LIGHT AT THE END OF THE TUNNEL: INDIAN POWER SECTOR CHALLENGES & OPPORTUNITIES

- Subodh Garg, Director General, NPTI, JSS Rao, Principal Director, NPTI

Power sector is the most important sector among various infrastructure sectors in the country. The existence and development of adequate power infrastructure is essential for sustained growth of the economy. The availability of reliable and inexpensive Power is critical for the sustainable economic development of our nation. Thus, it is imperative that the growth in Power Sector should be commensurate with the GDP growth rate of around 8-9 %.

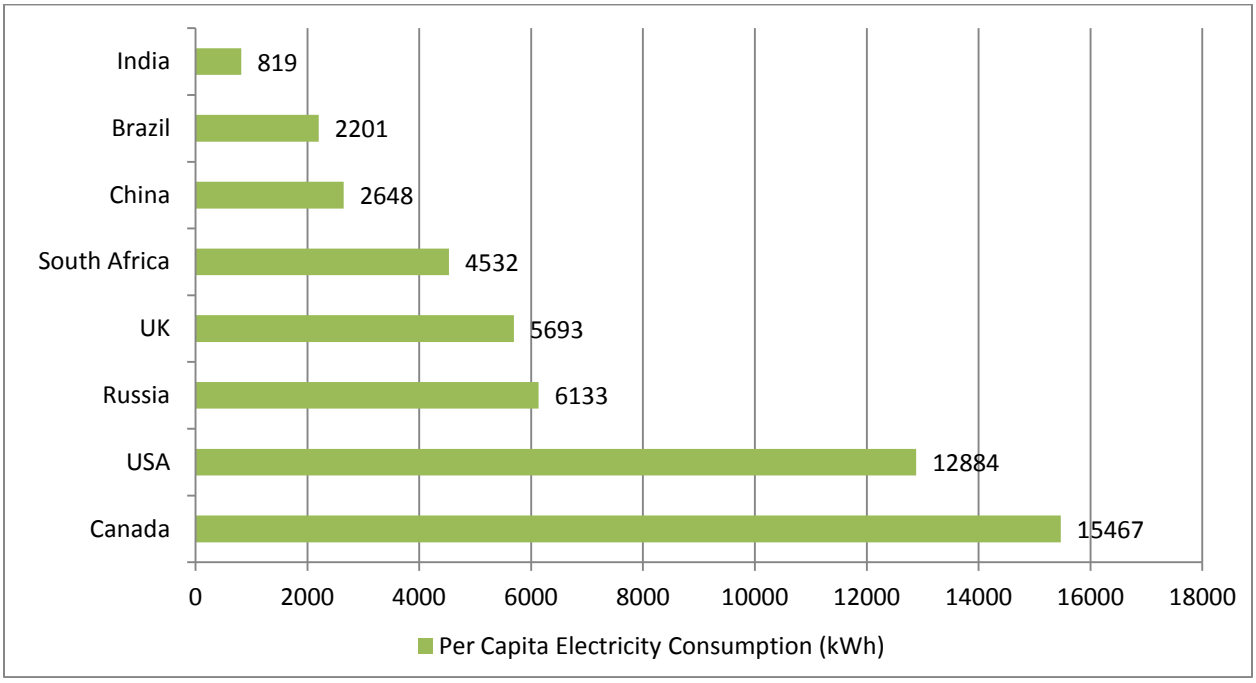
The Indian Power sector has grown significantly since independence and the generation capacity has increased from 1,362 MW in 1947 to over 2,00,000 MW in April 2012. Despite significant growth in electricity generation over the years, the shortage of Power continues to persist primarily on account of the growth in demand for Power outstripping the growth in generation and capacity addition. The gap between demand and supply exists, leading to consistent Power shortages. Even after considerable growth in the Power sector infrastructure and the supply of electricity, many parts of the country continue to face Power shortages as consumption by commercial and industrial consumers has been increasing at a much faster rate than electricity supply.

Power sector is a highly capital intensive business with long gestation periods before commencement of revenue streams with construction period of 4-5 years in case of Thermal Projects and 8 -10 years for Hydel Projects. Since most of the projects have a long time-frame, there are some inherent risks in both the internal & external environment. If we expect our economy to keep growing at 8-9% per annum, we need a commensurate growth in Power supply. Power sector has made good progress over the past few years. It has also seen very significant changes. Utilities have been restructured. Strong regulatory Institutions have been established. There is much greater public participation in Tariff-setting exercise. Tariff distortions have reduced over a period of time. Even after doing all this, we have not been able to meet the demand and improve financial health of distribution sector.

India’s Power sector is witnessing a turbulent phase and the Investors are wary of the challenges that need prompt addressal. It is important for all of us to introspect our achievements and analyze the challenges that the Sector is currently facing.

Power is one area of infrastructure where India lags behind in comparison to other developing countries. The Per capita annual consumption of electricity in India is one of the lowest in the world at approximately 819 kWh during the Year 2009.

Figure 1: Per Capita Electricity Consumption of various Countries during Year 2009



**Source: CEA- Growth of Electricity sector in India from 1947-2012*

CHALLENGES IN DISTRIBUTION SECTOR

Power sector cannot deliver on its social commitments unless it is commercially and financially viable. The Distribution Sector plays a crucial role in the overall functioning of the Power Sector. The Distribution sector provides the last mile connectivity of Power to the consumer. Government is emphasising on an efficient and well performing Distribution sector and focusing on the improvement of financial health of utilities towards providing reliable and quality power supply and universal access to power.

