# ASIA CLEAN ENERGY FORUM (ACEF) 2026

## Thematic Track 2

### Session 2.3: Smart Infrastructure and Predictive Technologies

# AI-Powered AT&C Loss Monitoring: Enabling Real-Time Detection and Rapid Response

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**Presented By:** Reena Suri
Executive Director, India Smart Grid Forum

# About India Smart Grid Forum (ISGF)

- The India Smart Grid Forum (ISGF) has evolved as a **Think-Tank** of global repute on Smart Energy, Electric Mobility and Energy Transition
- ISGF, established as a PPP Initiative of Government of India in 2011, is spearheading the mission to accelerate electric grid modernization, electric mobility and energy transition in India
- 200+ members comprising of ministries, utilities, technology providers, academia and research
- Working Groups: Grid Modernization and Smart Cities; IoT, Smart Metering, AI and Analytics; Digital Architecture and Cyber Security; Policy, Regulations and Business Models; Renewables and Microgrids; Flexibility & Electric Mobility;
- ISGF has been driving the digitalization of Utilities and is actively involved in training and capacity building and various advisory and research activities

# ISGF - Key Focus Areas

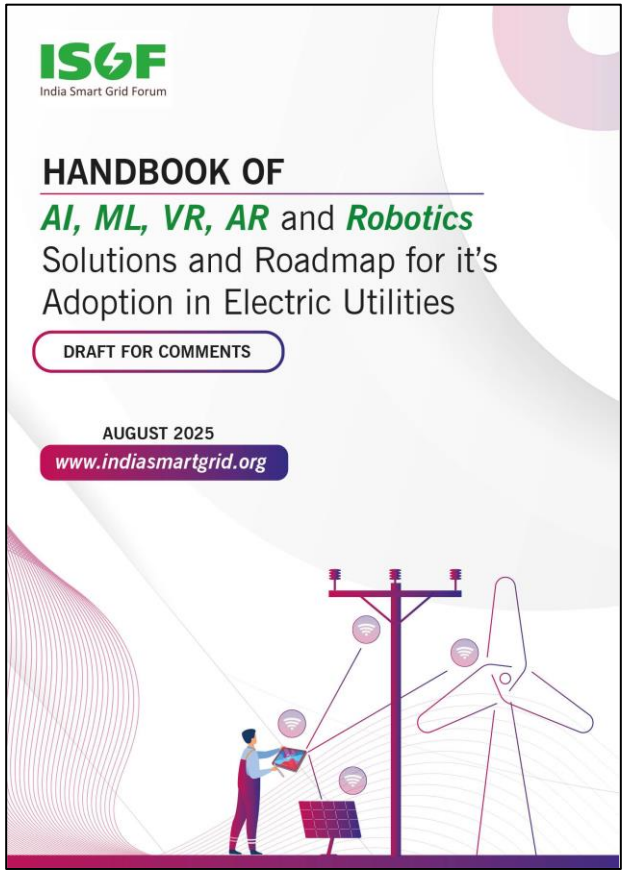
1. Electric Grid Modernization
2. Digital Architecture and Cyber Security
3. Smart Metering, AI and Analytics
4. Electric Mobility
5. Energy Transition
6. Policy, Regulations and Business Models
7. Renewables and Microgrids
8. Energy Efficiency
9. Smart Cities
10. Smart Gas and Water

**Research; Policy Advocacy; Feasibility Studies; Technology Demonstration Projects; Exchange of Best Practices and Capacity Building**

# ISGF Handbook of AI, ML, VR, AR, and Robotics Solutions with Roadmap for Adoption in Electric Utilities in India

ISGF has prepared a **Handbook** to present a select set of **Use-Cases of Successful Deployment** of AI, ML, VR, AR and Robotics Solutions in power utilities that are relevant to Indian power sector; and develop a roadmap for adoption of the shortlisted solutions in the Indian Power Utilities.

