Role of Information Technology in Indian Power Sector for reducing the AT&C losses.

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Abstract— Industries are using Information Technology (IT) as a tool for managing its strategic, tactical and operation activities. This is true to power sector also in which IT is used to handle large amount of information to carry out efficient operation for revenue and commercial management, distribution and automation, consumer relationship management, Outage Management , Power Management, Load Forecasting, Transmission and Distribution (T&D), Aggregate Technical and Commercial (AT&C) losses reduction. The main purpose of this paper is to identify the AT&C losses in all states of India and T&D losses in other countries and the different reasons for these losses. In this paper different technical and non technical losses have been identified and according to that numbers of Information Technology solutions are available to reduce these AT&C and T&D losses which will improve the efficiency of power distribution system. This paper also focuses on the project initiated by Government of India namely R-APDRP (Restructured Accelerated Power Development and Reform programme) for reduction in AT&C losses.

Index Terms— Aggregate Technical and Commercial loss (AT & C), IT (Information Technology),SCADA (Supervisory Control and Data Acquisition System), SEB (State Electricity Board), Transmissions and distribution (T & D)

1 Introduction

Power sector is at a crucial juncture of its evolution from a controlled environment to a competitive, market driven regime which endeavors to provide affordable, reliable and quality power at reasonable price to all sector of economy. The growth of economy now depends on performance and growth of power sector. India has made good progress in the power sector since independence, but that is not sufficient because demand has far outstripped the supply leading to a widening gap. Reason behind this gap is generation companies have not recovered their heavy dues from biggest buyers i.e. SEB (State Electricity Board). SEBs suffers huge loss every year due to ineffective practices of billing and collection, power theft. Distribution system in India is often characterized by inefficiency, low productivity, poor voltage and frequent interruption in supply. By 2012 power generation installed capacity increase to 210.936 GW. In power sector transmission and distribution system has been carried out in a planned way but in India transmission system design in a planned way through technical studies while distribution system has grown in unplanned manner to meet demand of consumers. This result high aggregate technical and commercial loss (AT & C loss) & poor low quality power to consumers.

2 Literature Review

A study conducted by Soham Ghosh (2012) on loss reduction and efficiency improvement of power supply identified that there are various factors responsible for AT&C losses and these losses can be eliminated by upgrading & improving the efficiency of sub-transmission and distribution (ST&D) system. Ms.Vebhav Gupta (2012) study the role of IT in power sector with special reference to power distribution in India identified that IT can contribute in many ways in electricity value chain and also in reduction of AT&C losses. Anutosh Maitra, Rahul Walawalkar and Anil Khanna study on assessment of IT for power sector, Tata Infotech Limited states that IT as a tool can be used for better planning, design, management operation and control of power system. Geetika and Pandey Neeraj study on e-government for improving performance of power sector in India assess that IT can eliminate routine problem in power sector and increase the performance of the organization.

3 Current Status Of It In Power Sector

IT provides wide range of solutions to increase the efficiency & productivity of power sector like setting up distribution network, distribution load management & meter data management. But in Indian power sector operation and distribution processes are manual, insufficient commercial focus, inadequate control, lack of transparency and reliable information this result high loss to power sector. Indian power sector is using stand alone system for limited operational requirements or as a tool to solve specific problem without a long term strategy. Most distribution utilities in India are still lacking in most basic requirements i.e. consumers and assets databases that results in to direct revenue losses. Most utilities maintain manual records of consumers (in the form of register) especially in rural areas that make the complete process time consuming. Using of electromechanical meters, manual reading of meters and bill preparation, inadequate bill collection facilities result in overall delay in revenue collection and that ultimately lead to losses for power sector companies.

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4 Transmission and Distribution losses(T & D) and Aggregate Technical and commercial losses

In India energy is lost in the distribution system by way of technical loss. These losses in transmission & distribution of energy from generating house to consumer can be reduced by eliminating the cause of losses.

Transmission and Distribution losses (T & D)

T & D losses (%) = [(Energy input – Energy billed) X 100]/ Energy input

Aggregate Technical and Commercial losses (AT& C)

It is sum total of technical losses, commercial losses and shortage due to non realization of billed amount.

