Best practices and strategies for distribution loss reduction

Final report

July 2016

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List of abbreviations

Abbreviation	Full Form
ABC	Aerial Bunch Cables
AMR	Automated Meter Reading
APTEL	Appellate Tribunal for Electricity
APDCL	Assam Power Distribution Company Ltd.
APSPDCL	Andhra Pradesh Southern Power Distribution Company Ltd.
AT&C	Aggregate Technical and Commercial
AVVNL	Ajmer Vidyut Vitran Nigam Ltd.
BESCOM	Bangalore Electricity Supply Company
BPL	Below Poverty Line
BRPL	BSES Rajdhani Power Ltd.
BSEB	Bihar State Electricity Board
BYPL	BSES Yamuna Power Ltd.
CESU	Central Electricity Supply Utility of Odisha
CGRF	Consumer Grievance Redressal Forum
CHESCOM	Chamundeshwari Electricity Supply Company
DDUGJY	Deen Dayal Upadhyay Gram Jyoti Yojna
DF	Distribution Franchise
DHBVN	Dakshin Haryana Bijli Vitran Nigam Ltd.
Discom	Distribution Company
DMS	Document Management System
DT	Distribution Transformer
DVVN	Dakshinanchal Vidyut Vitran Nigam Ltd.
EA 2003	Electricity Act 2003
FOR	Forum of Regulators
GESCOM	Gulbarga Electricity Supply Company
GoI	Government of India
HESCOM	Hubli Electricity Supply Company
HVDS	High Voltage Distribution System
IWS	Interest Waiver Scheme
JdVVNL	Jodhpur Vidyut Vitran Nigam Ltd.

Abbreviation	Full Form
JSEB	Jharkhand State Electricity Board
JVVNL	Jaipur Vidyut Vitran Nigam Ltd.
KESCO	Kanpur Electricity Supply Company Ltd.
KSEB	Kerala State Electricity Board
MSEDCL	Maharashtra State Electricity Distribution Company Ltd.
MGVCL	Madhya Gujarat Vij Company
MVVN	Madhyanchal Vidyut Vitran Nigam Ltd.
MYT	Multi Year Tariff
MW	Mega Watt
NBPDCL	North Bihar Power Distribution Company Ltd.
NESCO	North Eastern Electricity Supply Utility of Odisha
OMS	Order Management System
Pasch VVN	Paschimanchal Vidyut Vitran Nigam Ltd.
PFC	Power Finance Corporation
PGVCL	Paschim Gujrat Vij Company Ltd.
Poorv VVN	Poorvanchal Vidyut Vitran Nigam Ltd.
PPA	Power Purchase Agreement
PSPCL	Punjab State Power Corporation Private Limited
PwC	PricewaterhouseCoopers Pvt. Ltd.
RA	Regulatory Assets
R-APDRP	Restructured Accelerated Power Development Program
RInfra-D	Reliance Infrastructure Distribution
RLDC	Regional Load Dispatch Centre
SBPDCL	South Bihar Power Distribution Company Ltd.
SCADA	Supervisory Control and Data Acquisition
SERC	State Electricity Regulatory Commission
SESCO	Southern Electricity Supply Company of Odisha
SLDC	State Load Dispatch Centre
T&D	Transmission and Distribution
TPC-D	TATA Power Company Distribution
TPDDL	TATA Power Delhi Distribution Ltd.
UHBVN	Uttar Haryana Bijli Vitran Nigam Ltd.

Abbreviation	Full Form
UPCL	Uttarakhand Power Corporation Limited
WESCO	Western Electricity Supply Company of Odisha

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Executive Summary

The implementation of power sector reforms has embarked India on the journey of achieving a national turnaround. However the journey still seems incomplete due to challenges in terms of -

- Achieving 100% electricity access owing to issues related to grid connectivity in rural areas; and
- Providing round the clock quality and reliable supply in a cost economical manner.

Meeting these challenges require a special focus on the bleeding Indian power distribution sector. One of the critical factors for the present state of DISCOMs is the high level of distribution losses. FOR has been discussing this issue with various stakeholders at regular intervals. To take these discussions to a further logical conclusion, the FOR appointed PwC through a process of competitive bidding to study and suggest recommendations on "Best Practices on and Strategies for Distribution Loss Reduction".

Components of Distribution Loss

Aggregate Technical and Commercial (AT&C) loss and Transmission and Distribution (T&D) loss are referred in power sector as yardsticks for measurement of performance of distribution utilities. AT&C loss is the difference between energy input and the energy for which revenue is actually realized from the consumer while the T&D loss is the difference between the energy input and the energy billed to the consumer. The AT&C losses or T&D losses can be segregated into technical and non-technical losses as follows -

- **Technical loss:** Technical losses are due to current flowing in the electrical network. Although these losses are inherent to the distribution of electricity and cannot be eliminated, it is possible to compute and control these losses, provided the power system in question consists of known quantities of loads. The causes of technical losses include Harmonics distortion, Long single phase lines, Unbalanced loading, Losses due to overloading and low voltage, Losses due to poor insulation and lack of regular maintenance of the plant and machinery.
- **Non-technical loss:** The energy consumed in the distribution system but un-accounted constitutes the non-technical losses. These losses can further be classified as follows –
    - **Internal Non-Technical Losses:** The internal non-technical losses may arise from connection mismanagement (instances like release of connection without meters, under recording of load, illegitimate or non-existent consumers, mismanagement of billing records), to theft (hooking/tampering or bypassing meter), incorrect meter reading, incorrect billing (factors like generation of average bill due to delayed/erroneous readings, untimely delivery of bills, faulty billing software etc.) and insufficient field vigilance.
    - **External Non-Technical Losses:** External non-technical losses are due to non-collection of dues, collection & credit mismanagement (constraints like limited avenues for collections, relatively no defaulter follow-ups, concealing/wrong posting of revenue collection, delayed temporary/permanent disconnection, non-payment of bills).

Review of distribution loss reduction initiatives followed in Indian States

Data was collected and evaluated for the best practices of loss reduction adopted by various utilities in India. A framework was devised for the selection of states for detailed study of their loss reduction strategy. On the basis of this framework the following States were selected for conducting the study.

Table 1 States selected for Indian Review

Region	State	Selected Discom
Western Region	Gujarat	MGVCL
	Madhya Pradesh	MP Discoms
	Maharashtra	MSEDCL
Northern Region	Delhi	BSES YPL
	Uttarakhand	UPCL
	Punjab	PSPCL
Eastern Region	Assam	APDCL
	Jharkhand	JSEB
Southern Region	Andhra Pradesh	APSPDCL
	Kerala	KSEB

A data template was prepared for collection of primary data from various state utilities regarding their respective loss reduction initiatives in the past. The loss reduction initiatives were broadly classified into two categories as follows –

- **Internal Aspects** – initiatives taken up by utilities to improve upon their performance and reduce losses like Governance, Process Strengthening, soft initiatives and network strengthening.
- **External Aspects –** initiatives enforced by the government or state electricity regulator to mandate a loss reduction trajectory or strategy like Administrative initiatives, Competition promotion, Regulatory initiatives and Government Support.

Based on the exhaustive secondary research and data collected from primary research, the key initiatives implemented for distribution loss reduction by various utilities has been captured and represented in the table below –

Table 2 Loss Reduction initiatives adopted by Indian State Utilities

Aspect	Initiatives	Uttarakhand	Gujarat	Punjab	Maharashtra	Andhra Pradesh	Delhi	Kerala	Assam	Jharkhand	Madhya Pradesh
		UPCL	MGVCL	PSPCL	MSEDCL	APSPDCL	TPDL/BSES	KSEB	APDCL	JSEB	MP Discoms
	T&D loss level 2010	24.53%	14.51%	20.12%	20.60%	12.98%	16.06%	17.71%	26.05%	36.51%	35.15%
	T&D Loss level 2014	19.18%	12.41%	16.44%	14%	10.68%	10.63%	15%	24.07%	27.26%	29%
	Loss reduction (FY 10 to FY 14)	5.35%	2.10%	3.68%	6.60%	2.30%	5.43%	2.71%	1.98%	9.25%	6.15%
Administrative initiatives	Dedicated police stations/staff		✓	✓	✓		✓		✓		
	Dedicated courts			✓			✓				
Regulatory initiatives	Focused clauses in Supply Code/ Grid code				✓					✓	✓
	Loss reduction based MYT mechanisms	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Loss level based tariff design			✓	✓	✓					✓
Governance framework	Loss monitoring, audit committee / cells	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Nomination of feeder managers		✓		✓	✓					
	Theft reporting consumer incentive scheme		✓				✓				
	Employee incentive schemes				✓						
	Employee capacity building program				✓		✓		✓		✓
Competition promotion	Introduction of DF initiatives/ Privatization	✓	✓		✓		✓		✓	✓	✓
	Engagement of local groups								✓		
	Outsourcing/Third party monitoring bodies	✓		✓	✓		✓		✓		✓
Process strengthening	AMR, Hand Held Devices for billing	✓		✓	✓	✓	✓		✓		✓
	SCADA, DMS, OMS, ERP, SAP etc.		✓		✓	✓	✓		✓		✓
	100% consumer metering	✓	✓	✓	✓	✓	✓	✓			✓
	Replacement of defective meters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	MIS based periodic reporting	✓	✓	✓	✓	✓	✓	✓	✓		✓
Network strengthening/	Segregation of agricultural/rural feeders		✓	✓	✓	✓				✓	✓
	Implementation of HVDS system		✓	✓	✓		✓				✓

Aspect	Initiatives	Uttarakhand	Gujarat	Punjab	Maharashtra	Andhra Pradesh	Delhi	Kerala	Assam	Jharkhand	Madhya Pradesh
		UPCL	MGVCL	PSPCL	MSEDCL	APSPDCL	TPDL/BSES	KSEB	APDCL	JSEB	MP Discoms
Technical loss reduction	Installation of LT ABC	✓	✓	✓	✓		✓		✓	✓	✓
	Improving HT:LT ratio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Substation/DT augmentation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Government support	Capital injection			✓		✓					
	Performance monitoring and review			✓	✓		✓	✓	✓		✓
Soft initiatives	Consumer communication on loss reduction			✓	✓		✓		✓		✓
	Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme/VDS etc.	✓	✓		✓		✓				✓
	Customer feedback program			✓	✓	✓	✓		✓		
	Transformer Management System			✓							✓

Review of International Experience

The distribution loss reduction practices implemented in developing economies, having profile similar to India, which have consistently shown improvement in terms of loss reduction, have been considered for the study. Based on the in-depth analysis of these case studies, it may be inferred that the following loss reduction initiatives were taken in some of such countries -

Table 3 Summary of loss reduction initiatives adopted internationally

Technical loss reduction		Oman	Iran	Brazil	Uganda
Network Redesign and upgradation	Load Balancing	√	√		√
	Network Reconfiguration	√	√	√	√
	DT Management	√			
	Power Factor Improvement	√	√		√
Non- technical loss reduction					
Energy Accounting	100% Metering	√	√	√	√
	Replacement of Defective Meters				√
Meter Reading	AMR/HHD		√		√
	Smart Metering	√	√		√
Billing	Spot Billing				
	Appointment of MBC Franchisee				
Collection Efficiency	Increase in avenues			√	√
	Increase in Modes			√	√
Soft Initiatives	Community Campaigns	√		√	
	VDS/IWS etc.				
	Other initiatives				
Impact		Annual saving of ~ USD 5 mn	Losses from 23.17% to 3.85% in just one year	Improved collection efficiency & Reduction in average electricity consumption within pilot area	Losses from 35% to 30% in one year

Analysis of loss reduction initiatives

Following analysis are performed on the various loss reduction initiatives –

1. Type 1 Analysis – Overall Analysis of Loss Reduction initiatives included, classifying initiatives in 4 broad categories based on the number of states adopted for the same.

2. Type 2 Analysis – State Specific analysis included analysis to map types of initiatives against type of losses they are effective in reducing.

Type 1 Analysis – Overall Analysis of Loss Reduction

Depending on the number of states have adopted a particular initiative, an analysis has been done and initiatives are classified into four categories:

1. ***Must have Initiatives***: Initiatives adopted by 8 or more utilities out of 10 selected utilities

2. ***Strongly desirable initiatives:*** Initiatives adopted by 5 to 7 utilities out of 10 selected utilities

3. ***Good to have initiatives***: Initiatives adopted by 3-4 utilities out of 10 selected utilities

4. **Other initiatives**: Initiatives adopted by 2 or less no. of utilities out of 10 selected utilities

Type 2 Analysis - State Specific analysis

Further, we have analyzed various loss reduction initiatives to identify the best initiatives which can have maximum impact for each type of loss and for each type of consumer category. In order to do so, a framework has been developed in discussion with the FOR secretariat, which identifies a particular state as an ideal case study for tackling a particular type of loss. Depending on this analysis, the following table signifies such states.

Table 4 States to be used as case study

Type of Consumer	Type of Loss	State to be used as case study for loss reduction
LT	Technical	Andhra Pradesh
HT		Gujarat
LT	Commercial	Delhi
HT		Uttarakhand/Maharashtra
LT	Unauthorized use of electricity	Jharkhand
HT		Madhya Pradesh

Development of loss reduction strategy

To develop a loss reduction strategy, the following framework can be adopted -

1. **Define 'as-is' loss situation and desired 'to-be' state -** The Discoms should define a detailed loss reduction trajectory for each type of loss, along with the current levels of losses for the utility.

