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Restraining the DISCOM Losses- A Pragmatic Endeavor

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Abstract : Losses in Distribution Companies (Discoms) can be categorized into Technical Losses and Commercial Losses, often referred to collectively as Aggregate Technical & Commercial (AT&C) Losses.

Technical Losses: These occur due to the inherent resistance in electrical equipment and transmission lines. They are caused by: Power dissipation in transmission & distribution lines, Overloading of transformers and cables, Poor network design leading to longer transmission distances, Inefficient equipment, old transformers, and outdated infrastructure. Commercial Losses: These are primarily due to human and operational inefficiencies, including: Power theft (illegal connections, meter tampering), Billing inefficiencies (incorrect meter readings, underbilling), Low collection efficiency (delayed or unpaid consumer bills), Unaccounted energy losses (errors in energy accounting and auditing). Aggregate Technical & Commercial (AT&C) Losses: This is a key performance indicator of Discoms and includes both technical and commercial losses. High AT&C losses indicate inefficiencies in power distribution and revenue collection. This paper will provide pragmatic efforts to curb these losses using IT enabled services and policy-based decisions like: Upgrading infrastructure (better transformers, cables, meters), App development for Meter Reading, Asset Management and Vigilance based activities. Smart metering & prepaid meters to prevent tampering and theft, reducing illegal connections through strict enforcement, Improving billing & collection efficiency via digital payments, Feeder segregation & energy audits for better power management

Keywords: Discoms, Technical Loss, Commercial Loss, AT&C Loss, Billing , Vigilance, energy audit.

A. INTRODUCTION

Electrical power is a fundamental requirement for national progress, serving as the backbone of economic growth, essential public services, and overall societal development. Reliable electricity access is vital for advancing living standards, education, healthcare, and infrastructure, ultimately fostering economic and social growth.

1.1 Importance of Electrical Power:

- **Economic Growth**: Electricity supports industries, businesses, and infrastructure, driving economic expansion and employment opportunities.
- **Social Development**: It enables improved healthcare, education, and sanitation.
- **Poverty Reduction**: Reliable electricity empowers income-generating activities, helping alleviate poverty.
- **Sustainable Development**: Transitioning to renewable energy sources plays a critical role in addressing climate change.

1.2 Power Supply System:

1. **Power Generation**: Companies produce electricity from sources such as coal, natural gas, solar, wind, and hydro.
2. **Transmission**: High-voltage lines transport electricity over long distances from power plants to substations.
3. **Distribution**: Local companies reduce voltage levels and distribute electricity to homes, businesses, and industries.

The relationship flow between these companies looks like this:
1. Generation Company → Transmission Company: The generation company supplies electricity to the transmission company for long-distance transport.
2. Transmission Company → Distribution Company: The transmission company delivers electricity to the distribution company for local distribution.
3. Distribution Company → End Consumers: The distribution company supplies electricity to homes, businesses, and other users.

1.3 Distribution Companies (DISCOMs):

DISCOMs manage power distribution within specific regions. Their key responsibilities include:

- **Electricity Distribution**: Delivering power to residential, commercial, and industrial users.
- **Billing & Revenue Collection**: Managing electricity billing and payment collection.
- **Customer Service**: Handling service requests and addressing complaints.
- **Infrastructure Maintenance**: Ensuring grid reliability through upkeep of substations, transformers, and power lines.
- **Load Management**: Monitoring power demand to maintain stable supply.

1.4 Types of DISCOMs:

- **State-Owned DISCOMs**: Examples include Kerala State Electricity Board and Karnataka Power Corporation Limited.
- **Private DISCOMs**: Examples include Tata Power, BSES Yamuna, and Reliance Power.

1.5 Types of Power Losses:

a) **Technical Losses**: Unavoidable losses due to electrical resistance and system inefficiencies.
   - **Line Losses**: Power dissipation through cables and transformers.
   - **Transformer Losses**: Energy lost as heat in transformer windings.
   - **Capacitor & Inductor Losses**: Minor energy losses from system components.
   - **Short Circuit Losses**: Power loss due to system faults.

b) **Non-Technical Losses**: Losses due to human factors like theft, fraud, or billing errors.
   - **Electricity Theft**: Unauthorized connections and meter tampering.
   - **Metering & Billing Errors**: Inaccurate readings and misreporting.
   - **Consumer Disputes**: Billing disagreements affecting revenue.
   - **Unaccounted Energy**: Losses from outdated meters and data mismanagement.

c) **Operational Issues**:
   - **Voltage Fluctuations**: Instability causing energy inefficiencies.
   - **Outages & Interruptions**: Power loss due to failures or grid instability.

d) **Transmission Losses**:
   - Energy dissipation in long-distance transmission networks.