Apart from a few franchisees and privatized utilities, the Distribution sector is owned by State Utilities. The recent years have been a witness to growing concerns over the financial health of Distribution Utilities. The low collections and cash deficit scenario of the Distribution sector in turn severely impacts the financial viability of Generation and Transmission sectors as well.

Table1: Distribution Sector bottlenecks

➢ Under investment
➢ Unmetered service
➢ Over stretched systems
➢ Revenue covers only 70-75% of the cost.
➢ Significant Aggregate Technical & Commercial (AT&C) losses, largely due to theft and unmetered supply
➢ Rising gap between Cost of Supply & Revenue realized
➢ LT-HT line ratio is high and the Distribution Transformer lines are overloaded
➢ Skewed Tariff structure
➢ Lack of accounting and accountability
➢ Outdated Rules, Regulations, Management structure and Practices

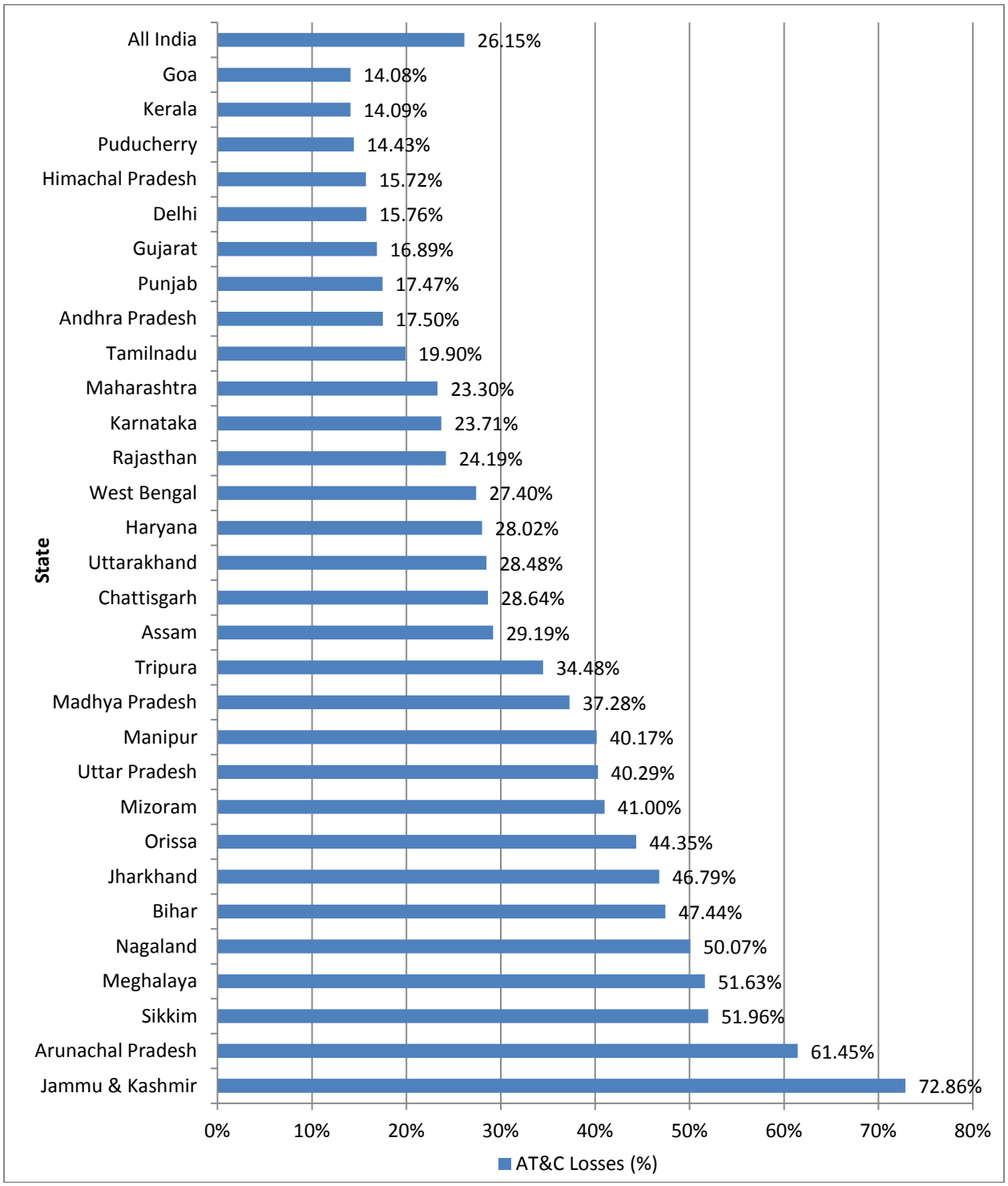
Some of the challenges in Distribution sector are highlighted in the next paragraphs.

(a) High AT&C (Aggregate Technical & Commercial) Losses:

The Distribution sector provides the last mile connectivity of sector to the consumer. At the same time, it has been the weakest link in the country's Power value chain. High Aggregate Technical & Commercial Losses are the biggest challenge to the Distribution sector. At present, Average annual AT&C loss is estimated to be around 26.15% for FY2010-11. However, there is a wide variation in the loss levels for different states. In some states, the losses are more than 40% while some others have been able to bring down these losses considerably.

