# AT& C Losses in Power Distribution

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# Challenges faced by Power Sector

| Generation | Transmission | Distribution |
|---|---|---|
| Inadequate power generation capacity | Inadequate inter-regional transmission links | Inadequate and ageing sub-transmission & distribution network leading to frequent power cuts and local failures/faults, erratic voltage and low or high supply frequency. |
| Lack of optimum utilization of the existing generation capacity | Lack of grid discipline and poor grid management | Large scale theft, skewed tariff structure, inefficient use of electricity by the end consumer. |
| | | Distribution losses up to 50%. |
| | Transmission losses up to 17% | Day to day problems of the consumers like hurdles in getting new connections or enhancement of loads, stiff procedures, unfriendly commercial policies, tardy metering, inflated billing and insufficient collection avenues, hostile staff, massive churning of the consumers, poor dispute resolution mechanisms. |

# Power Distribution Sector – Complexities

- Distribution Sector considered as the weakest link in the entire power sector
- Involves dealing with retail consumers with varied expectation and at the same time different paying capacity
- Involves Huge network and requires network management of vast area
- Theft, pilferages, network losses are maximum in this segment
- Distribution is often seen as a social obligation of Government toward society rather than a commercial activity
- Subsidised and often unmetered power adds to Distribution Utilities woes in terms of technical losses, billing, recovery and consumption habits

# Key Issues …….Contd.

- Since the metering, billing, and collection at many places involves human intervention most of the times human error, intentional or non intentional can occur
- Lack of infrastructure in many developing countries for database management system and at the same time absence of any data mining system
- Lack of employee ownership
- Internal Resistance to change

# AT& C Losses???

**Aggregate Technical and Commercial Losses (AT & C Losses)** is nothing but the sum total of technical loss, commercial losses and shortage due to non-realisation of total billed amount:

**{(Total Energy Input LESS Energy Realised)/ Total Energy Input}*100**

Where, Energy Realised is **Sale of Energy * Collection Efficiency**

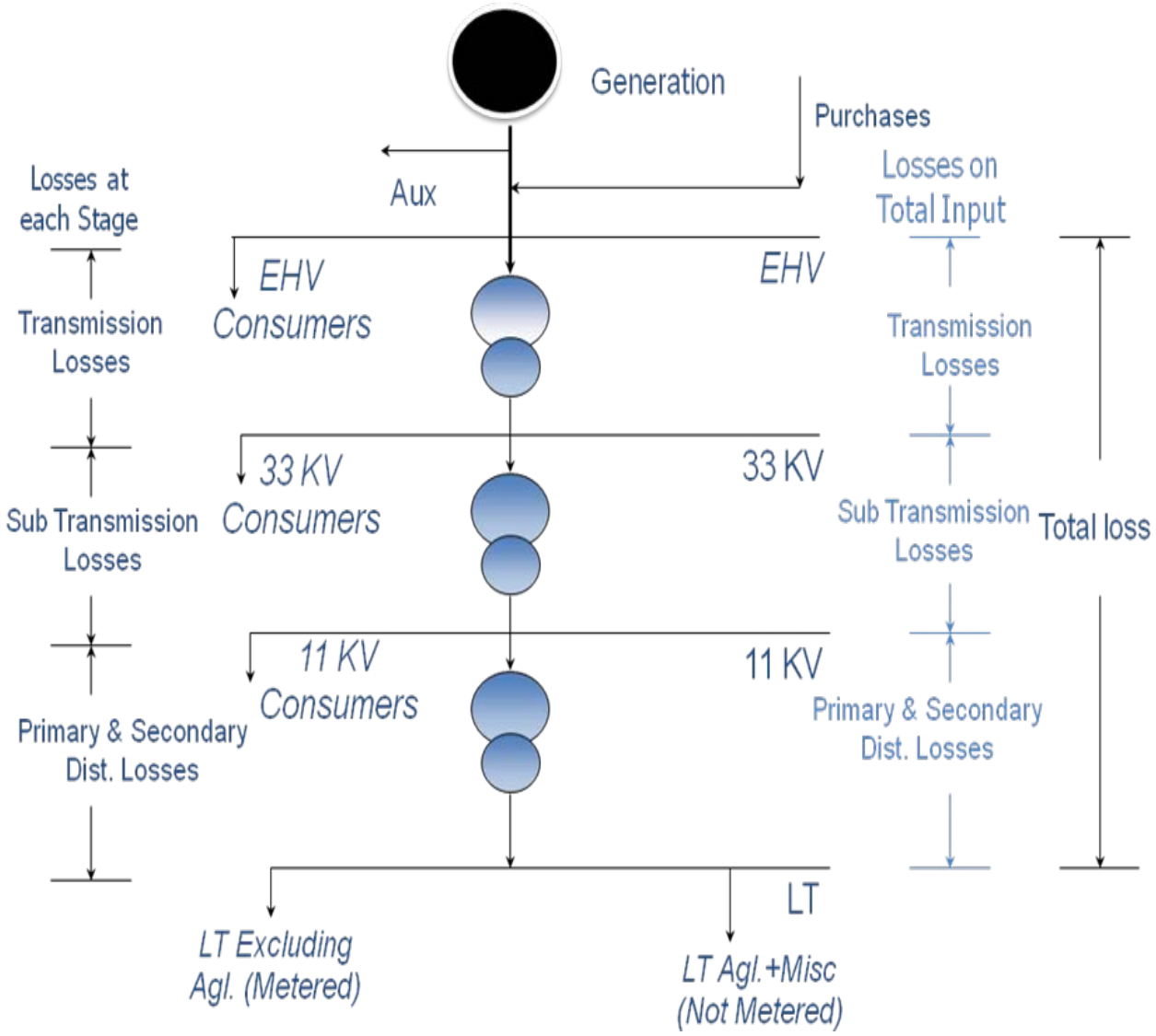
**Distribution Losses (Technical + Commercial Losses)** is nothing but the difference between energy supplied at the Input Points and Energy Billed to Consumers in percentage terms for a particular period:

**(Energy Input less Energy Billed to Consumers in kWh/ Energy Input in kWh)*100**

**Collection Efficiency** is nothing but the ratio of revenue actually realized from consumers and energy amount billed to Consumers for a particular period, in percentage terms:

**(Revenue Realized from Consumers/Energy Amount Billed to Consumers)*100**

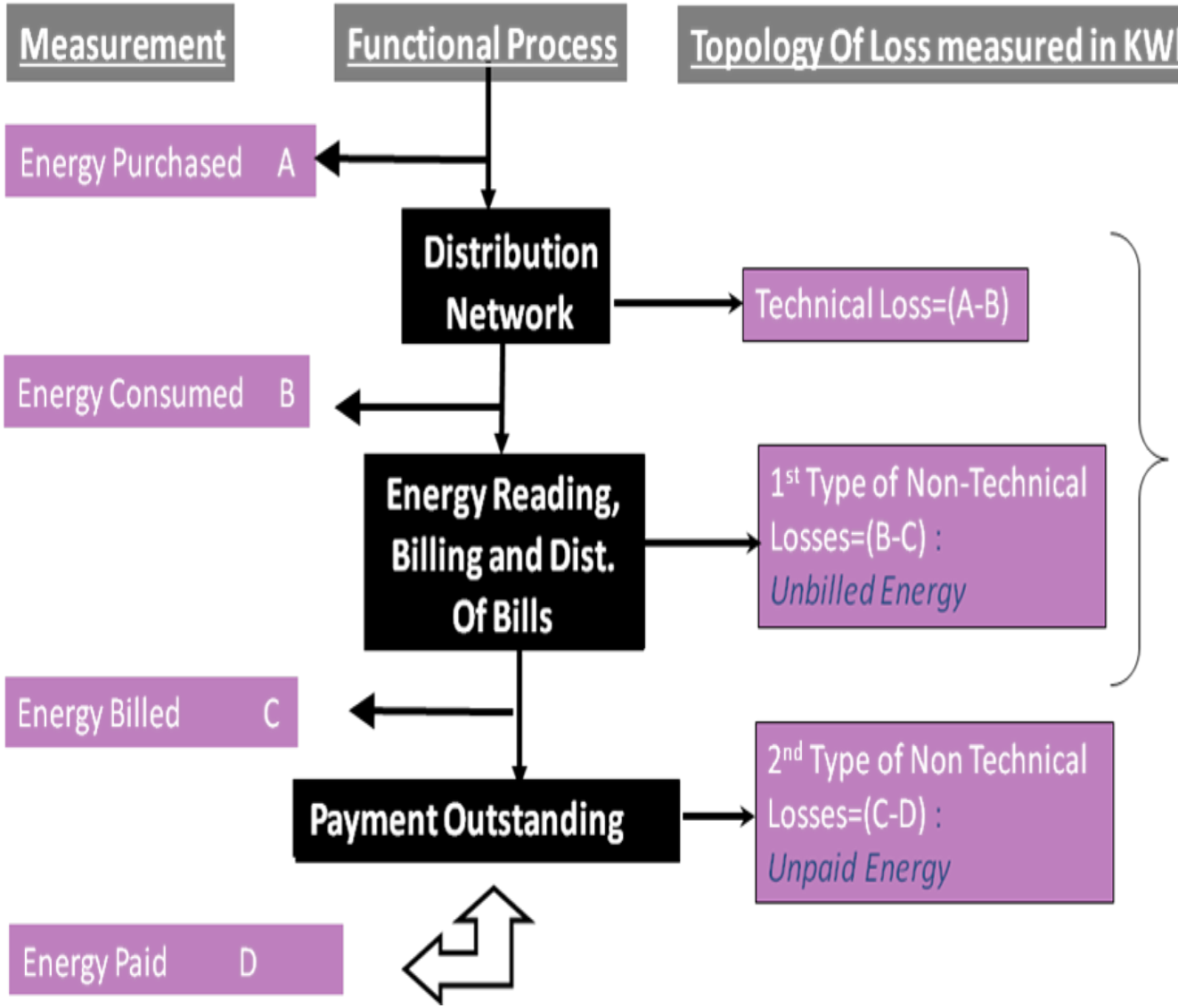
# Energy Flow from Generation to Consumers




Majority of Losses occur in the distribution phase.

The low voltage operation in the distribution is a major reason of higher technical losses due to inherent properties of the network.

# Losses in Distribution System




- Losses occur due to technical and commercial reasons.
- Minimising either Technical or Commercial Losses may not serve the purpose of any distribution utility and requires a simultaneous action on all of them.

# Losses in Distribution System - Reasons

Poor Infrastructure


## Technical Losses

- *Ill maintained equipment and substations, ageing transformers,*
- *Inadequate investments for infrastructure improvement,*
- *Overloading of system elements like transformers, feeders, conductors, etc.,;*
- *Insufficient reactive compensation, e.g., non inclusion of appropriate capacitor banks at appropriate places,*
- *No re-configuration of feeder lines & distribution transformers so as to reduce the length of LT lines, and*
- *Non usage of smaller size energy efficient distribution transformers.*

## Commercial Losses

- *Theft and pilferage,*
- *Low metering efficiency,*
- *Non-reading of meters,*
- *Faulty meter reading,*
- *Inefficient billing,*
- *Under billing,*
- *Faulty bill distribution,*
- *Software errors,*
- *Prolonged disputes,*
- *Inadequate revenue collection,*
- *Revenue accounts not updated regularly, and*
- *Insufficient collection avenues.*

# Technical Losses

Technical loss of a network is a result of-

- Network Design
- Specifications of the equipments used in the network
- Network operation Parameters