1.6 Strategies to Reduce Losses:

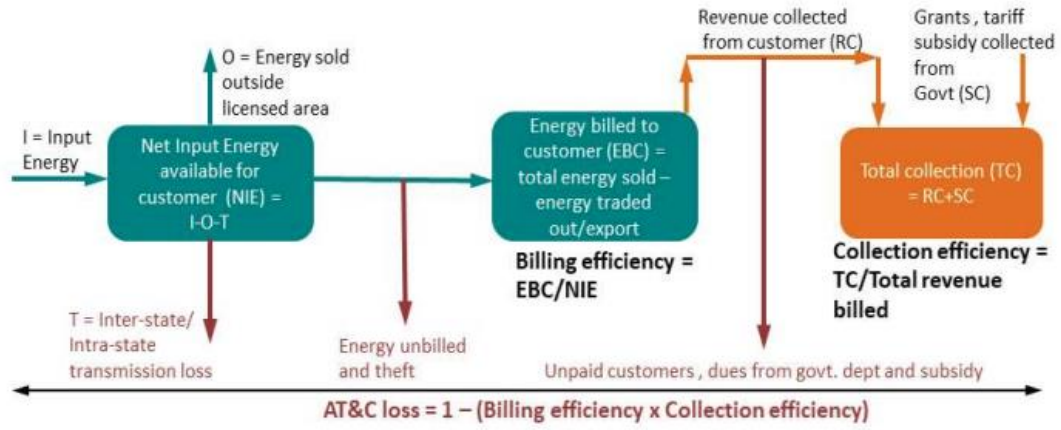
- **Infrastructure Upgrades**: Installing high-efficiency transformers and modern meters.
- **Smart Metering & Monitoring**: Real-time energy tracking to minimize theft and inefficiencies.
- **Anti-Theft Measures**: Enhanced monitoring and stricter enforcement.
- **Consumer Awareness**: Educating users about energy efficiency and billing integrity.

Aggregate Technical and Commercial (AT&C) losses for DISCOMs in India has risen to 17.6% in FY-2024, according to the MoP. This is a two-percentage point rise from the last year.
In FY-23, the economical losses of state owned Discoms in India stood at Rs 62,000 crore against Rs 31000 crore in FY-22, as per the info provided by Icra.

Fig 1.6

1.7 Some important Revenue parameters

a. **Billing Efficiency**
b. **Cash Demand**
c. **Electricity Sold**
d. **Power Input**
e. **CRPU (Cost Recovery per Unit)**
f. **RPU (Revenue per Unit)**
g. **Collection Efficiency**
h. **AT&C Loss Percentage**
i. **T&D Loss Percentage**



Source: CARE analysis

Fig 1.7 a

Madhya Pradesh Poorv Kshetra Vidyut Vitaran Company Limited

READY RECKONER

REGION : JABALPUR		CIRCLE : SE (O&M)		DIVISION			DC		
S. No.	Parameters	Unit	Last year Same Month Progress	Monthly Target	Achievement WEEK - 1	Achievement WEEK - 2	Achievement WEEK - 3	Achievement WEEK - 4	Monthly Achievement
1	NSC	No							
2	CASH COLLECTION	No							
		Amount							
3	INPUT	KWH							
4	Panchanama Prepared (O & M)	No							
5	Recovery Against Panchanama (O & M)	No							
		Amount							
6	Recovery Against PD Connection	No							
		Amount							
7	Balance SD Meter to be replaced	NDLF							
		IP							
		DL URBAN							
8	CM Helpline	L 1							
		L 2							
		L 3							
9	AG TC Served	No							
		Amount							
10	TRANSFORMER FAILURE	FAILED							
		REPLACED							
		BALANCE							

Important Formulas Pertaining to DISCOM

1	2	3	4	5	6	7
CRPU (Cash Realization Per Unit)	**RPU (Realization Per Unit)**	**Billing Efficiency**	**Collection Efficiency**	**AT&C Loss**	**T&D Losses**	**Paying Counts**
Cash Collection (from B.I) Present Month / Input (from S.T.M) Previous Month	Total Collection (Cash Collection of Present Month + Subsidy of Previous Month) / Input (from S.T.M) Previous Month	Sold Unit of Previous Month (From R15) / Input of Previous Month (from S.T.M) X 100	Total Collection (Cash from B.I Present Month + Subsidy from R15 Previous Month) / Total Demand (From R15 of Previous Month)	100 minus (Billing Efficiency X Collection Efficiency)	100 minus Billing Efficiency	No of Consumer who have Paid

Fig 1.7 b

B. GOVERNMENT INITIATIVES AND LITERATURE REVIEW

2.1 Restructured Accelerated Power Development and Reforms Programme (R-APDRP)

- Launched in 2008 to improve urban electricity distribution.
- Objectives:
  - Reduce transmission and distribution (T&D) losses.
  - Implement IT-enabled energy accounting systems.
  - Separate high-load rural feeders from urban supply.
- Implementation:
  - **Part A**: IT solutions for metering, GIS mapping, and consumer indexing.
  - **Part B**: Strengthening infrastructure and power networks.

2.2 Revamped Distribution Sector Scheme (RDSS)

- A five-year initiative to enhance power reliability and financial sustainability.
- Goals:
  - Reduce AT&C losses to 12-15% by 2024-25.
  - Eliminate the revenue gap between supply cost and collection.
- Components:
  - **Part A**: Infrastructure development, smart metering, and network upgrades.
  - **Part B**: Training, consumer outreach, and process improvements.

2.3 UDAY (Ujwal DISCOM Assurance Yojana)

- Launched in 2015 to improve DISCOM financial health.
- 16 state governments absorbed Rs 1.8 lakh crore in DISCOM debt.
- Measures:
  - Ensuring timely DISCOM payments.
  - Reviving gas-based power plants.
  - Deploying smart prepaid meters.
  - Ensuring affordable 24/7 electricity supply.

C. METHODOLOGY

The Pragmatic steps suggested by this paper to curb the losses incurred by the Discoms have been broadly divided into three divisions

3.1 IT enabled measures

3.1.1. Meter reading using Mobile App-

Development of 'Dakshata' started with clear vision of Auditing & Reading tool for DTR Loss. Initially started with limited parameters like downloading of master data in mobile, photo meter reading of consumers, uploading for validation and billing. Then option of field data like mobile no., meter no.& pole no. updation introduced.

