Methods to Reduce Aggregate Technical and Commercial (AT&C) Losses

***Abstract*- In the Power Sector, Distribution system plays an vital role where, The gap between the average revenue Realization and the average cost of the supply has been constantly increasing since a decade. Power is critical infrastructure for economic growth. However the financial growth of DISCOMs has become a matter of grave concern considering that their losses have reached a alarming level of 26,000crores which is equivalent to 1.5% of GDP in the year 2001 , All-India average AT&C losses(Aggregate Technical and Commercial) were pegged at 27.15% in 2009, in which southern region had an average of 19.49% and the north-eastern region 36.44%. Some states had loss levels as high as 70% and at the same time, some others had the loss average in single digit. So there is an emergency in reducing these AT&C losses by various preventive methods and reduction techniques so that we can utilize the power to various sectors i.e., we can reduce them to some extent but we cannot eliminate them completely we can reduce them to permissible Level of less than 15% by using some best practiced methods such that we can eliminate the electricity crisis.**

I. INTRODUCTION

We have already seen that distribution system has more complexities compared to all the other sectors so it is necessary to discuss about power distribution sector complexities 1. Distribution Sector considered as the weakest link in the entire power sector 2.Involves dealing with retail consumers with varied expectation and at the same time different paying capacity 3.Involves Huge network and requires network management of vast area 4.Theft, pilferages, network losses are maximum in this segment 5.Distribution is often seen as a social obligation of Government toward 6.society rather than a commercial activity 7.Subsidized and often unmetered power adds to Distribution Utilities woes in terms of technical losses, billing, recovery and consumption habits 8.Since the metering, billing, and collection at many places involves human intervention most of the times human error, intentional or non intentional can occur 9. Lack of infrastructure in many developing countries for database management system and at the same time absence of any data mining system 10.Lack of employee ownership 11.Internal Resistance to change

AT&C Losses = { 1- (Billing Efficiency x Collection Efficiency) } x 100

Let us assume that if the total losses in power sector assumed to be 100% ,among these 95% of losses are mainly due to Distribution losses and 5% is due to Transmission losses. In old days losses are termed as T&D (Transmission and Distribution) but now the distribution losses are increasing rapidly so we cannot treat them equally hence this is the key area to focus.

II. AT&C LOSSES

A. Definition: **"AT&C Losses is nothing but the sum total of technical loss, commercial losses and shortage due to non realization of total billed amount"**

B. Formula:

AT&C Losses ={(Total Energy Input LESS Energy Realized)/ Total Energy Input}*100

Where,

Energy realized =Sale of Energy * Collection Efficiency

We can define **T&D Losses** as "The difference between energy supplied at the Input Points and Energy Billed to Consumer in percentage terms for a particular period"

T&D Losses = (Energy Input less Energy Billed to Consumers in KWh/Energy Input in KWh)*100

Computation of Billing Efficiency

Billing efficiency is an indicator of proportion of energy that has been supplied to an area which has been billed (includes both metered and unmetered sales) to consumers. Billing Efficiency can be computed using formula provided below:-

$$\text{Billing Efficiency} = \frac{\text{Total Units Sold (kWh)}}{\text{Total Input (kWh)}}$$

Computation of Collection Efficiency

All the consumers are billed on the basis of energy consumed by them which is obtained from meter reading and assessment of unmetered connection. The bill amount is computed on the basis of tariff fixed by regulatory commission for applicable customer category.

However, there are quite a few consumers who have tendency to default in their payments for various reasons. Thus utility is not able to recover entire amount billed by it resulting in commercial losses. Collection efficiency is measured using formula given below:-

$$\text{Collection Efficiency} = \frac{\text{Revenue Collected (in Rupees)*}}{\text{Billed Amount (in Rupees)}}$$

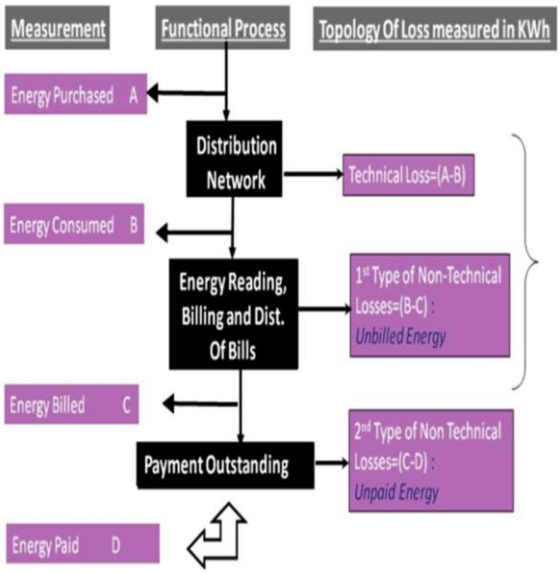


Fig I: Technical and Commercial losses

Losses occur due to 'Technical' and 'Commercial' losses Minimizing either Technical or Commercial Losses may not serve the purpose of any distribution utility and requires a simultaneous action.