High levels of AT&C loss poses a major challenge as a significant portion of the generated power is lost or goes unaccounted. This has largely been on account of old and outdated sub-transmission, poor distribution infrastructure and heavy commercial leakages.

Figure2: AT&C Loss % for FY 2010-11



**Source: PFC Report - Performance of State Power Utilities for FY2008-09 to FY2010-11*

Although over the years, the Transmission and Distribution losses have decreased, it has declined at a slow pace. It still continues to be much higher than T&D loss levels in other countries of the world. The scale of losses in the Distribution segment of Power sector is simply unsustainable to maintain the financial viability of the sector. A number of technical and non-technical factors contribute to the high Transmission and Distribution losses. These include populist measures of granting free or subsidized power supply to agricultural users, lack of consumer education, theft and inefficient use of electricity. Inadequate investments in the sector over the years have also resulted in overloading the distribution system elements. The major portion of the losses are due to theft and pilferage. Apart from rampant theft, the Distribution sector is affected by poor billing and collection efficiency in most of the States. More than 75-80% of the total technical loss and almost the entire commercial loss occur at the distribution stage.

The Transmission and Distribution losses in the developed countries vary in the range of 4 to 8%. Countries in Europe and United States of America have T&D losses of about 6 to 8 %. Developed countries have far lower loss levels compared to India. No other comparable developing country revenue loses on this scale. China at T&D loss level of approximately 6% is ahead of many developing countries.

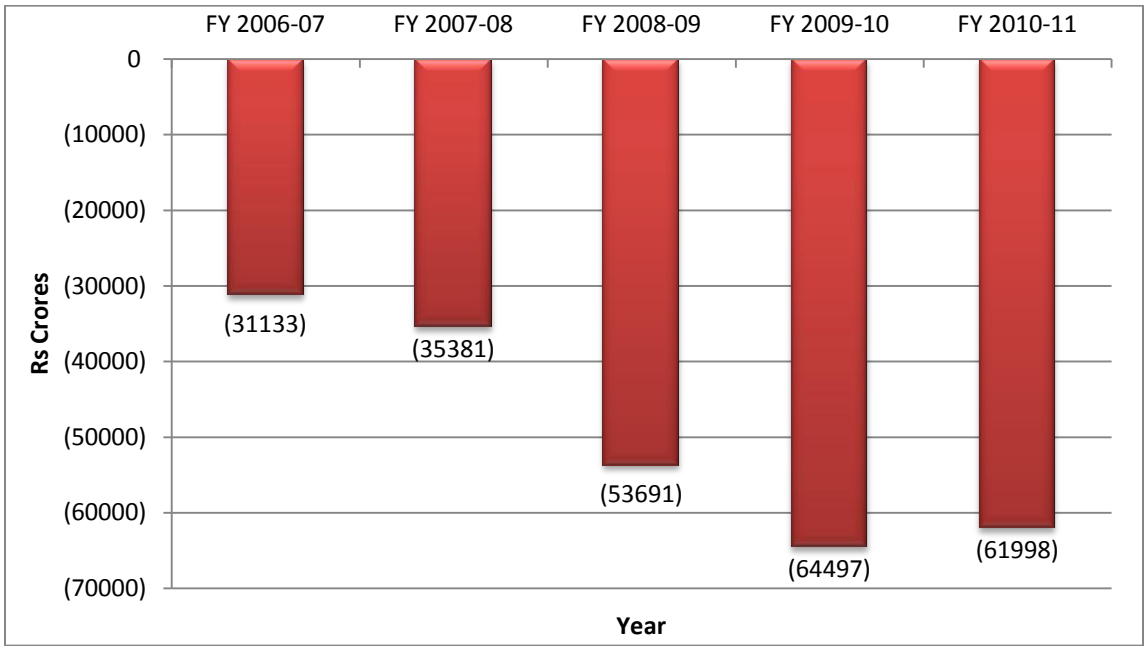
Table2: T&D Loss % for various Countries for year 2009

Country	**T&D Loss (%)**
India	25.39%
Brazil	16.44%
Russia	13.47%
UK	7.65%
Australia	7.37%
USA	6.68%
China	5.58%
World Average	**9.17%**

**Source: CEA- Growth of Electricity sector in India from 1947-2012*

The financial health of Distribution utilities in the country is a matter of concern. The Aggregate losses (without accounting for subsidy) for all the utilities rose to Rs. 61,998 Crs in FY2010-11.