The meter reading through Dakshata App will be digitised and this will reduce manual errors. The app will provide a platform in which every meter reader shall be provided with a downloader from the respective JE/AE and then the meter reader shall go to the consumer premises and take the reading via the Dakshata App. The reading through the app will record the image of the meter as well as the coordinates of the meter reader and thus will track the meter reader via app. Later on the business intelligence team will also verify the readings taken from the Dakshata app if required to assess its authenticity.

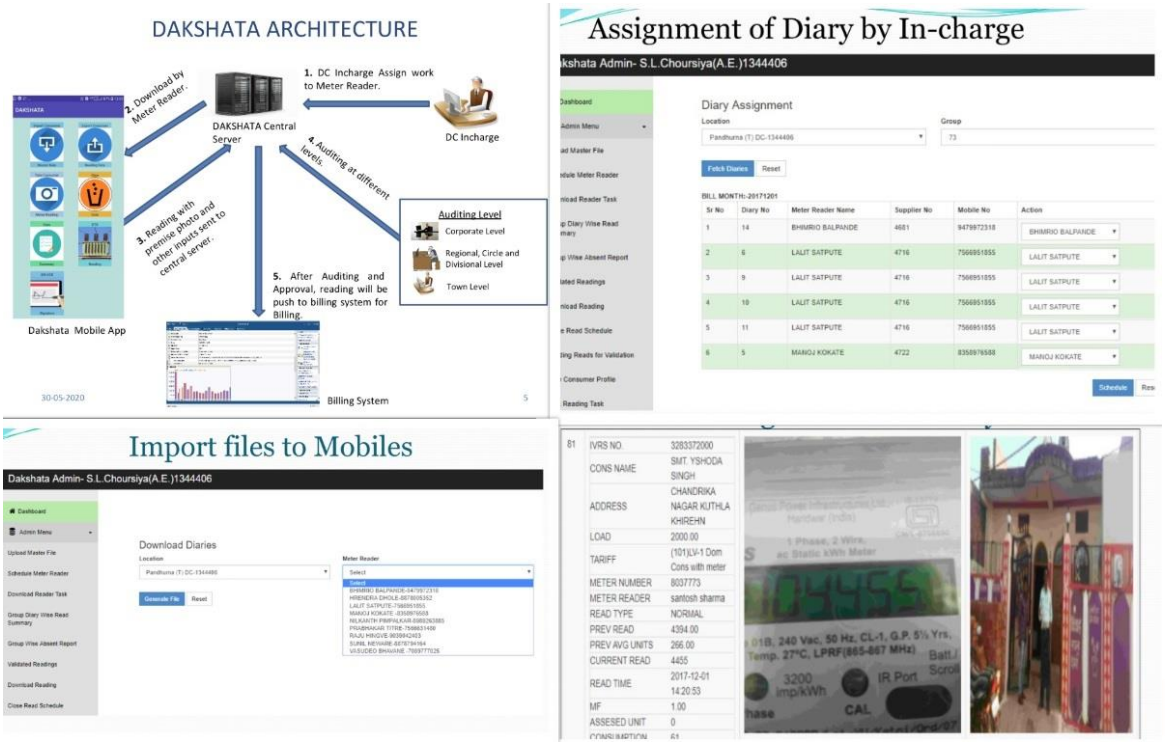


Fig 3.1.a

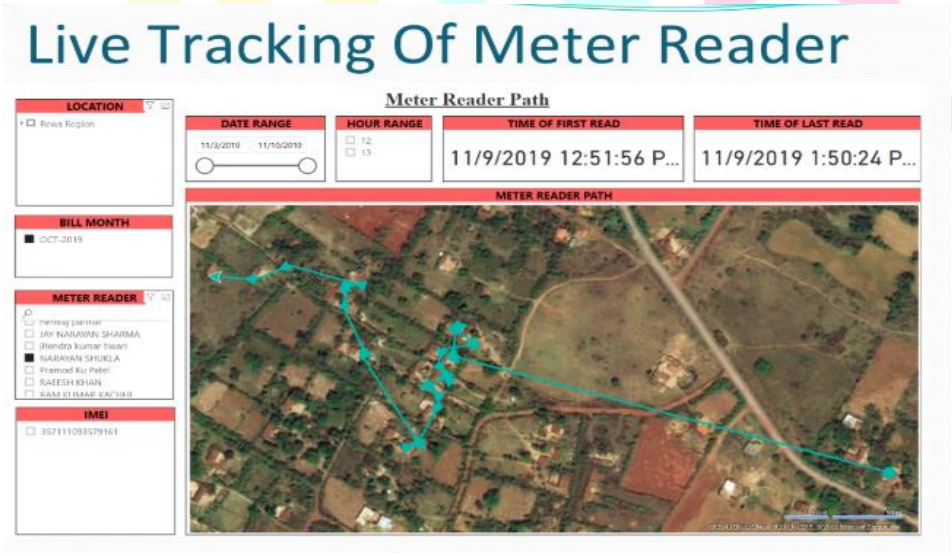


Fig 3.1.b

3.1.2 **Meter Data Management (MDM) Software** is a crucial tool for utilities and power distribution companies, enabling efficient collection, processing, storage, and analysis of meter data. It helps in accurate billing, grid monitoring, demand forecasting, and loss reduction.