II. CAUSES OF AT&C LOSSES

A. ***Technical losses:***

1.Long length of LT Lines and HT lines, transformers not located in load centers 2. Overloading of system elements like conductors , transformers, feeders 3. Fixed losses in transformers 4. Sparking due to ill maintained equipment, jumpers and isolators in substation..5. In sufficient Reactive compensation e.g. non inclusion of appropriate capacitor banks at appropriate places 6.Non reconfiguration of feeder lines and distribution transformers so as to reduce the length of LT lines and 7.Non usage of smaller size energy efficient Distribution Transformer

B. ***Commercial losses:***

1.Non reading of meters, unmetered connections, 2. Faulty meter reading, 3. Inefficient billing, Under billing, Faulty bill distribution, 4. Theft and pilferage, 5. Low collection efficiency, 6. Software errors**, 7.** Prolonged disputes, *8*. Inadequate revenue collection

III.TECHNICAL LOSS REDUCTION

A. Technical losses:

Technical loss can be reduced by 1.Proper Network Design by using smaller length lines 2. DTR to be placed in load centers 3. Increasing numbers of 33/11 kv substations near load centers 4. Energy efficient Specifications of the equipments in purchase process 5. Augmentation of overloaded conductors and transformers. 6.Feeder reconfiguration and load bifurcation

S.No.	System Component	Levels for Peak Power Losses	
		Target Level%	Maximum Tolerable %
1.	Step-up transformer and EHV transmission system	0.50	1.00
2.	Transformation to intermediate voltage level, transmission system and step-down to sub-transmission voltage level	1.50	3.00
3.	Sub-transmission system and step-down to distribution voltage level	2.25	4.50
4.	Distribution lines and service connections	4.00	7.00
	Total Power Losses	8.25	15.50

i.)Short term measures: 1. Network reconfiguration 2.Network reconductoring. 3. Preventing leakages at insulators. 4. Employing AVB (Automatic Voltage Booster) 5. Better management of Distribution transformers 6. Load balancing and load management 7.Capacitor Installation (Shunt or series) 8.Improving joints and connections 9.Laying Additional link lines 10.Increase in HT: LT Ratio 11. Adoption of high voltage distribution system (HVDS) 12.Regular maintenance of distribution network 13.Creation of Primary substation

ii.)Long Term Measures: 1. Data collection regarding existing loads, operating conditions, forecast of expected loads etc. from Grid substation up to consumer level.2.Mapping of existing system.3.Analysis of existing system (Voltage regulation T&D losses in existing system, Adequacy of backup system)4. Load recast.5.Plan for upgrading the network.6.Technology options including integration of features for modernization of system 7.Evaluation of various alternatives for least cost optimal solution. 8. Fuming up of scope of works. 9. Preparation of cost estimates.10.Phasing of works and their cost.11.Financial analysis 12.Distribution automation and SCADA.

IV. COMMERCIAL LOSS REDUCTION

A. Preventive Measures:

1.Defining installation procedures and ensuring that installation check points are tested/followed while installing meters.2.Use of electronic meters with tamper and load survey logging features for all categories of consumers.3.Use of optical port for taking the reading for all categories of consumers.4.Seating of meters with seals and having proper seal management system.5.Installation of CTs/Pts in sealed boxes

so that terminals are not exposed for tampering/bypassing.6.Testing of the metering system as a whole to ensure accuracy.7.Ensuring accuracy in meter reading and billing activities by generating exception lists and following up on exceptions.8.Carrying out regular energy audits covering the feeder DT and all end consumers to ensure that there is no revenue leakage beyond the permissible technical loss.

Planned Measures

1. Aerial Bunched Cables 2.HVDS or LT less system
3. Shifting of meters outside consumers premises.4.Spot Billing.5.Provision of additional counters, consumer collection centres 6.Installation of electronic cash register.7.Drop box facilities8.Collection agencies 9.E-bill payments 10.Online facilities 11. Development of MIS 12.Energy Accounting and Auditing13.User's Associations, panchayats and Franchisees in Billing &Collection 14.Consumer Indexing

V. BEST PRACTICES FOR AT&C LOSSES REDUCTION

A. High Voltage Distribution System (HVDS)

HVDS envisages running 11 KV lines right up to a cluster 2 or 3 pump sets, employ small sized distribution transformers (16 and 25 KVA)and extend supply to these 2 or 3 pump sets with least (or almost nil) LT lines.