The energy loss could be derived based on utilization pattern.

| 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 |

# Technical Loss Reduction

**Short Term Measures**

- Network Reconfiguration
- Network Reconductoring
- Preventing Leakages at Insulators
- Employing AVB (Automatic Voltage Booster)
- Better Management of Distribution Transformers
- Load Balancing and Load Management
- Capacitor Installation (Shunt or Series)
- Improving Joints and Connections
- Laying Additional Link Lines
- Increase in HT:LT Ratio
- Adoption of High Voltage Distribution System (HVDS)
- Regular Maintenance of Distribution Network
- Creation of Primary Substation

# Technical Loss Reduction

## Long Term Measures

- Data collection regarding existing loads, operating conditions, forecast of expected loads etc. from Grid substation up to consumer level.
- Mapping of existing system.
- Analysis of existing system. (Voltage regulation, T&D losses in existing system, Adequacy of backup system)
- Load forecast.
- Plan for upgrading the network.
- Technology options including integration of features for modernization of system.
- Evaluation of various alternatives for least cost optimal solution.
- Firming up of scope of works.
- Preparation of cost estimates.
- Phasing of works and their cost.
- Financial analysis.

# Commercial Losses

- Theft & Pilferage of Electricity
- Metering Issues
- Inefficient Billing
- Inadequate revenue collection
- Low Customer Satisfaction
- Non-remunerative tariff Structure & subsidies

# Commercial Loss Reduction

## Preventive Measures

- Defining installation procedures and ensuring that installation check points are tested / followed while installing meters.
- Use of electronic meters with tamper and load survey logging features for all categories of consumer.
- Use of optical port for taking the reading for all categories of consumers.
- Sealing of meters with seals and having proper seal management system.
- Installation of CTs/PTs in sealed boxes so that terminals are not exposed for tampering / bypassing.
- Testing of the metering system as a whole to ensure accuracy.
- Ensuring accuracy in meter reading and billing activities by generating exception lists and following up on exceptions.
- 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.

# Commercial Loss Reduction

**Planned Measures**

- Aerial Bunched Cables
- HVDS or LT less System
- Shifting of meters  outside consumer premises.
- Spot Billing
- Provision of additional counters, customer collection centres
- Installation of electronic cash register.
- Drop box facilities
- Collection agencies
- E-bill payments
- Online facilities
- Development of MIS
- Energy Accounting and Auditing
- User’s Associations, Panchayats and Franchisees in Billing & Collection

# AT&C Loss Reduction-Best Practices

- **High Voltage Distribution System (HVDS)**
- HVDS envisages running 11 KV lines right up to a cluster 2 or 3 pumpsets, employ small sized distribution transformers (15 KVA) and extend supply to these 2 or 3 pumpsets with least (or almost nil) LT lines.
- **HVDS** can be classified as:-
  - Single Phase HVDS
  - Three Phase HVDS
- **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 / 230-0-230 volts and changing all three phase pumpsets to single phase pumpsets.

Single Phase HVDS for Rural Residential Consumers

# AT&C Loss Reduction- Best Practices...Contd.

- **Three phase HVDS**
  - Existing LT lines are upgraded to 11 KV and small capacity 3-phase Distribution Transformers (15 KVA) are employed. The three phase load is feed by the three phase small capacity transformer. This results into improvements in tail-end voltage, reduction of losses.
- **Advantages of HVDS**
  - Customer has sense of ownership
  - Prevention of unauthorized loads.
  - Minimal Failure because of on over loading and no meddling of LT lines.
  - High quality of supply owing to pactically no voltage drop.
  - Less burnouts of motors because of good voltage and less fluctuations
  - Considerable reduction in line losses and consequent savings in power purchase cost
  - No additional generation capacity needed for giving new loads due to reduction in power drawals.
  - Accidents due to touching of snapped conductors reduce because the breaker trips at substation since the line is at 11KV potential.