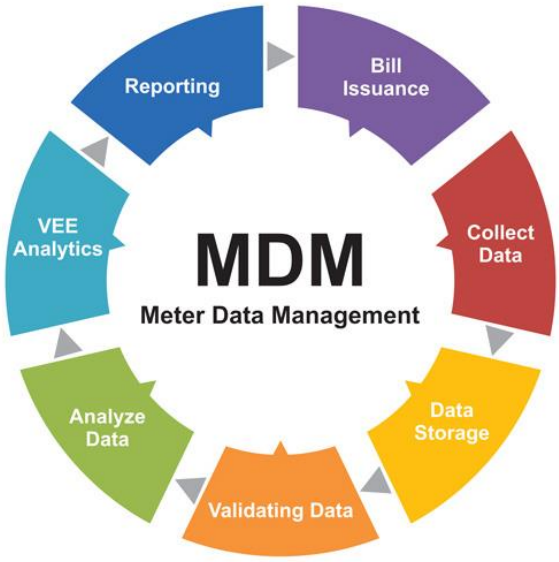


Fig 3.1.2.a

Key Functions of MDM Software:

i. **Data Collection & Integration**
   a. Aggregates data from smart meters, traditional meters, and IoT devices.
   b. Supports integration with SCADA, GIS, and billing systems.

ii. **Validation & Error Detection**
   a. Identifies missing, inconsistent, or erroneous readings.
   b. Performs automatic anomaly detection (e.g., meter tampering, power theft).

iii. **Billing & Revenue Assurance**
   a. Ensures accurate billing by validating consumption data.
   b. Reduces revenue losses due to incorrect readings.

iv. **Real-time Monitoring & Alerts**
   a. Detects voltage fluctuations, outages, and abnormal consumption patterns.
   b. Sends alerts for immediate corrective actions.

v. **Load Forecasting & Demand Analysis**
   a. Helps utilities predict demand and optimize energy distribution.
   b. Supports dynamic pricing strategies like **Time-of-Day billing**.

vi. **Consumer Engagement**
   a. Provides energy consumption insights through customer portals.
   b. Enables prepaid metering and flexible tariff plans.

vii. **Compliance & Reporting**
   a. Generates regulatory reports for government and energy agencies.
   b. Ensures adherence to industry standards like IEC, IEEE, and DLMS/COSEM.

Fig 3.1.2.b

3.1.3 Automatic Meter Reading (AMR) for DISCOMs

Automatic Meter Reading (AMR) is a technology used by Distribution Companies (DISCOMs) to automatically collect electricity consumption data from meters without the need for manual intervention. This enhances efficiency, reduces billing errors, and helps in real-time monitoring of electricity usage.

Key Features of AMR:

i. **Remote Data Collection**
   a. Automatically collects meter readings via wireless or wired networks (RF, GSM, GPRS, PLC, IoT).
   b. Eliminates manual meter reading errors.

ii. **Real-Time Monitoring & Alerts**
   a. Detects power outages, tampering, and unusual consumption patterns.
   b. Sends alerts for immediate corrective actions.

iii. **Accurate Billing & Revenue Protection**
   a. Reduces billing discrepancies and ensures timely payment collection.
   b. Supports **prepaid metering** and **time-of-day billing** (variable tariffs).

iv. **Loss Reduction & Theft Detection**
   a. Identifies unauthorized electricity usage and tampering.
   b. Helps reduce **Aggregate Technical & Commercial (AT&C) losses**.

v. **Consumer Engagement & Transparency**
   a. Provides real-time consumption data to consumers via mobile apps and portals.
   b. Encourages energy efficiency through smart monitoring.

vi. **Integration with Utility Systems**

   - Compatible with **Meter Data Management (MDM)**, GIS, and billing systems.
   - Supports both **AMI (Advanced Metering Infrastructure)** and traditional metering setups.

Types of AMR Technologies:

- **Power-Line Commn (PLC):** employs existing power lines to send data.
- **Radio Frequency (RF):** Wireless transmission using short-range communication.
- **GSM/GPRS-Based AMR:** Uses mobile networks for data transfer.
- **IoT & Smart Metering:** Enables real-time two-way communication.

3.1.4 Vigilance App for DISCOMs

A **Vigilance App** for Distribution Companies (DISCOMs) is a digital tool designed to detect, report, and prevent electricity theft, meter tampering, and other fraudulent activities. It enhances transparency, operational efficiency, and revenue protection.

Key Features of a Vigilance App:

i. **Real-Time Theft Detection & Reporting**
   a. Identifies unauthorized connections, meter tampering, and bypassing.
   b. Enables consumers and officials to report theft via images, videos, and GPS tagging.

ii. **Automated Meter Tampering Alerts**
   a. Integrates with **Automatic Meter Reading (AMR)** and **Smart Meters** to detect irregular consumption patterns.
   b. Sends real-time notifications for meter bypassing, reverse energy flow, or phase imbalances.

iii. **Geo-Tagging & GIS Integration**
   a. Uses location-based tracking to map theft-prone areas.
   b. Allows field officers to mark high-loss regions for targeted inspections.

iv. **Inspection & Case Management**
   a. Enables vigilance teams to schedule, conduct, and record inspections digitally.
   b. Maintains case history, evidence, and legal proceedings for theft-related cases.

v. **Consumer Grievance & Complaint Management**
   a. Allows users to submit complaints related to illegal electricity usage.
   b. Provides case status updates and resolution tracking.

vi. **Data Analytics & AI-Based Risk Assessment**
   a. Uses **Artificial Intelligence (AI) and Machine Learning (ML)** to predict theft-prone locations.
   b. Generates reports on revenue losses due to theft and recommends preventive actions.

vii. **Integration with Billing & Metering Systems**

   - Cross-verifies consumption patterns with billing data.
   - Flags sudden drops in billing despite normal consumption trends.

