Strategy for

Providing 24x7 Power Supply

Forum of Regulators

December, 2014

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Table of Contents

EXECUTIVE SUMMARY

In June 2014, the Government of India announced that it is committed to bring about transformative change in the power sector and ensure affordable 24x7 power for all in the next few years. The Union Power Minister urged the FOR to develop a road map for providing 24x7 quality power supply to consumers and at least 8-10 hours of power supply to the farmers. As a result, the Forum of Regulators (FOR) constituted a Working Group to develop a road map for providing 24x7 quality power supply to all consumers within the next five years.

The FOR defined the objectives of this report as following:

- Reliable 24x7 power supply to domestic, industrial and commercial consumers by 2018-19;
- Power supply for irrigation pump for 8 to 10 hours a day depending upon the agro climatic factors in different States; and
- Access to all unconnected households in five years, i.e., by 2018–19.

The FOR developed the following broad strategies to achieve the above objectives:

- Ensure adequate capacity additions for power procurement from conventional and renewable sources to meet the projected demand.
- Optimize energy mix and improve operational efficiency of state generation plants.
- Strengthen the transmission and distribution network to meet the demand of existing and future consumers.
- Reduce AT&C losses at per pre-defined loss reduction trajectory.
- Make distribution utilities function as efficient service providers and improve their financial viability
- Extend the electricity supply to all un-electrified households on a mission mode in States which have coverage of houses below the national average.

The present study focuses on the national context. Individual states/UTs will need to prepare their own detailed road maps considering their demand projections, generation mix, and transmission and distribution constraints.

Power Supply Position:

The installed capacity for power supply has exceeded 250 GW making India one of the largest producers of electricity. In spite of this capacity, power supply shortages continue to persist in the country across most states constraining the growth of the economy particularly in the industrial sector. Further, nearly one third of the 246 million households in the country do not have electricity supply according to the census of 2011.

The report describes the experience of select states from different regions to get insights into their challenges and innovative initiatives. The states considered in this study are Gujarat, Punjab, West Bengal and Kerala. The following important observations can be made from the experience of the above four states:

- Gujarat achieved a high per capita consumption and a power surplus situation due to large increases in the generation capacity mainly in the private sector.
- Feeder segregation enabled 8 hours supply for irrigation pumps and 24x7 supply to other rural consumers.
- The financial viability of utilities in Gujarat improved because of the strengthening of the T&D networks, and low cost of power procurement through long term PPAs.
- Inadequate inter-state transmission constraints Punjab and Kerala from meeting 24x7 power supply by importing power from outside the state/region
- West Bengal provides unrestricted supply to consumers but has low agricultural demand and a low percentage of households with electricity access.

Energy and Power Demand Position:

The installed generation capacity in the country as on 31.8.2014 was about 253 GW. However, the country could meet a peak demand of less than 130 GW as against the unrestricted peak demand of about 156 GW. The inability to meet the peak demand was mainly due to the coal and gas power plants operating at low PLF because of fuel supply constraints and low off take from discoms. This coupled with the transmission constraints and the inability of distribution companies to contract long term power supply, led to more than 20,310 MW of stranded generation capacity.

As per the 18th Electric Power Survey (EPS) of Central Electricity Authority (CEA), the energy requirement for the year 2018-19 is expected to be 1552 Billion Units (BU) and the peak demand about 229,465 MW. The estimated demand for electricity, for the next five years is as shown below:

Estimate of Demand for Electricity (18th EPS)

Consumption category	2014-15	2015-16	2016-17	2017-18	2018-19
Domestic – MU	237,347	262,202	289,924	315,335	339,762
Commercial & misc. - MU	95,497	105,472	116,535	128,099	140,506
Public lighting MU	8,661	9,315	10,021	10,675	11,315
Public Water Works - MU	22,064	23,829	25,742	27,651	29,592
Irrigation – MU	179,784	194,559	210,611	225,044	239,194
Industries LT – MU	63,721	70,010	76,898	84,096	91,626
Industries HT – MU	262,437	286,699	3,166,408	339,228	367,341
Railway traction - MU	17,489	18,635	19,832	21,055	22,353
Bulk Supply – MU	28,247	30,523	33,024	35,759	38,754
Total (Energy Consumption in MU)	915,249	1,001,244	1,098,995	1,186,942	1,280,444
Energy Requirement-MU	**1,153,606**	**1,248,081**	**1,354,874**	**1,450,982**	**1,552,008**
Peak Load in MW	**166,260**	**181,988**	**199,540**	**214,093**	**229,465**

As per the National Electricity Plan the generation capacity addition expected by 2018-19 is 3,72,140 MW, which if achieved will result in generation of 1,677 BU adequate to meet the energy requirement. For meeting the projected demand of 2,29,465 MW in 2018-19, with a loss of load probability (LOLP) of 0.2% as recommended by the CEA, the generation capacity will have to be operated at a PLF of 76% for coal & 75% for gas. On these assumptions, the targeted capacity addition as envisaged in the National Electricity Plan is adequate to meet the projected peak demand and energy requirement.

Generation Addition Planned (in MW) Summary

Year	Thermal	Nuclear	Hydro	RE	Total
Till 31/08/14	176119	5780	40798	31692	254389
2015-16	15000	2400	3989	7810	29199
2016-17	14000	1900	5100	15000	36000
2017-18	11280	3600	2400	9000	26280
2018-19	11280	3600	2400	9000	26280
Total	227679	17280	54687	72502	372148

The major findings from the demand supply analysis are listed below.

- The energy requirement and demand projections as per 18th EPS take into account the requirements of electricity supply to all households by 2016-17.
- The requirements of 24x7 power supply as defined above will be met only if

  i. The generation capacity is augmented as envisaged in the National Electricity Plan.

  ii. The T&D losses are reduced to about 17.5% by 2018-19 as assumed in the 18th EPS.

  iii. Energy efficiency measures are implemented to significantly moderate energy consumption and peak demand.

  iv. The distribution utilities are able to contract power to meet the full demand in their area of supply.

In the above context, the following factors need to be considered to increase generation from thermal plants and also add renewable generation capacity:

- **Generation Projects:** The generation projects envisaged for completion by 2018-19, need to be given priority in ensuring fuel linkage. For continuity of 24x7 power supply beyond 2018-19, other projects envisaged in the 13th plan should also get initiated immediately with their fuel linkages being considered.
- **Domestic Coal Supply:** The projected domestic coal requirement will be over 800 million tonnes by 2016-17 and 1070 million tonnes by 2022, against the projected availability of only 560 and 756 million tonnes for the power sector. Amendment of Coal Mining

Nationalization Act is required to enable auction of coal blocks to interested mining companies.

- **SPV for Coal Blocks:** Constituting a Special Purpose Vehicle (SPV) is suggested to expeditiously obtain environmental and other clearances before auctioning coal blocks for exploitation by mining companies.
- **Coal Linkage:** It is recommended to ensure adequate rakes capacity to transport coal. Use of washed coal should be promoted alongside augmentation of coal supply for achieving higher PLFs.
- **Gas Based Power Plants:** Gas based generation for meeting the peak demand may be bundled with other sources of energy to make peak power affordable for distribution companies.
- **Renewable Based Generation:** Considering that the renewable have a short gestation period, there should be emphasis on renewable capacity addition particularly in solar and wind energy. Payment security to RE generators is critical to investment promotion. For this, it would be desirable to have suitable policy / regulatory mandate for the distribution companies to provide payment security to RE generators in the form of Letters of Credit / escrow accounts.
- **Operationalize and augment pumped storage capacity:** There is a need to operationalize the existing pumped storage capacity and plan for additional capacity of about 5,000 MW over the next five years to more effectively meet the peak demand and manage the variability of renewable energy sources.
- **Adopt Energy Efficiency:** There is a need to promote adoption of efficient appliances particularly lighting devices and irrigation pumps. Efficient pumps can save 50 Billion Units (BU) per annum and avoid about 10,000 MW of generating capacity.
- **Renewable Energy Management Systems**: It is recommended to establish “Renewable Energy Management Systems” at least in the States of Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Gujarat, Rajasthan and Madhya Pradesh to begin with to monitor and manage renewable energy generation on real time basis.
- **Ancillary Services:** In order to have higher penetration of the renewable energy generation, ancillary services like frequency balancing mechanisms through gas based power plants,

hydro plants, pumped storage plants and also emerging cost effective storage technologies should be promoted.

Transmission:

It is important to develop adequate transmission infrastructure to meet the growing energy needs of different parts of the country. Though all the regions are interconnected, there are persisting congestion problems and corridor bottlenecks constraining the exchange of power from surplus regions to deficit regions. The present transmission capacity in the country does not adequately match the generation capacity, load requirements and market transactions. This impacts the market transactions and creates bottlenecks in the flow of power from power surplus regions to power deficit regions and between states.

The recommendations for planning for the required transmission system are as follows:

- Prune the Concept to Commissioning time to ~40 months. There is scope to reduce the conceptualization-to-award process from ~21 months to ~5-6 months under the competitive bidding framework. Additionally, the Ministry of Power can save ~5-6 months from the project development time by acquiring some key clearances in parallel to the project bidding phase.
- Policy for Realistic Compensation for land acquisition: Land acquisition for RoW to build transmission lines should be facilitated by evolving a policy for payment of compensation to land owners based on the present market value.
- Optimum utilization of existing RoW: Possibility of more optimal utilization of existing RoWs should be explored by construction of multi circuit lines, upgrading of existing power transmission corridor on the same route. Up-gradation and re-conductoring of existing lines can save valuable time, cost, RoW and forest cover.
- Use of High Performance Conductors in Existing & New Lines: Use of High Performance Conductors - HTLS needs to be taken up to increase power transfer intensity.
- The loadability of the existing transmission system should be increased by adding adequate reactive power compensation through series compensation, dynamic shunt compensation, FACTS and mechanically switched capacitor banks.

- Underground lines should be considered for all transmission below 220 kV.
- It is recommended that the transmission infrastructure as recommended in the report on Green Energy Corridors prepared by FOR / MNRE, be developed at intra-state, inter-state and inter-regional levels to evacuate additional capacities of renewable energy and remove the transmission constraints.

Distribution Sector:

It is necessary to expand the country's distribution networks substantially in order to ensure electricity supply to the un-electrified households numbering over 80 million. The financial viability of the distribution utilities is adversely affected by the high Aggregate Technical and Commercial losses (AT&C losses) estimated at 27%. The distribution sector accounts for nearly 20% of the losses. A 10% reduction in distribution losses per annum can augment the supply of electricity by nearly 100 BU per year. This will be equal to a generation capacity of about 15,000 MW of coal based plants.

The National Electricity Plan assumes reduction of AT&C losses to about 17.5% by 2018-19. This requires investments of about Rs 1,00,000 Cr. over the next 3 to 5 years. Recommendations for reforms in the Distribution sector are as follows:

- Accurate estimation of demand duly factoring in the increased electrification of rural areas, demand side management measures, is the basic requirement for any policy design on 24x7 power supply to consumers. For this each state would need to undertake an intensive study to with focus not only on load estimation / growth but also on assessing the actual level of transmission and distribution losses. It is only when we have accurate load profile and system losses that we can plan and project for adequate procurement of power to meet the demand.
- The strategy for 24x7 power supply must include universalization of consumer level and DTC level metering. The SERCs should mandate implementation of DTC metering with Advanced metering systems as part of the capital expenditure of the distribution utilities.
- Achieving 100% electrification of unelectrified households should receive the highest priority in the strategy for 24x7 power supply. A mission mode approach should be

adopted to implement this programme, particularly in states, which have less than the national average proportion of electrified households.

- A separate machinery should be set up with special funding arrangements to implement the programme for extension of electricity supply to unelectricified households in states like Bihar, Assam, Uttar Pradesh, Jharkhand and Orissa, which have less than 50% of the households with electricity supply.
- A special programme should be launched for aggressive reduction of AT&C losses to reduce the losses at the rate of 2% per year over the next five years. The distribution companies should be supported in strengthening the distribution networks by adopting High Voltage Distribution System (HVDS) and by improving the metering system in the rural areas.
- Feeder segregation to separate agricultural feeders from other rural feeders should be taken up in all states, which have significant electricity consumption for irrigation purposes.
- Replacement of inefficient irrigation pumps with star rated pumps should be made mandatory where agricultural consumption exceeds 10% of the total electricity consumed in a state. Adoption of solar irrigation pumps should be encouraged by providing 50% of the cost as subsidy.
- The availability of adequate institutional finance, timely payment of subsidies by State Governments and adequacy and regularity of tariff revision by the State Regulatory Commissions are essential for ensuring financial health of not only the distribution companies but the entire electricity sector in the country.
- The financial restructuring package introduced on the recommendation of the Shunglu Panel should be further liberalized to clean up the balance sheets of all distribution utilities on a one time basis.
- The management culture of distribution utilities should be altered to make every level in the organization accountable for sale of power (instead of merely supplying power). These utilities must be made to function as commercial entities instead of continuing with the culture of departmental undertakings providing service without regard for financial returns.

- Power Planning Cells should be established in each state to undertake long term planning and coordination of the development of the power sector.

Investment and Impact on Tariff:

- Generation: It is estimated that about Rs. 7,23,397 Cr. investment is needed in the generation sector to achieve required generation target by 2018-19. Most of this investment will come from private sector.
- Transmission: In order to develop a secure and reliable transmission system it is estimated that about Rs. 3,20,00 Cr. investment is needed. This investment is cumulative of both in central and state sector.
- Distribution: About Rs. 5,27,000 Cr. investment is required in the distribution system in the next five years to supply quality and reliable power to all consumers. Even though the investment appears to be higher side, it is anticipated that the loss reduction and the efficiency improvement will pay back the investment in a shorter period. This investment also includes the agriculture feeder segregation program being envisaged as recommended by the other sub-committee of FOR.
- Total investment: In order to achieve 24x7, reliable, secure and quality power supply to all consumers, the total investment estimated is around Rs. 15,70,397 Cr.
- Impact on Tariff: The investment of Rs. 15,70,397 Cr. will result in the sales of about 1280 BU. Assuming 18% of the capital investment to be the annual cost towards servicing this capital, it is seen from the detailed analysis that the tariff impact is nil or marginal to the extent of 25 paisa to 45 paisa after accounting that the loss reduction of about 9.5% by 2018-19 from the current level will result in a reduction of about 50 Paisa in the tariff.

1. Introduction

1.1 The Government of India has declared 24x7 power supply as one of the most important objectives of its policy for reviving economic growth. The Union Power Minister has given expression to this policy in the following words "*...the Government is committed to bring about a transformative change in the power sector and ensure affordable 24x7 power for all homes, industrial and commercial establishments and adequate power for farms, in the next few years*" (The Hindu, 8th September 2014).

1.2 Participating in a meeting of the Forum of Regulators (FOR) on 27th June 2014, the Union Power Minister had urged FOR to work on the crucial issues facing the power sector and to suggest a roadmap to achieve the objective of 24x7 quality power supply to all consumers and at least 8-9 hours of quality power supply to farmers.

1.3 In its meeting held on 27th August 2014, FOR deliberated on the issues relating to 24x7 power supply to consumers including the adequacy of generation capacity, transmission networks and distribution facilities. After a detailed discussion on the subject, the Forum decided to constitute a Working Group consisting of the Chairpersons of 9 State Electricity Regulatory Commissions under the Chairman, CERC as the head of the group to draw up a strategy for achieving the objective of 24x7 electricity supply throughout the country within a reasonable period of 4 to 5 years. The Working Group subsequently constituted a Sub-group to draw up its report consisting of the Chairman of Karnataka Electricity Regulatory Commission (KERC), Member (Planning) of the Central Electricity Authority (CEA) and Member, Maharashtra Electricity Regulatory Commission. An outline of the strategy for 24x7 power supply was presented by the Sub-group in the meeting of FOR held at Mussoorie on 17th October 2014.

1.4 The objective of providing 24x7 power supply, as declared by the Government of India, was broadly defined by FOR on the following lines:

- Reliable 24x7 power supply to domestic, industrial and commercial consumers within a period of five years, i.e., by 2018-19
- Power supply for irrigation pump sets to be provided for 8 to 10 hours a day, depending on the agro-climatic factors in different states
- All un-electrified households to be provided access to electricity in a time bound manner in the next five years.

1.5 The broad contours of the strategy for achieving the above objectives shall include the following:

- Ensuring adequate capacity additions and power procurement from conventional and renewable sources to meet the projected demand for power
- Optimizing energy mix to reduce power procurement costs and improving operational efficiency of state generation plant(s)
- Strengthening the Transmission and Distribution (T&D) network to cater to the expected growth in demand
- Substantial reduction of AT&C losses as per a specified loss reduction trajectory
- Introducing energy conservation and energy efficiency measures to reduce specific end-use energy consumption
- Assisting distribution utilities to become efficient service providers and improve their financial viability.

1.6 The present study focuses on a pan-India context, and it is proposed that every state will need to prepare its own detailed roadmap/plan for achieving the objective of 24x7 power supply, taking into account its demand projections, generation mix, and T&D constraints. It is noted that Rajasthan and Andhra Pradesh have already prepared such plans with the assistance of CEA.

2 POWER SUPPLY POSITION

2.1 India's present installed generation capacity is about 253 GW. The installed generation capacity (mode-wise and sector-wise) in India as on 31st August 2014 is shown in Table 2.1 below :

Table 2.1: Installed Generation Capacity (MW) in India *(as on 31st August 2014)*

Sector	Thermal				Nuclear	Hydro	RES (MNRE)	Grand Total
	Coal	Gas	Diesel	Total				
State	55290	6974	603	62867	0	27482	3804	94153
Private	50495	8568	597	59660	0	2694	27888	90242
Central	46525	7065	0	53590	4780	10623	0	68993
Total	152310	22607	1200	176117	4780	40799	31692	253389
%	60.10%	8.90%	0.50%	69.50%	1.90%	16.10%	12.50%	100%

Source: CEA

2.2 The installed generation capacity has seen a particularly impressive growth in the 11th Five Year Plan period, during which about 56,000 MW of new generation capacity was added. In spite of this additional capacity, power supply shortages continue to persist in the country, and across most states, constraining the growth of the Indian economy, particularly in the industrial sector. The total energy available during the year 2013-14 at the generation bus bars was 959.83 billion units (BU) as against an estimated requirement of 1066 BU (18th Electric Power Survey – CEA). Thus, there was a shortage of about 106 BU (-9.92%) in meeting the energy requirement during the year. In terms of the peak demand for power, as per the 18th Electric Power Supply of India (EPS), the restricted demand was estimated at 152,329 MW, against which the maximum peak demand met was 129,815 MW, representing a shortage of about 15%. Table 2.2 depicts the growth in supply of electricity against the estimated demand for the past five years.

Table 2.2: Growth of Power Supply *(since 2009-10)*

Period	Demand (MW)				Energy (MU)			
	Peak Demand as per 18th EPS	Peak Demand Met	Surplus(+) / Deficit(-)	(%) Surplus / Deficit	Energy Requirement as per 18th EPS	Availability	Surplus(+) / Deficit(-)	(%) Surplus / Deficit
2009-2010	105,194	104,009	-1,185	-1.13	762,732	746,644	-16,088	-2.11
2010-2011	114,658	110,256	-4,402	-3.84	829,680	788,355	-41,325	-4.98
2011-2012	126,959	116,191	-10,768	-8.48	904,012	857,886	-46,126	-5.1
2012-2013	139,682	123,294	-16,388	-11.73	984,743	911,209	-73,534	-7.47
2013-2014	152,329	129,815	-22,514	-14.78	1,065,571	959,829	-105,742	-9.92

2.3 While the supply of electricity in India has registered a growth of about 8% per annum since independence, the per capita consumption of electricity in the country has remained one of the lowest as compared to the per capita consumption levels in most countries in Asia and the world. Table 2.3 shows the per capita consumption in kWh of selected countries (source: 2013 IEA report).