Three Phase HVDS for agricultural loads

# AT&C Loss Reduction- Best Practices...Contd.

- **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:-
    - Total elimination of faults on LT lines
    - Improved reliability
    - Avoidance of Theft by direct tapping
    - Avoidance of Overloading of Distribution transformers
- **Metering**
  - **Static (electronic) Energy Meters**
    - 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.

# AT&C Loss Reduction- Best Practices...Contd.

- **Tamper Data**
  - The static meter can detect date pertaining to tamper such as
  - Missing potential: Gives the informantion regarding missing of supply to the potential coil and records the date and time of such occurrence.
  - 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.
  - Phase Sequence Reversal: The meter can also recognize proper phase association.

- **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.

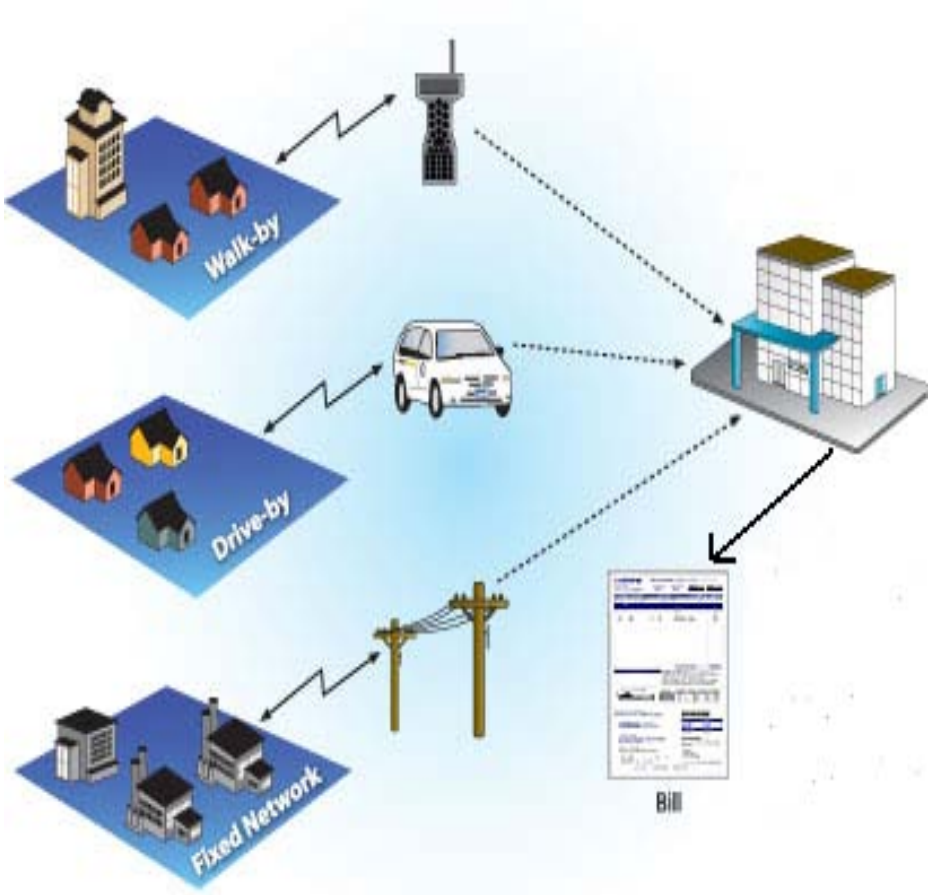
**TOD Metering system is very useful for utilizing the available electrical energy in an optimum way.**

# AT&C Loss Reduction- Best Practices...Contd.

- **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 15 Mts/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.
- **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.
- **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 trivector 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 H.T. 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.

# AT&C Loss Reduction- Best Practices...Contd.

- **Tele metering-Remote Metering**
  - Transfer of metered data through a communication network is known as telemetering.
  - 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.




