed ₹ 200,000 crores in 2013 itself.

IEP's projected increase in total electricity generating capacity (which was about 225,000 MW in January 2014) to 778,000 MW by 2031–2032, when considered from the perspective of overall economic impacts, resource constraints and dense population, gives rise to serious concerns on social, economic and environmental aspects on the vulnerable sections of our society. On a conservatively assumed average capital cost of ₹ 10 crores per MW, such a capacity addition may mean a direct expenditure of more than ₹ 5.5 million crores over the next 17 years. Such a huge public expenditure projection should demand due diligence, effective costs and benefits analysis, options analysis and effective public consultation. Given the inefficiencies already prevailing in the sector and the past history of fiscal discipline, it is difficult to imagine that such a colossal expenditure will lead to the commensurate benefits to the society. Such expenditure in one sector may deny resources to other priority sectors such as Poverty Alleviation, Drinking Water, Health, Agriculture and Education.

The National Electricity Policy has said in 2005:

> 'Out of total energy generated, only 55% is billed and only 41% is realised. The gap between average revenue realisation and average cost of supply has been constantly increasing. During the year 2000–2001, the average cost of supply was 304 paise per unit and average revenue per unit was 212 paise per unit'.

This is a sorry indication of the electricity governance in the country. Alas, not much improvement is evident since then.

The Electricity Regulatory Commissions Act, 1998 says:

> … It also aims at improving the financial health of the State Electricity Boards (SEBs) which are losing heavily on account of irrational tariffs and lack of budgetary support from the State Governments as a result of which, the SEBs have become incapable of even proper maintenance, leave alone purposive investment.

This is a sad admission of the failure of governance. Today, 15 years since this Act came into force, the financial health of the Electricity sector, as evidenced in the lack of rational retail tariffs, high level of cross subsidies, poor planning and operations, inadequate capacities, and the neglect of the consumer, is, to say the least, unsatisfactory.

The reasons mentioned in the Electricity Regulatory Commissions Act for the financial ill health of the sector are still relevant. Most states report financial losses of thousands of crores of rupees. One example may reveal the seriousness of the problem: two DISCOMS, which supply power to 70 per cent areas in Delhi, owe around ₹ 4,000 crore to Delhi government-run power generation and transmission companies. Such losses have become common for most of the electricity supply companies in the country, as per The Indian Express, 31 January 2014.

Lack of unscientific and responsible approach to various economic issues of the sector such as lack of due diligence in determining the true cost of service to each category of consumers, untargeted subsidies, absence of 100 per cent metering, political interference in tariff determination, corruption at different levels have been the root cause of the poor financial status of the sector. These issues combined together have resulted in shockingly poor financial status of electricity distribution companies to such an extent that these distributing companies are refusing to buy even the much needed power from costlier sources such as mercantile power companies, and also from the state-run NTPC at times. All these have lead to a strange situation wherein the thermal power companies are complaining about the underutilization of their generation capacity even as there is widespread power cuts in different states.

Absence of due diligence in determining the true Costs & Benefits to the society of Electricity sector projects, and refusal to consider the options analysis have resulted in heavy financial burden not only to the sector but also to the entire society. The continuing choice of large size conventional power generation technologies over the less costly choices such as efficiency improvement measures should be a cause for serious concerns. A report from the US (a Reuters report of 16 February 2011, quoting a study led by a Harvard University researcher) has revealed the hidden expenses not borne by miners or utilities, including health problems in coal mining communities and pollution around coal power plants. The report has estimated that such costs would effectively triple the actual price of

electricity produced by coal-fired plants. Unfortunately, no such considerations are given to the health aspects in India, where such costs are likely to be even more because of the laxity in enforcing the environmental regulations.

In the context of huge costs to the society in the form of global warming implications, last year the international development financial institutions such as the US Export–Import Bank, the World Bank and the European Investment Bank have set stricter financing standards for coal-fired power generation plants by forcing them to comply with much higher environmental standards. In fact, without the utilization of carbon capture and sequestration (CCS) technology, which stores CO_2 underground, these standards cannot be met. A report from Sierra Club, USA indicates that between 2005–2011 about 150 additional coal power plant proposals in the US are reported to have been dropped due to economics associated with the pollutions impacts, and many of the old power plants have been decommissioned (Website of Sierra Club, USA).