2. **Measurement of loss and verification -** Various types of losses can be measured as follows:

   - ***Technical Loss*** = *Energy input in the Discom periphery – Energy Consumed in the Distribution Network, or*

     Technical Loss = *[Energy input at the discom periphery – (DT level consumption+ sum of sales to consumer on HT)] + LT technical loss*

   - ***Non-Technical Loss (occurring due to incorrect energy accounting)*** = *Energy Consumed in the Distribution Network – Energy billed to consumers, or*

     Non-technical loss (occurring due to incorrect energy accounting) = *Energy input in the discom periphery – (technical loss + energy sales)*

   - ***Non-Technical Loss (occurring due to non-recovery)*** = *Energy billed to consumers – Energy collected from consumers, or*

     Non-technical loss (occurring due to non-recovery) = *100% - [billing efficiency (%)*collection efficiency (%)]*

     Where billing efficiency=100-distribution losses (%)

   The losses can be verified by concerned state regulators as follows -

- **Operational verification**: An initial, low cost step to ensure an efficient and correct measurement process including visual inspection, sample spot measurements, short term performance testing and data trending and estimate logic review.

- **Verification of energy input:** The Commission can direct SLDC to submit the energy input for the utility during the relevant time period and compare them to figures of energy input submitted by utility. Further the Commission can direct the utility to submit month wise station wise power purchase details along with the bills which can then be compared against Monthly Regional Energy Accounts prepared by relevant authority like SLDC, RLDC or Regional Power Committee.

- **Verification of energy billed:** For the verification of energy billed from metered consumers, the billing database of the utility can be analyzed for identifying ghost consumers or consumers with very low ABR. For the verification of energy billed from unmetered consumers, the category wise consumption pattern or unmetered consumers can be compared to category wise consumption pattern of metered consumers of respective consumer categories, to check if they are in the similar range. For the verification of energy billed from Assessment based sales, the billing database can be analyzed to look for spikes in energy billed. In theft cases, as a penalty on the defaulter, the amount collected is double the amount due in original bill. For the purpose of calculating energy billed from this amount collected, the entire amount collected should not be divided by the ABR, to avoid double counting of energy units.
- **Verification of energy collected:** The daily collection details from the above mentioned sources should match with the bank statements of the utility, allowing the Commission to verify the revenue collected figure claimed by the utility.

In order to measure and verify losses, the Discoms can carry out strengthening of Energy accounting infrastructure by 100% consumer metering, DT metering and feeder metering, Replacement of defective and electromechanical meters and implement customer satisfaction programs.

3. **Energy Audit and Analyze -** The key to efficient revenue management for any electricity distribution utility is proper and prompt accounting of the energy inflow and outflow at various voltage levels. In order to meet the desired outcomes, four integrated levels of loss measurement shall be required at company level, sub transmission level, feeder level and distribution transformer level. In order to do so, the Discoms can consider Implementation of IT application in Metering, Billing and Collection activities (AMR/HHD/e-mail, SMS based intimation), MIS based periodic reporting of unit wise business parameters, implementation of IT application in network management activities (SCADA, DMS, OMS etc.) and deploying a central level vigilance team.

4. **Planning, Execution and Improvement -**

Following initiatives can be adopted for improvement of technical losses –

- ***Network strengthening***
  - Improving HT:LT ratio
  - Substation/DT augmentation
  - Segregation/Bifurcation of feeders
  - Implementation of HVDS system
- **Other**
  - Distribution Franchise initiatives/ Privatization to promote competition
  - Loss based tariff design

Following initiatives can be adopted for improvement of commercial losses –

- Connection regularization scheme/waiver of surcharge scheme/interest waiver scheme/VDS etc. and
- Privatization and Outsourcing strategy
- 100% metering, Automated Meter Reading (AMR)
- Installation of LT Aerial Bunch Conductor

Following other initiatives can be adopted for planning of loss reduction initiatives:

- Loss reduction based MYT mechanism wherein targets for loss reduction are given during the MYT control period
- Capital injection by the government in the form of loan takeover or subsidy
- Employee capacity building with programs focused on loss monitoring and control measures

5. **Control and Sustain -** For continuous improvement some initiatives are required to control and sustain the successful loss reduction strategies, such as constitution of loss monitoring/energy audit. committee/cells, performance monitoring and review, dedicated police stations and staff, loss reduction based incentivisation mechanisms, nomination of feeder managers, dedicated field level loss management roles and consumer communication on loss reduction.

6. **Benchmarking with similar utilities -** the steps mentioned above should be verified with a similar utility loss reduction journey. The similarity should be matched against three parameters as follows:

   - Type of loss level
   - Initial HT/LT ratio, and
   - Effectiveness of initiatives for the selected utility

1. Introduction

1.1. Overview

The Forum of Regulators (FOR) has been constituted by the Government of India under of Section 166 (2) of the Electricity Act, 2003. The Forum is responsible for harmonization, coordination and ensuring uniformity of approach amongst the Electricity Regulatory Commissions across the country, in order to achieve greater regulatory certainty in the electricity sector.

Distribution segment continues to remain the weakest link in the power sector. Poor financial health of the distribution companies has been affecting the performance of the entire power sector. One of the critical factors for the present state of DISCOMs is the high level of distribution losses. As per the Performance Report of State Power Utilities for 2011-12 to 2013-14 published by Power Finance Corporation (PFC), while the overall AT&C losses for the distribution utilities in India is on the decrease, the overall loss is still at a high value of 22.70% (in FY14).

Table 5 AT&C loss levels region wise

Region	2012-13 (%)	2013-14 (%)
Eastern	42.04	38.02
North-Eastern	38.31	33.94
Northern	28.89	24.86
Southern	17.40	19.06
Western	23.36	18.37
National	**25.45**	**22.70**

Source: 1 Performance Report of State Power Utilities for 2011-12 to 2013-14, PFC

1.2. Objective of the study

As per the functions of the FOR, it has the mandate to undertake research work in-house or through outsourcing on issues relevant to power sector regulation. Since high level of losses in the distribution sector has a deep recurring impact on the financial health of Discoms, which in-turn puts pressure on regulatory tariffs, FOR has been discussing this issue with various stakeholders at regular intervals. To take these discussions to a further logical conclusion, the FOR appointed PwC to study and suggest recommendations on "Best Practices on and Strategies for Distribution Loss Reduction".

1.3. Scope of work

In this study, work was performed on the following areas for the development of a comprehensive mechanism of loss reduction, as per the terms of reference of the study:

- Identification of the components of distribution losses
- Study of distribution loss reduction strategies and practices followed in Indian States. Primary data collected and analyzed for 10 (ten) Indian States (selected in consultation with FOR secretariat)
    - Study of the existing strategies and practices followed
    - Analysis of the results achieved

  - Analysis of the resources deployed in terms of money and manpower
  - Comparison of the costs, efforts and time devoted
  - Identification of the best practices for distribution loss reduction
- Identification of the existing best practices followed in Indian States and Countries outside India (whose profile is similar to India)
  - Analysis of the results achieved
  - Analysis of the resources deployed in terms of money and manpower
  - Comparison the costs, efforts and time devoted
  - Analysis of identified Best Practices
  - Analysis of the suitability of identified Best Practices in Indian context
- Shortlisting of the Best Practices to suit Indian Electricity system
- Recommendation for the Best Practices and computation of the Costs involved
- Development of loss reduction strategy
- Development of a comprehensive mechanism consisting of strategies to accelerate the distribution loss reduction
  - Major areas to be focused upon
  - Segregation of T&D Losses
  - Computation of AT&C Loss
  - Baseline data for segregating Technical & Non-technical Losses
  - Trajectory for loss reduction
  - Selection of appropriate technological intervention for reducing the technical losses
  - Agricultural feeder separation
  - Energy Audit
  - Incentives/ disincentives schemes
  - Incentives/ disincentives schemes for the staff
  - Controlling Theft

Limitation of the Study: The co-relation between loss reduction in various states due to different initiatives and their respective capex has not been studied in this report due to non-availability of data. In all states, multiple initiatives were taken simultaneously because of which it is difficult to identify the cost of each initiative and the impact on loss reduction because of a particular initiative.

1.4. Approach of our study

In order to meet requirements of the Scope of Work, PwC, in consultation with the Forum of Regulators secretariat adopted the following phase wise approach for completion of the assignment –

Phase 1 – Inception

In this phase of the study, secondary research was carried out to study the various regulatory aspects in regards to the loss reduction in the electricity distribution sector along with the level of losses across states and their reduction trajectories over time. A similar analysis was performed for various international experiences as well to identify any noteworthy loss reduction initiative that can be implemented in Indian scenario as well. Also, preliminary analysis was carried out to identify select states for detailed analysis of their loss reduction initiatives. Further, in this phase of the study, various components of AT&C loss were discussed. An Inception report was prepared and shared with Forum of Regulators secretariat for the purpose of discussion at the end of this phase.

Phase 2 – Draft

In this phase of the study, primary research was carried out in order to collect data from select state utilities regarding their respective loss reduction initiatives (template used for the collection of primary data is provided in Appendix B). Data received from various state utilities was analyzed to identify the best loss reduction strategies. Wherever state utilities could not provide necessary data, data was either collected from secondary sources or certain logical assumptions were formulated for the analysis. 10 states were selected in consultation with FOR secretariat in order to perform a detailed study of the loss reduction initiatives of these states. These initiatives were briefly discussed and analyzed in this phase of the study. Further, these loss reduction initiatives were discussed based on the types of losses each of them targeted. A draft report was prepared and discussed with Forum of Regulators Secretariat at the end of this phase.

Phase 3 – Final

After the identification of various loss reduction initiatives based on the secondary as well as primary research for selected states, detailed analysis was carried out in this phase of the study to prepare a strategy for loss reduction. Under this strategy, detailed steps are defined for loss measurement, energy audit and loss verification as well. A Final Report was prepared after discussion with Forum of Regulators Secretariat.

1.5. Structure of this report

The following report is divided into sections as follows –

1. **Review of Policies and Programs** - This section discusses various act and regulations which deal with the treatment of AT&C losses and the mandates to various stakeholders to reduce/limit these losses. Also, this section discusses various ongoing programs at central and state levels which aim to reduce the AT&C losses in the distribution segment.

2. **Understanding distribution loss components –** This section discusses various components of AT&C losses along with the methods to measure and verify these losses. The overall AT&C loss is segregated into various identifiable loss components based on criteria like technical or non-technical nature of these losses or other reasons for occurrence of these losses such as billing related, meter related etc.

3. **Distribution loss reduction initiatives followed in Indian States –** While several utilities have adopted various approaches for loss reduction in the past, their impact and cost implications vary widely. Therefore in this section we discuss the various loss reduction strategies adopted by various state and central utilities of India. In order to do this, the following tasks are performed –

    a. **Selection of States for the study –** Based on parameters like total reduction in loss levels, consumer category with majority energy sales and availability of data, the states are selected from

each regions of North, West, South and East/North-East for performing detailed analysis of loss reduction initiatives.

b. **Data Collection** – Data is collected using primary and secondary resources for various loss reduction initiatives carried out in various states.

c. **Review of loss reduction initiatives** – In this part of the section, the various loss reduction initiatives identified are discussed briefly in order to explain the main features of each individual loss reduction initiative. Also, case studies of some select States with appropriate data available are discussed under this part of the section.

4. **Review of International Experience –** Similar to the various approaches adopted in India, this section discusses various approaches adopted by international utilities. For this study, countries having similar energy scenario like India, demand profile similar to Indian distribution sector and having consistently shown improvement in terms of loss reduction, are selected. The key activities carried out for international perspective were -

    a. Finalizing countries for study of loss reduction practices

    b. Desktop research on loss reduction initiatives

    c. Listing down of relevant loss reduction practices

5. **Development of loss reduction strategy –** This section involves analyzing the outcomes of the national and international studies and recommending a loss reduction strategy suitable for various Indian States. An analysis is performed to identify the best practices of loss reduction based on series of parameters like existing loss levels, ongoing initiatives etc. The approach followed for formulating a loss reduction strategy is -

    a. Defining 'As Is' loss situation and desire 'To Be' state

    b. Measurement of loss and verification of loss figures

    c. Identification of best loss reduction initiatives

        i. Desktop research of key initiatives taken by select power distribution utilities

        ii. Data collection – finalizing the data collection templates, sharing the data templates with target states, data collection and collation

        iii. Data analysis – analysis of the loss reduction results across states

    d. Energy Audit – defining strategy for accounting of the energy inflow and outflow at various voltage levels

    e. Planning, Execution and Improvement of loss reduction initiatives

    f. Control and Sustain loss levels

    g. Benchmarking with similar utilities to keep a check on loss levels

2. Background

2.1. Power distribution and loss levels in India

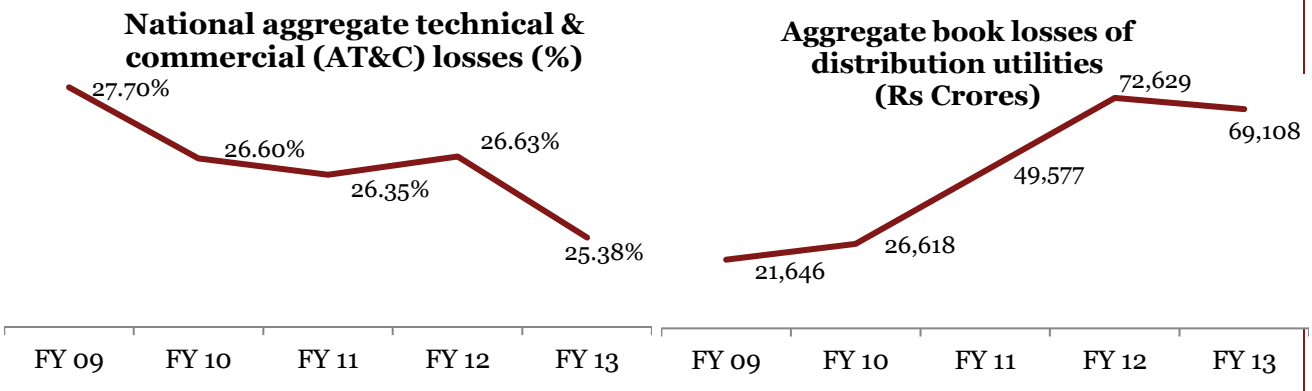
A decade after notification of the Electricity Act, 2003, which focuses on conducive development of electricity industry, promoting competition, protecting interest of consumers, ensuring supply of electricity to all areas, reduction of losses and rationalization of electricity tariff, the Indian power sector has undergone a major transformation. Extended access, added generating capacity, competitive power markets and a national transmission network are few of the major strides undertaken.