Figure 3: Aggregate Losses without accounting for Subsidy – All Utilities

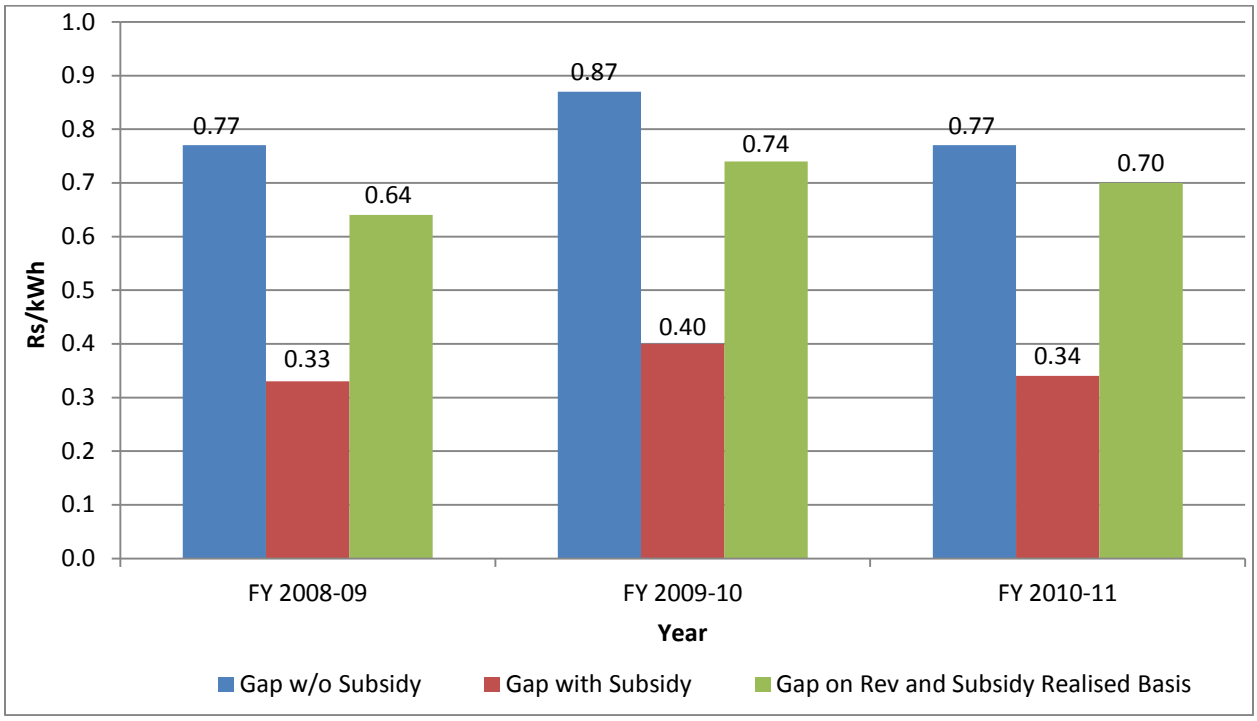


**Source: PFC Report - Performance of State Power Utilities for FY2008-09 to FY2010-11*

The Average cost of supply has increased from Rs 3.40/kWh in the year FY2008-09 to Rs 3.55/kWh in FY2009-10 and to Rs 3.78/kWh in FY2010-11. The Average revenue (without considering subsidy) increased from Rs 2.63/kWh in the year FY2008-09 to Rs 2.68/kWh in FY2009-10 and to Rs 3.01/kWh in FY2010-11.

The Revenue gap for the period FY2008-09 to FY2010-11 is summarized in the chart below:

Figure 4: Revenue Gap (Rs/kWh)



**Source: PFC Report - Performance of State Power Utilities for FY2008-09 to FY2010-11*

(b) Tariff Rationalization

It has been seen that Tariff is not appropriate to meet the cost of supply of electricity. This hinders the sustainability of Distribution companies. State Utilities/Regulators should examine the possibility of increasing the tariff in respect of agriculture, Industrial, Commercial and domestic sector for providing adequate revenue subsidy. Unless the Tariffs are made rational, Distribution companies will reach break down level due to financial imprudence.

(c) 100% Metering of consumers

Metered supply to consumers leads to correct estimates of losses, subsidies, incentives, and effective planning and implementation. There is an urgent need to identify an action plan for 100% metering of consumers and implementation. The recommended focus areas with regard to metering of consumers in the XII Plan are as follows:

- Identifying the unmetered consumers
- Metering of consumers should be initiated in phases depending on prioritization such as Urban, Rural etc.
- Implementation of prepaid metering

(d) Lack of credible database

Most of the Distribution utilities do not have IT based information system and thus struggle to maintain a comprehensive database. Lack of accurate information hinders decision making especially in arresting theft, making investments and estimating losses. IT based information system can be a key enabler in electricity distribution business to set baseline and measure performance.

(e) Energy accounting & auditing covering all feeders and Distribution Transformers (DTs)

Despite the focus given to proper energy accounting and auditing, metering especially for rural, domestic and agriculture consumers is still to be completed. This in turn puts a question mark on the veracity of the Distribution loss figures in itself as reported by the utilities based on estimated consumption taken for unmetered consumers.

MEASURES TO CHECK AT&C LOSS

Various approaches that can be followed to reduce AT&C loss are indicated in the following paragraphs:

(i) Private sector participation in Distribution

Privatization and Distribution Franchisee models have been attempted in some states. Delhi and Orissa experimented with privatization of Distribution utilities. Though Orissa was the first state to segregate electricity distribution business from generation and transmission, it did not work well due to lack of transitory support, tariff inadequacy and lack of implementation of theft-control measures.