Ignoring such far reaching social, economic and environmental consequences has IEP said: 'A massive effort is clearly required to expand domestic coal production'. Similarly it is the case for hydro power and nuclear power. CEA's generation plan for 12th and 13th plan periods generally goes along this path. Without an objective assessment of true costs and benefits to our society, and without due diligence in options analysis an apex body like CEA, which has the necessary technical know-how and the mandate of IE Act 2003, should not be projecting large addition of coal power plants as well as dam based hydro and nuclear power plants. Unfortunately, despite many reports and articles highlighting the need for due diligence in such planning, the authorities are continuing to build unbelievably large number of conventional power plants which can only result in massive economic burden to the society. Various Annexures in the book *Integrated Power Policy* indicate high level analysis of costs and benefits to three typical conventional power projects, from which it becomes obvious that the authorities have to adopt a paradigm shift to the way they look at demand/supply of electricity in future (Integrated Power Policy).

Regulatory Framework

Appellate Tribunal for Electricity (APTEL), Central Electricity Regulatory Commission (CERC), State Electricity Regulatory Commissions (SERC), and Grievances Redressal Forum and Ombudsman are the regulatory agencies in the country established under the Electricity Regulatory Commissions Act, 1998. When the economic issues besetting the sector even after 15 years since the enactment of this Act are looked at from the perspective of the overall welfare of the society, it is hard to say that the letter and spirit of the Act has been satisfactorily complied with.

Electricity Regulatory Commissions, both at the centre and the states were set up with high expectations among the consumers hoping for rational tariffs, healthy competition and highest possible efficiencies. The ground realities since 1998 can be said to be of huge disappointment. These regulatory commissions are increasingly being seen just as haven for retired bureaucrats, and have been frequently blamed for not being diligent in the deliberations, and not sensitive to the expectations of the consumers. Author's own experience with the regulator in his home state was one of huge disappointment, where even the written and oral submissions before the Regulator were not addressed year after year. Because of such issues many staunch supporters of Electricity Regulatory Commissions have developed cynicism, and have stopped participating in the associated deliberations, which can only lead to worsening status of the Electricity sector.

Electricity Governance Framework

The Electricity sector comes under the concurrent list of the Constitution, with joint responsibility of both the centre and state governments. Ministry of Power at the centre administers the IE Act 2003 and other related Acts in the sector. CEA is the technical wing of the Ministry entrusted with the responsibility for developing the sector. Many central Public Sector Undertakings such as NTPC, NHPC, PGCIL, DVC, PFC etc. function under the control of the Power Ministry in the areas of electricity generation and transmission. State governments primarily deal with distribution and revenue collection, in addition to the powers to generate and transmit electricity. Since year 2000 the electricity business in most states is getting unbundled into generation, transmission, distribution and revenue collection segments. Due to undue interference and penchant for cheap popularity by the political leadership in the states, most of the electricity companies have been pushed to the brink of bankruptcy, and are generally termed by financial institutions and the common man as utter failures in their welfare objectives.

Since early 1990s, privatization has been advocated as panacea for all the ills of the sector. But the experience of Enron and Cogentrix companies in generation segment,

and experiences in Orissa and Delhi in distribution segment have left a lot more to be desired. Whereas many state electricity boards (under the state control) and few private companies in Kolkata, Ahmedabad, Mumbai and Karnataka were known to have performed satisfactorily, the recent experience in post-IE Act 2003 liberalization of the sector has not been good. There are also cases of very good experiences from around the world where both the public sector (such as in New Zealand and France) and the private sector (as in the US and the EU) have done well. Even the Pubic Private Partnership model, as in the case of Delhi, has not been acknowledged as an ideal model for development, although this model might have worked well in other sectors. So, the ownership of a segment in Electricity sector alone should not be the primary consideration as it is with the proper governance.

In view of the very high percentage of import content in petroleum products, neither the gas power plants nor the diesel generator sets can be seen as an integral part of future power supply scenario. The inefficiency and pollution associated with diesel generators, which are reported to be mushrooming all over the country at commercial establishments, should be a major cause of concern, not only because of the huge inefficiencies involved but also for the local pollution impacts. Instead appropriate renewable energy technology for individual cases should be considered.

Whereas the policy makers during much of the past century considered large-scale single location generation and vast integrated grids as providing economies of scale and stability of operation, the social, economic and environmental implications of that approach have brought distinct changes in the present century with focus on distributed REs such as roof top solar panels, community run bio-mass units, hybrid of two or more REs etc, connected in micro grids and smart grids. Micro grids at municipal and village levels are gaining popularity, as has been examples from Germany and the US.

Whereas the successive governments have pursued a policy of advocating the integrated grid based, centrally controlled, large size conventional power plants as the only option to pull the people out of poverty, about 35 per cent of the population in the country has no access to electricity even after massive expenditures in the sector since independence (Census 2011). As an irony the governments in recent years have also started stating that due to cost factor the remote locations in the country have not been connected to the grid yet. Many recent examples from Bihar, Kerala and Himalayan states indicate that distributed REs such as roof top solar panels, community run bio-mass units, micro-hydro units, hybrids of REs etc, connected through micro grids or operating in isolated mode are much more effective to rural India (GreenPeace India).