{(Total energy input – energy realized) / Total energy input} * 100

Where energy realized is sale of energy * collection efficiency

Distribution losses (Technical + Commercial losses)

It is the difference between energy supplied at the input points and energy billed to consumers in percentages term for a particular period.

(Energy Input - Energy billed to consumer in KWh / Energy input in KWh) *100

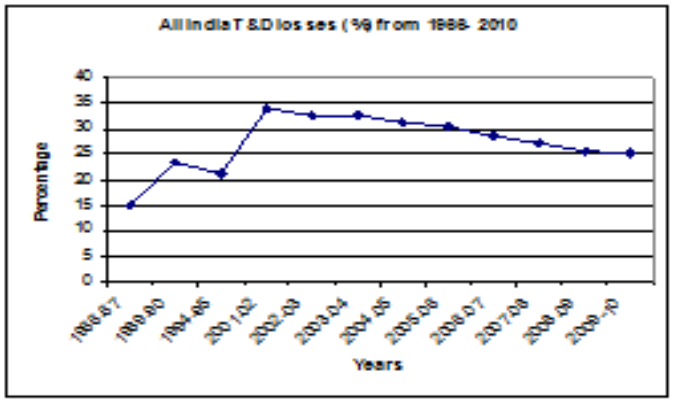
Collection efficiency

It is the ratio of revenue actually realized from consumer and energy amount billed to consumer for a particular period in percentage term.

(Revenue realized from consumers / Energy amount billed to consumer) * 100

4.1 All India T&D losses (%)

Fig 1: All India T&D losses (%) from 1966- 2010)



4.2 All INIDA AT&C losses (%)

Fig 2: Southern Region AT&C losses (%)

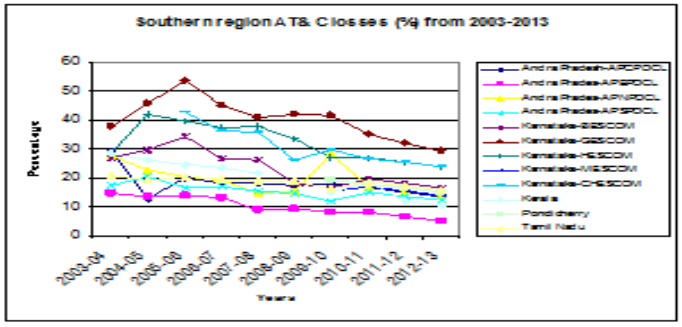
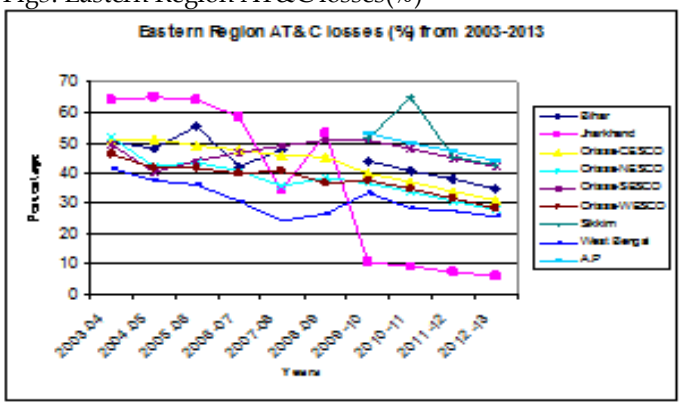


Fig3: Eastern Region AT&C losses(%)



4: North Eastern Region AT&C losses (%)