The implementation of power sector reforms has embarked India on the journey of achieving a national turnaround. However the journey still seems incomplete due to challenges in terms of :-

- Achieving 100% electricity access owing to issues related to grid connectivity in rural areas; and
- Providing round the clock quality and reliable supply in a cost economical manner.

Meeting these challenges require a special focus on the bleeding Indian power distribution sector. The fortunes of the whole sector are closely intertwined with the distribution business segment because it is the link between the sector and consumers. The continuing underperformance of distribution utilities has prevented the sector from providing adequate and reliable power to consumers.

Figure 1 Performance of Distribution sector in India

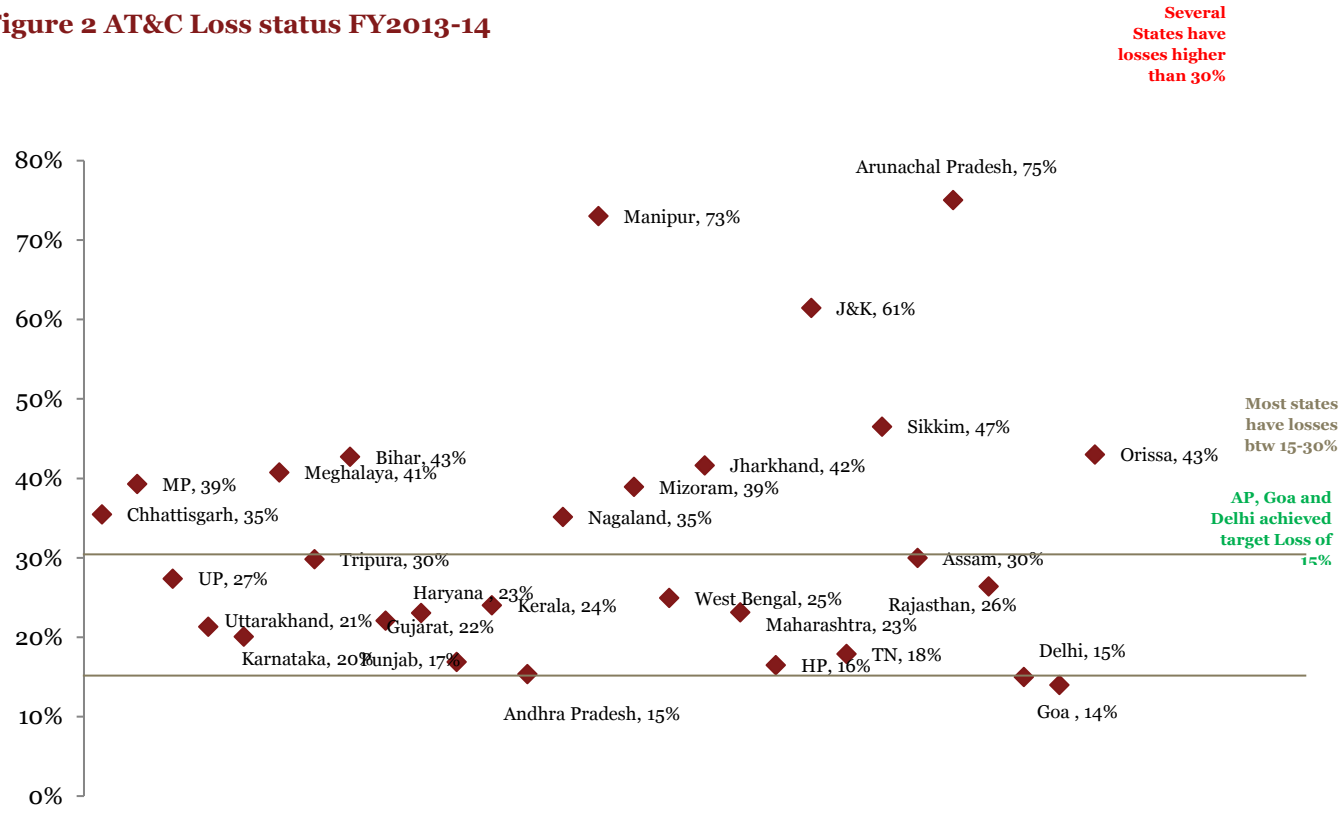


Source: PFC annual utilities performance report 2013

Besides the other challenges being faced by distribution utilities like high aggregate financial losses, poor cost recovery, insufficient tariffs etc., high distribution losses and AT&C losses among most distribution utilities has aggravated the impact of all other challenges. Although AT&C losses have shown a downward trend, the distribution losses have been almost static at 23% from FY 2010-11 to FY 2012-13[1]. The national average of T&D losses in FY 14 was 20.68% and AT&C loss was 23.96% (approximate basis)[2]. The following diagram provides a snapshot of AT&C loss of various states in FY 14 as per annual report 2014 of erstwhile planning commission. These losses are on estimated basis owing to the lack of robust metering infrastructure on a significant proportion of end consumers/distribution network.

[1] PFC – Annual utilities performance report 2013
[2] Annual report (2013-14)of erstwhile planning commission

Figure 2 AT&C Loss status FY2013-14



Source: PFC annual utilities performance report 2013

Reduction of AT&C losses would have a two pronged advantage since besides reduction of losses, it would also lead to availability of additional energy which can be supplied to existing or new consumers, leading to additional revenue. The impact of additional revenue on the financial bottom-line and ultimately the state economy is also undeniable. Complementing the additional electricity with strengthened rural/agricultural supply systems in terms of improved network and energy accounting would also impact subsidy requirements.

2.2. FoR report on loss reduction strategies, 2008

The Forum of Regulators (FOR) has been time and again engaged in conducting studies for distribution utility officials, focused on loss reduction strategies. In relation to this, FOR had undertaken a research study in 2008, on loss reduction strategies in India. The key issues identified in that report for evolving a loss reduction strategy were utilized as the background for this study.

Issues identified for evolving a strategy for loss reduction in the FOR report of 2008 are -

- Definition of distribution loss and the method of computation of AT&C loss
- Segregation of technical and commercial loss
- Compilation of baseline data
- Third party verification of data and energy audit
- Methodology for achieving loss reduction in a time-bound manner
- Relative adequacy of technical solutions etc.

2.3. Review of policies and programs

This section discusses the various provisions of the act and regulations which deal with the treatment of AT&C losses and the mandates to various stakeholders to reduce/limit these losses. This section also discusses the various ongoing programs at central and state levels which aim to reduce the AT&C losses in the distribution segment.

The Indian power sector reforms were initiated in 1991 after which State Electricity Boards (SEBs) were restructured and unbundled into separate companies for generation, transmission and distribution segments. Subsequently, The Electricity Regulatory Commissions (ERC) Act 1998 mandated creation of ERC in each state to regulate power sector in the state. With the enactment of ***Electricity Act, 2003***; the Government of India (GoI) facilitated further reforms measures to strengthen the power sector. The Act notifies liberal framework for development of the power industry, promoting competition, mandatory requirement of metering, protecting interests of consumers and supply of electricity to all areas, ensuring transparent policies with regard to subsidies, and protecting consumers' interests as well as providing more choices to the consumers. Further, the Act also envisaged a regulatory framework at both the central and state level by emphasizing on:

- Re-defined role and mandate of State Governments, Regulators and Licensee
- Promoting competition while breaking the monopoly of State Electricity Boards
- Creating economic imperative for fundamental changes
- De-licensing rural distribution
- Norms for transparent and public partnership
- Establishment of Consumer Grievance Redressal Forums (CGRF)
- Attracting new investments

In addition to above, the GoI rolled out ***National Electricity Policy, 2005*** and ***Tariff Policy, 2006*** which helped empower the Central /State Electricity Regulatory Commissions to regulate and address issues in power sector. During the same period, the GoI also initiated various programs for reduction of losses in electricity sector to bring in commercial viability to the state power utilities.

Over the past 12 -13 years, after notification of Electricity Act 2003, the power distribution utilities/state electricity boards have reduced their Transmission and Distribution losses (T&D) and Aggregate Technical and Commercial loss (AT&C) to a significant extent through multiple initiatives such as augmentation/upgradation of network, installation of electronic energy meters, relocation of energy meters outside consumer premises, technology upgradation like implementation of High Voltage Distribution Systems (HVDS) and low voltage distribution systems (LVDS), installation of Low Tension Aerial Bunch Conductors (LT ABC), putting in place measures to control losses and theft etc. There have been focused policy and program initiatives for loss reduction during the period to support the state level initiatives.

Figure 3 Timeline of acts and policies

A brief review of programs/guidelines/model regulations in electricity sector formulated to reduce the losses are discussed in following table -

Table 6 Brief of programs in loss reduction

Guiding document of methodology for baseline studies and establishment of losses	Restructured Accelerated Power Development Reform Program (R-APDRP program)	Financial bailout schemes	Deen Dayal Uppadhyay Gram Jyoti Yojna (DDUGJY)
In 2008, The Forum of Regulators had come up with a detailed report on loss reduction strategies and methodology for assessment of losses. The document had comprehensively covered definition of distribution loss, the method of computation of AT&C loss, segregation of technical and commercial loss and methodology for achieving loss reduction in a time-bound manner.	Restructured – Accelerated Power Development and Reforms Program was the continuation of the APDRP program into the XIth Plan with revised guidelines. The focus of the programme is on actual, demonstrable performance in terms of sustained loss reduction, establishment of reliable and automated systems for sustained collection of accurate base line data, and the adoption of	The prime objective of financial bailout schemes like Restructuring Scheme (FRP), National Electricity Fund (NEF) focuses on improving the financial viability of the state-owned Distribution Companies (Discoms), but the terms and conditions of the scheme identifies achieving loss reduction in a time bound manner as one of the yardstick for	The DDUGJY encapsulates three key initiatives viz segregation of agriculture feeders, strengthening of sub transmission and distribution systems including metering of distribution transformers/ feeders/consumers and rural electrification. Segregation of agriculture feeders from mixed feeders proved to be a tested approach for correct accounting of electricity supplied to primarily

Guiding document of methodology for baseline studies and establishment of losses	Restructured Accelerated Power Development Reform Program (R-APDRP program)	Financial bailout schemes	Deen Dayal Uppadhyay Gram Jyoti Yojna (DDUGJY)
In 2009, Power Finance Corporation had published a document explaining methodology for establishing baseline AT&C losses. This document is referred as the guiding document for erstwhile RAPDRP program of Government of India.	Information Technology in the areas of energy accounting. The scheme is envisaged with an objective of achieving 15% AT&C loss in each of the project area.	meeting the eligibility for the scheme. PwC associated with the Rural Electrification Corporation (REC) being the Nodal Agency for the scheme, in finalization of the Guidelines for operationalization of the aforementioned scheme. PwC is also assisting REC in implementation of the scheme.	unmetered agriculture category consumers. This has assisted in re-establishment of losses and accordingly, devising strategies for loss reduction. Strengthening of sub transmission and distribution system scheme also focuses on cent percent metering from feeder to consumer level resulting into accurate loss accounting and loss reduction.

Status of R-APDRP[3]

In January 2016 the Ministry of Power published a report on Impact Assessment Study of R-APDRP Go-Live Towns. Based on the result of this study, it has been observed that 65 out of 76 towns have shown improvement in the AT&C losses as compared to their baseline AT&C losses. These improvements range from 1% to 54% (17 towns: less than 5%; 26 towns: 5-15%; 15 towns: 15-25% and 7 towns: more than 25%). This reduction in losses corresponds to annual monetary benefit of approx. Rs.185 crores p.a. in 76 towns.

Projects worth Rs.39,198 crores (Part-A IT: Rs.5,427 crores covering 1409 towns; SCADA: Rs.1,556 crores covering 72 towns; Part-B: 32,214 crores covering 1,258 towns) have been sanctioned. 1131 towns have been declared Go-Live, SCADA Control Centers have been commissioned in 23 towns and Part-B projects have been completed in 360 towns till 31st December 2015.

Status of DDUGJY[4]

As of March 2016, with a cost of Rs. 41061.49 crores, a total of 3,51,223 villages have been intensively electrified (54% of the scope of DDUGJY) and 1,16,144 villages have been electrified (90% of the scope of DDUGJY). Total of 232.25 lakh BPL households have been given electricity connections till now under this scheme.

Other programs and policies

The Government of India (GoI) has also notified guidelines and model bid documents in 2011 for appointment of distribution franchisee (DF) to attract investments in the sector, bring in operational efficiencies and reduce the

[3] Impact Assessment Study of R-APDRP Go-Live Towns, Ministry of Power
[4] Status of Rural Electrification (RE) under DDUGJY, Ministry of Power

prevailing loss levels in the geographies. The model was tried and tested successfully in Bhiwandi post which multiple DFs have been appointed across the country. The Shunglu Committee's recommendations on Distribution Franchise suggests franchising of 255 towns from amongst those covered in RAPDRP town listing in order to bring down losses, to attract private investments and bring in efficiency in system.