**Automatic Remote Metering**

# AT&C Loss Reduction- Best Practices...Contd.

- **Prepaid Meters – A New Concept**

  - Payment before use of electricity by the consumer will eliminate difficulties involved in reading of energy meters periodically, preparing bills and collection of revenue.
  - Under this scheme, the consumer buys a specific number of units of energy as per his requirement by paying the cost in advance.
  - The electricity metering devices (consumer's meter) have the facility to read and store the number of energy units bought by the consumer, to subtract the energy consumed by the user and to cut-off the main supply on exhausting the units.

# AT&C Loss Reduction- Best Practices...Contd.

- **Distribution Automation**
  - The automation system can be designed using available technology in computer systems, control systems and metering systems and dovetailing the same into the existing power systems.
  - All the tools required such as Computers, Remote Terminal Units (RTUs), breakers, Switched Capacitor Banks, OLTC Transformers, Auto Reclosures, Sectionlisers, AMR Systems and Communication Systems are available.
  - The functional capabilities of the DAS (Distribution Automation System) for distribution operation are:
    - GIS and GPS
    - Supervisory Control and Data Acquisition (SCADA)
    - Historical Accounting and Reporting
    - Load Control of HT consumers
    - Automatic Meter Reading
    - Feeder SCADA including fault localization, restorations of supply and load balancing
    - Integrated volt/VAR control
    - Automatic Mapping and Facilities Management
    - Trouble Call Management System
    - CAT(Consumer Analysis Tool) software for analysis of Risk
    - Performance Management
      - ❑ PMRS (Performance Monitoring & Review System)
      - ❑ Uploading of PMRS data at field level and transfer through VSAT
      - ❑ TIMS (Transformer Information Management)
      - ❑ MIMS (Meter – tracking)
      - ❑ Loss study

# AT&C Loss Reduction- Best Practices...Contd.

- **Commercial Loss Reduction**
  - **The commercial losses** in power distribution utilities involve mainly the following:
    - Direct tapping by the non customers.
    - Pilferage by the existing customers.
    - Defective metering, billing and collection functions

  - **Direct tapping by the non customers**
    - In certain areas, direct tapping of power by non customers is widely prevalent.
    - Prevalent mainly in domestic and agricultural categories.
    - Geographical remoteness, mass basis for theft, poor law enforcement capability and inaction on the part of utility are helping this phenomenon.
    - Direct theft speaks volumes about the inefficient functioning of the company.
  - **Pilferage of power by the existing customers**
    - Theft by the existing consumers is the predominant cause of loss of revenue to the electrical utilities.
    - Almost all categories of the consumers are involved in this.
    - However emphasis can be given on inspecting high value services for more effective and immediate gains.
    - General methods involved in the pilferage are:
      - Totally bypassing the meter
      - Tampering the meter

# AT&C Loss Reduction- Best Practices...Contd.

- **Totally bypassing the meter**
  - The meter is not tampered.
  - It is like direct tapping.
  - From the supply lines, the tapping is made and part or full load is fed from that. This can be proved only when it is observed at the time of inspection.
  - The consumer can erase all traces of theft if the inspection is known in advance.

**By Pass Loop**

# AT&C Loss Reduction- Best Practices...Contd.

- **Tampering the meter.**
  - Bypassing at the terminal block.
  - Damaging the meter internal mechanism.
  - There are umpteen methods for tampering the meter such as inserting X-ray films, magnetic interference, direct connection etc. New methods are being constantly evolved. The thief is always ahead of the police.


**Magnet**

**Direct Connection**

# AT&C Loss Reduction- Best Practices...Contd.

- **Defective metering, billing and collection functions**

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

  - **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.
    - Purchasing of other materials shall be given low priority, if the financial position demands it.
  - **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.
  - **Collection**
    - Increased customer convenience shall be the guiding factor for smooth collections. Drop box facilities and bringing in more collection agencies will make the lengthy queues vanish.
    - E-Payment centres 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 arrears services are to be targeted.

Thank You