HVDS can be classified as:-

• Single Phase HVDS
• Three Phase HVDS

*i)Single Phase HVDS:*HVDS was first attempted as single phase system (i.e.) running one phase of 11 KV and one neutral wire from 33/11 KV SS, install small sized 5, 10 or 15 KVA single phase transformers 6350 / 230-0-230volts and changing all three phase pump sets to single phase pump sets.

ii) Three Phase HVDS: Existing LT lines are upgraded to 11 KV and small capacity 3-phase Distribution Transformers (16 and 25 KVA) are employed. The three phase load is feed by the three phase small capacity transformer. This results into im- provements in tail-end voltage, reduction of losses.

*iii) Advantages of HVDS:*1. Customer has sense of ownership. 2. Prevention of unauthorized loads. 3. Minimal Failure because of on over loading and no meddling of LT lines.4. High quality of supply owing to practically no voltage drop.5.Less burnouts of motors because of good voltage and less fluctuations.6.Considerable reduction in line losses and consequent savings in power purchase cost 7. No additional generation capacity needed for giving new loads due to reduction in power drawls. 8. Accidents due to touching of snapped conductors reduce because the breaker trips at substation since the line is at 11KV Potential.

iv) Disadvantage: The system is not suitable to cater in certain areas like deserts, Forests because the load density in these areas is low and load development is also very slow

Fig III: single phase HVDS

B. Aerial Bunched Cables (ABC)

Where LT lines could not be totally avoided, ABC (Aerial Bunched Cables) with a bearer wire can be used.

The major advantages of ABC are elimination of faults on LT lines, improved reliability, Avoidance of Theft by direct tapping, Avoidance of short circuiting of Distribution transformers

C. Metering

Static Energy Meters are utilized now-a-days at HT Services and LT High value Industrial services. The Static energy meters are microprocessors based. The programmability of microprocessor has become a useful tool to incorporate different features like Tamper data, Import-Export, Time-of day metering, load pattern analysis, Remote meter reading etc.

i) Tamper Data: The static meter can detect date pertaining to tamper such as

Missing potential: Gives the information regarding missing of supply to the potential coil and records the date and time of such occurrence.

ii) C.T. polarity reversal: The meter can also give information regarding availability of load current. The meter can also register the non-availability of load in a particular phase compared to the other phases.

iii) Phase Sequence Reversal: The meter can also recognize proper phase association.

ii) Time-of-day (TOD) Metering: The processor based electronic (static) meters have build-in Real-time clock, hence the time available in a day i.e., 24 hours is divided into different

time zones. The duration of each time zone is programmable and the user can define their time zones as per his requirements.

The meter records the energy consumed in different time zones in separate registers and exhibits accordingly

iii) Load Survey Data: The static meter has the provision to store the billing and tamper data for 35 days at the specified logging interval, say 15Mts/30 Mts. which is useful to draw the load curves of KWH & KVAH, KVA & KVAH. This is known as load survey data which gives complete picture of load pattern of that consumer. The interval by interval data from this function helps in several ways.

The energy supplied to the feeder(s) by the DT can be windowed (sliced)so that it aligns with the energy consumption from the route meter readers. This reduces the "time parallax" problem that plagues energy accounting at the feeder level. The magnitude of the peak load on the transformer can be measured. The time of the peak load on the transformer can be measured.

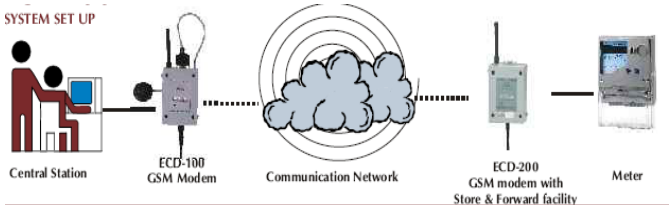
iv)Import/Export Metering: The static meter can measure the energy in both directions etc., the consumer acting as a load for some time and feeding into the grid for some other time.

v) Meter Reading Instruments: The meter reading instrument (MRI) is a simple hand held terminal used for data transfer from/to meter to/from the system-computer.MRI can be used for data transfer from HT tri vector meter for analysis of data& billing.

The MRI can be preloaded with meter numbers to be read and optionally the MRI can also have a bar code reader. The bar code reader will be useful to identify the serial number/identify of meter. In case of HT services with load survey data, MRI is very essential for transfer of data from meter to computer as the data collected is enormous and is not possible to read manually.

vi)Tele metering-Remote Metering: Transfer of metered data through a communication network is known as Tele metering. The meter is connected to say a telephone line at the consumer end via a Modem. At the system end also the computer is connected to the telephone via a modem.