The Government of India (GoI) also notified ***Model State Electricity Distribution Management Responsibility Bill, 2013*** to provide guidelines for State Governments to ensure financial and operational turn around and long term sustainability of the state owned distribution licensees and to provide:

- Adequate electricity supply to consumers through financial restructuring
- Support on sustainable basis in the area of long term planning, accurate energy accounting, loss reduction in time bound manner and developing monitoring framework
- Corporate governance
- Regulatory compliances and long term policy and
- Directives and various other measures connected therewith

In addition to above, the Ministry of Power (MoP) came up with its ***first Annual Integrated Rating report for the state distribution utilities*** in March 2013. The integrated rating report would facilitate realistic assessment of performance of distribution utilities and would help enable them to weigh their strength and weakness.

Despite the aforementioned initiatives a lot is yet to be achieved. The national level AT&C loss in FY 2013 was 25.38% (PFC report on performance of state power utilities, 2013), which is much higher than AT&C losses in other developing countries[5] like Brazil (16%), China (14%) and South Africa (8%).

[5] http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?name_desc=true

3. Understanding distribution loss components

Aggregate Technical and Commercial (AT&C) loss and Transmission and Distribution (T&D) loss are referred in power sector as a yardstick for measurement of performance of distribution utilities. AT&C loss is the difference between energy input and the energy for which revenue is actually realized from the consumer while the T&D loss is the difference between the energy input and the energy billed to the consumer. T&D loss takes into account the losses in the T&D system including commercial loss up to the point of billing and does not take into account the units for which revenue is actually collected or realized.

This section discusses the various components of AT&C losses along with the methods to measure and verify these losses. The overall AT&C loss is broke up into various identifiable loss components based on criteria like technical or non-technical nature of these losses or across reasons for occurrence of these losses like billing related, meter related etc.

The AT&C losses or T&D losses can be segregated into technical and non-technical losses basis the following understanding:

1) **Technical loss**: The primary reason for the technical losses can be associated with the poor network configuration of the system and inappropriate network/equipment maintenance. Non-standard practices, if followed during the initial planning and design stages, can lead to unnecessary longer feeder lengths, over-loading of the network etc. Losses are inherent to the distribution of electricity and cannot be eliminated. Technical losses are due to current flowing in the electrical network and generate the following types of losses:

   a) ***Copper losses*** are due to heat produced by electrical currents and are inherent in all inductors because of the finite resistance of conductors

   b) ***Dielectric losses*** are losses that result from the heating effect on the dielectric material between conductors

   c) ***Induction and radiation losses*** are produced by the electromagnetic fields surrounding conductors.

   Technical losses are possible to compute and control, provided the power system in question consists of known quantities of loads. The following are the causes of technical losses:

   - ***Harmonics distortion***: Pure electric signals (AC voltage and current) are expected to be like ideal sine wave and should contain only fundamental frequency (50Hz or 60Hz). However in reality, electric signals are distorted instead of pure sinusoidal and combination of multiple sinewaves of different frequencies. These frequencies are multiple of fundamental frequency. Distorted harmonics have detrimental effects on electrical system. It can increase the core loss of inductive electrical equipment like transformer or motors. Increased heating at neutral line is another bad effect of increased harmonics in system.

   - ***Long single phase lines***: Long single phase line creates the opportunity for more electrical load on single wire causing more I^2R Loss. Long single line will have greater resistance and low voltage leading to a high loss system.

   - ***Unbalanced loading:*** An electrical network where electrical parameters, i.e. voltage, current and load, in all three phases are similar, is called a balanced system. In a balanced system every phase is equally stressed and there will be no current in neutral wire. In unbalanced system, one or two phases are overstressed leading to under voltage, overloading, unbalanced current flow in neutral wire and more technical loss.

- ***Losses due to overloading and low voltage***: Technical loss is proportional to square of load or current level and inversely proportional to square of voltage. Overload means more current flow. So overloading and low voltage will increase the technical loss multiple fold.
- ***Losses due to poor insulation standard*** of equipment caused by ***lack of regular maintenance*** of the plant and machinery: Poor insulation will increase the leak level of the electric system and create situations like overload and under voltage causing more technical loss if not system collapse. Lack of regular maintenance activities increases the chance of poor insulation in the system.

2) **Non-technical loss (Internal)**: The internal non-technical losses may arise from the following:

   a) ***Connection management***: Efficient and accurate management of existing and new connections is an important activity of revenue cycle management. Instances like release of connection without meters, mismanagement of billing records, cleaning of past accounts on same premises before release of new connection etc. contribute heavily to the non-technical losses. Further the non-technical losses may be hidden due to illegitimate or non-existent consumers in the database leading to billing of non-existent sales. These instances can be managed by adopting efficient and industry level connection management practices.

   b) ***Meter reading***: The timely, accurate recording of consumption data from energy meters enables the containment of non-technical losses further. The major challenges faced with respect to meter reading may include no meter reading due to installation of the meter at inaccessible places, premises lock, conniving activities, under recording, no recording, absence of any quality checks on the actual meter readings, inaccurate posting of the readings, tampering the data recorded etc. These all immensely magnify the non-technical losses in the system and also create considerable revenue loss for the Discoms.

   c) ***Field vigilance***: Limited or no checks on the field leads to higher power pilferages, incorrect billing of theft cases, staff collusion with conniving consumers etc. enhance the losses further and deteriorates the health of the Discoms. Hence, regular visits to the fields and being vigilant is very important for the Discoms, etc.

   d) ***Billing***: Generating right bill based on the correct energy consumption data is of foremost importance for a Discom in order to realize the right revenue. Discoms tend to incur huge amount of losses owing to factors like generation of average bill due to delayed/erroneous readings, untimely delivery of bills, faulty billing software etc.

3) **Non-technical loss (External):** The external non-technical losses are due to non-collection of dues of the utility/Discom and may arise from Collection & credit management. Unless the revenue recovery processes are standardized and aligned to Discom's priorities, it is very difficult to optimize the non-technical losses. Constraints like limited avenues for collections, relatively no defaulter follow-ups, delayed temporary/permanent disconnection practices pose a great challenge in reducing the overall losses.

The below matrix represents various reasons and business process mapping of the technical losses and the non-technical losses and also provides an indication towards their assessment as in whether they can be assessed based on assumption or at actuals with help of data as recorded.

Table 7 Loss components

Loss	Process	Design/ specification/ procurement/ process related error	People/training/capacity related concerns
Technical	***Network configuration***	• Non-standardized network planning leading to high feeder lengths, over-loading etc. • Equipment not as per prescribed quality • DT transformation loss • HT/LT line loss	• Poor workman ship e.g. Jointing • Deviating from standard design norms to accommodate specific requests
	Lack of maintenance	• Absence or low level of maintenance process leading to leakage of electricity through faulty equipment	• Poor or no maintenance practice
Non-Technical (Internal)	***Connection management***	• Meter not installed • Ghost consumers	• Incorrect billing records • Collusion with consumer to update improper billing records
	Meter reading	• No/incorrect meter reading due to meter inaccessibility etc. • Absence of field quality check on reading records • Meter defective • Faulty meter reading equipment	• Wrong meter reading • Incorrect posting of meter reading • Intentional recording of wrong reading
	Billing	• Bill generated on average basis due to delayed/erroneous readings • Bill not delivered on time • Inadequate billing logic of the IT application	• Error in billing database
	Field vigilance	• Limited or no field vigilance for power pilferage • Hostile consumer resulting in threat to staff safety	• Wrong billing of theft cases • Staff collusion with conniving consumers
Non-Technical (External)	***Collection & credit management***	• Limited avenues for collections • Inadequate defaulter follow-ups	• Improper posting of collected revenue

4. Distribution loss reduction initiatives followed in Indian States

In this section, we have discussed various loss reduction strategies adopted by various state and central utilities of India. 10 states were selected in consultation with FOR secretariat for detailed analysis based on a framework discussed later in this section. Further data was collected through primary and secondary sources for evaluation of the best loss reduction practices adopted by various utilities in India. In order to collect the required data, the following key activities were carried out -

- Selection of States for the study
- Data collection
    - Secondary Research: Study of tariff orders, petitions, annual reports etc. of State Commissions and utilities
    - Primary Research
        - Preparation of the data collection templates
        - Sharing the data templates with target States
    - Data collection and collation
- Analysis of the loss reduction initiatives

4.1. Selection of states for the study

In order to study the loss reduction initiatives in detail, 10 Indian states were selected. This section, details our approach followed for selection of states for the study.

4.1.1. Framework for selection of state

A framework has been devised for selection of states for the study of best practices and strategies for distribution loss reduction. The framework has been so devised that the selected states shall have

- Uniform geographic representation
- Significant reduction in AT&C losses in past
- Comparatively lower present AT&C losses
- Significant contribution of agriculture and industrial category sales in the overall sales mix of the state
- Considerable loss reduction initiatives taken in past

The key steps followed for selection of states are as follows:

Step I: The country was divided in four regions viz eastern & north eastern, western, northern and southern region. The states in these regions have been assessed on certain criteria/parameters to identify select states for the study. The categorization of states based on this approach is as follows:

Table 8 Region wise classification of states

East/North East region		Western region	Northern region	Southern region
Manipur	Nagaland	Gujarat	Delhi	Karnataka
Tripura	Mizoram	Madhya Pradesh (MP)	Uttarakhand	Andhra Pradesh (AP)
Arunachal Pradesh	Bihar	Chhattisgarh	Jammu & Kashmir (J&K)	Tamil Nadu
Sikkim	Jharkhand	Maharashtra	Punjab	Kerala
Meghalaya	Orissa	Goa	Haryana	
Assam	West Bengal (WB)	Rajasthan	Himachal Pradesh (HP)	
			Uttar Pradesh (UP)	

Step II: The key selection criteria have been defined to shortlist the leading states in each of the region, having significant loss management along with considerable representation of agriculture and industry category consumers. The key selection criteria are:

- **AT&C loss reduction (C1) –** The AT&C loss reduction in the state has been considered as one of the parameter for selection of state. The states which have reduced AT&C losses more than 10% since the inception of Electricity Act 2003 till FY 13, have been shortlisted as per this criterion. The AT&C loss of FY 04 and FY 13 has been taken from PFC Annual utility performance report for FY 04 and FY 13 to assess state level loss reduction.
- **AT&C loss level (C2) –** The second criterion for selection of states is present AT&C loss level. The states having AT&C loss (FY 13) less than 25% have been shortlisted as per this criterion. The AT&C loss of FY 13 has been taken from PFC Annual utility performance report to evaluate the states on this criterion.
- **% Agriculture sales (C3)** - The next criterion for selection of states is percentage agriculture sales in total sales mix of the state. The states having agriculture category sales (FY 13) more than 20% of total sales of the state has been shortlisted as per this criterion. The agriculture category sales for FY 13 have been taken from PFC Annual utility performance to evaluate the states on this criterion.
- **% Industrial sales (C4)** - The next criterion for selection of states is percentage industrial sales in total sales mix of the state. The states having industrial category sales (FY 13) more than 30% of total sales of the state has been shortlisted as per this criterion. The industrial category sales for FY 13 have been taken from PFC Annual utility performance report to evaluate the states on this criterion.

Table 9 Evaluation of states for selection

Region	State	C1	C2	C3	C4
Eastern and North Eastern Region	Manipur	-	-	-	-
	Tripura	-	-	-	-
	Arunachal Pradesh	-	-	-	Yes
	Sikkim	Yes	-	-	-
	Meghalaya	Yes	-	-	Yes
	Assam	Yes	-	-	-
	Nagaland	-	-	-	-
	Mizoram	Yes	-	-	-
	Bihar	Yes	-	-	-
	Jharkhand	Yes	-	-	Yes
	Orissa	-	-	-	Yes

Region	State	C1	C2	C3	C4
	West Bengal	-	-	-	Yes
Western Region	Gujarat	Yes	Yes	Yes	Yes
	Madhya Pradesh	Yes	-	Yes	-
	Chhattisgarh	-	Yes		Yes
	Maharashtra	Yes	Yes	Yes	Yes
	Goa	-	Yes	-	Yes
	Rajasthan	Yes	Yes	Yes	-
Northern Region	Delhi	Yes	Yes	-	-
	Uttarakhand	Yes	Yes	-	Yes
	Jammu & Kashmir	-	-	-	-
	Punjab	-	Yes	Yes	Yes
	Haryana	-	-	Yes	-
	Himachal Pradesh	-	Yes	-	Yes
	Uttar Pradesh	-	-	-	-
Southern Region	Karnataka	-	Yes	Yes	-
	Andhra Pradesh	-	Yes	Yes	-
	Tamil Nadu	-	Yes	Yes	-
	Kerala	Yes	Yes	-	Yes

The state wise details of AT&C loss reduction (FY 04 to FY 13), AT&C loss (FY 13), agriculture sales (FY 13) and industrial sales (FY 13) are enclosed as Appendix A.

Step III: In the next step the key initiatives taken by each state for distribution loss reduction have been compiled based on secondary research. This exercise has been conducted in order to do a preliminary validation of states selected for study. In case, if a state is shortlisted in couple of criteria but there are fewer loss reduction initiatives implemented in that state, preference has been given to the state have multiple loss reduction initiatives implemented with equal or less number of shortlisting criteria.