Possible Technologies Used in Vigilance Apps:

- **IoT & Smart Metering** for real-time anomaly detection.
- **GPS & GIS Mapping** for theft-prone area identification.
- **AI & ML** for predictive analytics and fraud detection.
- **Mobile-Based Field Reporting** for on-site inspections and case tracking.

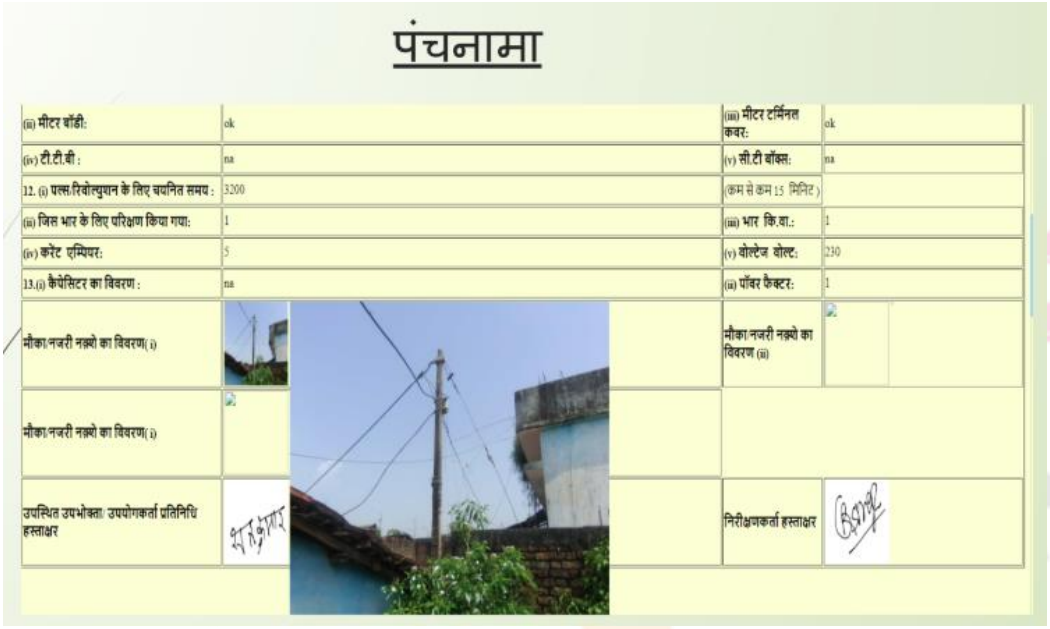

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Fig 3.1.4

3.2 Data Analysis for DISCOMs

Data analysis plays a crucial role in improving the efficiency, revenue collection, and operational management of **Distribution Companies (DISCOMs)**. By leveraging **Big Data, AI, and Business Intelligence (BI)** tools, DISCOMs can optimize electricity distribution, reduce losses, and enhance customer satisfaction.

Key Areas of Data Analysis in DISCOMs:

i. Load Forecasting & Demand Analysis

a. Uses **historical consumption data** to predict future electricity demand.
b. Helps in **grid planning and power procurement**, avoiding shortages or excess supply.
c. Supports **Time-of-Day (ToD) billing** for better demand-side management.

ii. Revenue Analysis & Loss Reduction

a. Tracks **billing efficiency, collection efficiency, and AT&C losses**.
b. Identifies **non-technical losses** (theft, billing errors, and unaccounted energy).
c. Helps in **smart meter deployment** and loss-prone area identification.

iii. Consumer Usage Patterns & Tariff Optimization

a. Analyzes **consumption behavior** to design better tariff structures.
b. Identifies **high-demand industrial, commercial, and residential consumers** for better load balancing.

iv. Theft & Fraud Detection

a. Uses **AI-driven anomaly detection** to flag suspicious usage patterns.
b. Cross-verifies **meter data with billing records** to detect under-reporting.
c. Uses **GIS mapping** to analyze theft-prone areas.

v. Outage & Fault Analysis

a. Analyzes **voltage fluctuations, transformer failures, and grid faults**.
b. Predicts and prevents outages using **real-time monitoring** and **IoT sensors**.