Table 2.3: Country-wise Per Capita Consumption

Description	Per Capita Consumption in kWh	Description	Per Capita Consumption in kWh
World	**2972**	**Asia**	**893**
USA	12947	South Korea	10346
Germany	7138	Japan	7753
Russia	6602	Malaysia	4313
UK	5452	China	3488
South Africa	4410	Vietnam	1273
Argentina	3027	**India**	**760**
Brazil	2509	Indonesia	733
Mexico	2098	Sri Lanka	527

Source: 2013 IEA report

The growth of per capita consumption of electricity in India since 2006-07 is depicted in the Table 2.4, which shows that the country has seen an increase in the per capita consumption by more than 20% in the last 5 years, even though it compares unfavorably with the world average of 2972 units and the Asian per capita consumption average of 893 units as per the 2013 International Energy Agency (IEA) report.

Table 2.4: Per Capita Consumption of Electricity in India since 2006 (as per CEA and IEA)

Year	Per Capita Consumption (kWh) as per CEA #	Per Capita Consumption (kWh) as per IEA
2006-07	671.9	520
2007-08	717.1	550
2008-09	733.5	570
2009-10	778.6	610
2010-11	818.8	644
2011-12	883.63	673
2012-13	914.14	760

2.4 The estimates of per capita consumption by the CEA and IEA are at variance due to the different methodologies adopted by these agencies. CEA considers the gross generation (including losses) and captive generation for computing the per capita consumption, while the IEA estimate is based on the net consumption of electricity at the consumer point.

2.5 The state-wise per capita consumption of electricity for the year 2012-13 is given in Table 2.5, which shows wide variation in the level of electricity consumption across different regions and states in India. The details of population, number of households and percentage electrification are given in Annexure-1.

2.6 As shown in Table 2.5, 15 states have a higher per capita consumption than the national average of 914 units, while the per capita consumption in 14 states is lower than the national average. The states with highest per capita consumption are Goa (2045 units), Gujarat (1796 units) and Punjab (1761 units). The per capita consumption of Bihar is only 145 units and Assam is in the second place from the bottom with 240 units. In the per capita consumption figures of the states of Gujarat and Jharkhand more than 20% is accounted for by captive generation by industries, while in the case of Orissa and Chhattisgarh such captive generation exceeds 50%.

2.7 In terms of urban and rural electrification, all the urban areas in the country and 5.71 lakh villages i.e., over 93% of the villages have been provided with electricity supply. On a regional basis, 100% of villages in the southern region have been electrified including Andhra Pradesh, Telangana, Karnataka, Kerala and Tamil Nadu. The western region had achieved 98.4% electrification of villages, as of the end of 2011-12, while the northern region had achieved electrification of 93.2%. The eastern and north-eastern regions had less than 90% coverage of villages with 88.7% and 89.3% respectively. As of the end of March 2012, there were over 18.18 million irrigation pump sets in the rural areas, with the largest number of 3.74 million and 2.92 million pump sets in Maharashtra and Andhra Pradesh (undivided) respectively.

Table 2.5: State-wise Per Capita Consumption of Electricity for the Year 2012-13

Name of the State/UT	Per Capita Consumption of Electricity (kWh)	Name of the State/UT	Per Capita Consumption of Electricity (kWh)
NORTHERN REGION	**852**	**WESTERN REGION**	**1284**
Haryana	1722	Gujarat	1796
Himachal Pradesh	1380	Madhya Pradesh	753
Jammu & Kashmir	1043	Chhattisgarh	1495
Punjab	1761	Maharashtra	1239
Rajasthan	982	Goa	2045
Uttar Pradesh	450	**NORTH EASTERN REGION**	**298**
Uttarakhand	1297	Assam	240
Delhi	1613	Manipur	353
EASTERN REGION	**552**	Meghalaya	690
Bihar	145	Nagaland	268
Jharkhand	847	Tripura	296
Orissa	1209	Arunachal Pradesh	719
West Bengal	594	Mizoram	469
Sikkim	862		
SOUTHERN REGION	**1094**		
Andhra Pradesh	1135		
Karnataka	1129		
Kerala	630		
Tamil Nadu	1226		
Puducherry	2136		
Total (All India)		**914**	

Source: Total Generation including private/captive generation (CEA General Review)

2.8 About one third of the 246 million households in the country do not have electricity supply, according to the census of 2011. This includes 5.77 million (7.32%) households in urban areas and 75.02 million (44.7%) households in rural areas. The states with very low percentage of electrified households are in Bihar (16.36%), Uttar Pradesh (36.81%), Assam (37.05%), Orissa (43%) and Jharkhand (45.80%). The state-wise and region-wise position of households having electricity supply is shown in Table 2.6:

Table 2.6: State-wise and Region-wise Position of Households having Electricity Supply

Name of the state	% Household electrificati on	Name of the state	% Household electrification	Name of the state	% Household electrificati on
Bihar	16.40%	**Manipur**	68.30%	**Karnataka**	90.60%
Uttar Pradesh	36.80%	**Tripura**	68.40%	**Andhra Pradesh**	92.20%
Assam	37.00%	**Chhattisgarh**	75.30%	**Sikkim**	92.50%
Orissa	43.00%	**Nagaland**	81.60%	**Tamil Nadu**	93.40%
Jharkhand	45.80%	**Maharashtra**	83.90%	**Kerala**	94.40%
West Bengal	54.50%	**Mizoram**	84.20%	**Punjab**	96.60%
Meghalaya	60.90%	**Jammu & Kashmir**	85.10%	**Himachal Pradesh**	96.80%
Arunachal Pradesh	65.70%	**Uttaranchal**	87.00%	**Goa**	96.90%
Rajasthan	67.00%	**Gujarat**	90.40%	**Delhi**	99.10%
Madhya Pradesh	67.10%	**Haryana**	90.50%		
Region wise					
North Eastern	47.00%	**Eastern**	38.40%	**Northern**	59.50%
Southern	92.50%	**Western**	80.20%	**All India**	**67.20%**

Source: Census 2011

2.9 Table 2.6 shows that six states in the country have more than 40% of their households without electricity. Further, the states in the eastern region have more than 60% of its households without electricity even though resources for power generation are relatively abundant. This also shows that the declared policy objectives of providing 'Power for All' and achieving a per capita supply of 1,000 kWh by 2012 are yet to be fulfilled.

Experience of Selected States

2.10 This section briefly outlines the experience of Gujarat, Punjab, West Bengal and Karnataka. These states have adopted a number of measures to provide adequate power supply to its consumers. While these states do not necessarily form a representative sample of the states in the country, their experience provides insights into the policy measures, which could be adopted in other parts of the country.

Gujarat

2.11 Gujarat has a high per capita consumption of 1796 units and 90% household electrification. With an installed generation capacity of 23,883 MW (including 4,277

MW of RE), Gujarat has eliminated both energy and peak hour shortages as of March 2014. The progress achieved by the state during the last 6 years in augmenting the supply of electricity is shown in Table 2.7:

Table 2.7: Power Supply Scenario - Gujarat

Sl. No.	Particulars	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
1	Peak Demand (Unrestricted)-MW	12119	11841	10406	10786	10951	11999
2	Peak Demand Met-MW	8885	8960	9515	9947	10759	11960
3	Gross Generation of Utilities (GWh)	48292	46834	55736	62427	69828	84969
4	Captive Generation (GWh)	20979	20714	21008	17290	20531	23495
5	Total Energy Sold - Utilities (GWh)	44236	45968	49778	54013	57654	63427
6	Domestic (% share)	17.10%	17.0%	16.8%	17.4%	17.4%	16.7%
7	Commercial (% share)	7.99%	7.8%	7.9%	8.1%	4.7%	6.7%
8	Industrial (% Share)	45.75%	45.4%	45.3%	45.7%	50.3%	49.5%
9	Agricultural (% share)	24.75%	25.5%	25.7%	24.7%	23.4%	23.6%
10	Per Capita Consumption-Units	1493	1457	1559	1508	1663	1796

Source: CEA General Review

2.12 Gujarat became a power surplus state by augmenting its generation, transmission and distribution capacity since 2002. The generation capacity increased from 8,756 MW in 2002 (RE – 99 MW) to 23,883 MW (RE – 4,277 MW) by 2014. This included an addition of 2,800 MW by state-owned generation companies, 2,300 MW by the Central Utilities, and 7,615 MW obtained through competitive bidding. The commissioning of two major projects by Tata and Adani Power has been a significant feature in the capacity addition. The state's present power generation capacity is more than adequate to meet the present peak demand of 13,740 MW. This has enabled Gujarat to enter into contracts for sale of power to other states like Karnataka. Gujarat utilities have also contracted long term power procurement at competitive prices of Rs. 2.25 - 2.89 per kWh enabling them to earn a margin on such inter-state sales.

2.13 The substantial private investments in the generation sector have enabled Gujarat to utilize its resources for augmenting the T&D networks. The length of transmission lines increased from about 31,000 km in 2002 to over 50,100 km in 2014. During the same period, the length of distribution lines increased from about 3,52,000 km to 6,24,000 km. The number of distribution feeders and distribution transformers more than doubled during the period, while the number of consumers increased from about 73 lakhs to 130 lakhs. The investments made in the T&D sectors were about Rs. 13,000 Cr. and Rs. 16,500 Cr. respectively. The distribution utilities, which incurred a loss of over Rs. 2,500 Cr. in 2001, reported a profit of Rs. 539 Cr. in 2012-13.

2.14 Gujarat has successfully completed a feeder separation program called Jyothi Grama Yojana. This segregates agriculture supply from supply to domestic and other consumers in rural areas. Over 2,350 new feeders were added to the distribution network at a cost of about Rs. 1,300 Cr. besides adopting a High Voltage Distribution System (HVDS) on agriculture feeders. This major reform in the electricity supply in the rural areas ensured near 24x7, three-phase supply to domestic and other consumers served by rural feeders, while restricting the three-phase power supply to agriculture consumers.

Punjab

2.15 Punjab has a high per capita consumption of 1,761 kWh. It also has a high household electrification of 96.6%. Table 2.8 shows some of the salient features of the electricity supply situation in Punjab:

Table 2.8: Punjab State Power Supply Scenario

Sl. No.	Particulars	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
1	Peak Demand (Unrestricted)-MW	8672	8690	9786	9399	10471	11520
2	Peak Demand Met-MW	7340	7309	7407	7938	8701	8751
3	Gross Generation of Utilities (GWh)	26315	27711	28630	28304	29984	27698
4	Captive Generation (GWh)	471	875	1599	1709	1645	1379
5	Total Energy Sold (GWh)	29887	29225	31291	32155	33888	35825
6	Domestic (% share)	21.2%	22.1%	22.4%	24.6%	25.5%	25.9%
7	Commercial (% share)	6.2%	6.5%	6.5%	7.4%	7.7%	7.6%
8	Industrial (% share)	35.3%	35.7%	34.0%	33.3%	32.9%	32.8%
9	Agricultural (% share)	33.5%	31.9%	33.5%	31.0%	30.2%	30.1%
10	Per Capita Consumption-Units	1614	1553	1663	1735	1799	1761

Source: CEA General Review

2.16 As of March 2013, it had an installed generation capacity of 5773 MW including 2230 MW of hydel and 3155 MW of thermal generation. The renewable capacity is about 388 MW. The state is unable to meet its peak demand of 11,500 MW, despite importing over 5,000 MW. Punjab has an energy shortfall of about 10% and peak shortfall of 7%. Punjab has completed feeder segregation to separate agriculture feeders from domestic and other feeders in rural areas. The share of agriculture in the total consumption exceeds 30%. Since agriculture supply is free, it required a subsidy of over Rs. 4,800 Cr. in the year 2013-14. The state faces a total T&D loss of 18.85%. The distribution utilities reported combined losses of over Rs. 400 Cr. in 2013-14.

West Bengal

2.17 West Bengal is one of the few states in the country which has been able to provide unrestricted power supply to its consumers in the recent past. However, the per capita consumption in the state is low (594 kWh per year) and only 54.5% of households are electrified, according to the 2011 Census. In both respects, the state’s performance is below the national average. The salient features of the state’s power supply situation are shown in Table 2.9.

Table 2.9: Power Supply Scenario -West Bengal

Sl. No.	Particulars	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
1	Peak Demand (Unrestricted)-MW	5283	5387	6094	6162	6592	7322
2	Peak Demand Met-MW	4987	5379	5963	6112	6532	7249
3	Gross Generation of Utilities (GWh)	27616	29414	33637	34449	36145	35678
4	Captive Generation (GWh)	2190	2165	2739	2449	2661	2499
5	Total Energy Sold (GWh)	26248	27779	31455	32609	33903	36320
6	Domestic (% share)	26.7%	27.5%	26.4%	27.3%	28.6%	30.5%
7	Commercial (% share)	12.0%	12.7%	11.7%	13.1%	13.2%	13.5%
8	Industrial (% share)	43.2%	44.6%	51.2%	47.2%	47.0%	45.1%
9	Agricultural (% share)	4.2%	3.0%	4.2%	5.5%	3.8%	3.4%
10	Per Capita Consumption-Units	436.48	442.45	515.08	537.8501	563.78	593.86

Source: CEA General Review

2.18 A notable feature of the West Bengal power supply situation is that the share of agricultural consumption is less than 4% of the total power supply, which is among the lowest compared to other larger states. The agriculture consumers are also provided with meters on par with other consumers. The state is also a net exporter of power and has reported no shortages in terms of peak demand or energy requirement.

Karnataka

2.19 The State has an installed generation capacity of 13179 MW, 3657 MW hydel and 5884 MW of thermal generation with considering central sector generation share at the end of March 2013. The total Renewable capacity is about 3638 MW. The State has a shortfall of about 11% in energy terms and about 15.5% in terms of peak demand during 2012-13.

2.20 The share of agriculture in the overall consumption of electricity is more than 30% in the year 2012-13. There are about 21 lakh irrigation pump set installations in the state. At present irrigation pump sets are generally not metered. However, the ESCOMs have provided meters at distribution transformers predominantly feeding to IP sets on a sample basis to assess their consumption.

2.21 The State has a total transmission and distribution loss of 17.39%. There are 12,34,444 households yet to be electrified in the state. The per capita consumption has increased from 834 units per year in 2007-08 to 1,129 units per year in 2012-13. Table 2.10 shows some of the salient features of power supply situation in Karnataka.

Table 2.10: Power Supply Scenario –Karnataka

Sl. No.	Particulars	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
1	Peak Demand (Unrestricted)-MW	6583	6892	7942	8430	10545	10124
2	Peak demand met-MW	5567	6548	6897	7815	8549	8761
3	Gross Generation of Utilities (GWh)	32743	32884	37384	37844	45448	46338
4	Captive Generation (GWh)	4468	4724	4752	4800	8029	9998
5	Total Energy Sold - Utilities (GWh)	34235	36040	36198	39789	47456	51439
6	Domestic (% Share)	18.13%	18.6%	20.1%	20.2%	18.5%	17.9%
7	Commercial (% Share)	10.56%	16.1%	11.8%	12.0%	11.4%	11.5%
8	Industrial (% Share)	32.44%	25.2%	27.0%	26.8%	29.6%	30.3%
9	Agricultural (% Share)	31.67%	31.4%	34.2%	34.1%	33.6%	33.4%
10	Per Capita Consumption-Units	834	854	873	925	1081	1129

Source: CEA General Review

2.22 The experience in power supply of the four states as outlined above leads to the following important observations:

- Gujarat achieved a high per capita consumption along with surplus power availability due to large increases in the generation capacity, mainly in the private sector
- Feeder segregation enabled better supply to other rural consumers and improved the financial viability of distribution utilities
- The financial viability of the transmission and distribution utilities improved because of the strengthening of the T&D networks and the low cost of power procurement through long term PPAs
- Inadequate inter-state transmission facilities constrain the ability of Punjab and Kerala from achieving 24x7 power supply by importing power from outside the state/region
- Low agricultural demand and low household electrification have allowed West Bengal to provide unrestricted supply to consumers.

2.23 The above observations will be relevant while developing a national strategy for achieving 24x7 power supply as indicated earlier.

3 THE DEMAND AND SUPPLY POSITION

3.1 The Central Electricity Authority has, in its 18th EPS, made demand projections for the period 2012-13 to 2021-22 covering all major consumer categories and all regions and states. The report estimates an energy requirement of 1,552,008 MU and a peak demand of 229,465 MW by 2018-19. Table 3.1 provides the consumer category-wise requirement of energy and peak demand estimates for the period from 2014-15 to 2018-19.

Table 3.1: Category-wise Consumer Requirement of Energy and Estimated Peak Demand

Consumption Category	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Domestic	237,347	262,202	289,924	315,335	339,762
Commercial & misc.	95,497	105,472	116,535	128,099	140,506
Public lighting	8,661	9,315	10,021	10,675	11,315
Public Water Works	22,064	23,829	25,742	27,651	29,592
Irrigation	179,784	194,559	210,611	225,044	239,194
Industries LT	63,721	70,010	76,898	84,096	91,626
Industries HT	262,437	286,699	3,166,408	339,228	367,341
Railway traction	17,489	18,635	19,832	21,055	22,353
Bulk Supply	28,247	30,523	33,024	35,759	38,754
Total (Energy Consumption in MU)	915,249	1,001,244	1,098,995	1,186,942	1,280,444
Energy Requirement-MU	**1,153,606**	**1,248,081**	**1,354,874**	**1,450,982**	**1,552,008**
Peak Load in MW	**166,260**	**181,988**	**199,540**	**214,093**	**229,465**

The category wise forecast for each of the States as given in the 18th EPS is enclosed in Annexure-2.

3.2 The 18th EPS projections are mainly based on historical trends in demand growth in respect of several consumer categories and End Use Method. Further, in case of households, the report assumes that all un-electrified households in the country will have access by 2016-17. This is important in the context of the objective of universal access, which is part of the 24x7 power supply strategy. Other important assumptions of the 18th EPS are as follows :

- GDP growth rate of 8-10% per annum.
- The elasticity of electricity with respect to GDP is less than 0.9.
- The average T&D losses will be reduced to 18.9% during the 12th Plan period and to 15.4% during the 13th Plan period (by 2021-22).

- The number of domestic consumers for the years 2016-17 to 2021-22 shall be equal to the number of estimated households for the respective years.
- Shortages have been worked out after accounting for restrictions, power cuts and under-frequency compensation, as reported by states/UTs to CEA in their daily reports for year the 2010-11.
- Forecast of electricity demand has been worked out after adding electricity shortage in full to electrical energy available and the peak demand met for the year 2010-11, and applying uniform growth rates for assessing the electricity demand.
- Higher growth rates of electricity consumption have been assumed for states/UTs which have low per capita electricity consumption, but have already initiated steps for up gradation of T&D systems.