Table 10 Types of initiatives taken across states

Region	State	Key initiatives
Eastern and North Eastern Region	Manipur	• Introduction of prepaid meters
	Tripura	• 100% feeder/consumer metering • Third party energy auditing
	Arunachal Pradesh	N/A
	Sikkim	• System augmentation and redesigning
	Meghalaya	• System augmentation and strengthening
	Assam	• Collection based DF at Feeder/DT level • DT level performance improvement scheme • HT consumer management application
	Nagaland	N/A
	Mizoram	• Introduction of pre-paid metering
	Bihar	• Appointment of collection based rural franchisees • Implementation of Own Your Transformer (OYT) scheme
	Jharkhand	• Appointment of Distribution franchisee • Installation of LT ABC • Introduction of spot billing

Region	State	Key initiatives
	Orissa	• Energy auditing • Deployment of energy police station
	West Bengal	• Vigilance and theft control • HT consumer management application
Western Region	Gujarat	• Implementation of Gram Jyoti Yojna (Feeder segregation) • Deployment of specially designed transformers
	Madhya Pradesh	• Robust energy accounting at feeder level and DT level • Business process re-engineering (meter reading, vigilance enforcement and arrear management) • Implementation of AMR system
	Chhattisgarh	• Deployment of circle level loss monitoring committees
	Maharashtra	• Feeder separation, 100% feeder metering, feeder level consumer mapping • IT application based meter reading, bill distribution , bill collection
	Goa	• System augmentation and redesigning
	Rajasthan	• Implementation of Feeder Renovation Program (FRP)
Northern Region	Delhi	• Consumer indexing • DT level energy audit • Implementation of HVDS system • Installation of LT ABC • Process re-engineering of revenue management activity
	Uttarakhand	• Double metering of high value consumers • Replacement of defective meters • Deployment of Key Consumer Cell
	Jammu & Kashmir	• Installation of consumer meters
	Punjab	• Feeder segregation • Vigilance and theft control • Meter replacement • Installation of LT ABC
	Haryana	• Implementation of HVDS system • Feeder segregation Community engagement (HESCL) for meter reading, billing and collection activity
	Himachal Pradesh	N/A
	Uttar Pradesh	• Third party energy audit
Southern Region	Karnataka	• Deployment of energy police stations • Feeder segregation • Implementation of HVDS system
	Andhra Pradesh	• Feeder segregation • Implementation of HVDS system • 100% Consumer and Feeder metering • Deployment of IT tools (Consumer analysis tool, Monitoring and audit system etc.)
	Tamil Nadu	• Replacement of defective and electromechanical meters • Vigilance and theft control

Region	State	Key initiatives
	Kerala	• Replacement of meters • 100% feeder and DT metering • Energy audit at DT level

Step IV: In the last step, final selection of states across the region is being done. The states having maximum number of shortlisting criteria along with multiple loss reduction initiatives has been selected for the study. The states in each of the region have been appraised, shortlisted and selected independently. The comparison of states across the region has not been done to ensure uniform geographic representation. Also, the criterion mentioned in step III has been kept into consideration while selecting final pilot states for the study.

Table 11 Framework for selection of states for Indian review

Region	State	Shortlisted in criteria	Key initiatives	Final selection	Reason/ remarks	Proposed Discom for the study
Eastern and North Eastern Region	Meghalaya	2	• System augmentation and strengthening			
	Assam	1	• Collection based DF at Feeder/DT level • DT level performance improvement scheme • HT consumer management application	√	Qualifies in one criterion and multiple loss reduction initiatives	APDCL
	Jharkhand	2	• Appointment of Distribution franchisee • Installation of LT ABC and introduction of spot billing	√	Qualifies in two criteria and multiple loss reduction initiatives	JSEB
Western Region	Gujarat	4	• Implementation of Gram Jyoti Yojna (Feeder segregation) • Deployment of specially designed transformers	√	Qualifies in all four criteria and multiple loss reduction initiatives	MGVCL
	Madhya Pradesh	2	• Robust energy accounting at feeder level and DT level • Business process re-engineering (meter reading, vigilance enforcement and arrear management) • Implementation of AMR system	√	Qualifies in two criteria and multiple loss reduction initiatives	MPMKVVNL
	Maharashtra	4	• Feeder separation, 100% feeder metering, feeder level consumer mapping • IT application based meter reading , bill distribution, bill collection	√	Qualifies in all four criteria and multiple loss reduction initiatives	MSEDCL
Northern Region	Delhi	2	• Consumer indexing • DT level energy audit • Implementation of HVDS system • Installation of LT ABC	√	Qualifies in two criteria, only state with private Discoms and multiple loss reduction initiatives	BSES YPL

Region	State	Shortlisted in criteria	Key initiatives	Final selection	Reason/ remarks	Proposed Discom for the study
			• Process re-engineering of revenue management activity			
	Uttarakhand	3	• Double metering of high value consumers • Replacement of defective meters • Deployment of Key Consumer Cell	√	Qualifies in three criteria and multiple loss reduction initiatives	UPCL
	Punjab	3	• Feeder segregation • Vigilance and theft control • Meter replacement • Installation of LT ABC	√	Qualifies in three criteria and multiple loss reduction initiatives	PSPCL
Southern Region	Karnataka	2	Deployment of energy police stations Feeder segregation Implementation of HVDS system			
	Andhra Pradesh	2	Feeder segregation Implementation of HVDS system 100% Consumer and Feeder metering Deployment of IT tools (Consumer analysis tool, Monitoring and audit system etc.)	√	Qualifies in two criteria and multiple loss reduction initiatives	APSPDCL
	Tamil Nadu	2	Replacement of defective and electromechanical meters Vigilance and theft control			

Region	State	Shortlisted in criteria	Key initiatives	Final selection	Reason/ remarks	Proposed Discom for the study
	Kerala	3	Replacement of meters 100% feeder and DT metering Energy audit at DT level	√	Qualifies in three criteria and multiple loss reduction initiatives	KSEB

4.1.2. Proposed states for study

Based on the aforementioned analysis, the following States are proposed for conducting the study.

Table 12 Selected states for Indian review

States from East and North East region	States from western region	States from Northern region	States from southern region
Assam - APDCL	Gujarat - MGVCL	Delhi – BSES YPL	Kerala - KSEB
Jharkhand - JSEB	Madhya Pradesh (MP) - MPMKVVCL	Uttarakhand - UPCL	Andhra Pradesh (AP) - APSPDCL
	Maharashtra - MSEDCL	Punjab - PSPCL	

4.2. Data collection

The data collection process was broadly classified across quantitative and qualitative data requirements. A data template was prepared for collection of primary data from state utilities. This template was then sent to select distribution utilities of identified states, for response. A sample of this template is attached along with this report in the Appendices.

The parameters captured in the data template included:

- Loss reduction initiative implemented – A brief write up
- Geographic coverage
- Scheme/initiative completion status
- Scheme/initiative implementation timelines
- Planned loss reduction vis a vis actual loss reduction

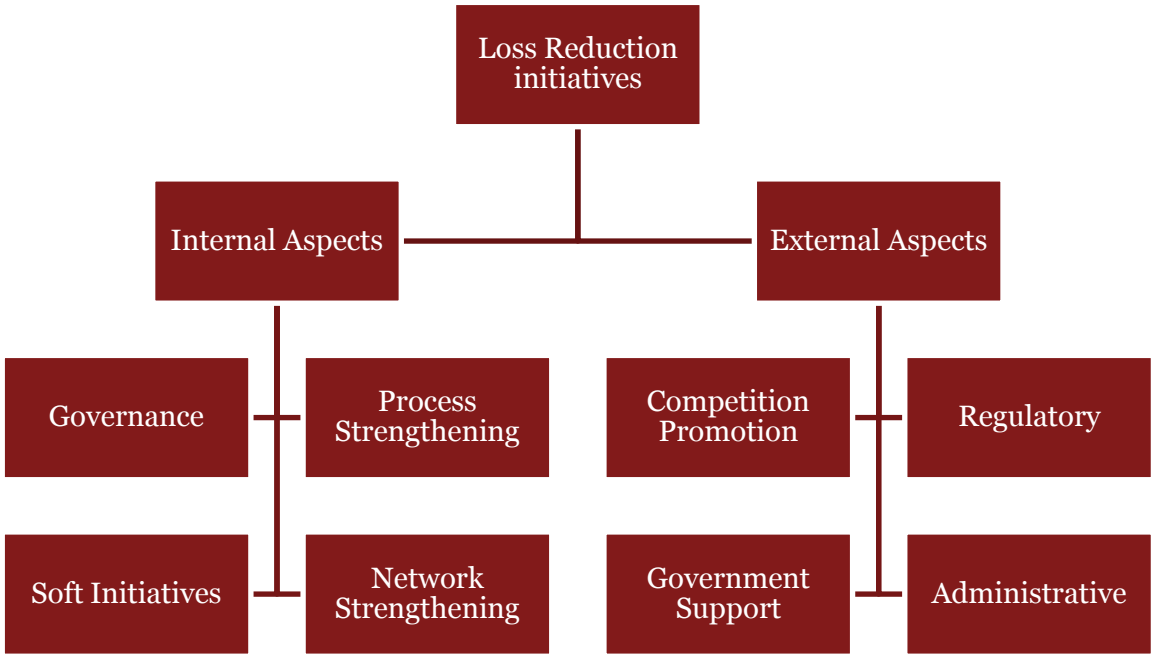
Any specific outcomes for each of the schemes in terms of loss reduction, peak load reduction etc. was captured in the data template. Data was received from the utilities of Gujarat, Jharkhand, Kerala, Maharashtra, Punjab, Uttarakhand, Assam, Madhya Pradesh, Delhi and Andhra Pradesh. Based on this data collected and the secondary research performed, the loss reduction initiatives adopted across various states were identified. However the data received from these state utilities was insufficient and inconclusive to analyze the loss reduction initiatives on cost and impact parameters. In order to overcome this shortcoming, a framework was designed to quantify and analyses the loss reduction initiatives based on certain assumptions. This framework is discussed later in this section.

4.3. Loss reduction initiatives

4.3.1. Brief review of various loss reduction initiatives

Based on the exhaustive secondary research and data collected from primary research, the key initiatives implemented for distribution loss reduction by various utilities have been captured. These initiatives have been outlined in the following diagram and explained briefly as follows:

Figure 4 Types of loss reduction initiatives



4.3.1.1. Internal Aspects (Implemented by utility)

4.3.1.1.1. Governance framework

- *Constitution of loss monitoring, energy audit committee/cells, central vigilance team:* Under this initiative a dedicated cell is formed to take care of loss monitoring/ energy audit. The whole process of collection of information, processing it and recommending solution is streamlined by such specialized cells/committees. Dedicated personnel for loss monitoring and control may also be inducted into the system.
- *Nomination of feeder managers:* Responsibility of specific feeders is given to specific personnel in order to better control and manage the losses of the same. For instance in Maharashtra, MSEDCL is launching a feeder franchise scheme under which a team of youngsters (one engineer and 5 ITI-trained youth) will be given the charge of curbing electricity theft and also sensitize consumers on paying power bills in the larger interest of the state.

- *Theft reporting consumer incentive schemes:* Consumers that report incidences of theft are incentivized through a cash reward as a percentage of amount realized[6].
- *Employee incentive schemes:* Incentives for loss reduction are created by linking employee KPIs to loss reduction in their respective regions. A detailed staff incentive scheme was prepared by MSEDCL where 10% of the incremental revenue brought in a division beyond a threshold, was paid out to employees of that division[7]. Similarly Performance Based Group Incentive Scheme (PBGIS) was developed in Haryana[8] based on equitable sharing of gains between Distribution Company and the contributing subdivisions emanating from reduction of AT&C losses.
- *Employee capacity building with focused programs:* Training programs focused at loss monitoring and control measures for the employees. Capacity Building was identified as an essential requirement as part of the R-APDRP scheme. Training was imparted to the employees of the Distribution Utilities in management, technical, commercial and consumer related areas, and exposure to the latest developments in electricity distribution, loss reduction, theft and pilferage control within India and abroad.

4.3.1.1.2. Process strengthening

- *Implementation of IT application in Metering, Billing and Collection activities (AMR/HHD/e-mail, SMS based intimation):* Fully automated metering, billing and collection systems like AMR or semi-automated systems like hand held devices for meter reading help to minimize meter reading error, billing time and increase collection efficiency leading to less commercial loss. Customer engagement and relationship management through modern communication mediums like email and SMS create enhanced customer service.
- *Implementation of IT application in network management activities (SCADA, DMS, OMS etc.):* IT Packages like Distribution management system (DMS), outage management system (OMS) or SCADA system helps the operation team to be updated with real time network situation and performance. These are essential requirements for distribution utilities to monitor network, plan activities, mobilize workforce in time to reduce network failure or down time. It also helps utilities to build a comprehensive zero information leakage operational system to meet and exceed customer satisfaction and optimize cost and time. IT applications like these helps operation team to identify any loss or leakage in the system through automatic and fast system and helps to reduce losses as a whole.
- *Strengthening of Energy accounting infrastructure - Feeder metering, DT metering & 100% consumer metering:* To reduce loss, the first step is to identify loss level. Energy accounting is the fundamental measurement process to identify electricity loss in a distribution system. For implementation of proper energy accounting measurement and recording of energy consumption is required at different level of network. Starting from 100% metering at consumer end to DTs, feeders should be covered to identify any technical and commercial losses across the network. Meter data management system (MDMS) is a central database of meter readings and a layer of meter data analytics on top of this MDMS can be of great help to identify loss of electricity at different level. Most of the states have implemented this initiative barring agriculture consumers which are supplied electricity at a flat rate.