vi. Energy Accounting & Smart Meter Insights

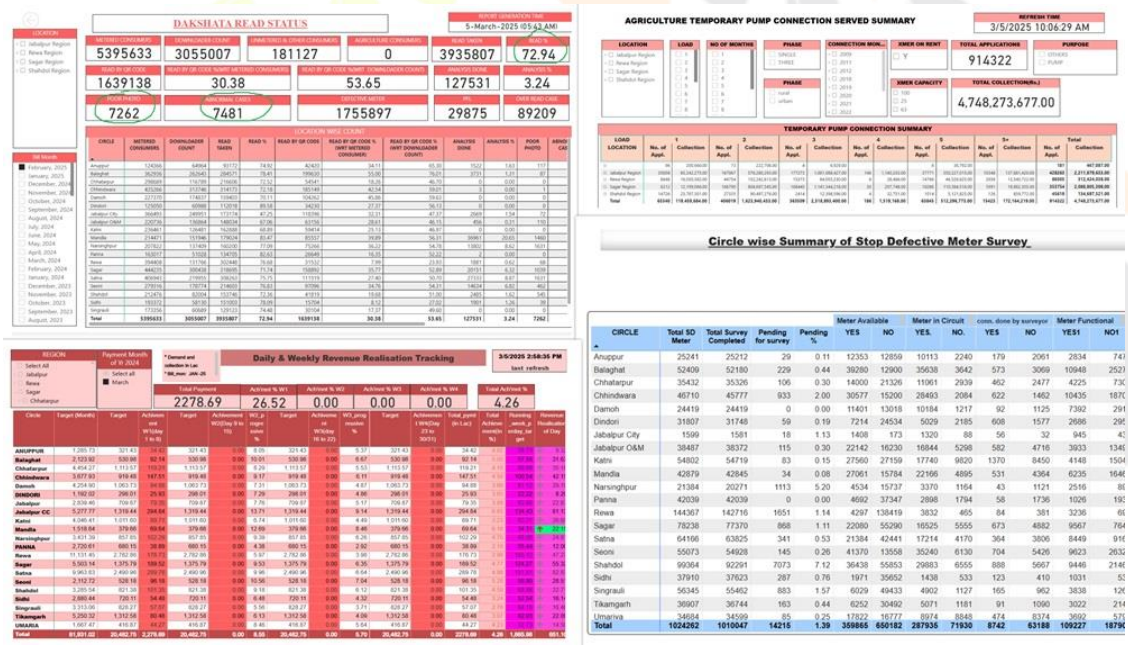
a. Compares **input energy vs. billed energy** to identify discrepancies.
b. Tracks **feeder-wise, substation-wise, and transformer-wise energy distribution**.
c. Uses **smart meter data** to provide **real-time consumption analytics**.

vii. Customer Service & Complaint Resolution

a. Analyzes **customer feedback and complaint trends** to improve service quality.
b. Uses AI-powered **chatbots and analytics dashboards** to enhance user experience.

Tools & Technologies Used for Data Analysis in DISCOMs:

- **Business Intelligence (BI) Tools:** Power BI, Tableau, Qlik Sense for interactive dashboards.
- **AI & Machine Learning:** Python, TensorFlow, Scikit-learn for predictive analytics.
- **Big Data Platforms:** Apache Hadoop, Spark for handling large datasets.
- **GIS & Mapping Software:** ArcGIS, Google Maps API for theft detection and network optimization.
- **SCADA & IoT Integration:** Real-time grid monitoring and automation.



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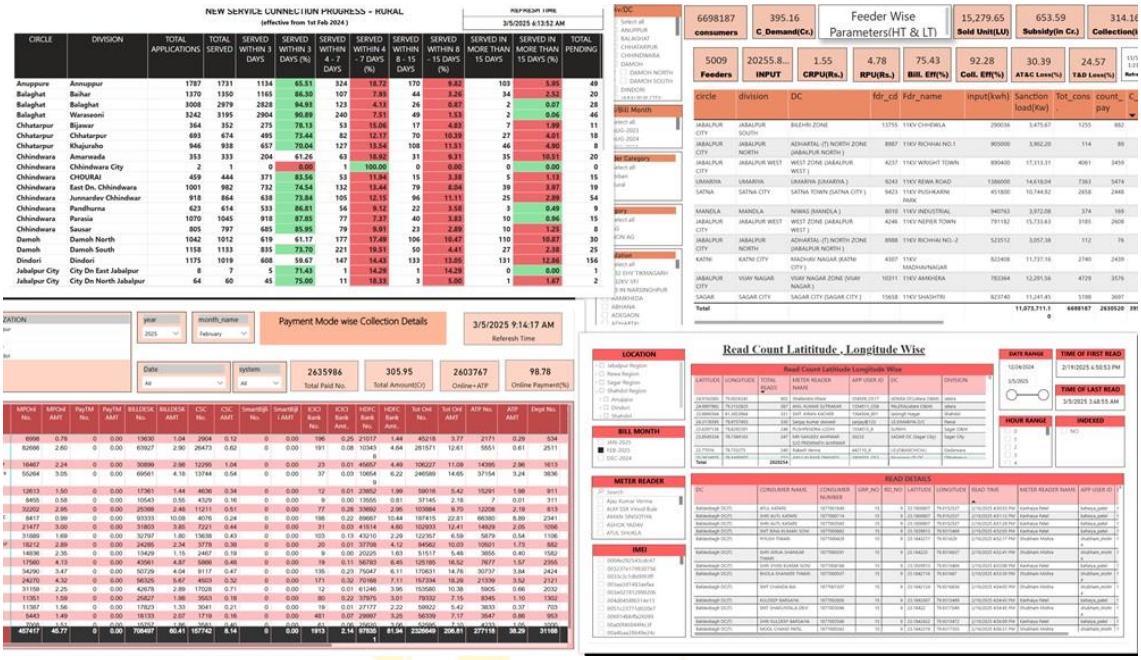


Fig 3.2.b

3.3 Policy enabled measures

3.3.1 AG QR Coding for DISCOMs

AG QR Coding is an advanced digital solution designed for **electricity distribution companies (DISCOMs)** to enhance **metering accuracy, asset tracking, and billing efficiency**. By integrating **Quick Response (QR) codes** with **metering and billing systems**, DISCOMs can streamline operations, improve revenue collection, and reduce losses.

Fig 3.3.1

Key Features of AG (Agricultural) QR Coding in DISCOMs:

a. Smart Metering & Consumer Identification

ii. Each Agricultural consumer's **meter is assigned a unique QR code** linked to their billing and consumption data.
iii. Enables **fast and error-free meter reading** by scanning the QR code.
iv. Reduces manual data entry errors and improves billing accuracy.

b. Recovery against PD arrears – Kurki

3.4 Infrastructure enabled measures

a) *Smart Metering for DISCOMs*

Smart metering is an advanced technology that enables **real-time monitoring, accurate billing, and efficient energy management** for **Distribution Companies (DISCOMs)**. It eliminates manual meter reading, enhances revenue collection, and helps reduce losses in electricity distribution.