3.3 The region-wise and state-wise demand, as estimated by the 18th EPS is shown in Table 3.3 and Table 3.4.

Table 3.3: Region-wise and State-wise Peak Demand (in MW) as per 18th EPS

State/STU	2014-15	2015-16	2016-17	2017-18	2018-19
Delhi	5,818	6,101	6,398	6,849	7,335
Haryana	8,655	9,429	10,273	11,006	11,749
Himachal Pradesh	1,665	1,778	1,900	2,022	2,151
Jammu & Kashmir	2,577	2,631	2,687	2,917	3,180
Punjab	11,271	11,794	12,342	12,826	13,228
Rajasthan	11,422	12,594	13,886	14,957	16,004
Uttar Pradesh	18,073	20,424	23,081	25,547	27,832
Uttarakhand	1,938	2,060	2,189	2,315	2,449
Chandigarh	387	406	426	450	475
Northern region	51,799	56,181	60,934	65,686	70,276
Goa	712	762	815	880	949
Gujarat	15,782	17,358	19,091	20,486	21,942
Chhattisgarh	4,070	4,367	4,687	5,028	5,385
Madhya Pradesh	11,967	12,899	13,904	14,934	15,803
Maharashtra	25,313	26,928	28,645	29,983	32,122
D. & N. Haveli	809	874	944	1,006	1,072
Daman & Diu	409	425	441	469	500
Western Region	53,936	57,835	62,015	65,871	70,383
Andhra Pradesh	18,681	20,476	22,445	24,271	26,246
Karnataka	11,256	12,102	13,010	13,964	14,945
Kerala	4,157	4,405	4,669	4,931	5,198
Tamil Nadu	17,497	19,489	20,816	22,375	24,057
Pudducherry	579	604	630	659	690

State/STU	2014-15	2015-16	2016-17	2017-18	2018-19
Southern Region	47,752	52,273	57,221	61,525	66,111
Bihar	3,777	4,354	5,018	5,660	6,398
Jharkhand	4,010	4,301	4,616	4,948	5,262
Orissa	4,994	5,322	5,672	5,866	6,066
West Bengal	9,887	10,798	11,793	12,882	13,964
Sikkim	130	137	144	148	159
Eastern Region	20,109	22,106	24,303	26,320	28,411
Assam	1,537	1,671	1,817	1,946	2,080
Manipur	249	294	346	373	399
Meghalaya	388	415	445	475	505
Nagaland	164	174	185	201	216
Tripura	294	317	340	365	389
Arunachal Pradesh	123	129	135	142	150
Mizoram	223	252	285	302	314
North Eastern Region	2,563	2,757	2,966	3,169	3,370
Andman & Nicobar Islands	63	65	67	71	75
Lakshadweep	10	10	11	11	14
All India	169,491	183,902	199,540	214,093	229,465

Table 3.4: Region-wise and State-wise Energy Requirement (in MU) as per 18th EPS

State/STU	2014-15	2015-16	2016-17	2017-18	2018-19
Delhi	32,934	35,151	37,529	40,176	43,023
Haryana	47,761	51,991	56,681	60,725	64,820
Himachal Pradesh	9,885	10,381	10,901	11,546	12,228
Jammu & Kashmir	14,503	15,351	16,298	17,180	18,172
Punjab	59,061	64,031	69,410	73,032	76,245
Rajasthan	65,385	71,339	77,907	83,914	89,792
Uttar Pradesh	110,625	123,906	138,854	152,571	164,997
Uttarakhand	11,628	12,174	12,751	13,466	14,223
Chandigarh	1,956	2,058	2,165	2,286	2,414
Northern region	**353,738**	**386,382**	**422,498**	**454,897**	**485,914**
Goa	4,206	4,518	4,853	5,205	5,573
Gujarat	93,659	100,977	108,704	116,649	124,937
Chhattisgarh	20,756	22,448	24,222	25,989	27,833
Madhya Pradesh	64,933	71,099	77,953	83,988	89,152
Maharashtra	145,641	155,276	169,353	175,870	187,034
D. & N. Haveli	5,584	5,924	6,286	6,665	7,064
Daman & Diu	2,509	2,659	2,817	2,976	3,143
Western Region	**337,289**	**362,901**	**394,188**	**417,342**	**444,735**

State/STU	2014-15	2015-16	2016-17	2017-18	2018-19
Andhra Pradesh	109,722	119,318	129,767	140,324	151,743
Karnataka	68,208	73,278	78,637	83,917	89,285
Kerala	23,554	24,975	26,584	28,080	29,595
Tamil Nadu	102,782	110,698	119,251	128,177	137,815
Pudducherry	3,268	3,425	3,586	3,755	3,929
Southern Region	**307,533**	**331,693**	**3,573,826**	**384,252**	**412,367**
Bihar	23,471	26,299	29,447	32,964	36,982
Jharkhand	24,407	25,990	27,691	29,592	31,381
Orissa	33,628	34,687	35,772	36,999	38,262
West Bengal	58,667	64,198	70,352	76,511	82,571
Sikkim	465	494	528	544	581
Eastern Region	**140,637**	**151,668**	**163,790**	**176,611**	**189,777**
Assam	7,909	8,413	8,947	9,615	10,313
Manipur	942	1,080	1,241	1,405	1,571
Meghalaya	2,059	2,143	2,243	2,396	2,553
Nagaland	748	789	834	895	954
Tripura	1,189	1,290	1,402	1,514	1,628
Arunachal Pradesh	494	521	552	580	611
Mizoram	698	808	936	1,031	1,112
North Eastern Region	14,039	15,044	16,154	17,435	18,743
Andaman & Nicobar	322	343	366	390	415
Lakshadweep	47	49	52	55	57
All India	**1,153,606**	**1,248,081**	**1,354,874**	**1,450,982**	**1,552,008**

4 Generation Plan

This section develops the generation plan to meet the projected annual energy and peak load requirements, as outlined in previous section.

4.1 Existing Generation Capacity

India's total installed capacity as at the end of August 2014 was around 253 GW including 59.8% from coal, 16.04% from hydro and 12.5% from renewable energy sources. Table 4.1 shows the source-wise and sector-wise generation capacity mix as on 31st August, 2014.

Table 4.1: Existing Installed Capacity (MW) (August 2014)

Sector	Thermal				Nuclear	Hydro	RES (MNRE)	Grand Total
	Coal	Gas	Diesel	Total				
State	55290	6974	603	62867	0	27482	3804	94153
Private	50495	8568	597	59660	0	2694	27888	90242
Central	46525	7065	0	53590	5780	10623	0	68993
Total	152310	22607	1200	176117	5780	40799	31692	254388
%	59.80%	9%	0.50%	69.20%	2.30%	16.04%	12.50%	100%

4.2 The installed capacity has grown from 199,877 MW in 2012-13 to 253,389 MW by September 2014, representing a growth rate of about 27% over the last one and half years. This additional capacity included about 46,000 MW of conventional power generation and about 7,200 MW of renewables. The capacity addition target for the 12th Plan period is 88,537 MW and it is possible to achieve this with a combination of conventional and renewable plants. However, whether the planned capacity addition would be adequate to meet the demand for power on 24x7 basis as intended, is subject to the following assumptions and constraints:

a) The required capacity addition as planned in the National Electricity Plan takes into account the possibility of reducing T&D losses in the country from the present 27% to 17.5% by 2018-19. Failure to bring down these losses by a substantial 10% in the next five years will result in energy shortages, which need to be met by further additions to the installed capacities. Similarly, the energy efficiency measures being implemented through the Bureau of Energy Efficiency are expected to significantly reduce the demand for power by 2018-19. Any shortfall in this reduction will also increase the need for generation capacities.

b) The National Electricity Plan assumes the elasticity of demand for electricity at 0.9 with respect to the Gross Domestic Product (GDP). The present thinking in the Government to substantially increase the share of the manufacturing sector in the GDP is likely to increase the elasticity of demand for electricity beyond 1.0. This would lead to increase in demand for power generation capacity in the country.

c) The low level of per capita consumption of electricity in India as compared to the Asian and global averages, makes it obvious that for India to develop as a major economic power at the global level, it needs to increase the consumption of electricity by at least two fold in the next ten years. This would necessarily require an addition of generation capacity both from conventional and renewable energy sources.

4.3 Even though the installed capacity in the country is more than 253 GW, the demand that could be met during 2013-14 was less than 130 GW (129,815 MW), representing a shortage of nearly 15% against the estimated unrestricted demand of about 156 GW. The inability to meet the peak demand was mainly due to the coal and gas power plants operating at low PLF because of fuel supply constraints and low off take from discoms. Coal-based thermal plants could achieve a PLF of only 65% during the year. Constraints of gas supply also resulted in most gas-based thermal capacity remaining idle, with only 24.85% PLF being achieved by gas-based plants during 2013-14. Table 4.2 shows that with fuel supply constraints, the existing generation capacity can meet a peak demand of only 126,944 MW. This assumes a coal shortage of about 10% and 30% of the gas requirement being available.

4.4 Coal requirements by the power sector are projected to reach about 800 million tonnes by 2017 and 1,070 million tonnes by 2022. As against this, the domestic coal supply is projected to increase to 554 million tonnes by 2017 and 756 million tonnes by 2022. Coal imports are expected to reach about 200 million tonnes by 2017. Further, the Hon’ble Supreme Court has recently cancelled the allotment of 218 coal blocks allotted to various companies. Therefore, augmentation of coal supply in the short to medium term is a major challenge facing the power sector. The continued stagnation in the domestic gas supply will add to this concern.

Table 4.2: Peak Demand Met with Existing Installed Capacity (MW) with Fuel Constraints

Source		Installed Capacity (MW)	Auxiliary	Forced Outage Rate	Constraint	Available Capacity(MW)
Thermal	Coal	152311	9%	12%	10%	105095
	Gas	22608	6%	12%	70%	2713
	Diesel	1199.75				
	Total	176119				
Nuclear		5780	9%	12%	30%	2832
Hydro		40798.8	1%	10%	30%	24071
RES (MNRE)		31692.1			80%	6338
Grand Total		253389				141049
			Loading constraint/ reserve		10%	14105
			Gen Capacity to Meet Peak			**126994**

Source: Analysis based on the peak demand met

4.5 The coal and gas shortages coupled with transmission constraints and the inability of some distribution companies to contract long term power supply has, led to more than 20,310 MW of stranded generation capacity as shown in Table 4.3.

Table 4.3: Region-wise Stranded Capacity of Power Plants

Sl.No	Region	Coal/Lignite based capacity (MW)	Gas based capacity (MW)	Total stranded capacity (MW)
1	Western Region	3445	4229	7674
2	Eastern Region	5345	68	5413
3	Northern Region	3262	1447	4709
4	Southern Region	306	2151	2457
5	North-Eastern Region	0	57	57
6	All India	12358	7952	20310

Source: CEA

4.6 As mentioned earlier, about 50,000 MW of generation capacity, consisting mainly of thermal power plants has already been added during the 12th Five Year Plan period. Even if the 12th Plan targets for generation capacity of 88,537 MW are fully achieved, it may still not be enough to meet the expected peak demand of 199,540 MW by 2016-17 if the fuel supply constraints continue as at present. Applying the same calculation for meeting peak demand with 10% shortage of coal and 50% shortage of gas for the thermal power plants, it is estimated that the peak demand that could be met with a total installed capacity of 3,18,414 MW targeted for the 12th Five Year Plan will be only 1,98,350 MW. This will imply a 0.6% shortage for the end of 12th plan period. Planning of Capacities in 12th & 13th Plan has been done based on 18th EPS demand projections. With commissioning of planned capacities (which includes 30,000 MW RE in the 12th plan & 18,000 MW RE in the first two years of the 13th plan), the projected demand is likely to be met in full. The low PLF of thermal plants is due to forced shut down, fuel shortage, low demand (inability of DISCOMS to purchase power) etc. Furthermore, the entire renewable capacity does not contribute in meeting peak load. The detailed capacity addition is enclosed in Annexure-3.

Table 4.4: Summary of Capacity Addition (in MW) Target for 12th Plan

Sector	Hydro	Thermal			Total thermal	High RE	Nuclear	Total
		COAL	LIGNITE	GAS/LNG				
CENTRAL	6004	13800	250	827.6	14878		5300	26182
STATE	1608	12210	0	1712	13922		0	15530
PRIVATE	3285	43270	270	0	43540		0	46825
TOTAL	10897	69280	520	2539.6	72340	30000	5300	118537

4.7 Given the fuel supply constraints mentioned above, the energy supply situation by 2018-19 needs to be considered under two scenarios: with continued low PLF of thermal power plants, and a possible improvement of 10–15% in their operation. Table-4.5 below shows the energy output under the two different scenarios, assuming an installed capacity of 372,140 MW as per the projection made in the National Electricity Plan.

4.8 Generation capacity addition target during 12th Five Year Plan is 88,537 MW from conventional sources on an all-India basis. This comprises of 10,897 MW hydro, 72,340 MW thermal and 5,300 MW nuclear. Out of this hydro capacity of 10,897 MW likely to be commissioned during 12th Plan, 3646 MW hydro capacity is likely to slip to 13th Plan. This slippage would be compensated by equivalent additional thermal capacity likely to be commissioned during 12th Plan.

Table 4.5: Projected Availability (Source-wise) as per Capacity Addition Planned/Likely

Power Plant		Installed Capacity MW	Case -1		Case -2	
			PLF	MU	PLF	MU
Thermal	Coal	2,03,862	0.65	1,16,0792	0.76	1,35,7234
	Gas	22,608	0.3	59,414	0.45	89,121
	Diesel	1,200	0	0	0	0
	Hydro	54,687	0.4	1,91,625	0.4	1,91,625
	Nuclear	17,280	0.76	1,15,043	0.76	1,15,043
Renewable	Wind	40,500	0.22	78,052	0.22	78,052
	Solar	19,000	0.16	26,630	0.16	26,630
	Others	13,003	0.4	45,563	0.4	45,563
Total		**3,72,140**		**16,77,119**		**19,03,268**

4.9 As seen from Table 4.5, the planned installed capacity of 3,72,140 MW, if achieved by 2018-19, as per the National Electricity Plan can result in generation of 1,677 BU as against the projected energy requirement of 1,552 BU. This will result in excess of the generation by nearly 1.25 lakh MU or about 8% of the projected energy requirement. The surplus is due to high RE scenario being considered in 12th and 13th plan period.

4.10 For meeting the projected demand of 2,29,465 MW in 2018-19, assuming PLF of 76% for coal & 75% for gas and a loss of load probability (LOLP) of 0.2% as recommended by the CEA, the targeted capacity addition as envisaged in the National Electricity Plan is adequate to meet the projected energy requirement. LOLP of 0.2% implies 0.2% i.e., 17.5 hours in a year the demand can exceed the generation. The LOLP computation takes into account the generator auxiliary power consumption, the generator planned and forced outage rates, the reserve margins etc.

Bridging the Gap

4.11 The above analysis shows that the adequacy of planned generation capacity to meet the projected demand for electricity to provide 24x7 power supply by 2018-19 is dependent on a number of factors like fuel availability, operational efficiency of the generating stations, T&D loss reduction, energy efficiency and DSM measures, etc.

4.12 The situation therefore calls for an aggressive strategy to ensure the operation of thermal power plants with a much higher PLF than achieved during the recent years. Adequate supply of coal for thermal power plants tops the list of measures to be taken to achieve the above objective. The decision of the Government of India to take up auction of coal blocks should result in bridging the gap in the supply of coal required for thermal power plants. In the allotment of coal blocks, it is obvious that priority shall be given to thermal plants which are already commissioned or ready to be commissioned in the near future. The reported thinking by Government of India to earmark the coal blocks already being operated for allotment to such power plants is to be appreciated in that context.

4.13 If the exploitation of the coal blocks (not yet under operation) to be allocated through auction is not facilitated by expeditious environmental and other clearances, the entire exercise may prove to be inadequate to meet the challenge. The clearances required for making the new coal blocks operational may be obtained through a Special Purpose Vehicle (SPV), which should aggressively pursue the required clearances before auctioning them to end users/developers. In this respect, the SPV model for allotment of UMPPs may be adopted.

4.14 Besides augmenting the mining of coal, increasing the capacity of railways to transport coal to thermal plants located far away from the pithead should also be given due attention. Use of washed coal should be incentivized for thermal plants located more than 500 kms from the coal mines to reduce the problem of logistics and ensure supply of high GCV fuel for the generating units.

4.15 Creation of additional capacities of coal-based power plants, as planned for the 13th Five Year Plan period, can be taken up only with the coal linkages being assured for such projects. Therefore allotment of coal linkage should be considered on priority for projects which are planned for being commissioned beyond 2018-19.

4.16 Measures to augment domestic coal supply need to be supplemented by import of coal for blending purposes. The country should take advantage of the present softening of coal prices in the international market to contract supplies on medium and long term basis.

4.17 Ensuring adequate supply of fuel for the gas-based thermal units is crucial to the strategy for 24x7 power supply. The peak demand for power can be met effectively with the operation of all existing gas-based generating units with at least 60% PLF. Operation of gas-based power plants is also crucial to the ability of the grid to cope with higher penetration of renewables like wind and solar energy in the coming years.

4.18 The installed gas based capacity of about 22,000 MW in the country requires about 70 mscmd to operate at a PLF of 70%. However with only about 25 mscmd gas being available these units are operating only at about 25-30% PLF. Therefore, it is important to address the issue of the availability of gas at affordable prices to make investments in gas based units viable. A peaking power policy should therefore be evolved to provide LNG supply at pooled prices or to bundle energy from gas based units with power from other thermal plants. Installation of new gas plants close to major load centers, like major cities, should also be taken up on a priority basis. Also, conversion of the existing liquid fuel based generation units into gas based units can be considered for further augmenting peak generation with a more economic and clean fuel.

Addition of Renewable Capacity

4.19 The present installed capacity of renewable energy is around 31,692 MW. Out of this, wind contributes more than 20,000 MW. Most of the investments in renewable energy generation are made by the private sector, which enables the augmentation of renewable capacity without any direct financial burden on the exchequer. The gestation period for most renewable plants ranges from 12 to 24 months. These aspects of renewables make it an attractive proposition for augmenting energy generation within a short period of time. Distributed generation is another attractive way of utilizing renewable energy to provide power supply to remote locations without huge investments for installing T&D networks for the purpose. The detailed roadmap of renewable capacity addition and their management is described in Annexure-5.

4.20 India has an estimated potential of over 100,000 MW of wind power. The Wind industry in India has reached maturity and India has manufacturing capability to produce about 10,000 MW of wind turbines and other equipment every year. Therefore, it should be possible to add about 50,000 MW of wind capacity over the next five years. This would require an aggressive policy of incentivizing wind generation by providing a combination of soft loans, accelerated depreciation, generation based incentive schemes and cost reflective tariffs.

4.21 India has a solar installed capacity of about 2,000 MW. The cost of solar energy has been rapidly declining in recent years. This provides an opportunity to swiftly augment solar power to about 50,000 MW. The government needs to facilitate this by enforcing Renewable Purchase Obligations (RPO) and also continuing with the scheme for viability gap funding. This should be coupled with support to roof top solar generation with net metering.