[6] http://www.dgvcl.com/dgvclweb/theftreport.php#
[7] FOR Report on Loss Reduction Strategies, 2008 - Appendix XII
[8] FOR: Final report on incentive-disincentive mechanism for distribution utilities

- *Replacement of defective meters and electromechanical meters:* There are different generations of electric meters, starting from electro mechanical to modern day smart meters. The purpose of meters has been changed from merely recording only energy consumption to storing other useful information like electric parameters and communicating them back to central remote database. Old electro-mechanical meters are maintenance heavy and not suitable to be a part of automatic metering infrastructure. All defective meters and electro-mechanical meters if replaced by modern digital meters or by smart meters, will help to increase transparency over the meter data and smooth operation for MBC.
- *MIS based periodic reporting of unit wise business parameters:* Identification and monitoring of key business parameters are required to gauge the health of the utility. Further, to get a true picture, correct recording of data is utmost important. A robust MIS can help to record correct data and report the business parameters including loss figures on a regular frequency.

4.3.1.1.3. Soft initiatives

- *Consumer communication on loss reduction:* Proper communication of the plans to the consumers in general is crucial in order to increase public participation and contribution towards the heath of a utility. Public outreach programs or communication program through media ads, posters, and videos can help in disseminating information related to penalties in case of theft/meter tampering among the consumers.
- *Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme/VDS etc.:* This initiative aims to bring the defaulters into the fold of the utility, be it through surcharge waiver, interest waiver or voluntary disclosure scheme (VDS).
- *Customer feedback programs:* Initiatives linked to consumer analysis and feedback indirectly help in loss reduction through faster collection of data/feedback about possible problems in the network. Initiatives like setting up of Interactive Voice Response System (IVRS), Toll Free numbers for consumer complaints, mobile alerts through SMS etc. are some of the examples of customer feedback programs. Consumer Analysis Tool (CAT) are used to monitor the metering, billing and collection of consumers to identify revenue leakages.[9] TPDDL has developed a home grown Customer Relationship Management (CRM) software SAMBANDH based on business process reengineering and integration of all modules/ commercial processes, with the provision of auto escalation of parameters and performance assurance.
- *Transformer Management System:* It is the next step to feeder management system. Here the local population is encouraged to take ownership of the specific transformers in their locality.

4.3.1.1.4. Network strengthening/ Technical loss reduction

- *Segregation of feeders/Bifurcation of feeders:* Feeder segregation program can result in following benefits:
  - Reduction in line losses
  - Improved financial condition of discoms
  - Improved transparency in subsidy distribution

[9] Report on summary of good practices adopted by discoms, Ministry of Power (2010)

- Ground water resource management

Pre-requisites for feeder segregation project:

- Metering at feeder level – Would help in effective energy audit thus identifying high loss feeders and LT lines.
- Economical remote metering infrastructure for DTRs or External meters for all customers – To facilitate, identify and avoid any type of power pilferage in the system.

- *Implementation of HVDS system:* This initiative attempts to reconfigure the existing Low voltage (LT) network as High Voltage Distribution System, wherein the 11kV line is taken as near to the loads as possible and the LT power supply is fed by providing appropriate capacity transformer and minimum length of LT line with an objective to provide better quality power supply, reduction of losses and better consumer service. In the existing system, large capacity transformers are provided at one point and the connections to each load is extended through long LT lines. This long length of LT lines is causing low voltage condition to the majority of the consumers and high technical losses. In the HVDS project, long length LT mains are converted into 11 kV mains and thereby installing the appropriate capacity distribution transformer as near as to the end and the supply is provided to the consumer at suitable voltage level. By converting these lines to HVDS, the current flowing through the lines shall reduce and bring down the technical losses in the LT line drastically.
- *Installation of LT ABC:* The major advantages of ABC are:-
  - Total elimination of faults on LT lines
  - Improved reliability
  - Avoidance of Theft by direct tapping
- *Improving HT:LT ratio:* Technical loss in electrical system is proportional to the resistance of the network. Electrical resistance is higher for LT lines because of its small diameter and low voltage and high current. One way to avoid this loss is to increase the ratio of HT lines in the network compared to LT lines. It will help in reducing the burden on LT network and eventually the loss.
- *Substation/DT augmentation:* Aging of an electrical equipment causes lower insulation value. Lower insulation increases the chance of electrical leakage and losses. Old sub stations and DTs are augmented in this initiative to avoid this loss.

4.3.1.2. External Aspects (Enforced by regulator/government)

4.3.1.2.1. Regulatory initiatives

- *Loss reduction focused clauses in Supply Code/ Grid code:* The electricity supply code or grid code of some States mention clauses which incentivize loss reduction or penalize high losses. For instance the Electricity Supply Code 2013 of Madhya Pradesh and Model Supply Code 2015 of Maharashtra, mandates the licensee to calculate feeder wise losses and carry out energy audit in order to work out suitable steps for loss reduction. The Electricity Supply Code 2015 of the Jharkhand prescribes a Low Voltage Supply Surcharge to be paid by consumers availing supply at lower voltage than their classification. This incentivizes consumers to move from low voltage to higher voltages and therefore reduce technical losses.

- *Loss reduction based MYT mechanisms:* The MYT mechanism adopted by SERCs classify AT&C losses as a controllable factor for the utilities and project a loss reduction trajectory during the control period for the approval of capex plan and the calculation of retail tariff. The utilities are therefore inevitably penalized in the form of lower tariff in case of non-adherence to these loss reduction trajectories.[10]

Case Study of United Kingdom: RPI-X regime

The price control regime adopted in United Kingdom for distribution utilities is RPI-X (where "I" is inflation and "X" is productivity index). Capex is set through the review of company business plans. The approach of incentive mechanism for capex in principle allows utilities to choose between getting:

- Lower cost allowance, but with a "higher-powered incentive" that allows them to retain significant benefits if they can do even better than the low figure, and
- Higher allowance, but with a "lower-powered incentive" that gives relatively smaller reward for under-spending the higher allowance.

Utilities that choose the low cost allowance get a reward (a small amount of additional return above the base cost of capital) for spending no more than their capex allowance, while companies that choose the high cost allowance do not get this incentive.

- *Loss level based tariff design:* Different consumer categories or different areas contribute different proportions to the overall loss level of the utility. Therefore the tariff design for these consumer categories should also depend on their respective loss levels and in turn on the cost of supply of the respective consumer category or respective area of supply. While the tariffs are still being calculated using aggregate loss levels for the entire utility, some states have initiated pilot studies to measure consumer category wise cost of supply for calculation of loss level based tariff design.[11]

4.3.1.2.2. Competition promotion/ cost optimization

- *Introduction of private participation - DF initiatives/ Privatization:* The emerging trend of states outsourcing a part of their distribution business while retaining the ownership of assets has proved successful in reducing losses and infusing much-needed capital in reviving ageing infrastructure. This electricity distribution franchisee (DF) model is structured such that the DF receives power supply from the state discom at designated input points, and pays an annual rate for this energy input. The DF has to achieve a minimum reduction in transmission & distribution (T&D) losses and increase collection efficiency. It is then permitted to keep the revenue collected from consumers.
- *Engagement of local groups - Panchayat/Ex Service League for MBC management:* This initiative involves engaging local bodies for MBC activities as well as to spread awareness about the impact of losses and how to control them.
- *Outsourcing/Third party monitoring bodies:* Experience of Delhi and Bhiwandi in Maharashtra indicate that when DF or privatization occurs, consumers do not have confidence in metering and billing practices / systems of the new operator. On the other hand, it is also possible that there are lacunas in the metering and billing systems of the new operator as it takes over the operations in such areas and for such large number of consumers. To avoid this it would be desirable to have stringent third party monitoring mechanisms to get an independent third party unbiased view of the situation.

[10] FOR study report on model of incentive-disincentive mechanism for Distribution Utilities 2010
[11] FOR study report on roadmap for reduction in cross subsidy

4.3.1.2.3. Government support

- *Financial support by Government/Cash injection:* The state government can provide financial assistance to state electricity distribution utilities subject to adherence to some loss reduction targets. The financial assistance can be in the form of –
  - *Capital Injection:* State Government adjust a certain portion of discom's debt through cash infusion or subsidy support or loan takeover.
  - *Direct Subsidy:* The State Government can shield the state discom against losses by directly funding the tariff of certain consumer categories like agricultural consumers or BPL consumers. For instance, the States of Punjab, Bihar, Himachal Pradesh and Andhra Pradesh provide direct subsidy to the state discoms.
  - *Taking over of Debt:* The State Government may take over debt liabilities of state discom and issue Government bonds against it to free up capital for the discom. This gives financial capacity to discom for investing in loss reduction capital projects. For instance, as per UDAY (Ujjawal Discom Assurance Yojna) Scheme of Government of India, if a state government takes over 75% of the debt of state discom as on 30th September 2015 and issues bonds against it, the Government of India would not consider this debt amount in the state's fiscal deficit.
- *Performance monitoring and review:* Regular monitoring by the government of the loss levels and the plans to mitigate the losses is a must, especially for government utilities where the government is the promotor. Eg, States of Punjab and West Bengal.

4.3.1.2.4. Administrative initiatives

- *Dedicated police stations and staff*: The standard process while handling cases of malpractice involve filing of an FIR, following which the legal proceedings begin, starting at a Police station. The idea of having dedicated police stations for the same stems from the need for a quicker and more transparent and able handling of such cases.
- *Dedicated courts:* This is similar to that of having dedicated police stations as it is focuses at developing a dedicated and trained legal system to take care of such issues being faced by utilities.

4.3.2. Loss reduction initiatives in select distribution utilities in India

Based on the exhaustive secondary research and data collected from primary research, the key initiatives implemented for distribution loss reduction by various utilities have been captured. A snapshot of the findings has been provided in the subsequent table:

Table 13 Analysis of loss reduction initiatives in selected states

Aspect	Initiatives	Uttarakhand[12]	Gujarat[13]	Punjab[14]	Maharashtra[15]	Andhra Pradesh[16]	Delhi[17]	Kerala[18]	Assam[19]	Jharkhand[20]	Madhya Pradesh[21]
		UPCL	MGVCL	PSPCL	MSEDCL	APSPDCL	TPDL/BSES	KSEB	APDCL	JSEB	MP Discoms
	T&D loss level 2010	24.53%	14.51%	20.12%	20.60%	12.98%	16.06%	17.71%	26.05%	36.51%	35.15%
	T&D Loss level 2014	19.18%	12.41%	16.44%	14%	10.68%	10.63%	15%	24.07%	27.26%	29%
	Loss reduction (2010 to 2014)	5.35%	2.10%	3.68%	6.60%	2.30%	5.43%	2.71%	1.98%	9.25%	6.15%
Administrative initiatives	Dedicated police stations/staff		✓	✓	✓		✓		✓		
	Dedicated courts			✓			✓				
Regulatory initiatives	Focused clauses in Supply Code/ Grid code				✓					✓	✓
	Loss reduction based MYT mechanisms	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Loss level based tariff design			✓	✓	✓					✓
Governance framework	Loss monitoring, audit committee / cells	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Nomination of feeder managers		✓		✓	✓					

[12] UERC order on Application seeking approval for investment on the project for implementing Integrated Automatic Meter Reading (IAMR) System dated 28th February 2014; https://www.upcl.org/wss/developmentplans.htm ; Presentation on Best Practices in Distribution Loss Reduction by DGM & Head (IT) UPCL; UERC order dated 19 Dec 2014 on application seeking approval for the investment on works covered under Part-'B' of RAPDRP

[13] FOR loss reduction strategies report 2008; Report on Power Distribution Reforms in Gujarat 2009; Business Plan For MYT Second Control Period (FY12 to FY16); http://www.dgvcl.com/dgvclweb/theftreport.php#

[14] Principles of Tariff determination PSERC; http://www.psebea.org/node/3337; World Bank - Punjab High Voltage Distribution System : P105618 - Implementation Status Results Report; http://www.pspcl.in/docs/arr_tariff_vol1_part1.pdf

[15] http://archive.indianexpress.com/news/steep-fall-in-theft-cases-filed-at-power-utility-police-station/974903/; Draft Maharashtra Electricity Supply Code 2015, Report on Power distribution reforms in Maharashtra 2009; FOR loss reduction strategies report 2008; letter by MSEDCL to CEA on Best Practices being followed dated 27 Sep 2012

[16] White Paper on Power Sector in Andhra Pradesh; Report On Restructuring Of APDRP 2006; http://www.apspdcl.in/SPDCL_Home.portal;jsessionid=fTt4V6pGJJRQP4T1p2WM3lqQsnvtYblRlw7m7TTDT36FcFBdHGsP!6902459?_nfpb=true&_pageLabel=Login_portal_page_38 ;

[17] http://www.tatapower-ddl.com/press-release-details.aspx?this=199&id=342; 23rd International Conference on Electricity Distribution Paper 0369 on AMR data for planning; Presentation on TPDDL Excellence Journey September 2014

[18] Application for approval of the Aggregate Revenue Requirement and Expected Revenue from Charges for the year 2013-14; State Distribution Utilities First Annual Integrated Rating, MoP 2013; Report on Identification of Technical Loss Reduction and Rationalization of Secondary distribution System at selected typical three Distribution Transformers of KSEB

[19] Diagnostic Study in Transmission and Distribution utilities of Assam, 2013; Assam Power Sector Enhancement Investment Program August 2014; http://www.apdcl.gov.in/irj/go/km/docs/internet/ASSAM/webpage/pages/IT_Initiatives.html ; Assam Power Sector Enhancement Investment Program, Tranche-3 ADB

[20] Report on Evaluation of Rajiv Gandhi Grameen Vidyutikaran; YojnaElectricity Supply Code 2015

[21] Presentation of National Workshop on disseminating information on good practices in public service delivery on June 5 2009; MPERC order (12.01. 11) for Feeder Separation scheme approval