Key Features of Smart Metering in DISCOMs:

Automated Meter Reading (AMR) & Remote Monitoring

- Eliminates the need for **manual meter readings** by automatically collecting and transmitting data.
- Uses **GSM, RF, PLC, or IoT-based communication** to send real-time consumption data to the utility.

Accurate Billing & Revenue Protection

- Prevents **billing errors, estimated readings, and delayed bills**.
- Enables **prepaid metering** and **dynamic pricing models**.

Theft & Tampering Detection

- **Alerts DISCOMs** about meter bypassing, tampering, or abnormal usage patterns.
- Uses **AI-based analytics** to identify electricity theft and unauthorized connections.

Load Management & Demand Response

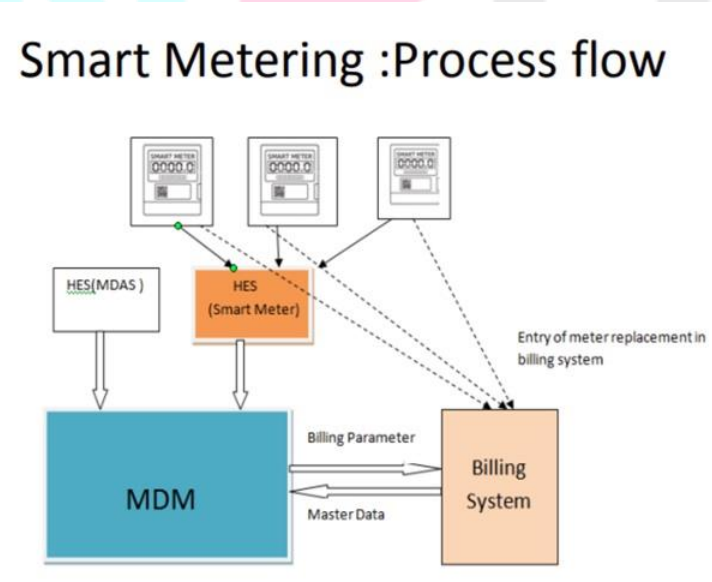
- Supports **Time-of-Day (ToD) billing**, allowing consumers to shift usage to off-peak hours.
- Helps in **peak load balancing** and **grid stability**.

Consumer Engagement & Transparency

- Consumers can **track real-time usage via mobile apps and online portals**.
- Encourages **energy conservation** by providing insights into usage patterns.

Integration with Smart Grid & Renewable Energy

- Enables **bidirectional metering** for rooftop solar and net metering.
- Supports **grid automation and outage management** by detecting faults in real time.



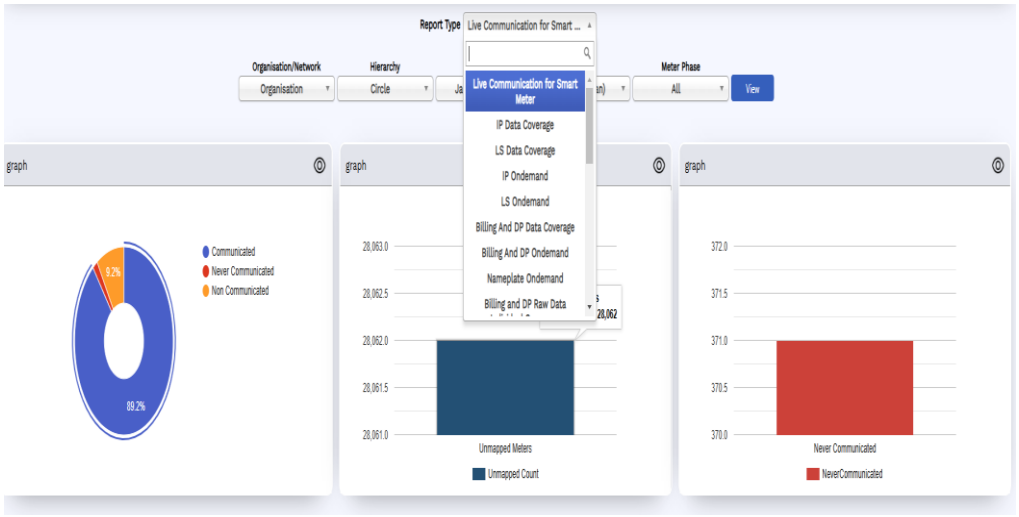


Fig 3.4.a

b) *Asset Mapping in DISCOMs*

Asset Mapping in **Distribution Companies (DISCOMs)** is a **digital mapping process** that involves **geo-tagging and tracking** electrical assets such as transformers, feeders, substations, poles, and meters. It helps DISCOMs improve operational efficiency, reduce losses, and enhance grid management.

Key Features of Asset Mapping in DISCOMs:

Geo-Tagging & Digital Inventory Management

- **Maps all electrical assets** (poles, substations, transformers, meters) using **GIS (Geographic Information System)**.
- Provides **real-time asset location tracking** for better field management.

Fault Detection & Predictive Maintenance

- Identifies **faulty transformers, aging cables, and overloaded feeders** before failures occur.
- Uses **IoT sensors & AI analytics** for predictive maintenance.

Improved Network Planning & Expansion

- Helps **DISCOMs plan new substations, feeder routes, and distribution lines** based on demand.
- Reduces **power losses by optimizing asset placement and energy flow**.