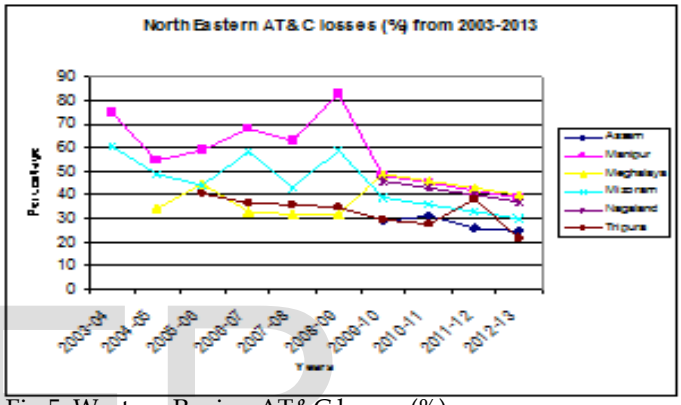


Fig 5: Western Region AT&C losses (%)

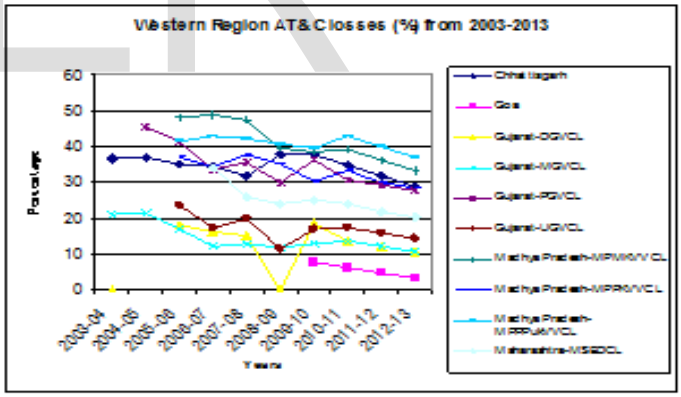
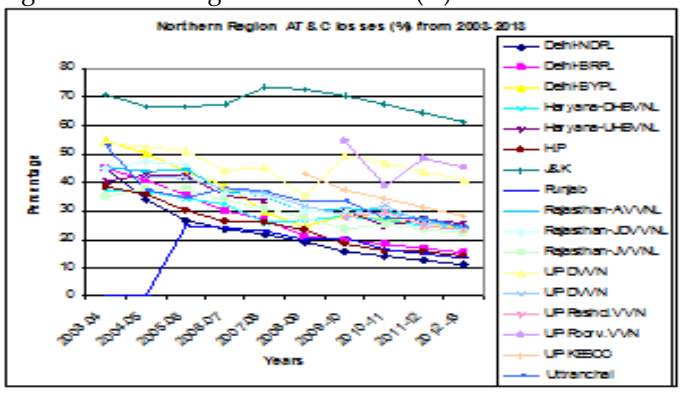


Fig 6: Northern Region AT&C losses (%)



Source: Report of the working group on power Twelfth plan (2012-19) Government of India Ministry of Power Jan 2012 & AT&C loss data –State & Utilities wise on Forum for Regulator.

In India we use the term AT&C losses but in developed countries T&D losses are calculated because commercial losses are practically non-exist.

Table 1: Transmission & Distribution losses (%) in other countries from 2008 to 2010

Country name	2008	2009	2010
Albania	39	24	13
Algeria	18	21	20
Angola	10	10	10
Argentina	13	15	13
Armenia	15	15	11
Australia	6	6	6
Austria	5	5	5
Azerbaijan	15	22	20
Bahrain	12	12	8
Bangladesh	5	2	2
Belarus	11	11	11
Belgium	5	5	5
Bolivia	11	11	11
Bosnia &/Herzegovina	13	12	9
Botswana	41	56	56
Brazil	17	17	17
Brunei Darus-salam	5	6	10
Bulgaria	10	11	10
Cote d'Ivoire	24	23	23
Croatia	14	16	14
Cuba	16	16	16
Cyprus	3	4	4
Czech Republic	6	5	5
Cambodia	11	14	29
Cameroon	9	9	10
Canada	10	11	11
Chile	9	11	8
China	6	6	6
Colombia	19	15	16
Congo, Dem. Rep.	11	5	11
Congo, Rep.	77	70	83
Costa Rica	10	11	10
Denmark	6	7	7
Dominican Republic	11	11	10
Ecuador	22	18	19
Egypt, Arab Rep.	11	11	10
El Salvador	12	12	13
Eritrea	16	12	13
Estonia	11	10	8
Ethiopia	9	9	10
France	6	7	6
Finland	4	4	3