Aspect	Initiatives	Uttarakhand[12]	Gujarat[13]	Punjab[14]	Maharashtra[15]	Andhra Pradesh[16]	Delhi[17]	Kerala[18]	Assam[19]	Jharkhand[20]	Madhya Pradesh[21]
		UPCL	MGVCL	PSPCL	MSEDCL	APSPDCL	TPDL/BSES	KSEB	APDCL	JSEB	MP Discoms
	Theft reporting consumer incentive scheme		✓				✓				
	Employee incentive schemes				✓						
	Employee capacity building program				✓		✓		✓		✓
Competition promotion	Introduction of DF initiatives/ Privatization[22]	✓	✓		✓		✓		✓	✓	✓
	Engagement of local groups								✓		
	Outsourcing/Third party monitoring bodies	✓		✓	✓		✓		✓		✓
Process strengthening	AMR, Hand Held Devices for billing	✓		✓	✓	✓	✓		✓		✓
	SCADA, DMS, OMS, ERP, SAP etc.		✓		✓	✓	✓		✓		✓
	100% consumer metering[23]	✓	✓	✓	✓	✓	✓	✓			✓
	Replacement of defective meters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	MIS based periodic reporting	✓	✓	✓	✓	✓	✓	✓	✓		✓
Network strengthening/ Technical loss reduction	Segregation of agricultural/rural feeders[24]		✓	✓	✓	✓				✓	✓
	Implementation of HVDS system		✓	✓	✓		✓				✓
	Installation of LT ABC	✓	✓	✓	✓		✓		✓	✓	✓
	Improving HT:LT ratio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Substation/DT augmentation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Government support	Capital injection			✓		✓					
	Performance monitoring and review			✓	✓		✓	✓	✓		✓
Soft initiatives	Consumer communication on loss reduction			✓	✓		✓		✓		✓
	Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme	✓	✓		✓		✓				✓
	Customer feedback program			✓	✓	✓	✓		✓		
	Transformer Management System			✓							✓

[22] Report of the Task Force 'Private Participation in Power Distribution' 2012, Planning Commission
[23] Forum of Regulators Working Group Report On "Metering Issues"
[24] http://www.worldbank.org/en/news/press-release/2013/10/01/lighting-rural-india-is-feeder-segregation-the-only-answer ; http://garv.gov.in/assets/uploads/reports/statesnaps/Jharkhand.pdf

4.3.3. Case Studies on Loss reduction journey of select Indian Distribution Utilities

In India, while the overall loss level of distribution companies still needs a lot of improvement, there are states which have notched ahead with their performance and initiatives. This section discusses the performance improvement and loss reduction stories of five Indian states which have various intensities of losses as on date, but share the common platform of achieving significant level of improvement in their performance levels.

Table 14 Loss levels in states selected for case study

Selected State	T&D Loss Level (%)	
	2010	***2014***
Delhi	16.06	10.63
Punjab	20.12	16.44
Gujarat	14.51	12.41
Maharashtra	20.60	14.00
Madhya Pradesh	35.15	29.00

A brief snapshot of these case studies for some of the select initiatives for which data was available is as follows –

Table 15 Snapshot of case studies

State /Discom	Initiative	Cost (Rs. cr)	Saving (Rs. cr)	AT&C Loss (to)	AT&C Loss (from)	Sample Size	Payback period
Delhi (NDPL)	Special Courts for Theft cases	-	-	47.79 % (FY 02-03)	<16% (FY 08-09)	-	-
	Delhi Distribution Public Private Partnership (PPP) Model	-	-			-	-
	Energy Billing System	-	-			-	-
	Optical fiber backbone	-	-			-	-
	Grid Substation Automation	-	-			-	-
	GIS	-	-			-	-
	AMR	-	-			-	-
	SCADA/CRM	-	-			-	-
	SAP/Unified call center	-	-			-	-
	Replacement of meters	-	-			-	-
	HVDS	-	-			-	-
	Replacement of LT bare conductor	-	-			-	-
	RMU Installation	-	-			-	-
Punjab (PSPCL, PSTCL)	Network Redesign	1165.99		19.29 %	11.28%		4.6 yrs
	Feeder Segregation	-	-	-	-	-	-
	Installation of meters outside consumer premises	0.05	0.45	28.09%			< 1 month
		0.50	1.09	~30%			6 month

State /Discom	Initiative	Cost (Rs. cr)	Saving (Rs. cr)	AT&C Loss (to)	AT&C Loss (from)	Sample Size	Payback period
Gujarat	MGVCL – 100% metering	110.44	-	-	-	-	-
	DGVCL – 100% metering	166.33	-	15%	9.33%	-	-
	UGVCL – 100% metering	80.57	-	-	-	-	-
	PGVCL – 100% metering	44.68	-	-	-	-	-
	Vigilance cells and police stations	-	-	-	-	-	-
	MGVCL – network redesign	627.65	-	-	-	-	-
	DGVCL – network redesign	N/A	-	-	-	-	-
	UGVCL – network redesign	1564.39	-	-	-	-	-
	PGVCL – network redesign	428.19	-	-	-	-	-
	MGVCL – LT ABC	103.64	-	-	-	-	-
	DGVCL – LT ABC	166.33	-	-	-	-	-
	UGVCL – LT ABC	23.26	-	-	-	-	-
	PGVCL – LT ABC	200.6	-	-	-	-	-
Maharashtra (MSEDCL)	Dedicated police stations	-	Rs. 25 cr btw apr to sep '08	-	-	-	-
	Gaothan Feeder Segregation	2389	-	-	-	-	-
	Energy accounting at various levels	-	-	-	-	-	-
	Transformers loading was restricted to 80% level; capex for new transformers	8918	-	-	-	-	-
Madhya Pradesh	Feeder Segregation	-	-	-	-	-	4 years
	Billing of Agricultural Consumption on the basis of Group Metering	-	-	-	-	-	-

Source: PwC Analysis

4.3.3.1. New Delhi (NDPL / TPDDL)

Delhi took to the reform path during FY 2002-03. In the time before privatisation, the AT&C and Theft related losses in the national capital used to range between 53% - 60% of input energy with Govt. subsidies ranging to the tune of 1,500 Crore per annum to bridge revenue gap. The network was in a poor condition and so was Consumer records in various electricity offices. There used to be bills receivable of close to a year with Consumers experiencing regular black-outs/ brown-outs of 4-6 hours.

The distribution sector in Delhi had a workforce of approx. 5,500 with very little skill set. Key management functions like HR, Finance, and Governance were missing, mixed with lack of accountability, initiative & service attitude.

Some of the focused steps taken by the utility towards loss reduction were as below -

- **Competition promotion initiatives**
    - During 2002-03, the assets of erstwhile Delhi Vidyut Board (DVB) were unbundled into generating company (Indraprastha Power Generating Company Limited), transmission company (Delhi Transco Limited) and the three distribution companies (BSES Yamuna Power Limited, BSES Rajdhani Power Limited & Tata Power Delhi Distribution Limited).
    - In July 2002 the Government of Delhi, formed 49%:51% Joint Venture Electricity Distribution Company and with the objective of improving quality of service to its consumers, as follows -
        - Tata Power Delhi Distribution Limited (TPDDL) – with TATA Power
        - BSES Yamuna Power Limited (BYPL) – with Reliance Energy
        - BSES Rajdhani Power Limited (BRPL) – with Reliance Energy
    - The Delhi Distribution Public Private Partnership (PPP) Model gave full functional autonomy to the Private Investors to manage the Business, provided complete Government Oversight through its representation in the Board of the Discom and Regulatory Oversight by the Delhi Electricity Regulatory Commission
    - Some of the key principles that made the PPP model of Delhi a success were as follows:
        - Past liabilities and past losses of DVB not to be passed on to the successor entities
        - The restructured entities started with a clean opening balance sheets
        - Govt. provided transition support in initial years till Discoms becomes self-sustainable
        - Incentives and profit sharing mechanism, related to performance, provided to Discoms
- **Process Strengthening initiatives -** Several rounds of initiatives were introduced in order to increase the system automation as follows -

- *Immediately after Privatization (FY2002-03)*
  - Energy Billing System: Fully implemented a homegrown online Decentralized Energy Billing System (DEBS) connected from its central server to all its Consumer Care and Cash Collection Centers.
  - Communication Backbone establishment: All the Grids and major commercial offices were also connected through a strong optical fiber backbone with capacity of 2.4 Gbps in core ring and 644 Mbps in sub rings. The Communication backbone is used for both operational (SCADA) and enterprise requirement like System Application Product (SAP), etc. and other data requirement such as internet, mail, video conferencing etc. This backbone has availability of more than 99.9%. Last mile connectivity to all zones is extended through radio frequency and optical fiber with min. bandwidth of 2 Mbps.
- *Between 2003 and 2006*
  - Grid Substation Automation: 66/11 and 33/11 kV grids of TPDDL have been automated with latest technology for remote connectivity to SCADA center. These grids are remotely monitored. Grid station automation include change of 66/33 KV /11 control and relay panel replacement with new panels fitted with state of Art Intelligent Electronic Devices and data concentrator. These stations are equipped with devices to make all control, monitoring and protection signal available at remote control center for efficient control and monitoring of Electrical network
  - Geographical Information System (GIS): TPDDL also implemented GIS system for complete TPDDL area. All Assets such as transformers, Buildings, Poles, Cables etc. have been mapped in GIS and helps TPDDL in various processes such as Capital Expenditure Management, Asset Management and Revenue Management.
  - Automatic Meter Reading (AMR): TPDDL also established Automatic Meter Reading (AMR) system for all of its high end consumers which have the capability to read meters of any make. This system has completely eliminated manual intervention in the process of meter reading to the final printing of the bill.
- *Between 2006 and 2009*
  - Supervisory Control and Data Acquisition system (SCADA): It has enabled TPDDL to control all connected grids from a SCADA Master Control Center at Pitampura - III. SCADA system is designed with the concept of main control center and backup control center is part of disaster management.
  - Customer Relationship Management (CRM): with the challenge to integrate all modules/commercial processes, a home grown work flow based CRM application SAMBANDH (Building Relationship) was implemented.
- *2009 till date*
  - In Apr 2011, as an integrated solution for commercial processes, SAP ISU (Industry Solution for Utilities) was implemented. This has facilitated online accounting of sales and collection without any manual intervention. The application has been seamlessly integrated with other applications like OMS, GIS, AMR, HHD, Spot Billing, IVRS, Payment Gateway, Lab testing M/c, etc. and with other ERP module like PS/MM/PM/FI.

- Unified Call Centre for attending to 'No Supply' & 'Commercial Complaints'. This has meant the sun-set of thirteen in house applications like BBS, DEBS, SAMBANDH, etc.

- **Network Strengthening initiatives**
  - Metering systems: TPDDL replaced the existing electro-mechanical meters with static meters which were tamper proof with almost no accuracy change with passage of time as these do not have moving parts. Approx. 8 lakh electromechanical meters have been replaced in last ten years.
  - High Voltage Distribution Systems (HVDS): Under HVDS, the existing LT network in theft prone areas was replaced by HT network and new small capacity transformers were installed, which were nearer to the load centers and cover reduced number of consumers. HVDS also enhanced reliability by localizing faults and contributed to better quality of supply by eliminating the need for long low tension lines. The HVDS, reduced system's technical losses, and thus helped TPDDL to meet the AT&C loss reduction targets.
  - Replacement of LT bare conductor with LT AB Cable: The same resulted in reduced direct 'hooking' done on bare LT conductor lines thereby reducing commercial losses drastically in theft prone areas.
  - Replacement of Sick Cables: Old 11kV underground cables with history of frequent and a number of faults were also replaced to ensure reliable and continuous power supply.
  - RMU installation by replacement of old HT panels: TPDDL conducted the technical audits of all the grids and distribution sub-stations. Based on the findings of the technical audit it was decided to replace the old 11 kV switchgear with state of art SF6 panels which were SCADA compatible.

- **Administrative initiatives**
  - Special Courts for facilitating faster disposal of Theft related cases set up by the Delhi Govt.; it also facilitated availability of Central Security forces and Delhi Police to assist in theft control.

As a result of these collective efforts, over the last decade, the AT&C loss level has come down to ~15% resulting in a total savings of upto USD. 1.8 Billion[25].

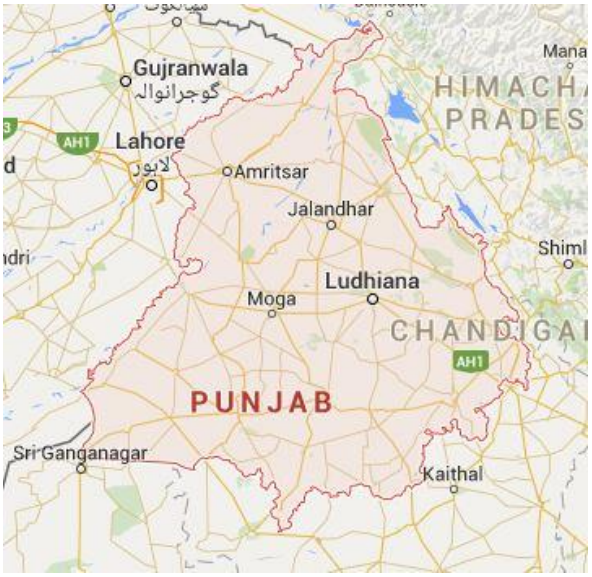
Table 16 Impact of loss reduction in Delhi

Parameters	FY 02-03	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09
Energy Input (MU)	5237	5552	5549	5695	5986	6281	6298
Units Billed (MU)	2813	3196	3667	4154	4351	4975	5050
Amount Billed (Rs Cr)	1126	1272	1565	1883	2032	2323	-
Amount Collected (Rs Cr)	1095	1219	1568	1897	2132	2394	-
% AT&C Loss	47.79	44.86	33.79	26.52	26.52	18.50	< 16

[25] FOR 43rd Minutes of Meetings

Parameters	FY 02-03	FY 03-04	FY 04-05	FY 05-06	FY 06-07	FY 07-08	FY 08-09
% Billing Efficiency	53.72	57.56	66.08	72.95	72.68	79.21	> 80
% Collection Efficiency	97.18	95.78	100.20	100.73	104.94	103.04	> 103

4.3.3.2. Punjab (PSPCL & PSTCL)



The State of Punjab has historically performed well in terms of containing distribution loss level. During the year 1991-92, they had a loss level of 21.8%, which came down to 17.7% in at the end of the decade. In the year FY 2013-14 also, Punjab has been able to sustain their distribution loss level of ~17%. The state has also not unbundled its electricity business properly, with Generation, Distribution and sub-transmission being handled by Punjab State Power Corporation Limited (PSPCL), and Transmission being looked after by Punjab State Transmission Company Limited (PSTCL). While historically being at a decent level of distribution loss has been strength to Punjab, the challenge lies in achieving the next level, which is to further bring down the level of AT&C Losses.