4.22 In order to integrate renewable energy successfully into the grid, the following measures need to be undertaken on priority :

a. Establishment of a "Renewable Energy Management System" in at least 7 states including Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Gujarat, Rajasthan and Madhya Pradesh to monitor the renewable energy generation on real time basis and perform forecasting and scheduling of renewable power in 15 minutes blocks. This center will give one single consolidated renewable power generation value every 15 minutes to the state load dispatch center for each hour, on a 24 hour rolling basis. This will enable the proper scheduling of the rest of the generation in the state.

b. In order to have a higher penetration of renewable energy generation, ancillary services like frequency balancing mechanisms and hour-ahead markets should be developed. Frequency balancing is possible through gas-based power plants, hydro plants, pumped-storage plants and also emerging cost-effective storage technologies.

c. One of the issues for renewable-energy rich states is the deviation settlement mechanism. It is argued that the present deviation mechanism restricts the deviation to be less than 150 MW and UI charges are imposed accordingly. However, renewable energy generations being variable in nature, it is difficult to balance their variation within individual states. With high penetration of renewables, balancing may occur within the regional boundary or sometimes beyond the regional boundary. There is a need to review the present scheduling and balancing mechanism enabling higher penetration of renewable energy sources. For example, for wind variation in Tamil Nadu and Karnataka, hydro resources in Karnataka, Kerala and Andhra Pradesh can be used for balancing services. The hydro capacity in the southern region can manage about 9000 MW of variation in wind and solar generation, provided an accurate forecasting and management system is put in place.

d. The power number of the interconnected system in the country being about 4000 MW as on date (it continues to increase over a period with the increase in demand), for

4000 MW of sudden variation in renewable energy, the frequency variation is only 1 Hz. With the help of frequency balancing mechanism, this variation can be corrected. In order to mitigate network congestion during variation in renewable energy power generation, it is advised to strengthen the inter-regional and inter-state network to accommodate higher renewable power in renewable rich states.

e. Availability of adequate investment credit is crucial to the expansion of renewable capacities. Besides increasing the corpus of IREDA, Government must consider refinancing arrangements for loans extended by banks and other infrastructure finance companies, rather than lending through one nodal agency. Also, the loan tenure for renewable generating projects can be extended to 20 years as against the prevailing 12 year repayment schedule with a moratorium of two years.

4.23 The absence of adequate payment security is one of the factors inhibiting the growth of the renewables in some states. The distribution utilities do not give adequate priority to payments for procurement of renewable energy which makes it difficult for the generating companies to service their debt financing. The Electricity Act, 2003 should be suitably amended to ensure that all distribution companies provide adequate payment security to RE generators in the form of Letters of Credit or Escrow payments. This is also likely to contribute to a reduction in the procurement cost of renewable energy by reducing the interest burden of the generating companies.

Pumped Energy

4.24 At present, India has a pumped storage capacity of 4,804 MW in 11 pumped storage projects. Out of the existing pumped storage projects, those at Purulia and Kadamparai are utilized adequately but the other plants are not optimally utilized. The pumped storage projects greatly help in augmenting the capacity for meeting peak demand, even though they are more expensive to operate as compared to other hydro-generating units. There is a need to provide appropriate tariff regime to encourage pumped storage capacity to the extent of about 5,000 MW over the next five years.

Table 4.6: Generation Addition (in MW) Summary

Year	Thermal	Nuclear	Hydro	RE	Total
Till 31/08/14	176119	5780	40798	31692	254389

Year	Thermal	Nuclear	Hydro	RE	Total
2015-16	15000	2400	3989	7810	29199
2016-17	14000	1900	5100	15000	36000
2017-18	11280	3600	2400	9000	26280
2018-19	11280	3600	2400	9000	26280
Likely slippages from 12th plan	-	500	3646	-	-
Total	227679	17280	54687	72502	372148

Demand Side Management and Energy Efficiency

4.25 Energy efficiency and demand side management are important options for reducing the overall energy requirement and peak demand. In the lighting sector, Compact Fluorescent Lamps (CFL) and Lighting Emitting Diodes (LED) lights are already being adopted in many states. Similarly, it is necessary to accelerate the adoption of energy efficient electrical appliances like fans, refrigerators and air conditioners. A very important option is to replace existing irrigation pumps with more efficient devices. At present, nearly 20% of electricity is being used in the agriculture sector for pumping water. By replacing the inefficient irrigation pumps with star rated efficient pumps can save about 25–30%, or nearly 50 BU of electricity per annum. This is equivalent to avoiding about 10,000 MW of generation capacity. Since energy efficiency measures have very low recurring costs, the payback period on investments made in energy efficiency is short and yields lasting benefits.

Recommendations

- Achieving a high PLF of 80 to 85% for coal-based thermal plants should receive the highest priority. Adequate coal linkages and supplies should be ensured for all commissioned capacities and for the plants likely to be commissioned within the next five years.
- **Generation Projects:** The generation projects envisaged for completion by 2018-19, need to be given priority in fuel linkage. For continuity of 24x7 power supply beyond 2018-19, other projects envisaged in the 13th plan should also get initiated with their fuel linkages being considered.

- **Domestic Coal Supply:** The projected domestic coal requirement will be over 800 Million tonnes by 2016-17 against the projected availability of only 560 million tonnes for the power sector. Amendment of Coal Mining Nationalization Act is required to enable auction of coal blocks to interested mining companies.
- **SPV for Coal Blocks:** Constituting a Special Purpose Vehicle (SPV) is suggested to expeditiously obtain environmental and other clearances before auctioning coal blocks for exploitation by mining companies.
- **Coal Supply Logistics:** It is recommended to ensure adequate rakes capacity to transport coal. Use of washed coal should be promoted alongside augmentation of coal supply for achieving higher PLFs.
- **Gas Based Power Plants:** Gas based generation for meeting the peak demand may be bundled with other sources of energy to make peak power affordable for distribution companies.
- **Renewable Based Generation:** Considering that the renewables have a short gestation period, there should be emphasis on renewable capacity addition particularly in solar and wind energy. Discoms should be made to make payments to RE generators on priority, preferably by opening LCs.
- **Operationalize and augment pumped storage capacity:** There is a need to operationalize the existing pumped storage capacity and plan for additional capacity of about 5,000 MW over the next five years to effectively meet the peak demand and manage the variability of renewable energy sources.
- **Adopt Energy Efficiency:** There is a need to promote adoption of efficient appliances particularly lighting devices and irrigation pumps. Efficient pumps can save about 50 Billion Units (BU) per annum and avoid about 10,000 MW of generating capacity.
- **Renewable Energy Management Systems**: It is recommended to establish "Renewable Energy Management Systems" at least in the States of Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Gujarat, Rajasthan and Madhya Pradesh to begin with to monitor the renewable energy generation on real time basis.
- **Ancillary Services:** In order to have a higher penetration of renewable energy, ancillary services like frequency balancing mechanisms through gas based power

plants, hydro plants, pumped storage plants and also emerging cost effective storage technologies should be promoted.

Generation Investment

The investments required in the generation sector for the capacities planned to be commissioned by 2018-19 is given in Table 4.7. The prevailing rates per MW have been considered while estimating at the investment. For the renewable energy, average rate of 6.5 Cr. per MW is considered, even though it is lower in the case of wind and slightly higher in the case of solar. Total investment required is around Rs. 7,23,397 Cr. A major share of this investment is like to come from the private sector.

Table 4.7: Generation Investment

Year	Thermal	Nuclear	Hydro	High RE	Total
Total addition - MW	51560	11500	13889	40810	117759
Cost per MW in Rs. Cr	4.5	10	8	6.5	--
Investment Rs. Cr	232020	115000	111112	265265	723397

5 TRANSMISSION SYSTEM

5.1 It is important to develop adequate transmission infrastructure to meet the growing energy needs of different parts of the country. The transmission system has evolved from a system of sub regional networks to strong regional networks inter-connected by high voltage transmission lines. At the beginning of the 12th Plan, the southern region was inter-connected synchronously with the rest of the grid, forming a single frequency grid throughout the country. Though all the regions are inter-connected, there are persisting congestion problems and corridor bottlenecks constraining the exchange of power from surplus regions to deficit regions.

5.2 The transmission networks available in the country, as at the end of 2012-13, are shown in Table 5.1.

Table 5.1: Total Line Length in ckm (as on 31 March 2013)

Voltage class in kV	Length of lines (ckm) as on 31 March 2013
HVDC (O.H)	8008
800 kV	6472
400	110408
230 & 220 kV	138534
132/110/90	155595
78/66	58403
33/22/20	395608
15/11	2954056
6.6/3.3/2.2	33026
Total Length	9080556

5.3 The total number of step-up transformers installed at various electricity generating stations and sub-stations in the country as on 31st March 2013 was 2,993 having an aggregate capacity of 196,005 MVA. The total number of step-down and distribution transformers were 52,421 and 62,51,685 with an aggregate capacities of 998,663 MVA and 374,418 MVA respectively.

Bottlenecks in the Present Transmission System

5.4 The present transmission capacity in the country does not adequately match the generation capacity, and is not adequate to meet the fluctuations in load requirements both bilateral and power exchange transactions. This impacts the market transactions and creates bottlenecks in the flow of power from power surplus regions to power deficit regions and between states. Even in the vicinity of the National Capital Region, inadequate transmission capacities have constrained the flow of power between state boundaries. For example, the power generated at Jhajjar is not available for the load centre at Gurgaon while the same is being conveyed all the way to Kerala. Similarly the Southern Region states are unable to obtain surplus power from the Eastern and Western Regions (Orissa, Gujarat) due to corridor bottlenecks even as the generating units complain of stranded capacity. Evacuation of power from the Himalayan region, which has a high potential for generation of hydro power is greatly constrained due to the difficult terrain and environmental factors. It is estimated that in the year 2012-13, about 1.93 BU of energy could not be dispatched from generating plants because of transmission constraints. Further, domestic power exchanges were unable to execute deals worth about Rs. 1,350 Cr. amounting to 15% of the traded volume of power due to transmission constraints. This has resulted in market splitting, with the short term power prices in some regions (typically the Southern region) ruling much higher than those prevailing in the rest of the country. Transmission networks within several States also have constraints due to which they are unable to meet the distribution loads in different areas as also evacuate the entire power generated in the generating units.

5.5 During the 12th Plan period, about 107,440 circuit kilometers (ckm) of transmission lines, 270,000 MVA of AC transformation capacity and 12,750 MW of HVDC systems are to be added to the existing transmission system. Highlights of this transmission expansion are:

- Addition of new HVDC Bipole systems and quantum jump in 765 kV transmission systems
- About 27,000 ckm of 765 kV lines and 149,000 MVA transformation capacity is to be added

- Addition of 400 kV lines of 45,000 ckm, 220kV lines of 38,000 ckm and transformation capacity of 45,000 MVA and 76,000 MVA respectively
- There would also be additions in the 66 kV, 110 kV and 132 kV systems
- Table 5.2 indicates the planned addition to sub-stations in the transmission network.

Details of the transmission capacity in the country as at the end of the 11th Plan period and the proposed additions during the 12th plan period are given in Table-5.2.

Table 5.2: Sub-stations (220 kV and above system)

Substations (AC) and HVDC Terminals expected by the end of 12th plan (values in MVA/MW)	**At the end of 11th plan**	**Expected addition during 12th plan**	**Expected by the end of 12th plan**
HVDC Terminals			
HVDC back-to-back	3000	0	3000
HVDC Bi-pole terminals	6750	12750	19500
Total HVDC terminal Capacity, MW	9750	12750	22500
AC Substations			
765 kV	25000	149000	174000
400 kV	151027	45000	196027
220 kV	223774	76000	299774
Total- AC Substations capacity, MVA	399801	270000	669801

Source: National Electricity Plan-Volume-II (Transmission)

5.6 **Inter-regional Transmission Capacity Program:** A number of inter-regional transmission links either associated with generation projects or as system strengthening schemes have been planned during the 12th Plan. These links would be implemented matching the progress in the addition of generating capacity. Considering the addition of over 88,000 MVA of generation capacity during the 12th Plan, inter-regional transmission links of about 40000 MW are planned to be added during this period. Thus, the inter-regional transmission capacity is expected to reach 68050 MW by 2018-19 (Table 5.3).

Table 5.3: Projected Growth of Inter Regional Transmission Capacity

I-R Transmission Capacity between Regions	At the end of 11th plan (MW)	Expected by 2018-19 (MW)
ER – SR	3630	3630
ER – NR	12130	17930
ER – WR	4390	12790
ER – NER	1260	2860
NR – WR	4220	16920
WR – SR	1520	7920
NER/ER – NR/WR	0	6000
132/110kV radial links	600	0
Total ALL INDIA	27750	68050

5.7 The country is planning to increase the generation of renewable energy substantially in the coming years. Factors like availability of land for solar energy units and the potential for wind energy dictate that generation from these sources may be concentrated in a few states in the beginning. Given the high variability of these sources, Renewable Energy Management Center (REMC) need to be set up in addition to additional transmission lines. On the advice of CERC / FOR and MNRE, the PGCIL has recently prepared a Green Energy Corridor Transmission Plan for evacuating about 46,000 MW of wind energy and over 10,000 MW of solar energy from seven high potential states at a cost of about Rs. 20,500 Cr. for intra-state transmission and about Rs. 19,000 Cr. for inter-state transmission lines.

5.8 A major hurdle in the development of new transmission lines is the difficulty in obtaining additional right of way (ROW). To build the transmission lines/sub-stations targeted in the 12th Plan, about 1.4 million acres of land is required. Acquisition of land for laying transmission networks is being resisted by farmers and other land owners on account of the inadequate compensation that is paid as per the provisions of the Telegraph Act. Major transmission projects both of inter state and intra state transmission lines are getting delayed on account of the inability of the transmission utilities to obtain ROW in time resulting in escalation of project costs as well as continued inadequacy of transmission capacities. It is therefore necessary to recognize the current situation of scarcity of agricultural and urban land and its high value to evolve, a realistic policy to pay reasonable compensation at market rates to land owners, for acquiring land for tower footprints and for compensating loss of usage value of the RoW area of transmission lines.

* Provisions of the Forest Conservation Act need to be implemented with due consideration for the need for creating critical infrastructure in the form of transmission lines so that construction of major transmission corridors is not delayed unduly.

5.9 Since land acquisition is associated with delays and uncertainties, it is important to utilize the existing land and RoW optimally. Therefore it is necessary to adopt methods to increase power transfer per width of RoW by upgrading the existing transmission corridors to higher voltages. This can be achieved by increasing the capacity of transmission lines through re-conductoring using High Temperature Low Sag (HTLS) conductors. Re-conductoring takes much less time (about 6 months), as compared to creating a new parallel corridor (about 4-5 years). It also increases the power intensity without utilizing any incremental RoW.

5.10 An example of such upgradation of the existing transmission works is provided by a leading Indian conductor manufacturer, who in 2012, collaborated with CTC Cable Corporation to re-conductor an existing 132 kV line in Ahmedabad. The new line with ACCC (Aluminum Conductor Composite Core) conductor doubled the capacity of the existing transmission line, without modifying or reinforcing the existing lattice towers. In another example, the Israel Electric Corp (IEC) upgraded a major part of its transmission network to HTLS conductors, increasing the circuit capacity by about 50%.

5.11 All new sub stations in urban areas should invariably be Gas Insulated Stations (GIS) to reduce their footprint. Also, the option of increasing the capacity of existing lines by implementing series compensation, FACTS and dynamic reactive power compensation should be considered.

5.12 Other options to meet challenges associated with RoW in transmission corridors would include providing multi-circuit lines in existing transmission corridors. Also, lower voltage lines could be converted to underground cables in the urban areas and the RoW of these lines used for constructing transmission lines at 220kV and above.

5.13 At present, the transmission planning process takes into account Long Term Access (LTA) commitments and transfer of surplus power from one region to another.

Seasonal diversities and medium term or short term transactions are permitted only considering the transmission margins available after providing for long term commitments. This approach, based on long term requirement of transmission, does not take market realities into account. The increase in short and medium term transactions post the Electricity Act, 2003 makes it imperative to provide for short term transactions to avoid the situation of stranded generation on the one hand and un-served loads on the other. It is therefore necessary to plan for of the transmission capacity augmentation in such a way as to facilitate short term transactions and seasonal variations in demand in different regions and states.

5.14 In India, reactive power compensation in the transmission system is provided only through reactors which are employed to contain over-voltages. Augmenting reactive compensation through series compensation, dynamic shunt compensation and FACTS, along with mechanically switched capacitor banks at 400kV and 220kV level will greatly add to the reactive power requirement of the transmission system, thereby increasing the loadability of the existing transmission capacities.

Recommendations for Planning the Transmission System

5.15 The following recommendations need to be kept in view to eliminate constraints in the transmission system in the country:

- **Prune the Concept to Commissioning time to about 40 months:** There is scope to reduce the conceptualization-to-award process from about 21 months to about 5-6 months under the competitive bidding framework. Additionally, the Ministry of Power can save about 5-6 months from the project development time by acquiring some key clearances in parallel to the project bidding phase. The project authorities face difficulties in acquiring land for sub stations and RoW in urban areas. The problem mostly relates to value of compensation to be paid for the land. The State governments need to address the issue to determine the more liberal compensation packages so the time required for acquisition is drastically reduced.
- **Policy for Realistic Compensation for land acquisition**: Land acquisition for RoW to build transmission lines should be facilitated by evolving a policy for payment of compensation to land owners based on the present market value.

- **Optimum utilization of existing RoW**: Possibility of more optimal utilization of the existing RoWs should be explored by construction of multi circuit lines, upgrading of the existing power transmission corridor on the same route. Up-gradation and re-conductoring of the existing lines can save valuable time, cost, RoW and forest cover.
- **Focused planning for short and medium term transactions**: The planning process needs to account for market realities so as to provide flexibility to buyers and sellers. The transmission system should be planned based on potential generation areas and more accurate load projections and capture possible market transactions. All stakeholders need to sit together and share more realistic load and generation projections before arriving at transmission requirement.
- **Use of High Performance Conductors in the Existing & New Lines**: Use of High Performance Conductors - HTLS needs to be taken up to increase power transfer intensity.
- The loadability of the existing transmission system should be increased by adding adequate reactive power compensation through series compensation, dynamic shunt compensation, FACTS and mechanically switched capacitor banks.
- Underground lines should be considered for all transmission below 220 kV, and the RoW in existing corridors used for higher capacity lines.
- **Green Energy Corridors**: The transmission infrastructure as recommended in the report on Green Energy Corridors prepared by FOR / MNRE, be developed at intra-state, inter-state and inter-regional levels to evacuate additional capacities of renewable energy and remove the transmission constraints.

5.16 The total investments for the development of the transmission system during the 12th plan period is estimated at about Rs. 2,00,000 Cr. With this planned investment, the additional investment required for augmenting the capacity and maximizing the utilization of assets with reactive power compensation by 2018-19 is tentatively estimated at Rs. 1,20,000 Cr. (for upgrading the transmission system Rs.90,000 Cr. and for reactive power compensation Rs. 30,000 Cr.).

6 DISTRIBUTION

6.1 The distribution network in the country consists of a total of 8,603,136 ckm of distribution lines catering to nearly 200 million consumers. While most distribution utilities are registered as companies, they are mostly owned by the State Governments subject to the control of state and are influenced by the Governments in their day to day functioning as well as in the policies pursued by them.

6.2 The percentage of the population provided with electricity supply varies from state to state. The National Electricity Policy issued in 2006-07 set a target of providing electricity supply to all households in the country and achieving a per capita consumption level of 1,000 kWh per year by 2012, which could not be achieved. The present initiative of 24x7 supply to all households in about five years should be seen as subsuming the above target. The growth of electricity consumption in India by different categories of consumers since 1947 is shown in the Table 6.1.