| Use Case Category | Number of Use Cases Covered per Category | | | Total |
|---|---|---|---|---|
| | Main Report | Appendix A | Appendix B (web links) | |
| **Generation** | 8 | 12 | 16 | 36 |
| **Transmission** | 7 | 9 | 15 | 31 |
| **Distribution** | 9 | 12 | 21 | 42 |
| **System Operations** | 8 | 4 | 18 | 30 |
| **Power Trading** | 8 | - | 10 | 18 |
| **Robotic Process Automation (RPA)** | 6 | - | 6 | 12 |
| **Total** | 46 | 37 | 86 | **169** |




**Report Link:** https://shorturl.at/CR2Mw

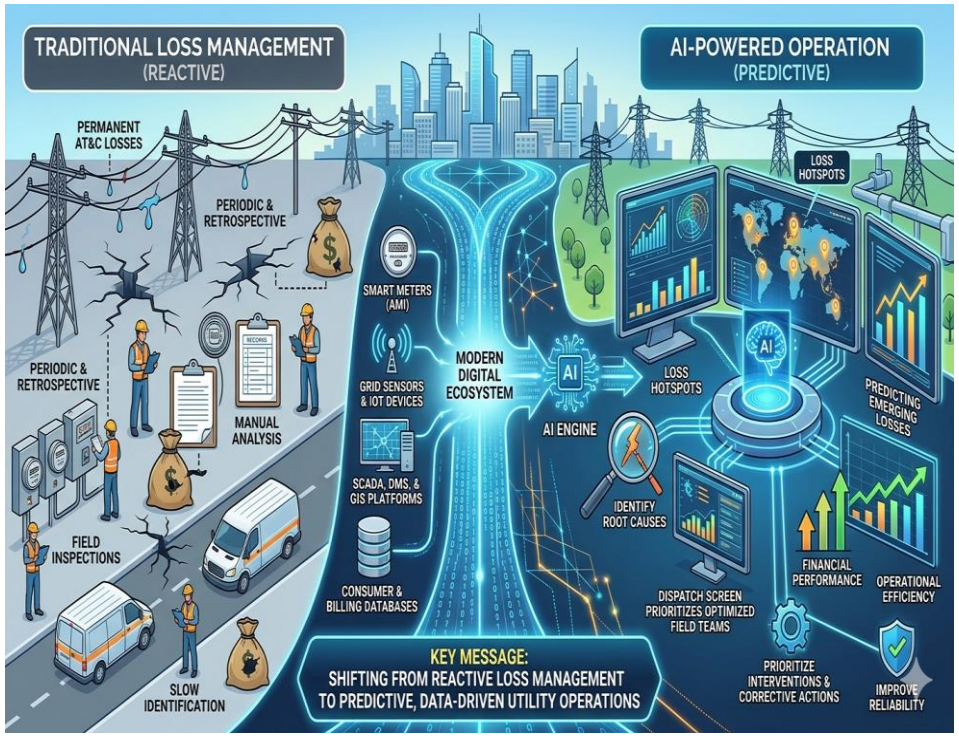
# Overcoming Grid Losses with Data-Driven Utilities

**Distribution Utilities Face Growing Challenges**

- Distribution utilities lose billions of dollars annually due to technical and commercial losses
- High Aggregate Technical and Commercial (AT&C) losses impact utility financial sustainability and quality of service
- Conventional loss assessment methods are periodic, reactive, and often delayed
- Increasing penetration of distributed energy resources, EVs, and prosumers adds operational complexity

**Need for a New Approach**

- Real-time visibility
- Predictive analytics
- Data-driven decision making
- Automated identification of loss hotspots




***AI is enabling a shift from reactive loss management to predictive, data-driven utility operations-helping utilities reduce losses, improve reliability, and accelerate their digital transformation journey***

# India's AT&C Loss Reduction Journey

| 16.12% | ₹90,000 Cr+ | 250 M+ |
|---|---|---|
| **National AT&C Loss Rate (FY24)** | **Annual Revenue Loss to DISCOMs** | **Smart Meters Being Deployed** |
| *Despite decades of effort* | *Theft + technical losses* | *Under RDSS Scheme* |