Effective governance in future should take such location specific applications into objective consideration, if the country is to have any realistic chance of 100 per cent electrification on a sustainable basis in the near future.

Electricity Infrastructure for the Future

Keeping all the issues discussed in the earlier sections, especially keeping in context the lack of access to electricity to about 30 per cent of the population even after 66 years of independence, the chronic power cuts in all parts of the country, not-so-infrequent grid collapses, poor financial performance of the sector, the inability to live up to the mandates of various Acts of Parliament etc. it will not be an exaggeration to aver that in general the policies, the planning and implementation in the sector have not been satisfactory, and they are highly unlikely to meet the society's requirements for the future.

The large number of conventional power plants in the pipeline, whether they are of coal based, dam based or nuclear based technologies, should be a matter of great concern to a densely populated and resource constrained country. Hence, they reveal serious issues with the governance because this additional capacity amounts to many times more than that indicated in the CEA generation plan for 12th and 13th plan periods. Even if 50 per cent of this planned addition get to fruition in next 10–15 years, it will become a mockery of CEA's generation plan to add about 140,00 MW of coal power in the next 10 years.

It can be even stated that to continue in the business as usual scenario, especially in the context of the country's own experience and worldwide knowledge during the last few decades, will amount to serious let down of our people from all perspectives. Hence, there is a need for a thorough review of the very basis of the future electricity infrastructure, and the structure of overall governance in the sector.

When looked at holistically it becomes clear that the generation planning in the country has not been going on a scientific basis, and the generation capacity is being planned and added without due diligence process. In the process of generation planning CEA should take into objective account our own experience since independence, various Acts of the Parliament, international experience

and obligations, true costs and benefits to our society, natural limitations, global warming implications and the obligations to future generations.

Our own experience since independence should establish the fact that business as usual scenario must not be continued. In the short-term measures such as efficiency improvement, DSM and conservation; and effective harnessing of the huge potential in the new and REs will be critical. In the medium and long term distributed REs such as roof top solar panels, community run bio-mass units, wind turbines and hybrid of two or more of these sources connected to micro grids and smart grids shall be the way to go. In some remote cases isolated usage of these REs can be most effective. Micro grids at municipal and village levels can be the best options to have better control and economy for the end consumers. There will be a critical need to manage various types of electricity usage at the level of individual customers in order to minimise the electricity demand. For example, domestic and agricultural customers may modify their life styles such that most of their applications get transferred to day time when the solar power can directly feed them, because of which the need for energy storage devises or appliances will be greatly reduced.

In the context of intractable problems in effective governance of the Electricity sector a paradigm shift in the form of integrated energy resource management approach has become imminent. Such an approach consists of deploying all the available options to meet the legitimate energy demand of the entire society at least overall societal cost on a sustainable basis. There is the imperative to reduce dependence on conventional energy sources gradually until the new and REs can effectively replace them. These conventional energy sources should be targeted to be completely eliminated in the long term, say by 2040. Other REs such as ocean energy and geo-thermal energy also need to be developed and harnessed after due diligence process.

Keeping all the issues discussed in the earlier sections, it is likely that the components of electricity infrastructure of the future, say by 2040 or 2050, will appear vastly different to what we see today. Much of the electricity generation is likely to be in the form of large number of small size REs such as roof top solar photo voltaic (SPVs) or wind turbines or community based bio-energy or concentrated solar power (CSP) type solar power plants with energy storage facility, and a small number of large size REs (such as off-shore wind power parks), and with a minimum number of conventional power plants, if at all necessary. The need for a stronger and highly reliable integrated grid will increase, but the nature of the grid is likely to be different. In view of the need for vastly reduced number of conventional power plants and the scope for a large number of distributed RE sources spread all over the country, much of the investment in the integrated grid could shift from transmission segment to the distribution segment, though the importance of transmission segment may not diminish greatly. In view of the need for exporting excess power from small sources such as roof top solar PV panels on a reliable basis, smart and reliable metering, advanced control and communication systems at distribution levels should become a reality. Micro grids and smart grids to optimize the energy demand—supplies are likely to be the order of the day. Much lower system losses, better voltage regulation, reliable supply, realistic prices, equitable supply and much higher customer focus, should be the norms than exceptions. An obvious outcome of such a changed infrastructure is much improved reliability of the network, which will result in much higher quality of electricity supply service to sections. The consumers will be the clear beneficiaries, which is the very purpose of the Electricity sector.