6.3 The viability of the entire power sector depends upon the financial health and the operational efficiency of the distribution utilities. Therefore, it is necessary to focus on improving their performance, especially the performance of the Government owned utilities. A drastic reduction in the AT&C losses and a radical reorientation of the operational procedures of these utilities is crucial to the country achieving the goal of adequate power supply to all its citizens.

6.4 Distribution utilities in the country procured 967 BU of electricity during the year 2013-14. However, their actual sales to consumers were estimated at only 726 BU considering AT&C losses of about 27%. It is believed that the figures relating to AT&C losses are somewhat understated, and the actual losses may be in excess of 30%. Thus out of about 1000 billion units of electricity generated in the country, over 300 billion units is lost as either transmission and distribution (T&D) losses or as power consumed but not accounted/paid for – either because of defective metering and billing or as theft of energy. Considering that the total consumption of all the domestic consumers (about 180 million households) in the country in 2012-13 was only about 185 billion units, the energy lost as AT&C losses is 63% more than the consumption of all the households.

6.5 While the AT&C losses in many countries amount to less than 10%, it is reasonable to surmise that these losses can be reduced to about 12-15% in our country by strengthening the distribution networks and by preventing unauthorise use of power. Reducing the present losses by about 10% will result in the increased availability of over 100 billion units which would completely eliminate the energy deficit today. On the other hand, the capacity needed to generate an additional 100 billion units will be about 15,0000 MW which would involve an estimated Rs.100,0000000 Cr. in capital investment besides a recurring cost of about Rs.25,000 to 30,000 Cr. per year! Thus, inadequate availability of electricity in the country is further compounded by the huge AT&C losses.

6.6 On account of such unusually high AT&C losses, the non-recovery of charges from several consumers like farmers, local bodies and even government departments, the distribution sector in the country is losing an estimated Rs. 70,000 Cr. per year. The distribution companies in several states are therefore unable to procure the required quantity of electricity due to their weak financial position. Further, non-revision of electricity tariff and non-receipt of subsidies from state governments add to these problems. The utilities have not been able to make necessary investments to strengthen the distribution networks and adopt standard maintenance practices to ensure satisfactory quality of supply.

Table 6.1: Growth of Electricity Consumption (GWh) in India

Sl.No	During financial year ending with	Domestic	% to total	Commercial	% to total	Industrial	% to total	Traction	% to total	Agriculture	% to total	Misc	% to total	Total
1	1947	423	10.11	178	4.26	2960	70.78	277	6.62	125	2.99	219	5.24	4182
2	1950	525	9.36	309	5.51	4057	72.32	308	5.49	162	2.89	249	4.44	5610
3	1955-56 (End of the 1st plan)	934	9.2	546	5.38	7514	74.03	405	3.99	316	3.11	435	4.29	10150
4	1960-61 (End of the 2nd plan)	1492	8.88	848	5.05	12547	74.67	454	2.7	833	4.96	630	3.75	16804
5	1965-66 (End of the 3rd plan)	2355	7.73	1650	5.42	22596	74.19	1057	3.47	1892	6.21	905	2.97	30455
6	1968-69 (End of the 3 Annual plans)	3184	7.69	2126	5.14	29931	72.31	1247	3.01	3465	8.37	1439	3.48	41392
7	1973-74 (End of the 4th plan)	4645	8.36	2988	5.38	37791	68.02	1531	2.76	6310	11.36	2292	4.13	55557
8	1978-79 (End of the 5th plan)	7576	9.02	4330	5.15	54440	64.81	2186	2.6	12028	14.32	3445	4.1	84005
9	1979-80 (End of the 2 Annual plans)	8402	9.85	4657	5.46	53206	62.35	2301	2.7	13452	15.76	3316	3.89	85334
10	1984-85 (End of the 6th plan)	15506	12.45	6937	5.57	73520	59.02	2880	2.31	20961	16.83	4765	3.83	124569
11	1989-90 (End of the 7th plan)	29577	15.16	9548	4.89	100373	51.45	4070	2.09	44056	22.58	7474	3.83	195098
12	1991-92 (End of the 2 Annual plans)	35854	15.51	12032	5.2	110844	47.94	4520	1.96	58557	25.33	9394	4.06	231201
13	1996-97 (End of the 8th plan)	55267	17.53	17519	5.56	139253	44.17	6594	2.09	84019	26.65	12642	4.01	315294
14	2001-02 (End of the 9th plan)	79694	21.27	24139	6.44	159507	42.57	8106	2.16	81673	21.8	21551	5.75	374670
15	2006-07 (End of 10th plan)	111002	21.12	40220	7.65	241216	45.89	10800	2.05	99023	18.84	23411	4.45	525672
16	2011-12 (End of 11th plan)	171104	21.79	65381	8.33	352291	44.87	14206	1.81	140960	17.95	41252	5.25	785194
17	2012-13 (End of 1st year of 12th plan)	185858	21.79	71019	8.33	382670	44.87	15431	1.81	153116	17.95	44809	5.25	852903

Source: CEA

6.7 The work culture in most distribution utilities does not have adequate commercial orientation to treat every unit supplied as sale of electricity for which a price as determined by the regulators needs to be recovered. The metering is often faulty and the supply is not metered in the case of certain categories of consumers like farmers. The distribution utilities are therefore caught in a vicious cycle of poor quality supply, leading to inadequate recovery of cost of service, which affects their ability to incur capital and maintenance expenditure to improve the quality of supply. The future development of the power sector and its sustainability therefore depends critically on reforms in the distribution sector.

6.8 With about one third of the households in the country not having access to electricity even for lighting purposes, it is imperative to expand the country's distribution networks substantially in order to ensure electricity supply to all un-electrified households. This is particularly challenging in the eastern and north-eastern regions and tribal areas, which have the largest concentration of unelectrified households. The number of unelectrified households in the country was over 80 million as per 2011 census. The Rajiv Gandhi Gramin Vidyudhikaran Yojana (RGGVY) has so far resulted in supply to about only 19.4 million households. Since more than 95% of villages have electricity lines (See Annexure-1A), the distribution utilities' main task is to provide extension of service connections within electrified villages. The financial investments for service to all un-electrified households is estimated at about Rs. 1,60,000 Cr. at an average cost of about Rs. 20,000 per household. With respect to households in remote hamlets, provision of electricity by setting up micro grids based on solar energy or other renewables should be considered if extension of the grid is not cost effective particularly in the case of remote tribal areas. A detailed note on distributed generation may be seen in Annexure-7.

Distribution Reforms Needed

6.9 The inability of distribution utilities to fully meet the demand for electricity manifests itself in frequent load shedding, poor voltage and high degree of interruptions in supply. The objective of 24x7 supply can be achieved meaningfully not only by augmenting the availability of electricity but also by ensuring better quality of supply. This would call for major investments in upgrading the distribution networks. Such upgradation would include re-conductoring of distribution lines, addition of transformation capacities, adequate provision of reactive power in the system as well as adoption of smart grid technologies. The additional capital investments required for these purposes can be mobilized by the distribution utilities through institutional finance, which can be serviced out of the increased revenues resulting from better efficiency in distribution management. There is a need for evolving a standard package of distribution reforms to be adopted by distribution utilities across the country so that investments for this purpose could be mobilized from institutional sources and external aid agencies.

6.10 Distribution Reforms must also include the universalization of consumer and DTC level metering. In the absence of metering and accounting of energy at different levels in the distribution network energy audit to determine the technical and commercial losses accurately is not taken up by the distribution utilities. The resultant underestimation of losses has led to considerable complacency in the distribution sector delaying the much needed upgradation of the distribution networks. This is also responsible for the increasing burden of subsidy payments on the State Governments and, in some cases, unsustainably high tariff for the paying consumers. The strategy for 24x7 power supply must include universalization of consumer level and DTC level metering. The SERCs should mandate implementation of DTC metering with Advanced metering systems as part of the capital expenditure of the distribution utilities.

6.11 The National Electricity Plan assumes reduction of AT&C losses to about 17.5% by 2018-19. This calls for substantial investments in upgrading the distribution networks by converting low voltage distribution lines into High Voltage Distribution Systems (HVDS), rigorous energy auditing, and by preventing theft of power by switching to aerial-bunched cables (ABC). It is possible to introduce these improvements in the distribution infrastructure within a short duration of about 3–5 years with an investment of about Rs. 1,00,000 Cr. These investments not only have a short payback period of 4–5 years, but are less than the investment and recurring costs needed to generate additional electricity equal to what can be saved by such loss reducing measures.

6.12 Electricity supply to the agriculture sector requires urgent reforms. In most states, the supply to the agriculture sector is unmetered and subsidized. The distribution companies therefore assess the total power supplied to farmers by an indirect method which gives scope for part of the overall distribution losses being included in the assessed consumption of the agricultural sector. The subsidy payments in many cases are not adequate to cover the cost of supply to the agriculture sector. The payment of subsidy by State Governments is also not made on a timely basis in spite of the legal requirement of advance payment of subsidy under the Electricity Act, 2003.

6.13 The above situation underscores the need for feeder segregation to regulate electricity supply to the agriculture sector. This not only enables regulating the quantity of subsidized supplies, but also helps in scheduling supply to the agriculture sector during off-peak hours. The feeder separation program implemented in Gujarat under the Jyothi Grama Yojana is a successful example in this respect. This has enabled providing supply to the agriculture sector for about 8–10 hours a day and 24x7, three-phase supply to rural consumers. States like Punjab, Madhya Pradesh, Andhra Pradesh and Karnataka have also taken up feeder separation programs to regulate electricity supply to the agriculture sector. The Central Government has recently announced the Deendayal Upadhyay Feeder Segregation Program to support the State Governments in this regard. Adoption of feeder segregation program is necessary in all states which have a significant proportion of electricity being supplied for agriculture both to ensure 24x7 supply to consumers and to reduce peak demand by avoiding supply to irrigation pump sets during peak hours.

6.14 The agriculture sector also has the greatest potential for adoption of energy efficiency measures in the present situation. Pilot projects taken up in several states like Gujarat, Maharashtra and Karnataka for replacement of inefficient irrigation pumps with star rated pump sets have demonstrated the possibility of reducing electricity consumption by 25-30%. Several distribution utilities in the country are likely to replace inefficient irrigation pumps with the help of energy saving companies (ESCOs), which make the upfront capital investments and recover their costs from the estimated electricity savings.

6.15 Use of solar energy to power irrigation pumps is another innovative option, given the substantial reduction in the cost of Solar PV in recent years. This will provide pumping power to agriculture on all sunny days when the requirement for irrigating the crops is at its maximum. The resultant savings in the supply of grid power to agriculture could reduce the subsidy burden on the State Governments and non-agricultural consumers. Government should now initiate a major programme for incentivizing the use of solar power with 50% supplies for irrigation pump sets to progressively reduce the use of grid power for irrigation.

6.16 The management culture of distribution utilities requires urgent reforms as there is a near absence of commercial orientation. The utilities continue to function like government departments providing service without much regard for financial returns. The management and field staff need to be oriented to adopt a commercial approach to generate adequate revenue for every unit of electricity sold to consumers. There should be responsibility on specific officials to recover the revenue corresponding to the electricity supplied in each feeder in the system. The manpower of distribution utilities at the operational as well as the management levels need to be trained in techno-commercial and regulatory aspects to increase both their technical efficiency and financial accountability. For this purpose, Government should consider establishing Power Sector Management Training Centers in each State.

6.17 Adequacy and regularity of tariff revisions by State Electricity Regulatory Commissions is the very foundation of sustainable functioning of distribution utilities. In the wake of a direction by the Appellate Tribunal for Electricity issued in November 2012, the State Electricity Regulatory Commissions in some states where tariff revision was delayed or was irregular in the past have also been effecting tariff revisions. However, the backlog of regulatory assets and accumulated losses in some states has seriously impaired the financial viability of their distribution companies.

6.18 Another factor contributing to the weak financial position of distribution utilities is the inadequate compensation received by them for electricity supplied to the subsidised categories of consumers like farmers and weaker sections. Given the difficult financial position of the State Governments, payment of subsidies to distribution companies does not receive due priority resulting in the accumulation of huge regulatory assets in some states. It is necessary to design a system of ensuring that payment of subsidies to electricity utilities for free or subsidised supply is made a priority charge on the State finances.

6.19 The financial restructuring of distribution utilities taken up on the basis of the **Shunglu Committee Report** has not been availed by most distribution companies in the country due to the restricted norms adopted for assistance under the Scheme. Most distribution utilities not only have accumulated losses, but also show (unrecoverable) arrears on their balance sheets as part of their assets. The financial restructuring scheme needs to be suitably modified to recognize the actual financial strength of these companies by excluding such unrecoverable dues and making applicable to all distribution utilities which are in need of institutional finance to implement distribution reforms.

6.20 Accurate estimation of demand duly factoring in the increased electrification of rural areas, demand side management measures, is the basic requirement for any policy design on 24x7 power supply to consumers. For this each state would need to undertake an intensive study with focus not only on load estimation / growth but also on assessing the actual level of transmission and distribution losses. It is only when we have accurate load profiles and data on system losses that we can plan and project for adequate procurement of power to meet the demand.

6.21 Most states today do not have an agency which is responsible for the overall planning and coordination of the development of the power sector. The Energy departments of the state secretariats are usually not equipped to undertake the detailed planning required for the sector. While the State Regulatory Commissions require the utilities to submit detailed plans of their activities for 5–10 years, such plans submitted by individual utilities are lacking in the required degree of integration and long term perspective. Therefore, it is necessary at this stage to consider setting up of adequately equipped Power Planning Cells at the state level, under the guidance of the Central Electricity Authority.

Recommendations

- **Accurate Estimation of Demand**: Accurate estimation of demand duly factoring in the increased electrification of rural areas and demand side management measures, is the basic requirement for any policy design on 24x7 power supply to consumers. For this each state would need to undertake an intensive study with focus not only on load estimation / growth but also on assessing the actual level of transmission and distribution losses. It is only when they have accurate load profiles and data on system losses that the utilities can plan and project for adequate procurement of power to meet the demand.

- **Electrification of Unelectrified Households:** Achieving 100% electrification of unelectrified households should receive the highest priority in the strategy for 24x7 power supply. A mission mode approach should be adopted to implement this programme, particularly in states, which have less than the national average proportion of electrified households.
- **Special Funding Arrangements for Extension of Electricity Supply:** A separate machinery should be set up with special funding arrangements to implement the programme for extension of electricity supply in states like Bihar, Assam, Uttar Pradesh, Jharkhand and Orissa, which have less than 50% of the households with electricity supply.
- **Aggressive Reduction of AT&C Losses:** A special programme should be launched for aggressive reduction of AT&C losses to reduce the losses at the rate of 2% per year over the next five years. The distribution companies should be supported in strengthening the distribution networks by adopting High Voltage Distribution System (HVDS) and by improving the metering system in the rural areas in addition to the urban areas under RAPDRP.
- **Universalization of Consumer Level and DTC Level Metering:** The strategy for 24x7 power supply must include universalization of consumer level and DTC level metering. The SERCs should mandate implementation of DTC metering with Advanced metering systems as part of the capital expenditure of the distribution utilities.
- **Feeder Segregation:** Feeder segregation to separate agricultural feeders from other rural feeders should be taken up in all states, which have significant electricity consumption for irrigation purposes.
- **Replacement of Inefficient Irrigation Pumps**: Replacement of inefficient irrigation pumps with star rated pumps should be made mandatory where agricultural consumption exceeds 10% of the total electricity consumed in a state. Adoption of solar irrigation pumps should be encouraged by providing 50% of the cost as subsidy.
- **Ensuring Financial Health of Distribution Companies:** The availability of adequate institutional finance, timely payment of subsidies by State Governments and adequacy

and regularity of tariff revision by the State Regulatory Commissions are essential for ensuring financial health of not only the distribution companies but the entire electricity sector in the country.

- **Liberalize Financial Restructuring Package:** The financial restructuring package introduced on the recommendation of the Shunglu Panel should be further liberalized to clean up the balance sheets of all distribution utilities on a one time basis.
- **Reorienting the Management Culture of Distribution Utilities:** The management culture of distribution utilities should be reoriented to make every level in the organization accountable for sale of power in every feeder. These utilities must be made to function as commercial entities instead of continuing with the culture of departmental undertakings providing service without regard for financial returns.
- **Power Planning:** Power Planning Cells should be established in each state to undertake long term planning and coordination of the development of the power sector.

Investments to improve the Distribution System

- It is necessary to expand the country's distribution networks substantially in order to ensure electricity supply to the un-electrified households numbering over 80 million. The financial implication of the extension of service to the un-electrified households is estimated at about Rs.1,60,000 Cr. at an average cost of about Rs. 20,000 per household.
- Feeder segregation and other improvements as suggested by the working group of FOR requires about Rs. 1,67,000 Cr. investment.
- The National Electricity Plan assumes reduction of AT&C losses to about 17.5% by 2018-19. This and the load growth would require an investment plan of about Rs. 1,75,000 Cr.
- Rs.25,000 Cr. is estimated as the amount needed to improve Distribution Management. This is in addition to the present R-APDRP spending of 10,000 Cr. towards IT enabled services. This amount is required to cover the rural areas and also to meet the requirement of additional consumers in the urban areas currently covered under R-APDRP.
- Total Investment needed for the Distribution System would be about Rs. 5,27,000 Cr.

7 INVESTMENT IMPACT ON COST

7.1 Generation: It is estimated that about Rs. 7,23,397 Cr. investment is needed in the generation sector to achieve required generation target by 2018-19. Most of this investment will come from private sector.

7.2 Transmission: In order to develop a secure and reliable transmission system it is estimated that about Rs. 3,20,000 Cr. investment is needed. This investment is cumulative of both in central and state sector.

7.3 Distribution: About Rs. 5,27,000 Cr. investment is required in the distribution system in the next five years to supply quality and reliable power to all consumers. Even though the investment appears to be higher side, the loss reduction and the efficiency improvement will pay back the investment in a shorter period. This investment also includes the agriculture feeder segregation program being envisaged as recommended by the other sub-committee of FOR.

7.4 Total investment: In order to achieve 24x7, reliable, secure and quality power supply to all consumers, the total investment estimated is around Rs. 15,70,397 Cr.

7.5 The average cost of power supply pan India is given in Table 7.1 from year 2009-10 to 2013-14. Few values are provisional in the table. From the Table 7.1 it is observed that the average cost of power supply is ever increasing and from year 2009-10 to 2013-14, there is about 25.8% increase and the annual increase is about 5.2%

Table 7.1: Average cost of power supply in Paisa/Unit

Year	Fuel*	Power Purchase	O&M	Est. & Adm.	Misc.	Depre.	Interest	Total
2009-10	16.24	343.15	7.14	51.43	8.29	14.86	31.57	472.68
2010-11	15.34	373.33	7.26	53.43	8.87	14.83	34.68	507.74
2011-12	17.01	417.93	7.43	55.22	17.47	14.45	41.7	571.21
2012-13	18.48	446.84	7.52	55.79	7.75	15.45	42.16	593.99
2013-14	20.3	449.15	7.11	51.56	7.56	14.9	44.05	594.63

Source: Annual Report; 2013-14; Working of State Power Utilities and Electricity Departments; * Own Generation

7.6 From Table 2.2, it is observed that the ex-bus generation is 9,59,829 MU for the year 2013-14. Considering 27% loss level, the sales works out to 7,00,675 MU. The power purchase cost given in Table 7.1 has two parts, the fixed cost and the variable cost. On an average the fixed cost varies 40%-60% of the total power purchase cost, depending on the fuel mix and the transmission charges (STU+CTU). Table 7.2 gives the fixed cost for the five years when fixed cost is varied from 40%-60% for the total power purchase cost including transmission charges. From the above analysis the fixed cost of the power purchase including transmission is between Rs. 1.80 to Rs. 2.70 per unit, based on the variation considered.