- AT&C losses encompass technical losses in distribution lines + commercial losses from theft, billing errors, and collection shortfalls
- AT&C Losses in India was >36% in 2002; it now stands at 16.12% - this was achieved through focused programs and technology interventions – saving of over 350 billion units of electricity annually!
- Conventional monitoring is periodic and retrospective - teams detect losses weeks or months after they occur
- India's RDSS scheme aims to reduce average AT&C losses to 12–15% by 2025-26 through smart metering and grid upgrades

- 250 million smart meters being deployed create a data-rich environment - need advanced analytical tools to make advantage of the smart meter data for accurate demand forecasting and grid operations
- Field teams are overwhelmed - without intelligent prioritization, they cannot act on thousands of daily alerts
- **Agentic AI offers solutions to continuously monitor, identify anomalies, and dispatch crews to attend to real-time alerts**

# AI Agents for Predictive Utility Operations – Moving from Reactive to Predictive Utilities

India Smart Grid Forum

**Traditional Reactive Approach**

- Losses identified through periodic (often monthly) data analysis
- Dependence on manual investigations and field inspections
- Delayed detection of revenue leakages and operational issues
- Slow implementation of corrective actions
- Prolonged impact on reliability and service quality

**AI-Enabled Predictive Approach**

- Continuous monitoring of network and consumer data
- Automated anomaly detection and predictive risk scoring
- Early identification of loss hotspots and equipment issues
- Risk-based prioritization of field inspections
- Targeted interventions and faster resolution cycles

**Key Benefits**

- Reduced AT&C losses
- Lower operational expenditure (OPEX)
- Improved grid reliability and resilience
- Enhanced customer service and satisfaction
- More efficient, proactive, and data-driven utility operations

# How It Works: From Data to Field Action

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## 01 Ingest & Monitor

*Real-Time Data Layer*

- AMI, SCADA, billing & meter data
- Energy input tracked per DT and feeder
- Consumer-level consumption mapped
- Continuous 24/7 data ingestion

## 02 Detect Anomalies

*AI Analytics Engine*

- Compares input vs. billed consumption
- Flags sudden loss spikes instantly
- Separates technical & commercial losses
- Scores consumers by theft probability

## 03 Generate Briefs

*Vigilance Investigation Report*

- Auto-generates concise investigation brief
- Identifies feeder/DT/consumer anomaly
- Includes loss quantum & risk score
- Replaces several weeks of manual compilation

## 04 Alert & Respond

*Daily WhatsApp Dispatch*

- Briefs sent via WhatsApp to field teams
- Alert – timely deployment of teams
- Accountability loop with field response
- Revenue recovery tracked & reported

**Net effect: A traditionally 3-week manual process compressed into a proactive daily 7 AM alert mechanism — with full field accountability.**

# The Granularity Advantage: What the Agent Monitors

## 3-Level Monitoring Hierarchy

### Customer Level

Individual consumer consumption vs. billed units — flags anomalous usage profiles

### Feeder Level

Aggregate energy input vs. total billed on each feeder — detects feeder-wide loss pockets

### DT Level

Distribution transformer losses — identifies overloaded or tampered DTs in near real-time

## What the AI Detects

### Sudden Loss Spikes

Rapid increase in unaccounted energy — indicative of direct theft or meter bypass

### Billing Irregularities

Consumer billed units inconsistent with historical patterns or peer benchmarks

### DT Overloads

Technical losses signalling infrastructure issues requiring maintenance

### Feeder Imbalances

Phase imbalances or systematic under-recording across distribution feeders

# AI-Enabled Theft Detection: Case study 1 from India

## Solution

- AI/ML-Powered Analytics Engine processes smart meter data, historical consumption, billing records, and network parameters in real-time (SAP HANA)
- Pattern Recognition identifies anomalies indicative of theft, meter tampering, and direct hooking
- AI generates prioritized list of suspected cases for targeted field inspections