India has huge potential in RE sources as Table 4 indicates. In view of the serious issues associated with conventional energy sources, adequate focus through funding and R&D efforts to popularize the technologies to optimally harness REs has become an imperative. A high level estimate of the huge solar power potential can highlight the point. Of the 300 million households expected by 2032, 100 million houses can be assumed to be structurally and economically strong enough to support SPV systems. Assuming an average of 1,000 sq. ft. of roof surface area available for SPV systems at each of these houses, the total potential for installing SPV systems on such surfaces can be about 1,000,000 MW @ 1 kW per 100 sq. ft. of roof surface. If 20 to 30 per cent of roof top surfaces in each of the other categories of buildings are effectively harnessed for this purpose, the potential is enormous; running to many millions of MW of installed capacity. The production cost of solar power in India has fallen by more than half from ₹ 17 per kilowatt-hour (kWh) in 2010 to 7.50 rupees per kWh in 2013, and is projected to keep dropping further for few more years because of the economies of scale and due to improved efficiency in solar light conversion. The solar power cost is projected to become competitive with coal power cost by 2017.

The experience of Germany, Japan and the US where large number of RE installations are being set up every

year should be of huge relevance to India, which has much more RE potential.

As future Electricity sector policy the critical role of distributed REs connected in micro and smart grid mode, as compared to the present grid based system of large conventional power plants, need objective consideration. Such a scenario will:

- Greatly reduce the effective demand on the grid based power supply system; will drastically reduce the T&D losses; and vastly improve the power supply to those consumers essentially needing the grid supply; much better voltage profile; leads to much reduced spending on grid management;
- Assist in drastically reducing the GHG emissions and other pollutants;
- Provide a sustainable, environment-friendly and people-centric energy supply model;
- Accelerate the rural electrification due to shorter gestation period of individual projects;
- Enhance rural employment opportunities; assists in minimizing urban migration;
- Require negligible or nil additional resources such as land and water;
- Eliminate the costs of recurring fossil fuel expenditure.

Such an approach has the potential to address all the issues discussed in the earlier sections with respect to the conventional energy sources. Since the electricity governance cannot be expected to improve appreciably in the near future because of the political and corrupt environment in the country, a large number of micro or smart grids controlled by the end consumers can provide a much better model.

As per a report by World Institute of Sustainable Energy, Pune (WISE) in year 2012, which has undertaken a simulated study of the related issues, the major problems in moving over to a system based on renewables are more a result of perception gaps than a result of real technical constraints. For the Electricity sector that is tuned to a centralized generation model with defined system behaviour, switching to renewables requires a paradigm shift. Many similar studies from around the world have come to the same conclusion (WISE, 2012).

Conclusions

1. Governance in the Electricity sector in India can be said to be satisfactory only when the letter and spirit of relevant Acts of Parliament and the National Electricity Policy are complied with in both letter and spirit.
2. Electricity sector should function in harmony with other critical needs of society such as clean air, water, and land; right to live in one's chosen habitat; food security; and social equity.
3. But the social, economic and environmental impacts on our communities of poor management of the Electricity sector since independence have been too glaring. Hence, the electricity governance cannot be associated with satisfactory results.
4. The gross inefficiency in the sector, the chronic power cuts, frequent increase in the tariffs, all-round displeasure to the quality of electricity supplied, and the indifference shown to the social, economic and environmental impacts of poor planning/management of the sector are clear indicators of poor governance for decades.
5. The ongoing practice of electricity demand projection which is unrealistic and without regard to the changed circumstances and the nature's limit should be rationally reviewed. In view of the serious issues associated with the supply side due to industrialization, urbanization and consumerism, the society has to take a judicious call on how many more and what type of energy intensive industries are really needed, and whether it is desirable to allow the perpetual growth in demand.
6. Since large tracts of the geographical area of the country are drought prone; since the country is fresh-water stressed; and since the fossil and nuclear fuels are fast running out, the number of conventional power plants being planned should be minimized through an integrated resource planning approach including measures such as DSM, energy efficiency and energy conservation.
7. Much of the direct and indirect subsidies being given to the conventional energy sources should be diverted to develop appropriate RE technologies to suit the requirements of our communities.

Effective public consultations, rational analysis of all the costs and benefits, transparent options analysis, and realistic tariffs along with appropriately targeted subsidy regime should be primary planks of electricity governance. The electricity regulators should unambiguously realize the need for effective public consultation, and the spirit of all the relevant Acts of Parliament.

In summary, it is difficult to associate most of the administrative and policy actions in recent decades with

the long-term welfare needs of the nation, and hence, cannot be identified with good governance either. A paradigm shift in our approach is essential as discussed in these pages.

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