Table 7.2: Average fixed cost of power purchase in Paisa/Unit

Year	Power Purchase	Fixed Cost		
		40%	50%	60%
2009-10	343.15	137.26	171.575	205.89
2010-11	373.33	149.332	186.665	223.998
2011-12	417.93	167.172	208.965	250.758
2012-13	446.84	178.736	223.42	268.104
2013-14	449.15	179.66	224.575	269.49

7.7 Generation & Transmission Investment Impact on power purchase cost: The investment of Rs. 7,23,397 Cr. in generation and Rs. 3,20,000 Cr in transmission (total Rs. 1043397 Cr.) will result in the sales of about 1280 BU. Considering the annual cost to service the capital at 18% (16% toward interest & depreciation and 2% towards O&M expenses), the annual expenditure towards the capital works out to Rs. 1,87,812 Cr. The power purchase cost towards the fixed cost works out to Rs. 1.47 per unit, with an expected sales of 1280 BU. Adding the existing fixed cost given in Table 7.2, the cost of power purchase including transmission varies from 2.44 Rs/Unit to 2.93 Rs./Unit. The overall tariff impact per annum ranges from 7.2% to 1.82% for 40% fixed charges to 60% fixed charges, respectively (i.e., between Rs.0.65 to Rs.0.247). The impact is marginal attributing to the fact that 24x7 strategy recommends the higher PLF of the power plant compared to existing PLF and hence the unit fixed charge will come down.

7.8 Distribution investment impact on the power supply cost: The total capital investment envisaged for the next five years in the distribution sector is Rs. 5,27,000 Cr. Considering the annual cost to service the capital at 18% (16% toward interest & depreciation and 2% towards O&M expenses), the annual expenditure towards the capital works out to Rs. 94,860 Cr. The unit charges to recover the capital cost towards distribution works out to Rs. 0.74 per unit, with an expected sales of 1280 BU. From table 7.2, for the year 2013-14, the unit charges for the distribution system infrastructure is Rs. 0.66/Unit (O&M + Depreciation + Interest). The average cost with the increase sales works out to Rs. 1.10/Unit. The loss reduction to 17.5% by 2018-19 from the current level will result in a reduction of about 50 Paisa in the tariff. Hence, it is seen that there is no tariff impact of the envisaged investment in the distribution system on the tariff, as the investment cost is offset by the loss reduction benefit.

7.9 Impact on the variable cost: The average variable cost of power purchase depends on the fuel mix. As the renewable energy mix increases in terms of hydro, wind and solar, the variable cost may come down in future. The current trend in tariff change in the variable cost may not see drastic impact in the coming years, even after 24x7 power supply strategy is being implemented by 2018-19.

8 Conclusion

8.1 In conclusion, it is useful to summarize the main tasks that need to be accomplished if the country has to achieve the objective of 24x7 electricity supply in the next five years and sustain the position in future. They are –

a) Increasing the installed capacity for power generation from the present 2,53,000 MW to 3,72,140 MW to meet a peak demand of about 2,29,465 MW and energy requirement of 1,552 BU;
b) Increasing the availability of domestic coal to the power sector from 554 million tons supplied in 2011-12 to 800 million tons by 2018-19 representing a growth rate of 5.4% per annum as against 3 – 5% growth seen earlier;
c) Augmentation of the capacity of Railways to transport coal to the power plants from the present 0.64 million tons per day to 0.95 million tons;
d) Increasing the availability of natural gas from 25 mmscmd supplied in 2013-14 to 70 mmscmd by 2018-19 to ensure 70% PLF of gas based generation units;
e) Renewable Energy sources to be augmented from the present installed capacity of about 33,000 MW to 150000 MW including about 50000 MW addition each of wind and solar energy;
f) Establishment of Renewable Management Centres in the Southern and Western Regions to manage the variability of wind and solar energy generation;
g) Augmenting the Inter-regional / Inter-state transmission capacity by adding 27,000 ckt kms of 765 kV lines 45,000 ckt. kms of 400 kV lines and 38,000 ckt. kms. of 220 kV to increase the Inter State transmission capacity from the present 27750 MW to 68050 MW;
h) To increase the HT and LT distribution lines to provide connectivity to 43,000 unconnected villages and about 80 million households without electricity at present;
i) To segregate agriculture feeders from rural feeders by ercting new feeder lines to provide 24x7 three phase power supply to villages;
j) To upgrade the distribution network by increasing high tension lines through HVDS and installations of feeder level and DTC level metering for energy audit to reduce AT&C losses from the present 27% to less than 17%.

k) Replacement of inefficient irrigation pumps with star rated pumps though Energy Saving Companies (ESCOs) and to promote the use of solar energy based pump sets;

l) Extending the coverage of the financial restructuring package to improve the financial viability of distribution companies.

8.2 The financial implications of the various measures needed for achieving 24x7 power supply as proposed in this report are outlined separately in Annexure. The bulk of the investment of over Rs. 15,70,397 Cr. required for the power sector ins the coming years, it is hoped, can be mobilized through the private sector and institutional sources. Public Sector utilities can also raise part of the funds from external funding agencies given the fact that most investments have good economic returns.

ANNEXURE-1

Population, Households, Percentage of Electrified houses and per household consumption (kWh)

Table A: Details of state wise per household consumption

S.No	Name of the State	Domestic Energy Sales (MU) for 2011-12	Population (2011-12) (Millions)	Total No. of Households	% Electricity	Electrified Households	Per household Consumption/day (kWh)	Domestic Energy Sales (MU) as per 18th EPS	Projected population (millions)-2018-19	House hold Projections (2018-19)	Per household Consumption/day (kWh)
				For the year 2011-12				2018-19			2018-19
1	**Haryana**	**5,751.66**	**25.68**	**4,717,954**	**90.50**	**4,269,748**	**3.69**	**10,185**	**28.90**	**5,309,947**	**5.26**
2	Himachal Pradesh	1,399.00	6.83	1,476,581	96.80	1,429,330	2.68	1,878	7.30	1,577,875	3.26
3	Jammu & Kashmir	1,431.98	11.80	2,015,088	85.10	1,714,840	2.29	3,857	12.87	2,197,715	4.81
4	Punjab	8,635.93	27.86	5,409,699	96.60	5,225,769	4.53	12,915	30.06	5,837,737	6.06
5	Rajasthan	7,262.27	68.47	12,581,303	67.00	8,429,473	2.36	18,842	76.54	14,064,795	3.67
6	Uttar Pradesh	18,200.00	202.83	32,924,266	36.80	12,116,130	4.12	49,408	230.50	37,415,757	3.62
7	Uttarakhand	1,675.92	10.03	1,997,068	87.00	1,737,449	2.64	2,984	11.11	2,211,377	3.70
8	Chandigarh	525.79	1.48	235,061	98.40	231,300	6.23	813	2.09	331,505	6.72
9	Delhi	10,839.24	18.76	3,340,538	99.10	3,310,473	8.97	15,687	23.55	4,193,823	10.25
10	Gujarat	10,008.87	59.48	12,181,718	90.40	11,012,273	2.49	19,133	65.40	13,393,491	3.91
11	Madhay Pradesh	6,619.24	72.88	14,967,597	67.10	10,043,258	1.81	5,989	81.86	16,812,841	0.98
12	Chhattisgarh	3,313.35	24.45	5,622,850	75.30	4,234,006	2.14	16,047	26.99	6,207,897	7.08
13	Maharashtra	20,843.55	113.57	23,830,580	83.90	19,993,857	2.86	30,848	125.33	26,298,249	3.21
14	Goa	713.92	1.80	322,813	96.90	312,806	6.25	1,188	2.16	386,754	8.42
15	Daman & Diu	74.37	0.28	60,381	99.10	59,838	3.40	132	0.39	83,639	4.32
16	D & N Haveli	58.00	0.36	73,063	95.20	69,556	2.28	154	0.48	96,592	4.37
17	Andhra Pradesh	16,914.47	85.19	21,024,534	92.20	19,384,620	2.39	32,050	90.82	22,412,771	3.92
18	Karnataka	8,771.53	59.78	13,179,911	90.60	11,940,999	2.01	16,752	64.32	14,181,841	3.24
19	Kerala	7,772.99	34.71	7,716,370	94.40	7,284,253	2.92	11,669	36.40	8,090,992	3.95
20	Tamil Nadu	17,332.00	67.70	18,493,003	93.40	17,272,465	2.75	32,415	70.61	19,288,177	4.60
21	Puducherry	546.54	1.43	301,276	97.70	294,347	5.09	837	1.92	404,589	5.67
22	Lakshadweep	23.37	0.08	10,703	99.70	10,671	6.00	31	0.09	11,830	7.18
23	Bihar	2,368.10	98.50	18,940,629	16.40	3,106,263	2.09	13,285	108.15	20,796,121	1.75
24	Jharkhand $	3,353.99	31.73	6,181,607	45.80	2,831,176	3.25	6,512	35.17	6,852,368	2.60
25	Orissa	3,983.12	40.96	9,661,085	43.00	4,154,267	2.63	8,741.00	43.67	10,301,206	2.32
26	West Bengal $	9,689.41	89.99	20,067,299	54.50	10,936,678	2.43	20,143.00	96.40	21,496,914	2.57
27	A & N Islands	93.98	0.50	93,376	86.10	80,397	3.20	177.00	0.60	111,144	4.36
28	Sikkim	115.70	0.62	128,131	92.50	118,521	2.67	177.00	0.68	139,646	3.47
29	Assam	1,487.80	30.79	6,367,295	37.10	2,362,266	1.73	4,024.00	33.76	6,981,362	1.58
30	Manipur	173.72	2.47	507,152	68.40	346,892	1.37	693.00	2.67	547,948	3.46
31	Meghalaya	344.72	2.64	538,299	60.90	327,824	2.88	389.00	2.88	587,385	1.81
32	Nagaland	202.36	2.26	399,965	81.60	326,371	1.70	405.00	2.47	436,422	2.54
33	Tripura	262.23	3.64	842,781	68.40	576,462	1.25	731.00	3.97	919,694	2.18
34	Arunachal Pradesh	143.56	1.25	261,614	65.70	171,880	2.29	148.00	1.36	285,435	1.42
35	Mizoram	170.92	1.01	221,077	84.20	186,147	2.52	524.00	1.10	241,335	5.95

ANNEXURE-2

Category-wise, State-wise Forecast

Electrical Energy Consumption in Domestic (in Million units)					
State/STU	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Delhi	12402	13152	13948	14792	15687
Haryana	7304	8053	8878	9554	10185
Himachal Pradesh	1498	1589	1686	1780	1878
Jammu & Kashmir	2451	2746	3075	3444	3857
Punjab	10180	10969	11818	12414	12915
Rajasthan	11602	13393	15461	17258	18842
Uttar Pradesh	32084	36682	41938	46132	49408
Uttarakhand	2194	2369	2559	2763	2984
Chandigarh	643	682	723	767	813
Northern region	**80358**	**89634**	**100086**	**108903**	**116570**
Goa	900	972	1050	1119	1188
Gujarat	13295	14588	16007	17521	19133
Chhattisgarh	4194	4624	5097	5538	5989
Madhya Pradesh	10290	11885	13727	15032	16047
Maharashtra	24718	26221	27815	29362	30848
D. & N. Haveli	92	107	125	140	154
Daman & Diu	93	103	113	122	132
Western Region	**53582**	**58500**	**63934**	**68834**	**73490**
Andhra Pradesh	21767	24201	26907	29366	32050
Karnataka	12971	13895	14884	15791	16752
Kerala	9219	9826	10472	11054	11669
Tamil Nadu	23559	25563	27701	29983	32415
Pudducherry	692	732	773	806	837
Southern Region	**68209**	**74217**	**80737**	**87000**	**93724**
Bihar	5991	7446	9148	11024	13285
Jharkhand	4258	4746	5290	5969	6512
Orissa	6740	7219	7731	8240	8741
West Bengal	13103	14845	16859	18664	20143
Sikkim	128	145	155	160	177
Eastern Region	**30221**	**34401**	**39183**	**44057**	**48857**
Assam	3003	3216	3443	3722	4024
Manipur	336	410	499	594	693
Meghalaya	307	326	345	366	389
Nagaland	288	311	336	371	405
Tripura	491	552	620	676	731
Arunachal Pradesh	93	107	123	135	148
Mizoram	306	367	440	484	524
North Eastern Region	**4824**	**5287**	**5806**	**6349**	**6914**
Andman& Nicobar Islands	126	137	150	163	177
Lakshadweep	25	27	28	30	31
All India	**237347**	**262202**	**289924**	**315335**	**339762**

Electrical Energy Consumption in Commercial &Misc (in Million units)					
State/STU	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Delhi	7568	8325	9158	10073	11081
Haryana	2712	3046	3432	3825	4221
Himachal Pradesh	620	664	711	754	800
Jammu & Kashmir	416	466	522	585	655
Punjab	3028	3306	3610	3923	4243
Rajasthan	2758	3041	3352	3695	4074
Uttar Pradesh	8620	9861	11281	12783	14358
Uttarakhand	1320	1386	1455	1528	1605
Chandigarh	508	539	572	607	643
Northern region	**27551**	**30635**	**34094**	**37774**	**41680**
Goa	274	296	320	345	369
Gujarat	6725	7485	8331	9184	10125
Chhattisgarh	768	855	952	1014	1081
Madhya Pradesh	2423	2774	3176	3600	4045
Maharashtra	17007	18536	20203	21828	23584
D. & N. Haveli	24	26	28	30	33
Daman & Diu	45	49	54	58	63
Western Region	**27267**	**30022**	**33064**	**36060**	**39299**
Andhra Pradesh	8977	9882	10855	11901	13024
Karnataka	7429	8268	9202	10192	11237
Kerala	4041	4447	4893	5335	5764
Tamil Nadu	10553	11603	12813	14176	15727
Pudducherry	234	253	273	293	313
Southern Region	**31214**	**34453**	**38034**	**41897**	**46065**
Bihar	911	1042	1192	1364	1560
Jharkhand	474	523	577	630	681
Orissa	1275	1362	1455	1546	1643
West Bengal	5625	6123	6659	7234	7851
Sikkim	57	60	65	71	75
Eastern Region	**8343**	**9111**	**9948**	**10845**	**11810**
Assam	757	842	937	1014	1088
Manipur	44	53	64	78	94
Meghalaya	60	64	68	71	74
Nagaland	59	68	79	89	99
Tripura	76	84	92	102	112
Arunachal Pradesh	22	25	28	30	33
Mizoram	28	33	39	45	50
North Eastern Region	**1046**	**1169**	**1307**	**1429**	**1551**
Andman& Nicobar Islands	68	73	78	83	89
Lakshadweep	8	9	10	10	11
All India	**95497**	**105472**	**116535**	**128099**	**140506**

Electrical Energy Consumption in Irrigation (in Million units)					
State/STU	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Delhi	31	29	28	26	25
Haryana	11843	12433	13053	13704	14387
Himachal Pradesh	43	44	46	48	50
Jammu & Kashmir	361	404	453	507	568
Punjab	18194	20138	22266	23152	23733
Rajasthan	18626	19678	20777	21766	22739
Uttar Pradesh	16746	19748	23279	26126	28805
Uttarakhand	363	377	392	408	424
Chandigarh	1	1	1	2	2
Northern region	**66208**	**72854**	**80295**	**85739**	**90734**
Goa	32	35	38	41	44
Gujarat	18335	19740	21216	22778	24431
Chhattisgarh	2752	2959	3157	3369	3594
Madhya Pradesh	11153	12378	13738	14958	15998
Maharashtra	17885	18990	20164	21412	22739
D. & N. Haveli	3	3	3	3	3
Daman & Diu	0	0	0	0	0
Western Region	**50158**	**54105**	**58316**	**62560**	**66809**
Andhra Pradesh	27667	29750	31994	34414	37022
Karnataka	17052	18237	19420	20764	22026
Kerala	318	329	341	348	355
Tamil Nadu	14141	14608	15087	15569	16058
Pudducherry	95	98	100	103	105
Southern Region	**59273**	**63022**	**66942**	**71196**	**75565**
Bihar	1597	1789	2003	2204	2424
Jharkhand	88	93	99	104	109
Orissa	217	239	264	292	324
West Bengal	2083	2281	2497	2734	2994
Sikkim	0	0	0	0	0
Eastern Region	**3984**	**4401**	**4863**	**5334**	**5851**
Assam	94	104	114	126	138
Manipur	1	1	1	1	1
Meghalaya	1	1	1	1	1
Nagaland	0	0	0	0	0
Tripura	53	58	62	67	72
Arunachal Pradesh	0	0	0	0	0
Mizoram	11	14	17	20	23
North Eastern Region	**161**	**177**	**195**	**214**	**235**
Andman& Nicobar Islands	0	0	0	0	0
Lakshadweep	0	0	0	0	0
All India	**179784**	**194559**	**210611**	**225044**	**239194**

Electrical Energy Consumption in Other category (in Million units)					
State/STU	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Delhi	7663	8195	8767	9379	10035
Haryana	15632	17801	20265	22407	24683
Himachal Pradesh	6140	6512	6907	7324	7763
Jammu & Kashmir	3007	3368	3773	4226	4733
Punjab	18209	20013	21999	23320	24679
Rajasthan	18211	20317	22658	25167	27883
Uttar Pradesh	25356	28438	31881	35571	39514
Uttarakhand	5511	5843	6194	6567	6962
Chandigarh	491	517	545	573	603
Northern region	**100220**	**111005**	**122987**	**134531**	**146856**
Goa	2341	2525	2721	2932	3158
Gujarat	37032	40169	43582	46870	50259
Chhattisgarh	9385	10100	10845	11644	12488
Madhya Pradesh	22678	25348	28354	31316	34234
Maharashtra	56670	61778	70417	72737	78891
D. & N. Haveli	4833	5124	5433	5758	6104
Daman & Diu	1887	2010	2141	2275	2417
Western Region	**134825**	**147052**	**163493**	**173532**	**187549**
Andhra Pradesh	32767	35559	38599	41911	45522
Karnataka	19325	20891	22581	23945	25377
Kerala	6065	6377	6704	7019	7339
Tamil Nadu	36239	39314	42647	46257	50166
Pudducherry	1489	1529	1570	1614	1659
Southern Region	**95887**	**103669**	**112104**	**120746**	**130062**
Bihar	7676	8505	9424	10435	11546
Jharkhand	15381	16409	17509	18604	19772
Orissa	16484	17403	18344	19150	20016
West Bengal	27546	29983	32657	35595	38822
Sikkim	131	141	160	172	190
Eastern Region	**67219**	**72441**	**78093**	**83956**	**90344**
Assam	2324	2512	2709	2916	3136
Manipur	193	216	242	268	296
Meghalaya	1177	1255	1349	1470	1596
Nagaland	116	132	153	167	183
Tripura	273	298	323	353	383
Arunachal Pradesh	163	183	205	225	247
Mizoram	156	177	196	225	248
North Eastern Region	**4404**	**4774**	**5177**	**5622**	**6088**
Andman& Nicobar Islands	60.37	64.44	68.51	72.58	76.66
Lakshadweep	3	3	3	4	5
All India	**402619**	**439011**	**481925**	**518464**	**560981**