Georgia	13	13	11
Germany	5	4	4
Ghana	22	20	24
Greece	8	5	7
Guatemala	14	14	10
Gabon	18	18	18
Haiti	53	51	58
Honduras	21	22	24
HongKong	13	13	13
Hungary	10	10	10
Iceland	3	3	4
India	22	22	22
Indonesia	10	10	9
Iran, Islamic Rep.	18	16	14
Iraq	49	40	37
Ireland	7	8	7
Israel	2	3	4
Italy	7	7	7
Japan	5	5	4
Jordan	14	14	21
Kazakhstan	9	8	8
Kenya	16	16	16
Korea, Dem. Rep.	16	16	16
Korea, Rep.	4	4	4
Kosovo	18	19	18

Kuwait	13	12	12
Kyrgyz Republic	31	30	28
Latvia	15	13	11
Lebanon	13	13	12
Libya	14	14	14
Lithuania	8	7	20
Luxembourg	4	4	4
Macedonia, FYR	23	17	18
Malaysia	8	6	7
Malta	14	16	18
Mexico	16	16	16
Moldova	50	41	36
Mongolia	11	12	11
Montenegro	22	25	16
Morocco	11	12	7
Mozambique	9	9	9
Myanmar	29	28	17
Namibia	18	15	25
Nepal	32	34	34
Netherlands	4	4	4
New Zealand	7	7	7
Nicaragua	21	21	24
Nigeria	9	6	17
Norway	7	6	7
Oman	15	15	17
Pakistan	21	20	16
Panama	14	13	14

Paraguay	5	6	6
Peru	8	8	10
Philippines	13	12	12
Poland	8	8	8
Portugal	9	8	8
Qatar	7	7	6
Romania	11	12	12
Russian Federation	11	11	10
Saudi Arabia	9	8	9
Senegal	20	17	18
Serbia	16	16	16
Singapore	5	7	7
Slovak Republic	3	3	3
Slovenia	5	5	6
South Africa	9	10	10
Spain	4	4	4
Sudan	22	22	22
Sweden	7	7	7
Switzerland	6	6	7
Syrian Arab Republic	21	26	15
Tajikistan	18	17	17
Tanzania	19	22	21
Thailand	6	6	6
Trinidad and Tobago	2	2	7
Tunisia	14	12	12
Turkey	14	15	14
Turkmenistan	14	13	13
Ukraine	12	12	12
United Arab Emirates	7	7	7
United Kingdom	7	7	7
United States	6	6	6
Uruguay	12	13	11
Uzbekistan	9	9	9
Venezuela, RB	27	27	19
Vietnam	10	10	10
Yemen, Rep.	23	24	23
Zambia	24	22	24
Zimbabwe	7	7	6

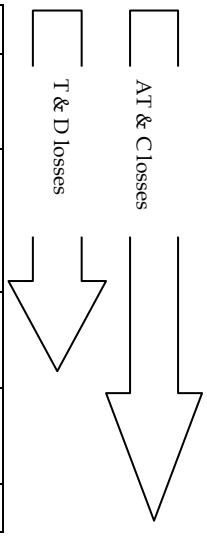
Source: International Energy Agency

Table 2: Findings

Losses	**Country**	**2008**	**2009**	**2010**
Lowest T&D Loss (%)	Bangladesh	5	2	2
Highest T&D Loss (%)	Congo,Rep.	77	70	83
Out of 132 countries India at 116 position in T&D losses (%)	India	22	22	22

Table 3: AT &C losses calculation

Energy Purchase	100 units	Distributed to consumers
Energy consumed	86 units	The contributing factors are technical losses i.e. iron & copper losses at transmission & distribution
Energy billed to consumer	68 units	The contributing factors are meter tampering & bypassing, meter problem(burn, stop), billing gaps (under billed) & theft
Amount billed to consumer @ 3.70	₹ 252	Bill sent to consumer
Amount recovered from consumer	₹ 233	This is due to healing gap like part payment, bill not delivered, consumer not paid etc.
Hence energy recovered	63 units	AT & C losses 37%



* All figures are hypothetical

5 T&C LOSSES MEANS (A) TECHNICAL LOSS (B) COMMERCIAL LOSS

Reasons for Technical loss

- Design of Network
- Specifications of the equipments used in the network
- Operation parameter used in the network

Solutions for reduction in Technical losses.