Whenever data is to be accessed by the computer, the consumer telephone number host is dialed and the modem connected to the telephone connects to the meter. This type of metering system can be very useful in case of H.T. services as well as substation/services which require constant monitoring. The figure shown below represents the Tele metering which involves metering by using fixed network, drive by and also by using some communication network.



D. Eliminating Defective metering, billing and collection functions:

These losses are not due to any deliberate actions of the customers. They are due to internal short comings and hence are that much easier to tackle. This has sustained over years because of absence of focus on commercial areas.

i)Metering: There are many unmetered services. A large scale drive is necessary to bring all unauthorized consumers on to the rolls. All the existing unmetered services shall be stopped to be so immediately. The utility should concentrate on purchasing of adequate quantity of meters both for fresh services and for replacement of the defective meters in the existing services. The service line must be armoured and completely visible from pole to meter. The meter must be installed (or shifted) to call bell location. The meter must be kept in a transparent polycarbonate meter box .The wire connection must be fully inside the meter box.

ii) Billing: Correct billing and timely serving will go a long away in improving the collections. The normal complaints in the billing process are: non receipt/late receipt of bills, receiving of wrong bills, wrong reading/status, table readings and wrong calculations. All these can be avoided in a single go by going for computerized spot billing as is already done in some states. A thorough understanding by the readers on the various statuses of the meter is a sine qua non for the success of the system.

iii) Collection: Increased customer convenience shall be the guiding factor for smooth collections. Drop box facilities and bringing in more collection agencies will make the length y queues vanish E-Payment centers will give relief to the customer as around 25 types of bills can be accepted in a cool atmosphere at convenient hours. Online facilities like bill junction are extended. Special collection drives, coupled with intensive inspections, in the areas where the payment history was bad, should be adopted. Effective disconnection of defaulters should be a norm rather than a chance occurrence. CAT is to be applied and high areas services are to be targeted. We must increase the number of collection points. The payment option mode through ATP machines, netbanking, debit card and credit card. Consumer can pay electricity bills from home, cyber café and any MPONLINE kiosk. Number of ATP Machines should be increases at least upto ward or block level

VI. AT&C LOSSES IN THE REAL SCENARIO

The AT&C losses for some states such as Andhra Pradesh and Tamilnadu is less than 15% while in Bihar, Jharkhand and J&K it is around 50% . In our company the AT&C losses for the year 2013 was 27.46 . In some European countries the losses are around 7 %. If in a state has percentage of losses of 27% it means out of the total power generated 27% is going waste without revenue realization which meant a lot in terms of economy.

VII. CONCLUSION

We must take serious measures to reduce the AT&C losses as it badly effects the financial health of the DISCOM. Higher AT&C losses causes low CRPU and higher implication on tariff. By energy audit we can find out the clusters of higher losses and take preventive measures. We can reduce them to below 10% for commercial viability of our company which in turn helps to improve our Indian economy.

EXAMPLES :

1) In a certain area the energy input is 90 MU and sold units are 74 MU with the collection efficiency of 95 % . Find the AT&C Losses .

SOLUTION:

Energy realized = sold units X Collection Efficiency

Energy realized = 74 X 0.95 = 70.3 MU

AT&C Losses ={(Total Energy Input LESS Energy Realized)/ Total Energy Input}X 100

AT&C Losses = {(90- 70.3)/90 } X 100 = 21.88 %

2) In a city the Distribution losses are is 12% and collection efficiency is 92%. Find the AT&C Losses .

SOLUTION:

Billing efficiency = (100 - Distribution losses }

= 100-12 = 88 %

AT&C Losses = {1- (Billing Efficiency X Collection Efficiency)} X100

AT&C Losses = {1- (0.88 X 0.92)} X100

AT&C Losses = 19%

3) The input energy in a circle is 30MU for a particular month . the sold units are 18MU and billed units are 24 MU. Find the Billing efficiency collection efficiency , Distribution loss and AT&C Loss for the circle.

SOLUTION:

Billing efficiency = billed units/ input energy

Billing efficiency = 24/30 = 0.8 or 80%

Distribution loss = 1- Billing efficiency = 1-0.8

Distribution loss = 0.2 or 20%

Collection efficiency = sold units/billed units

Collection efficiency = 18/24 = 0.75 or 75%

AT&C Loss = {1- (Billing Efficiency X Collection Efficiency)} X100

AT&C Loss = {1- (0.8 X 0.75)} X100

AT&C Loss = 0.4 or 40%

ILLUSTRATIONS:

Energy Flow from Generation to Consumers