ANNEXURE-3

Proposed Generation Addition up to 2018-19

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
1	Lower Jurala HEP	A.P.	APGENCO	State	Hydro	240
2	Pulichintala HEP	A.P.	APGENCO	State	Hydro	120
3	NagarjunaSagar TR HEP	A.P.	APGENCO	State	Hydro	50
4	Sri DamodaramSanjeevaiah TPP (Krishnapattnam TPP) U1,2	A.P.	APGENCO	State	Coal	1600
5	Rayalseema TPP U6	A.P.	APGENCO	State	Coal	600
6	Thamminapatnam TPP U3,4	A.P.	Meenakshi Energy Pvt Ltd.	Private	Coal	700
7	Nagarjuna Construction Company Ltd Ph-I U-1,2	A.P.	Ngarjuna Construction Co. Ltd	Private	Coal	1320
8	Painampuram TPP U 1,2	A.P.	Thermal Powertech. Corporation Ltd	Private	Coal	1320
9	Bhavanapaddu TPP U-1,2	A.P.	East Coast Energy	Private	Coal	1320
10	Thamminapatnam TPP U1,2	A.P.	Meenakshi Energy Pvt Ltd.	Private	Coal	300
11	Simhapuri TPP Ph-I, U 2	A.P.	Simhapuri Energy Pvt Ltd.	Private	Coal	150
12	Hinduja TPP,U1-2	A.P.	Hinduja	Private	Coal	1050
	SUB TOTAL (AP)					**8770**
1	Pare HEP	Ar. P	NEEPCO	Central	Hydro	110
2	Kameng HEP	Ar. P	NEEPCO	Central	Hydro	600
3	Subansiri Lower HEP	Ar. P	NHPC	Central	Hydro	1000
	SUB TOTAL (ARUNACHAL PRADESH)					**1710**
1	Bongaigaon TPP U 1,2,3	Assam	NTPC	Central	Coal	750
2	Namrup CCGT	Assam	APGCL	State	Gas	100
	SUB TOTAL (ASSAM)					**850**
1	Muzaffarpur (Kanti) TPP U 3,4	Bihar	NTPC JV	Central	Coal	390
2	Barh STPP-1 U 1,2,3	Bihar	NTPC	Central	Coal	1980
3	Barh STPP-11 U 1,2	Bihar	NTPC	Central	Coal	1320
4	Nabinagar TPP U1-4	Bihar	NTPC JV	Central	Coal	1000
	SUB TOTAL (BIHAR)					**4690**
1	Sipat-1 TPP U 3	Chhattisgarh	NTPC	Central	Coal	660
2	Korba West St.lll TPP US	Chhattisgarh	CSEB	State	Coal	500
3	Marwah TPP U1-2	Chhattisgarh	CSEB	State	Coal	1000

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
4	AvanthaBhandar TPP U1 Power Company Ltd.	Chhattisgarh	Korba West	Private	Coal	600
5	Maurti Clean Coal & Power Ltd.TPP U1	Chhattisgarh	Maurti Clean Coal & Power Ltd.	Private	Coal	300
6	LancoAmarkantak TPP U-3,4	Chhattisgarh	LANCO AmarkantakPvt Ltd	Private	Coal	1320
7	Uchpinda TPP U1-3	Chhattisgarh	R.K.M. Power	Private	Coal	1080
			Gen Pv1 Ltd			
8	Vinjkote (Darrampura) TPP U1-3	Chhatisgarh	SKS Ispat and Power Ltd.	Private	Coal	900
9	Akaltara (Nariyara) TPP U 1-3	Chhattisgarh	KSK Mahanadi Power Co.Limited	Private	Coal	1800
10	Kasaipalli TPP U 2	Chhattisgarh	ACB India	Private	Coal	135
11	SwastikKorba TPP U 1	Chhattisgarh	ACB India	Private	Coal	25
12	VandanaVidyut TPP U 1,2	Chhattisgarh	VandanaVidyut	Private	Coal	270
13	Balco TPP U-1,2	Chhattisgarh	Bharat Aluminium Co. Ltd	Private	Coal	600
14	Athena Singhtarai TPP U-1	Chhattisgarh	Athena Chhattisgarh Power Ltd.	Private	Coal	600
15	DB Power TPP U-1,2	Chhattisgarh	DB Power Ltd	Private	Coal	1200
16	TRN Energy TPP U-1,2	Chhattisgarh	TRN Energy	Private	Coal	600
17	Ratija TPP	Chhattisgarh	ACB India	Private	Coal	50
18	Raigarh TPP U1,2	Chhattisgarh	Jindal Power Ltd	Private	Coal	1200
	SUB TOTAL (CHHATTISGARH)					**12840**
1	Pragati -Ill (BAWANA) CCGT	Delhi	PPCL	State	Gas/LNG	750
	SUB TOTAL (DELHI)					**750**
1	KAPP U-3,4	Gujarat	NPC	Central	Nuclear	1400
2	Sikka TPP Ext. U3	Gujarat	GSECL	State	Coal	250
3	Ukai TPP EXT U6	Gujarat	GSECL	State	Coal	500
4	Pipavav JV CCGT Block-1,2	Gujarat	GSECL	State	Gas/LNG	702
5	Mundra UMPP, U 2	Gujarat	The Tata Power Company Ltd	Private	Coal	800
6	Salaya TPP U 2	Gujarat	Essar Power Salaya Ltd	Private	Coal	600

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
	SUB TOTAL (GUJARAT)					**4252**
1	Parbati-11 HEP	H.P.	NHPC	Central	Hydro	800
2	Rampur HEP	H.P.	SJVNL	Central	Hydro	412
3	Kol Dam HEP	H.P.	NTPC	Central	Hydro	800
4	Chamera-111 HEP	H.P.	NHPC	Central	Hydro	231
5	Parbati - Ill HEP	H.P.	NHPC	Central	Hydro	520
6	Kashang - I HEP	H.P.	HPPCL	State	Hydro	65
7	Uhl-111 HEP	H.P.	BVPC	State	Hydro	100
8	Sawara Kuddu HEP	H.P.	HPPCL	State	Hydro	111
9	Kashang II & Ill HEP	H.P.	HPPCL	State	Hydro	130
10	Sainj HEP	H.P.	HPPCL	State	Hydro	100
11	Tidong-1 HEP	H.P.	N S L Tidong Power Generation Ltd	Private	Hydro	100
12	Sorang HEP	H.P.	Himachal Sorang Power Pv1. Ltd	Private	Hydro	100
13	Tangnu Romai-1 HEP	H.P.	TangnuRomai Power Generation Ltd	Private	Hydro	44
14	Budhil HEP	H.P.	LANGO Green Power Pvt Ltd	Private	Hydro	70
	SUB TOTAL (HP)					**3583**
1	Indira Gandhi TPP (Jhajjar) JV U-3	Haryana	NTPC	Central	Coal	500
2	Mahatmi Gandhi Jhajjar TPP U2	Haryana	China Light Power	Private	Coal	660
	SUB TOTAL (HARYANA)					**1160**
1	Kishan Ganga HEP	J&K	NHPC	Central	Hydro	330
2	Uri-11 HEP	J&K	NHPC	Central	Hydro	240
3	NimooBazgo HEP	J&K	NHPC	Central	Hydro	45
4	Chutak HEP	J&K	NHPC	Central	Hydro	44
5	Baglihar-11 HEP	J&K	J&K State Power Development Corp. Ltd.	State	Hydro	450
	SUB TOTAL (J&K)					**1109**
1	Bokaro TPP A Exp U1	Jharkhand	DVC	Central	Coal	500
2	Koderma TPP U2	Jharkhand	DVC	Central	Coal	500
3	Mata ShriUsha TPP Ph-I U 1,2	Jharkhand	Corporate Power Ltd.	Private	Coal	540
4	Adhunik Power & Natural Resources Ltd TPP U1,2	Jharkhand	Adhunik Power & Natural Resources Ltd.	Private	Coal	540
	SUB TOTAL (JHARKHAND)					**2080**

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
1	Thottiar HEP	Kerala	KSEB	State	Hydro	40
2	Pallivasal HEP	Kerala	KSEB	State	Hydro	60
	SUB TOTAL (KERALA)					**100**
1	Vindhyachal TPP St-IV U-11,12	MP	NTPC	Central	Coal	1000
2	Satpura TPP EXT U-10,11	MP	MPGENCO	State	Coal	500
3	Shree Singhaji TPP U-1,2	MP	MPGENCO	State	Coal	1200
4	Annupur TPP Ph-I U1,2	MP	MB Power (Madhya Pradesh) Ltd	Private	Coal	1200
5	Bina TPP U 1,2	MP	Bina Power Supply Camp. Ltd (Jaypee Group)	Private	Coal	500
6	Sasan UMPP U 1,2	MP	Reliance Power Ltd.	Private	Coal	1320
7	Maheshwar HEP U 1-10	MP	SMHPCL	Private	Hydro	400
8	DB Power TPP, Sidhi U-1	MP	DB Power (Madhya Pradesh) Ltd	Private	Coal	660
9	Jhabua TPP U1	MP	Jhabua Power Ltd	Private	Coal	600
	SUB TOTAL (MP)					**7380**
1	Mauda TPP U1,2	Maharashtra	NTPC	Central	Coal	1000
2	Chandrapur TPP Ext. U 8	Maharashtra	MAHGENCO	State	Coal	500
3	Koradi TPP Ext U 8	Maharashtra	MAHGENCO	State	Coal	660
4	Parli TPP U3	Maharashtra	MAHGENCO	State	Coal	250
5	India Bulls-AmravathiTPP , Ph-1, U1-5	Maharashtra	India Bulls Power Ltd	Private	Coal	1350
6	India Bulls- Nasik TPP , Ph-1, U1-5	Maharashtra	India Bulls Realtech Ltd	Private	Coal	1350
7	Dhariwal Infrastructure (P) Ltd TPP U1,2	Maharashtra	Dhariwal Infrastructure (P) Ltd	Private	Coal	600
8	EMCO Warora TPP U1,2	Maharashtra	GMR EMCO Energy Ltd	Private	Coal	600
9	Butibori TPP Ph-II U1	Maharashtra	Vidarbha Industries Power Ltd	Private	Coal	300
10	Lanco Mahanadi, Vidarbha TPP U1,2	Maharashtra	Lanco Mahanadi Power Pvt Ltd	Private	Coal	1320
11	Tiroda TPP Ph-I U1,2	Maharashtra	Adani Power Ltd	Private	Coal	1320
12	Tiroda TPP Ph-II U1	Maharashtra	Adani Power Ltd	Private	Coal	660

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
13	GEPL TPP U1,2	Maharashtra	Gupta Energy Pvt Ltd	Private	Coal	120
14	Bela TPP U1	Maharashtra	Ideal Energy Projects Ltd	Private	Coal	270
	SUB TOTAL (Maharashtra)					**10300**
1	New Umtru HEP	Meghalaya	MeECL	State	Hydro	40
2	Myntdu St-I HEP Addl Unit	Meghalaya	MeSEB	State	Hydro	42
	SUB TOTAL (MEGHALAYA)					**82**
1	Tuirial HEP	Mizoram	NEEPCO	Central	Hydro	60
	SUB TOTAL (MIZORAM)					**60**
1	Derang TPP U1	Orissa	Jindal India Thermal Power Ltd.	Private	Coal	600
2	IndBarath Energy Pvt Ltd TPP U1,2	Orissa	IndBarath Power (Utkal) Ltd	Private	Coal	700
3	LancoBabandhDhenkanal TPP U1	Orissa	LancoBabandh	Private	Coal	660
4	K.V.K Nilanchal TPP U1	Orissa	K.V.K Nilanchal Power Pvt Ltd	Private	Coal	350
5	Kamalanga TPP U 1-3	Orissa	GMR Energy	Private	Coal	1050
6	Sterlite TPP U4	Orissa	Sterlite Energy	Private	Coal	600
	SUB TOTAL (ORISSA)					**3960**
1	Talwandi Sabo TPP U1-3	Punjab	Vedanta	Private	Coal	1980
2	Goindwal Sahib TPP U1,2	Punjab	GVK Industries	Private	Coal	540
3	Nabha TPP U-1,2	Punjab	L&T Power Development Ltd	Private	Coal	1400
	SUB TOTAL (PUNJAB)					**3920**
1	RAPP U 7 & 8	Rajasthan	NPC	Central	Nuclear	1400
2	Kalisindh TPP U1	Rajasthan	RRVUNL	State	coal	600
3	Chhabra TPP Ext U3,4	Rajasthan	RRVUNL	State	coal	500
4	Ramgarh CCGT	Rajasthan	RRVUNL	State	Gas	160
5	JallipaKapurdi TPP U 5,6	Rajasthan	Raj West Power Ltd	Private	Lignite	270
	SUB TOTAL (RAJASTHAN)					**2930**
1	Bhasmey HEP	Sikkim	Gati Infrastructure Ltd.	Private	Hydro	51
2	Jorethang Loop HEP	Sikkim	DANS Pvt. Ltd	Private	Hydro	96

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
3	Rangit-IV HEP	Sikkim	Jal Power Corp. Ltd.	Private	Hydro	120
4	Teesta-VI HEP	Sikkim	Lanco Energy Pvt. Ltd.	Private	Hydro	500
5	Teesta-111 HEP	Sikkim	TeestaUrja Ltd	Private	Hydro	1200
6	Chujachen HEP	Sikkim	Gati Infrastructure Ltd.	Private	Hydro	99
	SUB TOTAL (SIKKIM)					**2066**
1	Kudankulam U 1,2	TN	NPC	Central	Nuclear	2000
2	PFBR(Kalpakkam)	TN	NPC	Central	Nuclear	500
3	Vallur (Ennore) TPP U 2,3	TN	NTPC/TNEB JV	Central	Coal	1000
4	Tuticorin TPP JV U1,2	TN	NPTL (NLC JV)	Central	Coal	1000
5	Neyveli II TPP U2	TN	NLC	Central	Lignite	250
6	Bhawani Barrage HEP II & III	TN	TNEB	State	Hydro	60
7	Mettur TPP EXT U1	TN	TNEB	State	Coal	600
8	North Chennai TPP Ext U1,2	TN	TNEB	State	Coal	1200
9	IndBarath TPP U1	TN	IndBarath Power (Madras) Ltd	Private	Coal	660
	SUB TOTAL (TN)					**7270**
1	Tripura CCGT	Tripura	ONGC JV	Central	Gas	726.6
2	Monarchak CCGT	Tripura	NEEPCO	Central	Gas	101
	SUB TOTAL (TRIPURA)					**827.6**
1	Rihand TPP-111 U 5,6	UP	NTPC	Central	Coal	1000
2	Anpara-D TPP U 1,2	UP	UPRVUNL	State	Coal	1000
3	Parichha TPP EXT U-5,6	UP	UPRVUNL	State	Coal	500
4	Harduaganj TPP EXT U-9	UP	UPRVUNL	State	Coal	250
5	Sara TPP U1-3	UP	Prayagraj Power Gen. Co. Ltd (Jaypee Group)	Private	Coal	1980
	SUB TOTAL (UP)					**4730**
1	TapovanVishnugad HEP	Uttarakhand	NTPC	Central	Hydro	520
2	SingoliBhatwari HEP	Uttarakhand	L&T Power	Private	Hydro	99
3	PhataByung HEP	Uttarakhand	Lanco Kondapalli	Private	Hydro	76
4	Srinagar HEP	Uttarakhand	GVK	Private	Hydro	330
	SUB TOTAL (UTTARAKHAND)					**1025**

Sl. No:	Project Name	State	Developer	Sector	Fuel type	Capacity in MW
1	Teesta Low Dam-Ill HEP	WB	NHPC	Central	Hydro	132
2	Teesta Low Dam-IV HEP	WB	NHPC	Central	Hydro	160
3	Raghunathpur TPP U1,2	WB	DVC	Central	Coal	1200
4	Haldia TPP U1-2	WB	CESC	Private	Coal	600
	SUB TOTAL (WB)					**2092**
TOTAL						**88537**

YEAR-WISE THERMAL UNITS TO BE COMMISSIONED DURING THE YEARS 2017-18 AND 2018-19

State	Project Name	Impl. Agency	No. of units	Capacity in MW
YEAR 2017-18				
CENTRAL SECTOR				
Assam	Bongaigaon TPP	NTPC	U-2	250
			U-3	250
Bihar	Barh STPP- I		U-1	660
			U-2	660
	Nabi Nagar TPP		U-4	250
	New Nabi Nagar TPP		U-1	660
			U-2	660
			U-3	660
Chhattisgarh	Lara STPP		U-1	800
			U-2	800
Jharkhand	North Karanpura TPP		U-1	660
Karnataka	Kudgi STPP Ph-I		U-2	800
			U-3	800
Maharashtra	Mouda STPP-II		U-4	660
	Solapur STPP		U-2	660
MP	Gadarwara STPP		U-1	800
			U-2	800
Orissa	Darlipali STPP		U-1	800
UP	F.G Unchahar TPS St-IV		U-6	500
			Sub Total :	**12130**
STATE SECTOR				
AP	Rayalseema St-III U-6	APGENCO	U-6	600
Rajasthan	Chhabra TPP Extn.	RRVUNL	U-5	660
	Suratgarh TPS		U-7	660
			U-8	660
			Sub Total :	**2580**
PRIVATE SECTOR				
AP	Bhavanpadu TPP	M/s East Coast Energy Ltd.	U-1	660
			U-2	660
Chhattisgarh	Akaltara (Naiyara) TPP	KSK Mahandi Power Company Ltd	U-5(1st)	600
	Binjkote TPP	M/s SKS Power Generation (	U-3	300

State	Project Name	Impl. Agency	No. of units	Capacity in MW
		Chhattisgarh) Ltd.	U-4	300
	Lanco Amarkantak TPS-II	LAP Pvt. Ltd.	U-3	660
Jharkhand	Mata shri Usha TPP-Ph-I	M/s Corporate Power Ltd	U-1	270
			U-2	270
	Tori TPP	Essar Power	U-1	600
Maharashtra	Amravati TPP Ph-II	India Bulls	U-1	270
			U-2	270
	Nasik TPP Ph-I		U-3	270
			U-4	270
			U-5	270
	Nasik TPP Ph-II		U-1	270
			U-2	270
Orissa	KVK Nilanchal TPP	KVK Nilachal	U-2	350
	Lanco Babandh TPP	Lanco Babandh Power Ltd	U-1	660
			U-2	660
TN	Tuticorin TPP (Ind- Barath TPP)	IBPIL	U-1	660
			Sub Total :	**8540**
			Total (2017-18) :	**23250**
YEAR 2018-19				
CENTRAL SECTOR				
Bihar	Barh STPP- I	NTPC	U-3	660
Jharkhand	North Karanpura TPP		U-2	660
			U-3	660
Orissa	Darlipali STPP		U-2	800
UP	Meja STPP	JV of NTPC & UPRVUNL	U-2	660
WB	Raghunathpur TPP Ph-II	DVC	U-1	660
			U-2	660
			Sub Total :	**4760**
PRIVATE SECTOR				
Bihar	Jas Infra TPP Ph-I	JICPL	U-1	660
			U-2	660
			U-3	660
			U-4	660
Chhattisgarh	Akaltara (Naiyara) TPP	KSK Mahandi Power Company Ltd	U-6	600
	Deveri TPP (Visa TPP) Raigarh	Visa Power Ltd	U-1	600
	Lanco Amarkantak TPS-II	LAP Pvt. Ltd.	U-4	660
Jharkhand	Mata srhi Usha TPP-Ph-II	Corporate Power Ltd	U-3	270
			U-4	270
	Tori TPP	Essar Power	U-2	600
Maharashtra	Amravati TPP Ph-II	India Bulls	U-3	270
			U-4	270
			U-5	270
	Lanco Vidarbha TPP	Lanco Vidarbha	U-1	660
			U-2	660
	Nasik TPP Ph-II	India Bulls	U-3	270

State	Project Name	Impl. Agency	No. of units	Capacity in MW
			U-4	270
			U-5	270
MP	Gorgi TPP (DB Power)	D.P Power (MP) Ltd	U-1	660
Orissa	KVK Nilanchal TPP	KVK Nilachal	U-3	350
			Sub Total :	**9590**
			Total (2018-19) :	**14350**
			Total (2017-19):	**37600**

ANNEXURE-4

Distribution Schemes and Investment Plans

National Electricity Fund (NEF)

The Working Group on Power (12th plan) estimate the requirement of funds for the power sector at Rs.10,31,600Cr. Of this, the distribution sector is identified as the most important and the weakest link in the power sector value chain, which channelizes all the revenues and responsible for overall stability of the sector. Considering the relevance, Government of India has approved the NEF (Interest Subsidy) Scheme to promote the capital investment in the distribution sector by providing interest subsidy, linked with reform measures, on the loans taken by public and private power utilities for various capital works under distribution projects. This scheme is applicable in the entire country and all the works except the works covered under RGGVY & R-APDRP projects. These projectsare not eligible so as to ensure non-duplication and non-overlapping of grant/subsidy towards investment. NEF Scheme have provision to provide interest subsidy and other charges aggregating to Rs 8466 Crs for a period of 14 years on loans availed by the distribution utilities in both public and private sector. The Creation of National Electricity Fund is more relevant since this will encourage utilities to match the investments with the planned Generation capacity targets for XII Plan.

Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

In order to attain National Common Minimum Programme (NCMP) goal of providing access to electricity to all rural households and electrification of all villages. Government of India, in April, 2005 conceived “Rajiv Gandhi Grameen Vidyutikaran Yojana” (RGGVY) to electrify all un-electrified villages / habitations and to provide access to electricity to all rural households in un-electrified and electrified villages in the entire country. The scheme covers electrification of all the villages in the country except the villages under the programme of Ministry of Non-conventional Sources (MNES) for providing electricity from non-conventional energy sources under their remote village electrification programme. With the launch of this scheme the existing “Accelerated Electrification of One lakh Villages and One Crore Households" and the Minimum Needs Programme for rural electrification got merged with RGGVY.The scheme is being implemented through the Rural Electrification Corporation (REC) which has been designated as Nodal Agency by Ministry of Power.

The scheme has the following important features:

- 90% capital subsidy is provided towards overall cost of the projects under the scheme. 10% of the project cost is contributed by States through own resources / loan from financial institutions.
- Prior commitment of the States has been obtained before sanction of projects under the scheme for:

  A. Guarantee by State Government for a minimum daily supply of 6- 8 hours.

  B. Free of cost service connection to all families Below Poverty Lines.

Scope of the scheme

- Rural Electricity Distribution Backbone (REDB)
  - Creation of REDB with atleast one 33/11 kV (or 66/11 kV) sub-station in each block. New 33/11 KV sub-station, augmentation of existing 33/11 KV sub-station, construction and augmentation of 33/11 KV lines required for catering to RGGVY loads.

Village Electrification Infrastructure (VEI)

  - Creation of VEI with at least one distribution transformer in each village / habitation. It also consists of LT Lines / LT AB Cables

Household connections

  - Free of cost service connection to all families Below Poverty Lines

Decentralized distribution-cum-generation (DDG)

  - Creation of DDG systems in villages where grid supply is not feasible or not cost effective from conventional or renewable resource. The funding is on same pattern of 90% subsidy from Government of India and 10% loan from REC or from own funds of the State. 90% capital subsidy also includes cost of operation for 5 years.

Financial Outlay:

For XII Plan projects	Rs. 22,598 Cr.
Subsidy for spillover works	Rs. 12,849 Cr.
Total Capital Subsidy	Rs. 35,447 Cr.

ANNEXURE-5

Renewable Energy Roadmap & Management

Renewable energy as an alternative source of power

The wind power capacity in the country, up to the end of 9th Plan i.e. 2001-02 was just 1667 MW, which has gained acceleration and reached around 21,693 MW as on 31.07.2014 (Source: MNRE: India's renewable energy capacity increases drastically in Q4 of 2013-14). With this installed wind energy, Renewable Energy Sources (excluding large Hydro) currently accounts for 13.86% of India's overall installed power capacity of 21693 MW. Wind Energy holds the major portion of 64.85% (of 33447.17 MW total RE capacity) among renewable and continued as the largest supplier of clean energy. In its 12th Five Year Plan (2012-2017), the Indian Government has set a target of adding 19 GW of renewable energy sources to the generation mix out of which 11 GW is the Wind estimation and rest from renewable sources like Solar 4 GW and others 3.5 GW[1].

Most of the renewable capacity addition is in the renewable potential rich states of Tamil Nadu, Maharashtra, Karnataka, Gujarat and Rajasthan. These five states contribute more than 80% of total renewable capacity installation in the country. The state wide wind installed capacity has been presented in Table

Table B: Wind installed Capacity in India by 31st May 2014

States	Installed Capacity (MW)
Tamil Nadu	7276
Maharashtra	4098
Gujarat	3414
Rajasthan	2820
Karnataka	2409

The rapid expansion of renewable energy sources gives rise to a number of challenges for power system operators and electricity market participants. The important challenges include scheduling, system control and dispatch; reactive supply and voltage control; regulation and frequency response reserve; energy imbalance service; operating synchronized reserve; and operating supplemental reserve. In the past 15 years, considerable research has been carried out to understand the impact of variable generation on the grid. However, in the recent years, the importance of variable generation forecasting has been stressed in several industry reports. Few of the issues related to large scale renewable energy integration are listed below:

1. Variability and predictability

[1] IWTMA

2. Role/Purpose/Use of forecasts and schedules
3. Treatment of renewable energy sources and its unique characteristics
4. Policy Issues
5. Changes in Market mechanism to promote Renewable energy
6. Technical challenges
7. Economic challenges
8. Willingness

Among the various renewable energy resources, solar energy potential is the highest in the country. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. The annual radiation varies from 1,600 to 2,200 kWh/m^2, which is comparable with radiation received in the tropical and sub-tropical regions. The equivalent energy potential is about 6,000 million GWh of energy per year. The National Action Plan on Climate Change also points out: "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy, thereby empowering people at the grassroots level".

With the objective to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible Government of India launched National Solar Mission.

The National Tariff Policy was amended in January 2011 to prescribe solar-specific RPO to be increased from a minimum of 0.25 per cent in 2012 to 3 per cent by 2022. CERC and SERCs have issued various regulations including solar RPOs, REC framework, tariff, grid connectivity, forecasting etc. for promoting solar energy. Many States have come up with up their own Solar Policy.

In view of the ongoing efforts of Central and State Governments and various agencies for promoting solar energy, Ministry of New and Renewable Energy has undertaken an exercise to track and analyze the issues in fulfillment of Solar Power Purchase Obligation and implementation of Solar REC framework in India. This would help various stakeholders to understand the challenges and opportunities in the development of solar power. It would also include monitoring of Solar RPO Compliance; analyzing key issues related to the regulatory framework for solar in various states of India.

The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010 by the Prime Minister. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 is aimed at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022. Mission will create an enabling policy framework to achieve this objective and make India a global leader in solar energy.

As described earlier, in order to meet the 24x7 power supply, the renewable energy addition is an important option. However, in order to integrate renewable energy successfully into the grid, the following measures need to be under taken

a. Establishment of "Renewable Energy Management System" at least in the 7 States Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Gujarat, Rajasthan and Madhya Pradesh to begin with to monitor the renewable energy generation in real time basis and perform the forecasting and scheduling of the renewable power once in 15 minutes block. This center will give one single consolidated renewable power generation value every 15 minutes block to State load dispatch center for each hour for rolling 24 hours. This will enable the proper scheduling of the rest of the generation in the State.
b. In order to have higher penetration of the renewable energy generation, ancillary services like frequency balancing mechanism, hour ahead market should be developed. The frequency balancing is possible through gas based power plants, hydro plants, pumped storage plants and also emerging cost effective storage technologies. Once the proper tariff signals are given and the policy is in position, power plants to provide these services will be setup.
c. The main issue of Renewable energy rich states is regarding the deviation mechanism. The present deviation mechanism restricts the deviation to be less than 150MW and imposes penalty accordingly. As it is noted that the renewable energy generations are variable in nature and it would not be possible to balance their variation within the State boundary. With this large penetration, the balancing may occur within the Regional Boundary or sometimes maybe beyond the Regional boundary also. There is a need to relook into the present deviation

mechanism for large penetration of Renewable energy sources. For example, for the wind variation in Tamilnadu and Karnataka, the hydro resources in Karnataka, Kerala and Andhra Pradesh can be used for balancing services. The hydro capacity in Southern region to an extent of 9000 MW can manage the variation in the wind and solar provided an accurate forecasting and management system is put in place.

d. The power number of the interconnected system in the country being about 4000 MW as on date (continue to increase over the period with increase in demand), for 4000 MW sudden variation in the renewable energy, the frequency variation is only 1 Hz. With the help of frequency balancing mechanism, this variation can be corrected. In order to mitigate the network congestion during the variation in the renewable energy power generation, it is advised to strengthen the inter regional and also the interstate network to accommodate higher renewable power in renewable rich states.

e. There is already a thought process to mandate the generation linked RPO compared to utilization based RPO. Speedy implementation of this mechanism will enable the fast track implementation of solar and wind power projects. Generating companies are better equipped to meet the RPO compared to distribution companies.

f. In order to maintain the Voltage in stipulated limits, at point of Common Coupling (PCC), under different RE generation scenarios, Static as well as Dynamic reactive support is essential. For this, Reactive compensation is to be provided at strategic locations in the form of Switchable /Thyristor Controlled Reactors (TCR) as well as Dynamic VAR compensator such as STATCOM/SVC. In order to address high voltage situations, Bus reactors at RE pooling stations are the solution. However at some places, in view of the variable reactive absorption requirement, Thyristor Controlled Reactors (TCR) is found to be an appropriate solution.

g. Operational/Technical Requirement of Large Scale Wind/Solar Integration

Successful operation of power system requires continuously achieving a balance between generation output and system load plus losses. This delicate balance must be maintained over periods ranging from instantaneous to years ahead. Such a wide boundary encompasses machine and system transient response, automatic governor action, Automatic Generation Control, and dispatch, unit commitment, capacity procurement and infrastructure developments.

Balancing resources and other infrastructure include;

- Reserves like spinning/hot reserves, quick ramp up plants like pumped storage/gas turbines as well as frequency dependent loads in the system to address power-balance.
- Flexible Generators which can respond to system requirement.
- Demand Side Management & Demand Response.
- Energy storage.
- Strong transmission interconnections.
- State-of-the-art in Centralized Forecasting centre and integration with SCADA through telemetry.
- Suitable market design to handle reserves for power balancing.
- Possibility must be explored to regulate or continuously control wind power through means like pitch control, wind farms SCADA etc.
- Deployment of synchrophasor technology i.e. PMUs/WAMS on pooling stations and interconnection with centralized control centre through Fiber optic communications for real time information, monitoring and control.
- FACTS devices such as STATCOM/SVC at strategic locations in the grid
- Relay Protection coordination.

ANNEXURE-6

Transmission & Distribution Losses

(From CEA General Review Report)

States/UT	T & D losses in %				
	2008-09	2009-10	2010-11	2011-12	2012-13
NORTHERN REGION					
Delhi	22.20	22.09	20.04	19.32	22.11
Haryana	30.74	31.00	29.66	28.58	35.95
Himachal	15.51	20.52	22.22	18.62	19.14
J & K	58.02	67.35	63.27	61.78	56.63
Punjab	23.08	23.39	25.10	23.08	20.30
Rajasthan	31.47	29.99	27.87	27.94	24.93
Uttar Pradesh	30.94	33.15	34.01	32.35	26.88
Uttarakhand	41.79	25.27	29.97	28.67	26.93
Chandigrah	22.36	23.19	20.25	23.67	19.32
NR	**29.78**	**30.21**	**29.87**	**28.66**	**27.22**
WESTERN REGION					
Gujarat	24.07	22.77	19.24	21.81	18.48
Madhya Pradesh	38.46	38.32	37.62	34.47	31.45
Chhattisgrah	26.38	18.62	15.06	16.45	28.83
Maharastra	23.88	25.16	20.68	19.99	21.82
Goa	17.12	16.99	15.27	12.43	13.35
Daman & Diu	20.06	17.19	16.83	14.50	15.61
Dadra & Nagar Haveli	15.57	11.21	10.14	12.07	9.86
WR	**26.23**	**25.77**	**22.50**	**22.39**	**22.66**
SOUTHERN REGION					
Andhra Pradesh	19.56	18.37	16.59	17.46	19.30
Karnataka	17.03	18.76	17.34	12.66	11.14
Kerala	13.16	19.59	18.29	17.23	17.73
Tamilnadu	18.14	18.41	13.47	16.34	14.51
Puducherry	12.24	11.84	12.41	14.66	13.53
Lakshadweep	24.87	11.59	25.65	22.47	18.60
SR	**17.96**	**18.50**	**15.81**	**15.81**	**15.66**
EASTERN REGION					
Bihar	46.37	43.58	50.77	50.89	49.42
Jharkhand	24.27	22.24	17.07	14.34	13.58
Orissa	42.65	37.00	42.47	44.63	39.84
West Bengal	16.79	18.33	22.40	23.19	24.07
Sikkim	38.80	39.01	33.67	31.12	28.14
Andaman	24.16	19.76	20.68	18.16	18.14
ER	**28.48**	**26.57**	**29.70**	**30.20**	**28.72**
NORTH EASTERN REGION					
Arunachal Pradesh	46.88	48.04	47.12	46.25	46.00
Assam	37.59	32.82	34.17	33.48	30.68
Manipur	63.37	54.66	50.87	40.45	35.12
Meghalaya	37.45	39.06	35.77	30.97	23.64
Mizoram	52.70	53.80	45.63	47.73	37.79
Nagaland	58.30	56.91	48.24	41.53	40.16
Tripura	35.78	35.55	27.36	39.07	31.73
NER	**41.33**	**38.56**	**37.03**	**35.94**	**31.92**
All India	**25.47**	**25.39**	**23.97**	**23.65**	**23.04**

ANNEXURE-7

Electrification of remote households through Distributed Generation

Introduction

Rural electrification is characterised by geographical remoteness, dispersed consumers, higher costs of supply and maintenance, low consumption and limited ability to pay. Successful community rural electrification projects generally require community participation and supportive institutional frameworks. In order to achieve the electrification of remote households, distributed generation mechanism can be implemented.

Distributed Generation (DG), which is electricity generation located close to the load/demand. While the definition of DG is far from "settled", here in this context, DG will refer to electricity generation that is produced and consumed within the catchment area of the local Distribution Network Service Provider (DSNP). Many in the energy economics and policy literature also use the term "embedded generation", which tends to reflect DG that has been incorporated into a larger electricity grid (but often still retains the ability to operate in isolation from the grid).

The two types of DG most commonly used are individual household electrification (the most common method being solar home systems (SHS)) and mini/micro-grids.

- Distributed Generation is more able to match growing demand by using smaller units, thereby reducing the impact of large stepwise additions to centralised generation capacity. The "lumpiness" of investment, in generation assets has long been seen as not only an optimal timing issue but also a soothsayer for dramatic shifts in price.
- Distributed Generation allows for reduced electrical losses from T&D by locating generation close to the point of use. Although it has since been shown that the ability for DG to reduce distribution losses is highly dependent on the rate of deployment and its percentage of total load in that network.
- Distributed Generation is modular and can be tailored to end-user requirements.

Individual Household Electrification

Household electrification is considered to be at the very small scale and has been used primarily in developing countries that have previously had no access to electricity. These systems are generally scalable and can therefore cater to different electricity requirements. However, due to the high cost per kWh they tend to only be used to satisfy basic electricity requirements including lighting, radios, TVs, and to recharge batteries. Household electrification presents some advantages over a mini-grid especially when provided to households that have not previously had access to electricity. This is because it is not necessary to construct infrastructure to distribute electricity throughout a community, and newly electrified households tend to have relatively low electricity requirements (at least initially). When used for lighting and charging batteries (small units) household systems tend to be relatively inexpensive and not offer 24 hour a day power. This method of electrification has been favoured by many international donor agencies as a method for providing basic electricity needs - primarily via solar home systems (SHS).

Household electrification when combined with appropriate training and a suitable institutional framework is an effective method of providing basic electricity needs. Powering whole communities via individual distributed generators (whether via solar or other methods) is expensive, as economies of scale generally cannot be exploited. Further, even for communities that are not grid-connected, electricity distribution infrastructure is already in existence and can be exploited by larger systems. Consequently, household scale electrification will not be considered further in this review. Mini-grid systems are more closely aligned with existing institutional frameworks and can exploit existing infrastructure. Success of an electrification program tends to be reflective of the institutional framework underpinning it.

Mini-grids

Mini-grids represent a compromise between scale, and adaptability to exploit local resources. They allow community scale electrification, centralisation of maintenance and repair responsibilities, and have been used with varying degrees of success around the world.

The key benefits of mini-grids include economies of scale, the ability to exploit local energy resources for electricity generation, scalability of production, matching generation capacity to community requirements, having electricity available for public buildings.

Mini-grids are generally suited to communities where the population is less dispersed as this minimises the distribution network costs. They can provide 24 hour electricity and the capacity for that power to be used for a range of applications comparable to consumers connected to conventional electricity grids.

Mini-grids also have the potential to be incorporated into large centralised grids if those grids ever expand sufficiently to include the relevant community. In this way, they can be a valuable transitionary electrification alternative to ensure reliable electricity access while centralised grids expand. Some technical issues have been identified regarding the integration of DG systems into larger grids. These generally relate to network stability and reinforcement and connection costs. Nevertheless, the prospect of grid-connected communities powered with DG that can also be isolated from centralised grids is advantageous, especially to communities that are in a grey area (or just beyond) where the viability of grid extension is too low at the time of electrification.

Mini-grids provide a practical alternative to grid extension, while still having the capacity to provide electricity in a manner similar to centralised electricity grids. The potential to exploit local resources (when utilising renewable technologies), and cater for community characteristics, while avoiding excessive costs associated with grid extension is also significant. It allows for more practical implementation of renewable energy into established distribution networks (both on and off-grid).

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