On the other hand, privatization of distribution business in Delhi reflects success as it took adequate care about the shortcomings of the Orissa model. Bhiwandi in Maharashtra is an example of successful distribution franchisee experiment. Torrent Power in Bhiwandi has been successful in bringing down the AT&C losses in the region from 54.64% to 20.20%. The metering in the region has improved from 23% to 100%. After Bhiwandi experiment, several other towns including Nagpur, Aurangabad and Jalgaon were also awarded to distribution franchisees. Many other distribution companies are considering appointing distribution franchisees. Distribution reforms in Delhi and other Franchisee Models have led to positive results. This is being reflected in reduced AT&C losses, low deficit situation, improving quality of supply parameters and no subsidy to Discoms.

(ii) Use of HVDS & ABC Cables

In the High Voltage Distribution System (HVDS), long length Low Tension (LT) lines are converted into 11 kV lines by installing the appropriate capacity of distribution transformer near to the end and the supply is provided to the consumer at suitable

voltage level. By converting the lines to HVDS, the current flowing through the lines reduces significantly which helps bring down the technical losses in the LT line drastically. HVDS is recommended to improve the quality of supply and reduce line losses. Moreover, unauthorised hooking of loads is not possible as LT lines are short and insulated. There are reduced burnouts of motors because of good voltage and fewer fluctuations. The major advantage of using Aerial Bunched Cables (ABC) in HVDS are that the faults on LT lines are totally eliminated which increases reliability and theft by direct tapping is also avoided.

(iii) SCADA & IT application

Due to inadequate metering and data collection system in place, utilities have not been able to conduct energy audit, which is crucial for any energy business. Discoms do not have proper load monitoring and control mechanisms (e.g. SCADA, Distribution Control Centre, telecommunications etc.), which results into haphazard control of the demand and often leads to loss of revenue and inconvenience to the consumers. Supervisory Control and Data Acquisition Systems (SCADA) are vital in ensuring greater efficiency and reduction of AT&C losses. This enables real time communication, information storage and energy loss calculations.

(iv) Use of Remote Meters

Automatic Meter Reading (AMR) is often referred to as Smart Metering. AMR notes the meter readings remotely & electronically eliminating any chances of errors that are associated with manual data recording. By implementing AMRs, the utilities can save the time and resources that are required to visit the site and record meters manually. It also ensures that the meter reading is accurately noted and hence the cash flow to the utility gets improved. The utilities are able to identify any tampering with the meters immediately. The defects in the meters are also identified promptly.

The amount of data read by electronic meters has increased manifold and meters have to be read more often for load profiling and analysis. AMR has become a necessity for effective energy management, energy accounting and to overcome the problems of manual readings. The preparation of electrical network database, consumer indexing and documentation is the first step for effective AMR and correct energy accounting.

(v) Distribution Transformer & Feeder-wise Metering

The Distribution Transformer metering is a prerequisite for carrying out energy audits and identify the high loss area in the LT system. The overall DT metering in the country is still low in most of the states. States should also endeavor to achieve 100% metering at Feeder Level.

(vi) Reactive Power compensation by Capacitors

The Reactive Power compensation if suitably designed is capable of improving voltage quality significantly. The losses in equipment and Power systems are reduced, the permissible loading of equipment can be increased, and the over-all stability of system operation gets improved.

Shunt compensation with capacitor banks reduces kVA loading of lines, transformers, and generators, which means with compensation they can be used for delivering more power without overloading the equipment.

(vii) Separation of Agriculture & Distribution Feeders

There is an urgent need to focus on segregation of agriculture and rural feeders. By separation of agriculture and rural feeders, agricultural load can be given supply during off peak hours, resulting in better utilization of installed generation capacity. The CEA data reveals that estimated agricultural connected load in country is more than 66000 MW contributing to 19% of the countries connected load.

The load segregation can be used to estimate accurate agricultural and rural consumption in states which impacts loss calculations as well as agricultural consumption. This will also help in reliable subsidy estimations for the state Discoms especially in states where proportion of supply to agriculture sector is substantial.

(viii) Improving Collection Efficiency levels

Low level of collection is attributable to lack of employees accountability, inadequate collection facilities, limited usage of advanced systems and technology (e.g. payment through ECS, credit/debit cards, special centres like e-Seva centres), billing errors, political/administrative interference etc.

Improvement in collection efficiency can be realized by facilitating Bill payments through Internet, Easy Bills, Credit Cards, Door-step collection. Automated Bill Payment Kiosks can also be introduced for consumer convenience. These unique ATM like kiosks accept both cash and cheque payment towards electricity bills and even issue a receipt to the consumer.

(ix) Regulators to play active role

Regulators should take cognizance & take urgent action on Tariff revision in various States with mounting Revenue gap. Appellate Tribunal of Electricity (APTEL) in its judgment has also directed the State Regulators to initiate suo moto proceedings for tariff declarations in case States don’t file the Tariff Petitions in due duration..

(x) Sub-standard CRGO steel for Transformers affecting its reliability

Cold Rolled Grain-Oriented (CRGO) steel continues to be primary concern for the Transformer industry. There are challenges in respect of absence in domestic manufacturing, and imports of inferior material. CRGO steel is a very crucial input for manufacture of transformers and is estimated to account for over half of the manufacturing cost of a transformer. There is need to set up local manufacturing capacity for CRGO. Presently the country's entire demand for CRGO is met through imports. However, the BIS-certification for CRGO electrical steel has now been made compulsory to improve its quality. Rashtriya Ispat Nigam Ltd has signed an agreement with Power Grid Corporation of India for setting up a joint venture route to make electrical steel.