## Outcomes

- AT&C losses reduced from 8.5% (2017) to 5.54% - among the lowest for any DISCOM in India
- Enhanced Revenue Recovery through targeted theft detection and field action
- Sustained reduction maintained across the distribution network

## Impact and Benefits

- Strengthened financial health enabling further network investment
- Automated detection reduces manual inspection burden significantly
- Model adopted as a best-practice benchmark for other DISCOMs

# AI-Enabled Theft Detection: Case study 2 from India

## Solution

- Deployed AI/ML-based Energy Theft Analytics Platform integrated with smart meter ecosystem
- Continuously analyzed smart meter interval data to detect anomalous consumption patterns
- Identified cases of meter bypassing, high-load appliance bypassing, night-time theft, meter tampering, and tariff misuse
- Enabled consumer-level theft detection without reliance on feeder-to-transformer-to-consumer tracing
- Detected revenue leakage using AI-driven analytics without additional hardware investments

## Outcomes

- Identified over **136 potential theft** and revenue leakage cases using AI-based analytics
- Achieved 100% field verification of all flagged cases by utility teams
- Enabled assessment and revenue recovery in nearly 63% of tariff misuse cases
- Delivered 51% validation accuracy for meter bypassing and night-theft detection
- Achieved a 41% successful booking rate in flagged theft cases.
- Established as India's first utility to deploy AI-driven theft detection and commercial loss mitigation at scale

## Impact and Benefits

- Accelerated energy theft detection, reducing revenue leakage and commercial losses
- Enhanced AT&C loss monitoring through real-time smart meter analytics
- Improved field inspection effectiveness with AI-driven, targeted leads
- Reduced reliance on manual investigations and consumer indexing accuracy
- Strengthened revenue protection and utility financial performance
- Established a scalable foundation for AI-enabled utility operations and smart grid modernization

# Two AI Use Cases By ISGF - Pilot Study 3 from India

## ISGF and our member Impresa.AI conducted 2 AI Use Cases

### Case 1

**Energy Disaggregation, enabling granular visibility of behind-the-meter consumption patterns**

- Disaggregated energy consumption for 39,298 residential smart meters
- Achieved 85% data completeness and 100% energy balance validation
- Identified **13.6 MW of shiftable load**, unlocking significant DSM potential
- DSM interventions for **T5/T6 consumers** could reduce morning peak demand by 12 - 18 MW
- Detected 382 inactive (T0) meters showing active consumption, indicating potential energy theft/revenue leakage

### Case 2

**Source of Supply (SOS) Mapping, facilitating improved accuracy of upstream network topology**

- Analysed **52,954 meters** across 27 feeders and 982 DTs using AMI data
- Achieved **66.7% mapping success (35,304 meters)**, a 4.9% improvement over previous models
- **86.2% of mapped meters** achieved high-confidence accuracy within 300 meters
- Identified **27% outdated/incorrect DT GIS records** and 22% feeder changes (7,755 meters)
- Detected major **GIS data gaps: 12,033 consumer meters and 553 DTs** missing GIS coordinates

# Case Study 3: Meter tampering and direct theft in dense urban-slum areas

**Challenge:** High commercial losses from meter tampering and direct theft in dense urban-slum areas.

**Solution:** **AI-based Energy Theft Detection and Prevention System (ETDPS)** - Applied bottom-up machine learning models to individual premises to detect anomalies like meter bypassing, heavy appliance bypassing (e.g., air conditioning), night theft, and tariff misuse.

**Objective:** Minimize the financial gap between the Average Cost of Supply (ACS) and Average Revenue Realized (ARR) by converting raw smart meter outputs into actionable grid insights.

**219** **Theft instances detected**
*In 45-day pilot (Jan–Feb 2020)*

**8.96%** **Revenue loss rate**
*Contained to ~₹0.5 lakh in pilot area*

# Thank You


## Reena Suri

**Executive Director, India Smart Grid Forum**

reena.suri@indiasmartgrid.org | www.indiasmartgrid.org


## India Smart Grid Forum

CBIP Building, Malcha Marg, Chanakyapuri, New Delhi-110021, India

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