- Collection of data regarding operating conditions, forecast of expected loads from substation to consumer.
- Analysis of existing system.
- Upgrading of network.
- Preparation of cost estimates and evaluation of alternatives for least cost solutions.
- Efficient management of distribution transformers and employing AVB (Automatic Voltage Booster).
- Preventive leakage at insulators.
- Implementation of High Voltage Distribution System(HVDS)

Reason for Commercial loss

- Theft
- Issues related to meter
- Inefficient Billing & inadequate revenue collection
- Poor Customer Satisfaction

Solutions for reduction in Commercial losses.

- To maintain accuracy testing of meter on regular basis.
- Electronic meter with tamper, load survey features with port facility that helps in reading of meters.
- Meters have proper seal management system.
- Spot billings.
- E-payments and online facilities

6 R-APDRP (RESTRUCTURED ACCELERATED POWER DEVELOPMENT AND REFORM PROGRAMME) FOR REDUCTION IN AT & C LOSSES

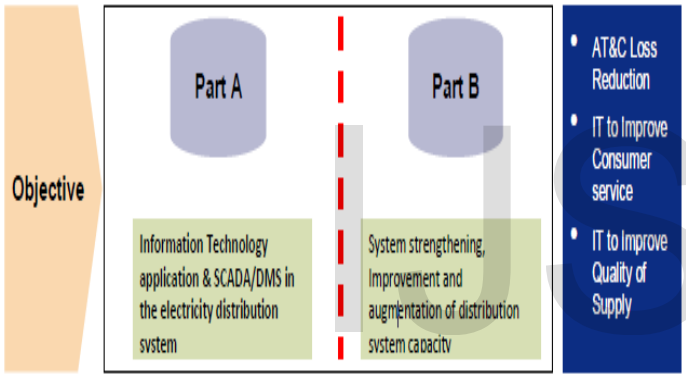
Reforms in Indian power sector going on for more than decades. In this reform focus was basically on independent generation, transmission & distribution. But in the recent past it has been found that power distribution is the weakest link in the entire value chain so to overcome this problem government of India launched R-APDRP project. Purpose of this project is to reduce AT&C losses, improve cus-

tomer satisfaction and financial viability of the State Distributions Company (SDCs).
R-APDRP is a central sector project of XI plan of Government of India. This project focuses on actual, demonstrable performance in term of sustained loss reduction. This project basically divided into parts Part A & Part B.

Part A: It includes base line data for the project area covering consumer indexing, GIS mapping, SCADA/DMS systems. Adoption of information technology for meter reading, energy accounting and auditing, IT enabled customer service center.
Part B: It basically focus on strengthens & improvement of distribution system.

a. Identification of high loss areas.
b. Prepare of investment plan for high loss area.
c. Implementation of plan.
d. Monitoring of losses.

Fig 7: R-APDRP Project



6.1 Automated Meter Reading (AMR)

Earlier power sector is using human interface for uploading/ downloading the data. MRI (Meter reading instrument) or physically going to customer is the only way to collect data in this process lot of time wasted. So to overcome this problem AMR is being used.
In this technology modem is installed at the customer/ grid end. Reading of meter can be taken from central location by dialing remote modem. After taking data from meter than it can be used for analyzing load survey, billing and also making MIS reports for critical business issues. It is point to point dial up system on GSM/CDMA/ PSTN network.
Benefits from this technology is entire data of meter along with history can be downloaded and analyzed. It will save operational cost, reduce the power theft and workforce. On the other hand side billing time reduces that improve customer satisfaction and better revenue for department.
It also helps in monitoring of voltage, power factor on minute basis. By using this technology generation of MIS reports on system outage/ down time of the feeder, daily peak load and voltage profile at regular basis at a short period of time.
PSTN (Public Switched Telephone Network), CDMA (Code Division Multiple Access), GSM (Global System for Mobiles)