(xi) TOD Metering

Time-of-Day (TOD) Metering should be taken up by all the utilities for effective Demand Side Management. It will be an important component of Smart Grid Pilots being planned under R-APDRP. India is reeling under power deficit conditions. Under such environment, there is a tremendous need that adequate demand side management is resorted to for flattening of load curve. Electricity Regulatory Commissions may come out with a suitable regulation for making it mandatory to operate the industries during night time with suitable TOD tariff.

(xii) Promoting Energy efficient BEE rated equipments

Regulatory Commissions should introduce components in the tariff structure for incentivizing energy efficiency. Focus should be made on Load Research, load forecasting and appropriate Demand Side Management options. Measures should be introduced for promoting energy efficiency in pumping ground water for Agricultural use.

(xiii) Role of Training

In many of the State owned utilities, recruitment has been either stopped or restricted since last 15 years. Lack of fresh talent and domain expertise (e.g. in area of IT, communication, SCADA) impedes development of the sector and efficiency improvement. Induction of new technology in the field and office level also needs proper training for staff for efficient handling. Discoms need to undertake training need analysis and roll out training programmes for employees working in different areas. The training themes can include AT&C loss reduction, O&M practices, demand side management, Safety aspects, performance benchmarking, quality management, financial management, project development etc.

CHALLENGES IN GENERATION SECTOR

The rapidly growing demand for electricity has led the Government to plan for huge capacity expansions. The total Installed Generation Capacity of India as on 31.10.2012

is 2,09,276 MW. Thermal energy constitutes the maximum share of total Installed Capacity of India. The share of Hydro is only about 19% despite the fact that Hydro potential in India is about 84,000 MW at 60% load factor. The ideal mix of Hydro: Thermal as far as India is concerned is 40:60. However, the share of Hydro is declining and the current actual Hydro: Thermal mix is 19:67.

There are several concerning issues in the Generation sector that need prompt addressal. Availability of Coal and Gas remains a matter of serious concern.

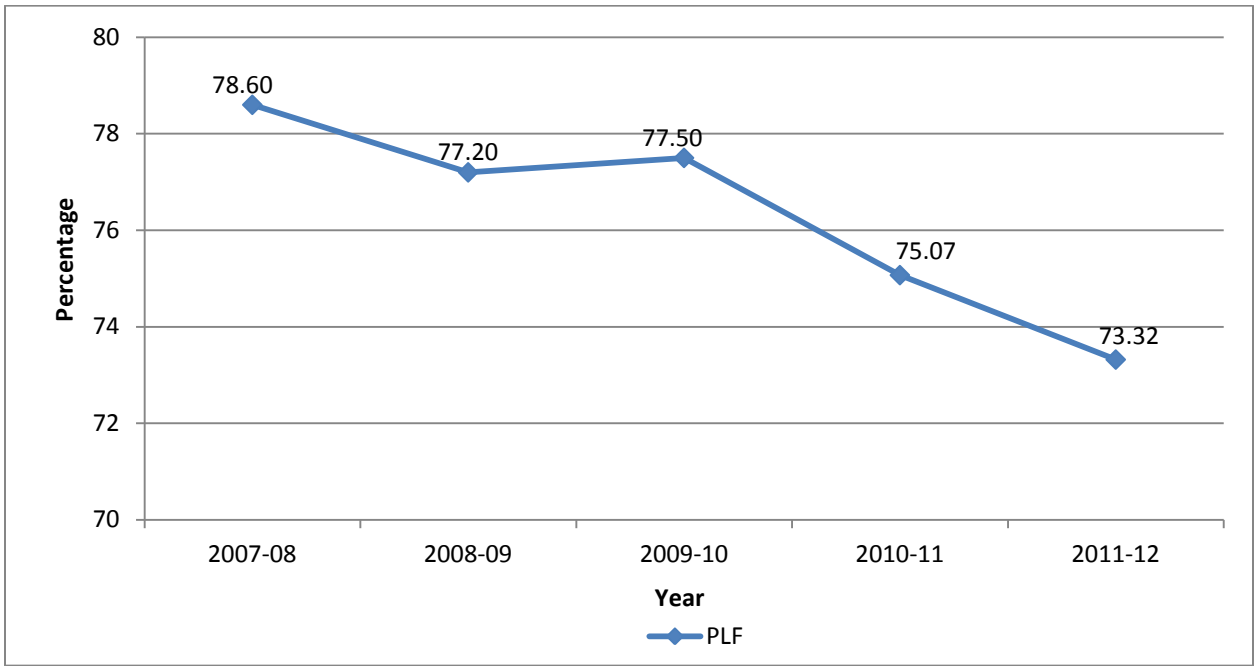
(a) Shortage in Coal supply

India's Power requirement over the years has largely been dominated by Coal based Generation, with close to 67% of the total Installed capacity and thereby being the mainstay of country's Power generation fuel mix. However, recent delays in the development of captive coal blocks have led to shortages in the supply of Coal, and this has led to recent Coal shortages. Captive Blocks allocated to various utilities may be advised to enhance their production through some incentive oriented strategy and surplus production after meeting their Coal requirement may be supplied to Power stations.

(b) Dipping All India average PLF

Availability of Coal and Gas for Power generation has been a big issue. The Gas supply to Power sector projects has been quite erratic. Due to reduced availability of gas from KG D6 field and also from Administered Price Mechanism sources, existing Power plants in the country are operating at low PLF.