Theft & Loss Reduction

- Detects unauthorized connections by mapping **energy input vs. actual consumption**.
- Identifies high-loss areas and helps **prevent meter bypassing or illegal tapping**.

Integration with Smart Metering & SCADA

- Provides **real-time monitoring of power flow** across assets.
- Enhances **remote fault detection and faster outage restoration**.

Consumer Indexing & Load Management

- Links consumer meters with **nearest transformers and feeders** for better load balancing.
- Helps in **accurate billing and revenue collection** by mapping **actual consumption**.

Technologies Used in Asset Mapping:

- **GIS & GPS Mapping** – Google Maps, ArcGIS, OpenStreetMap for real-world asset tracking.
- **IoT & AI Analytics** – Smart sensors for real-time asset health monitoring.

- **SCADA Integration** – Remote monitoring and grid automation.
- **Drones & LiDAR Mapping** – Aerial surveys for efficient network planning.

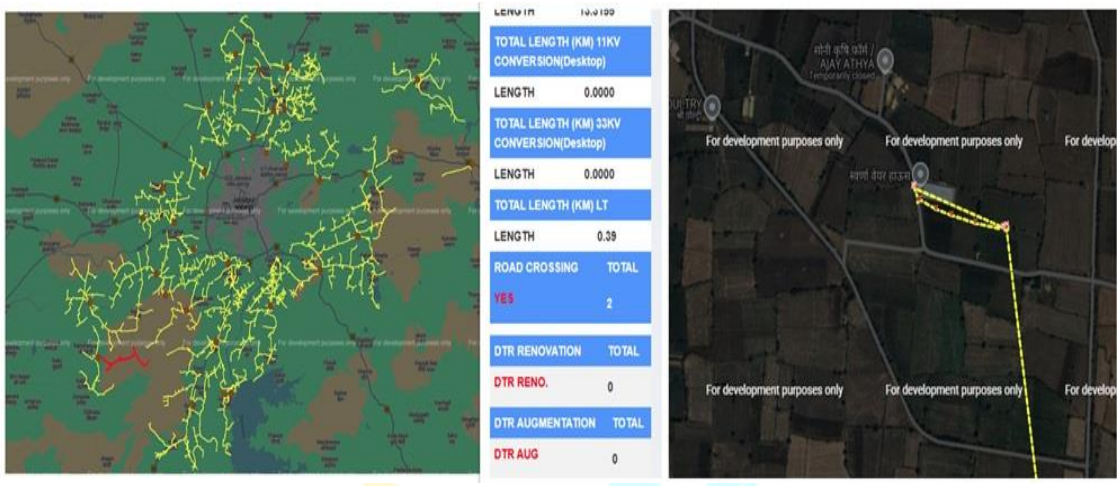


Fig 3.4.b

c) Time-of-Day Billing:

A system where electricity tariffs vary based on usage time, promoting demand management and cost efficiency.

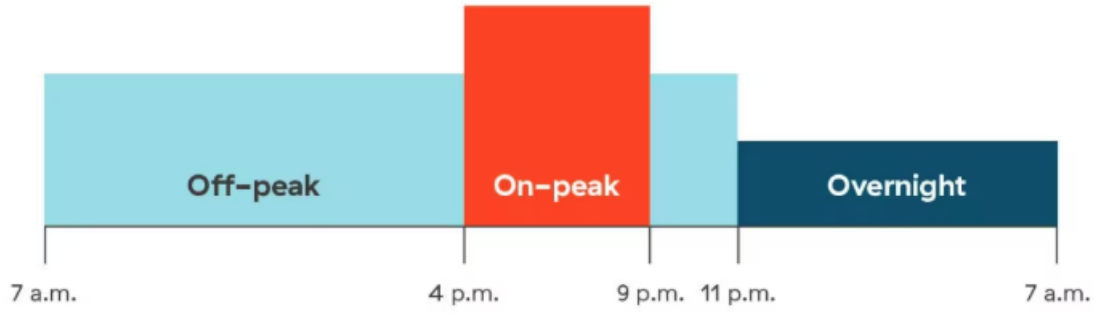


Fig 3.4.c

- **Higher rates** during peak hours.
- **Lower rates** during off-peak hours.
- **Smart meters** are required for implementation.
- Benefits include grid load balancing, better renewable energy integration, and consumer cost savings.

D. CONCLUSION AND FUTURE WORK

The Indian power sector falls under the concurrent list in the Constitution of India, granting authority to both the central and state governments. Consequently, the success of power sector policies and their implementation requires collaboration and consensus from both stakeholders. This is especially crucial for distribution reform policies, as regional dynamics and priorities differ. All stakeholders within the federal structure—including the Center and State, political entities, bureaucracy, technocrats, regulators, and consumers—must work together as part of a cohesive ecosystem to achieve a shared objective.

Using IT as tool can signifantly help in restoring the health of Discom. Apps like Dakshata and Software's like MDM can come handy to increase revenue of Discom

Despite significant disparities among states, effectively monitoring their performance within a complex market framework requires a core set of indicators. These indicators for distribution utilities are derived from the key factors identified in this paper.

A key takeaway from the analysis is that tariff adjustments—aimed at managing power purchase costs, bridging financial gaps, and ensuring quality service—are critical areas for improvement across most states. Achieving this requires substantial investments and the implementation of integrated and consistent energy policies to steer India's power sector. The future lies in smart grids and net metering solutions. Further AI powered data analytics to predict load forecasting/consumer profile/ asset health shall be helpful in boosting revenue parameters.

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