6.2 Online Mobile cash collection and customer service

Generally consumer approach to power company's offices to make payments and other issues related to power. This is difficult and time consuming approach so government started new scheme in which mobile vans used to collect cash and update payments to central system in batch mode which take half day to process. These vans reach to consumer doorstep with all up to date information.
Online cash collection vans used CDMA technology to connect mobile vans with central offices. All types of transactions are updated in real time mode also it can be used for complaints tracking, new connection, logging complaints and other problems related to power. This resulted in saving time and effort and improves customer services. Now these vans are running as fully functional moving offices.

6.3 Outage Management System (OMS)

The Outage Management System is used to monitor and analyze the whole process of fault restoration from receipt of customer complaint to normalization of power supply. It also track the resources in the power supply and distribution system. This system generates SMS for escalation of fault and breakdown. It also provides integration between call center, breakdown offices and circle control. This provides speed detection of faults and improvement in customer care.

6.4 SCADA (Supervisory Control and Data Acquisition System)

The major problem in power sector is poor visibility of network operations, lack of network analysis, inadequate information of consumers, absence of real time and historical data. So to overcome these problems SCADA is used as a real time system to control and supervise power system network. It can run on-site to monitor and control equipment to achieve data acquisition, equipment control, measurement, parameter adjustment and a variety of functions such as alarm signals.
It also provides complete information to improve efficiency, speed up decision-making, quickly diagnose of system failures, improve the operation of its power grid reliability, safety and economic efficiency, to reduce the burden on dispatchers to achieve automation and modernization of power dispatching.

6.5 Power Management and Load Forecasting

The goal of electricity distribution companies is to provide quality and uninterrupted power to consumer. Power management function is to encompass arrangement of power for the power companies predicting the future demand. Power demands are of three types- daily, weekly and annually. Other type is short term demand which basically depend upon number of factors like holiday, temperature,

humidity, wind speed direction etc. so for these types of problem various statistical tools are used for forecasting of power. Purpose is to identify a day ahead forecast demand. It saves both overbuying and last minute scouting of power.

6.6 CORE (Converged Operational & Reporting Engine)

Operation and maintenance department require updated data on regular basis to support stores and meter management but currently data are available but not update one so department face many problem on daily basis which lead to delay in fault restoration, long outages resulting in poor customer services etc. so to overcome this implementation of GIS for network, SAP R/3 for stores and meter management, complaint management system and finally integration of all these technology together to generate smooth operational advantage and critical reports for customer benefits.

6.7 GIS-based consumer indexing and electrical network mapping:

This tool is used by customer information system, billing system, energy audit, customer service etc. it generate consumer and electrical database which can be used to map HT/LT consumers and electrical network assets. This involves conducting GPS survey of consumer households, connected electrical feeders and transformers. After that all consumer are indexed and given unique electrical address (Consumer index number or CIN) make it possible to segregate consumer for energy audit and accounting purpose.

6.8 Meter Data Logging System:

It is used to control the energy consumption by putting load threshold on meter when consumption exceeded it trips the meter circuit. It helps in aggregation, validation, load estimation, meter data management and also integrate with other **applications**.

6.9 Prepaid Metering System:

These system uses a smart card for electricity that consumer consume. The customer inserts this card into prepaid meter, which reads the data when the prepaid energy is used up. Customer has to recharge this card on frequently basis. By using this system it resolve problem related to meter reading, billing disputes and bill distributions.

Table 4: AT & C losses after implementing R-APDRP project.