Figure 5: Dipping All India Thermal PLF



**Source: CEA*

(c) High ash content Coal

About 80% of Indian Coal reserves have ash content between 25-45%. The absence of adequate numbers and location of Coal washeries in the Country makes it necessary to import low-ash Coal. Low ash Coal is largely imported as high ash content in Indian Coal makes washing necessary before it is supplied to Power plants.

(d) Securing land and clearances

Land is a basic necessity for setting-up Power generation projects. A lot of projects get either cancelled or delayed due to non-availability of land or difficulties in land acquisition. Another major hurdle post identification and selection of land is securing the required clearances. There are a number of clearances required from the MoEF, Ministry of Aviation, Department of Forests and other Government bodies. Single Window clearance at State level to handle all issues should be facilitated.

(e) Revision in competitively bid Tariffs

The recent change in international markets, most notably among which being the enactment of the new mining law in Indonesia, has significantly impacted the cost of imported coal for Indian companies, many of which were relying on supply of coal from this south-east Asian nation. Securing fuel from imported Coal market is turning out to be increasingly costly and uncertain. Recently, both Krishnapatnam and Mundra

UMPPs have expressed their concern over rising cost of imported coal, which would make the projects unviable at the tariffs quoted by them.

CHALLENGES IN TRANSMISSION SECTOR

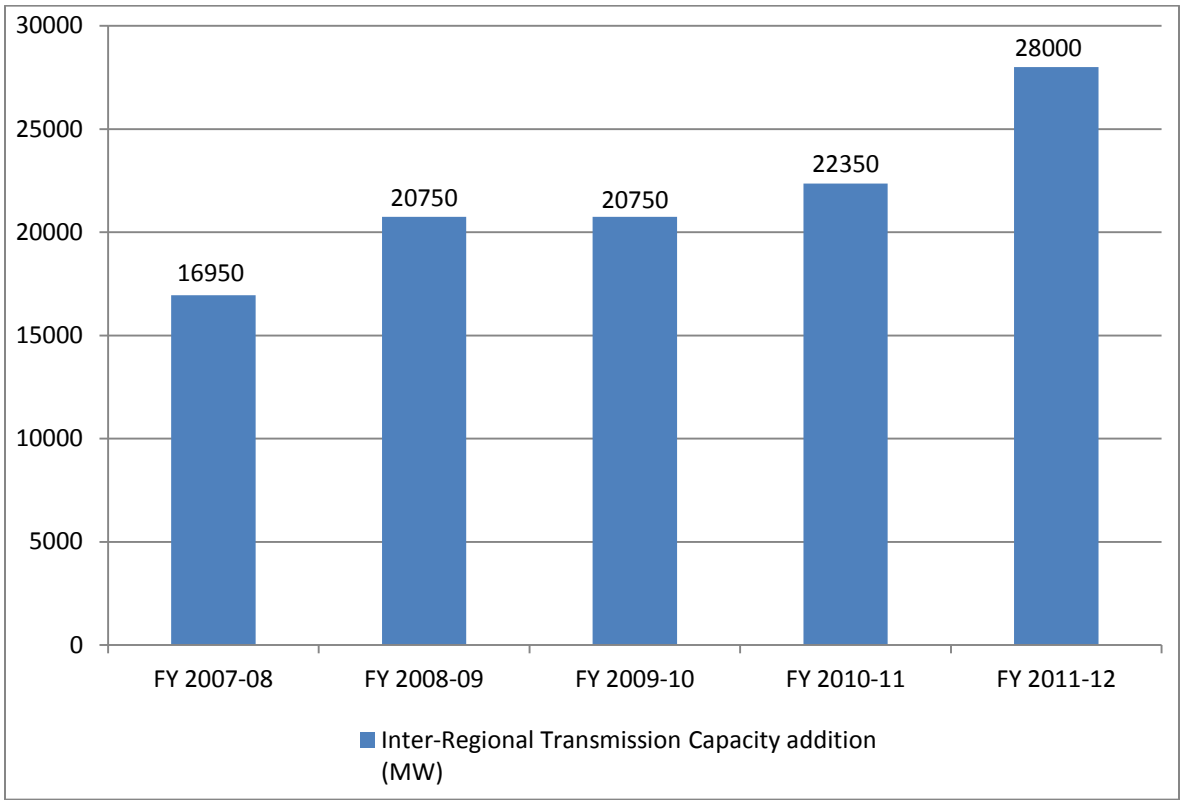
At the time of Independence, Power systems in the country were essentially isolated systems developed in and around urban and industrial areas and the highest transmission voltage was 132 kV. The state-sector network grew at voltage level up to 132 kV during the 50s and 60s and then to 220 kV during 60s and 70s. Subsequently, in many states (U.P., Maharashtra, M.P., Gujarat, Orissa, A.P., and Karnataka) substantial 400 kV network was also added as large quantum of power was to be transmitted over long distances.

Table 4: Growth of Transmission Sector

Particulars	**Transmission Lines (Ckt Km)**		**Sub-stations (MVA)**	
	400 kV	**220 kV**	**400 kV**	**220 kV**
End of VI Five Year Plan	6029	46005	9330	37291
End of VII Five Year Plan	19824	59631	21580	53742
End of VIII Five Year Plan	36142	79600	40865	84177
End of IX Five Year Plan	49378	96993	60380	116363
End of X Five Year Plan	75722	114629	92942	156497
End of XI Five Year Plan	113367	140164	151027	223774

**Source: CEA*

Figure 6: Growth in Inter-Regional Transmission Capacity addition



**Source: Transmission sector growth & challenges - Presentation by Gammon*

The Transmission systems in the country consist of Inter-State and Intra-State Transmission System. Inter-State (and Inter-regional) transmission system is mainly owned by Power Grid. Planning and developing Inter-state transmission system for IPP projects is a challenging task because there is greater uncertainty about their actual materialization, commissioning schedule and their beneficiaries are most often not known at the time of transmission planning. The process of transmission planning and development has become very dynamic in the market driven scenario.

There are several concerning issues in the Transmission sector and are serious challenge to the development of sector.

(a) Inter-regional Transmission capacity enhancement

Frequent Congestion in the Inter-State Transmission system affects the operation of Power Exchanges. The cumulative Inter-regional Power transfer capacity of National Grid has been enhanced to about 28,000 MW. Commissioning of inter-regional links has strengthened the Inter-regional grid capacity of Eastern Region with Western Region and Northern Region. This would go a long way in promoting economic energy exchange by facilitating transfer of power across the Country.

To further strengthen the National Grid, various high capacity HVDC and EHV Alternating Current (EHVAC) Inter-regional links with total capacity of 38,400 MW have been planned to take care of Inter-regional Power transfer requirement of various planned generation projects including Independent Power Producers (IPPs) scheduled for commissioning in XII Plan. The Inter-regional power transfer capacity of National Grid is thus envisaged to be enhanced to about 66,400 MW by the end of XII Plan.

The augmentation of inter-regional capacity shall also facilitate the integration of a large renewable Power generation in the southern region with the rest of the country,

(b) Grid Failure

With the ever expanding transmission network in the Country, complexities of Grid operation are also escalating. Keeping this in mind, the facilities at all the five Regional Load Despatch Centers (RLDCs) and National Load Despatch Centre (NLDC) are being upgraded continuously through deployment of latest technology. Indian Power Grid had not experienced any major grid disturbance during the past nine years. However, the Grid experienced two major disturbances consecutively on 30th July & 31st July, 2012. While the first disturbance affected only Northern Region, the second one affected Northern, Eastern and North Eastern Regions. However, the essential loads were restored at the fastest pace within few hours of the incidents and power supply was restored progressively and normalized completely on the same day of the incident(s). Further, strong measures should be put in place to avoid such recurrence in future.

Since Power Grid Corporation has the jurisdiction over the regional grids, it must maintain an overall control and must trip off power supply when the frequency keeps dipping.

(c) Islanding scheme like in Mumbai

In any power system, the transmission network is designed to be adequate for normal load flows and also for certain reasonable contingencies. However, when there is a major disturbance with considerable loss of network/generating capacity; the remaining network may not be in a position to cater to the load and generation. This may result in overloading and cascade tripping of the remaining network following the disturbance.

In order to provide a further layer of system protection, following major system disturbance a scheme called islanding scheme has been developed. This protection is a system protection of last resort. This scheme pre-supposes that the integrity of the system cannot be maintained in spite of the automatic load shedding. Instead of allowing the system to disintegrate by the tripping of generators and transmission lines as the disturbance develops, the islanding scheme itself sectionalises the whole system into sustainable small systems each consisting of a group of generating stations and a group of load that can be supplied by these generating stations. In effect each group becomes a sustainable island and hence the name islanding scheme. Tata Power had developed and commissioned a system islanding scheme co-ordinated with an

automatic under frequency load shedding scheme a number of years back. Similar, Schemes can also be developed for Delhi for system protection.

(d) Smart-Grid recommendation

Smart Grid is confluence of Information, Communications & Electrical/Digital technologies. Smart Grid, apart from facilitating real time monitoring and control of power system will also help in reduction of AT&C losses, peak load management/demand response, integration of renewable energy, power quality management, outage management etc.

CONCLUSION

The Indian Power sector has achieved a lot over the last decade in the areas of Policy reforms, Private sector participation in Generation and Transmission, new manufacturing technology and capabilities, but there is still much to achieve and a number of challenges to overcome before the opportunities can be leveraged. We need to overhaul our Coal sector to ensure long-term energy security and maintain economic growth momentum.

Private participation in Distribution sector should be promptly sought for and promoted. The size of the Distribution opportunity in India is very large and it could easily have over 50-60 Distribution Franchisee companies, that will attract more investment and innovation. The Distribution Utilities should be allowed to function on commercial lines and skewness in Tariff structure should be gradually reduced. The State Electricity Regulatory Commissions should penalise Distribution companies that do not file Petitions for Tariff revision in the fixed timeframe.

The opportunities for investment in India's power sector are huge. The policy and regulatory frameworks are well defined. All the segments be it Generation, Transmission, Distribution, electricity trading or equipment manufacturing, are open to Private participation. Several path-breaking regulations such as Standard bidding guidelines, Open access, Multi-year tariff regime and so on, are in place.

We need to emphasize competition and transparency besides charting out a clear Regulatory framework namely Tariff reforms and Private participation to make the sector attractive to capital flow. A holistic reform of the sector is imperative to put the country on a strong growth path.