State	Companies	Towns	AT & C Losses (%)	Years
Andhra Pradesh	APCPDCL	30	17.96	2009-10
	APEPDCL	29	7.95	2009-10
	APNPDCL	22	28.22	2009-10
	APSPDCL	32	11.78	2009-10
AP	Arunanchal-PD	0		
Assam	ASEB	47	30.96	2010-11
Bihar	BSEB	0		
Chandigarh	Chandigarh-ED	0		
Chhattisgarh	CSPDCL	20	37.8	2009-10
Goa	Goa-PD	0		
Gujarat	DGVCL	11	18.67	2009-10
	PGVCL	36	36.16	2009-10
	UGVCL	20	16.97	2009-10
	MGVCL	17	13.08	2009-10
Haryana	DHBVNL	8	24.79	2011-12
	UHBVNL	15	24.9	2010-11
Himachal Pradesh	HPSEB	14	16.05	2010-11
Punjab	PSPCL	37	20.6	2009-10
Rajasthan	JaVVNL	27	23.6	2009-10
	JoVVNL	31	29.21	2009-10
	AjVVNL	29	30.68	2009-10
Sikkim	Sikkim-PD	2	65	2010-11
Tamil Nadu	TANGEDCO	105	16.19	2009-10
Tripura	TSEC	4	38.33	2011-12
J & K	J&KPDD	0		
Jharkhand	JSEB	0		
Karnataka	BESCOM	25	16.35	2009-10
	CESCOM	12	29.73	2009-10
	GESCOM	21	41.4	2009-10
	HESCOM	29	26.91	2009-10
	MESCOM	11	15.37	2009-10
Kerala	KSEB	33	18.6	2010-11
Madhya	MPPKVVCL-	24	30.3	2009-10

Pradesh	W			
	MPPKVVCL-E	27	39.55	2009-10
	MPPKVVCL-C	32	38.48	2009-10
Maharashtra	MSEDCL	9	23.39	2010-11
Manipur	Manipur-PD	0		
Meghalaya	MSEB	0		
Mizoram	Mizoram-PD	0		
Nagaland	Nagaland-PD	0		
Puducheery	Puducherry-PD	0		
Uttar Prdesh	DVVNL	31	46.8	2010-11
	MVVNL	35	31.81	2010-11
	PaVVNL	55	29.59	2010-11
	PoVVNL	23	38.67	2010-11
Uttranchal	UPCL	5	27.44	2010-11
West Begal	WBSEDCL	23	28.24	2010-11

Source: Report of the working group on power Twelfth plan (2012-19) government of India Ministry of Power Jan 2012. Page 35, 36 of chapter 3

7 Outcome of R-APDRP project.

1. The AT&C losses which were about 36.86% in the year 2001-02 have reduced to 27.15 % in the year 2009-10.

(Source: Report of the working group on power Twelfth plan (2012-19) government of India Ministry of Power Jan 2012. Page 35, 36 of chapter 3)

2. 313 towns covered under APDRP have shown reduction in the AT&C loss.

3. 212 APDRP towns have brought down AT&C losses below 20 percent.

4. 169 towns have shown loss below 15%

5. 38 towns have achieved AT&C loss between 15 & 20%

(Source: Ministry of Power- Methodology for Establishing Baseline AT&C losses 4th Sep 2009)

6. The AT&C losses for companies selling directly to consumers have reduced by 1.35%, i.e. from 30.59% in 2006-07 to 29.24% in 2007-08.

7. The southern region continues to have the lowest AT&C losses of 20.10%. AT&C losses have shown a reduction in all regions in 2007-08 compare to 2006-07.

(Source: The Financial Express - A strategy to cut mounting power losses - Devender Singh: Dec 16, 2009)

8. Conclusion:

In this paper an attempt has been made to assess the current scenario in the power sector and the various factors which are responsible for AT&C losses. These AT&C losses cab be eliminated by the induction of Information Technology. Advance countries are using IT tools to gain in term of productivity, efficiency, reliability etc. It has been observed that Indian power companies are lagging behind due to not proper implementation of Information technology. Other countries which have AT&C losses in single digit figure their IT play central role in their business. A huge investment required to attain global standard which is not feasible at one go. Therefore, it is needed to adopt phase approach in IT implementation. IT is one of the pillars to achieve this future successfully.

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