The erstwhile PSEB was unbundled into PSPCL and PSTCL during FY 2010-11, which had an effect on reporting of T&D losses. Whether the components should be reported separately or together is still a matter of concern, though the same has not affected the performance level of utilities in Punjab. PSPCL of late has seen a reduced level of sales to large supply industrial category, which have been amongst the highest paying consumers with lowest T&D/AT&C Loss levels. A lot has been invested into areas like performance monitoring also, by initiatives in areas like DSM, SAP implementation for error-free billing and trying to improve metering infrastructure. Overall, Punjab can be taken as a model state while looking from the view point of distribution performance improvement.

Some of the focused steps towards loss reduction were as below -

- **Network Strengthening**
    - Network Redesign: Between the period of 2009 and 2012, a total of 186072 substations were installed in Punjab with various transformation capacities in order to redesign the network. This initiative led to a loss improvement of 11.28% to 19.29% at an estimated cost of Rs. 1165.99 crores and an average pay back period of 4.6 years on the investment[26].
    - Feeder Segregation: Work of segregating about 2000 mixed feeders was started in 1996-97 & completed in 2003 - 04. 50% job of the project launched to segregate 11kV feeders was carried out departmentally and remaining through turnkey basis. Simultaneously work for

[26] Based on primary data collected by FOR from state discoms for the purpose of this study

segregating AP load from other mixed rural loads (virtual segregation) started in 1996 – 97 by erecting 4th wire on mixed rural feeders. After restricted three phase supply on mixed rural feeders, two phase supply was provided to non – AP loads in villages through 4th wire. About 900 mixed feeders were covered under this scheme which was discontinued due to high accident rate & also failure to record pumped energy to AP sector. The work of physical segregation of 900 three phase four wire feeders by erecting separate 11kV UPS line was started in 2008 – 09 and has been completed during 2013 – 14. After segregation, it was observed that AT&C losses of UPS feeders were in the range of 50-70%[27]. With increased supply hours to UPS feeders, the AT&C losses mounted after segregation.

- **Process Strengthening**
  - Installation of meters outside consumer premises: To reduce AT&C losses on UPS feeders, pilot projects by shifting consumer meters to pillar boxes was started in 2007 – 2008. An activity was carried out to quantify the benefits of installing meters outside consumer premises in terms of loss reduction and payback period of investment. This activity was performed in several feeder areas with following key findings[28] –

Table 17 Impact of loss reduction in Punjab

Feeder	Loss reduction	Cost	Savings	Payback period
11 KV hospital feeder	28.09%	5 Lacs	45 Lacs	< 1 month
11 KV Ablowal UPS feeder	~30%	50 Lacs	109 Lacs	6 months

4.3.3.3. Gujarat (PGVCL/MGVCL/DGVCL/UGVCL)

At the beginning of the last decade, Gujarat reported T&D Loss of around ~ 35%. The erstwhile Gujarat Electricity Board (GEB) reported a loss of Rs. 2,246 Crore in the same year. Power theft was high ranging between 20% in urban areas to 70% in rural areas. Unmetered power supply was high, while state money was not in abundance to invest so as to add new generating capacity. Employee morale was low due to lack of clarity regarding reforms and cost of cross-subsidization was also high. At this point of time, private players were reluctant to invest in the electricity sector in Gujarat.

The unbundling began in 2005 and focused reform included steps like –

- **Process Strengthening**

[27] FOR 44th Minutes of Meeting
[28] FOR 44th Minutes of Meeting

- 100% metering of customers, feeders and transformers: The total cost of such meter replacements and the related loss reduction across various utilities in Gujarat is as follows[29] –

Table 18 100% metering initiative in Gujarat

Utility	Cost (Rs. Crore)	Planned loss reduction (%)	Actual loss reduction (%)
MGVCL	110.44	In progress	In progress
DGVCL	166.33	15%	9.33%
UGVCL	80.57	In progress	In progress
PGVCL	44.68	N/A	N/A

- **Administrative Initiatives**
  - Setting-up of Vigilance cells and police stations to contain power theft: GEB had set up one vigilance department headed by IPS (Indian Police Service) officer in the rank of Addl. Director General of Police on deputation by the Government of Gujarat. He is designated as "Director of Security & Chief Vigilance Officer" (DSCVO). GEB had formulated 74IC Squads working under Addl. Chief Engineer Vigilance under the control of DSCVO. In vigilance department, they have formed two types of squads' i.e.
    - HT Squad – to check the HT installation
    - LT Squad – to check the LT industrial, Commercial, Residential installations.

    In order to supervise LT industrial connections, there are 63 LT squads, out of which 19 Squads are headed by Dy. Engineer and 44 Squads are headed by Jr. Engineer, stationed at different circles. Over and above these, the remaining 11 HT squads, headed by Dy. Engineer, are stationed at Surat, Bharuch, Baroda, Bhavanagar, Mehsana, Sabarmati, Rajkot and at Baroda Head Office. GEB had set up separate police stations purposefully to deal with power theft cases in Surat, Baroda, Rajkot, Mehsana and Bhavanagar Zones [30].
- **Network Strengthening**
  - This involves, network Redesign & capex for installing transformers, HVDS to improve HT:LT etc. The total cost of such network redesign across various utilities in Gujarat is as follows[31] –

Table 19 Network Strengthening initiative in Gujarat

Utility	Network Re-design Cost (Rs. Crore)	Installation of LT ABC Cost (Rs. Crore)
MGVCL	627.65	103.64
DGVCL	N/A	166.33
UGVCL	1564.39	23.26

[29] Based on primary data collected by FOR from state disoms for the purpose of this study
[30] Annual Administrative Report, 2003-2004 page no. 15, 17, & 18 published by GEB
[31] Based on primary data collected by FOR from state discoms for the purpose of this study

PGVCL	428.19	200.6

- Jyoti Gram Yojana (JGY)[32] - a pilot initiative in eight districts in September 2003 with the objective of supplying reliable and quality power. This initiative was extended to entire state in 2004. At the end of FY 2007-08, 17839 villages were covered under the JGY. It involved laying a parallel rural transmission network across the state involving the erection of 15,500 transformers and 75,000 km of lines at an investment of Rs 1,200 crore. The investment was almost entirely funded through grants from GoG (Rs. 1017 crore) with the remaining funds being contributed by the concerned DISCOMs, the Asian Development Bank and schemes such as the APDRP, the MLA fund, etc.

4.3.3.4. Maharashtra (MSEDCL)

Unbundling in the distribution sector of Maharashtra happened during 2005 while the erstwhile Maharashtra State Electricity Board (MSEB) was segregated into four entities, one each for generation, distribution and transmission along with a holding company. MSEB was the largest state electricity board in the country excluding Mumbai before unbundling. Performance in the state dipped after the unbundling process. During 2001-02, the energy deficit grew by 9% with a peak deficit of 13%. Post unbundling, the same went up to 23% during 2005-06 while AT&C loss levels increased to 50%. Maharashtra being an agri-focused state, there was always a pressure of cross-subsidy. The gap between cost and revenue was high due to this factor and reached Rs. 2084 Crore in 1999-2000. The collection efficiency was also poor and was at 80% in 2005-06.

Post unbundling, Maharashtra took some of the following effecting initiatives –

- **Administrative initiatives**
  - Theft detection drive was launched and corruption cases were handled with a strong-hand: MSEDCL launched a theft detection drive in order to improve its collection efficiency. Six dedicated police stations have been established in Maharashtra to handle power theft cases. During FY 2007-08 about 90,000 cases of power thefts amounting to Rs. 55.41 Cr. were detected. Speedy disposal of vigilance cases and strict action against default. As a result, more than 9000 FIRs were registered against the power theft accused. This drive was implemented consecutively for 15 days every alternate month. During April to September 2008, the drive resulted in 36383 cases and recovery of Rs. 25 Cr. as penalties and FIRs against 3559 persons[33].
- **Network Strengthening**

[32] Power distribution reforms in Gujarat, October 2009, IDFC
[33] Power distribution reforms in Gujarat, October 2009, IDFC

- Gaothan Feeder Segregation: Under this scheme, MSEDCL is separating the rural feeders that service homes from those that feed agricultural pump sets. Gaothan Feeder Separation Scheme has been planned for more than 15000 villages. This scheme will be implemented with an estimated total cost of Rs 2389 Crores[34].
- Energy accounting at various levels was taken up: MSEDCL started carrying out feeder wise energy audit (EA) to obtain feeder wise distribution loss data. MSEDCL started to undertake Monthly Energy Accounting at Division, Feeder and DTC level.
- Transformers loading was restricted to 80% level while capex was taken for installation of new transformers: The plan includes setting up of 76,182 km of power distribution lines in order to improve the HT-LT ratio of the distribution network. MSEDCL is also expected to set up 565 new substations and augment the existing substations. Total project cost for infrastructure investment in 119 divisions was expected to be Rs 8918 Cr[35].

As a resultant of such various initiatives, the AT&C loss levels were down from 54.3% in 2004-05 to 24.8% in 2008-09 while collection efficiency was improved to ~99% by 2014.

4.3.3.5. Madhya Pradesh

Madhya Pradesh State Electricity Board (MPSEB) was unbundled into five entities, one each for generation & transmission along-with three distribution entities during November, 2001. The companies started their independent operation w.e.f. June 2005. Distribution losses in the state of Madhya Pradesh have historically been above the 20% mark during early 90s. The loss level in MP, as shown in the report before, has been hovering at a range of ~30% during FY 2013-14.

While the same has been a matter of concern, the initiatives in the state are on track to bring the loss level down to a manageable position.

Post unbundling, Madhya Pradesh took some of the following effective initiatives –

- **Network Strengthening**
  - Feeder Segregation - The Project was designed to separate domestic load from Irrigation in rural area and for that separate 11 KV feeders along with 11 KV bay and VCB from existing 33/11 KV substation was proposed. The key objective of the project was to separate domestic load in rural area and for that conversion of existing LT system to HVDS system & AB Cable was proposed. Conversion of existing LT system to HVDS system in inhabitant area of village was taken into consideration. HVDS for 1258 agriculture pump consumers in the area of Nasrrulaganj division in Sehore district. 20% of total existing LT line were proposed to be converted from LVDS to HVDS or AB LT cable covering inhabitant area of villages 25 KVA transformers @ Two to Three per village are proposed. The internal rate of return (IRR) of project is 26.03 % and payback period 4 years[36].

[34] Power distribution reforms in Gujarat, October 2009, IDFC
[35] Power distribution reforms in Gujarat, October 2009, IDFC
[36] http://www.mpcz.co.in/portal/Bhopal_home.portal?_nfpb=true&_pageLabel=abtUs_Feeder_bpl

- **Process Strengthening**
    - Billing of Agricultural Consumption on the basis of Group Metering[37]: Provide meter on the Distribution Transformer for the group of agriculture consumers served by the DTR. The consumption recorded by the DTR meter could be divided amongst the connections on per HP pro-rata basis. Some of the key features of this initiative are –
        - The billing would be based on actual consumption recorded in the DTR meter instead of some theoretical calculations based on small sampling and applied uniformly all across the State.
        - Such a procedure would discourage the theft of electricity, which will be not be allowed by the regular consumers connected to the DTR.
        - Consumer as an individual shall be motivated to adopt Demand side Management by the other consumers in that group.
        - Billing will be based on actual reading recorded by DTR meter and as such fixing an assessment based on presumed supply hours shall not be required.
        - The consumers would also free to opt for "Own your transformer" scheme as per prevailing practices to own and maintain transformer.

The Distribution loss targets were set at a level of around 20% for the period of FY 2013-14 to FY 2015-16, with gradual progress in the same over the said period. The state DISCOMs are having a common capital expenditure plan in the direction of load reduction of overloaded 33kv feeders and improvement of agricultural feeder network. Capital expenditure in overall distribution infrastructure improvement has also been given due importance of late. In FY16, Gap of Rs. ~2300 Crore was reported by MP DISCOMs.

[37] Report on Loss Reduction Strategies, FOR, October 2008

5. Review of International Experience

This section of the report captures various practices and strategies implemented for reduction of distribution losses in select developing economies. The key agenda behind studying international standpoint is to understand various initiatives adopted by developing economies which can be in turn applied to the Indian scenario. The countries have been so selected that they are comparable to Indian scenario in terms of economy, power sector, demography etc. The following subsections details out selection criteria and experiences of distribution loss reduction across selected countries.

5.1. Selection of international geographies

The distribution loss reduction practices implemented in developing economies, having profile similar to India, and have consistently shown improvement in terms of loss reduction have been considered for the study. Alongside, best practices for loss reduction followed in developed economies have also been mapped to have a comprehensive outlook on loss reduction. The developing economies will be closer to the Indian scenario making it more relevant for the benchmarking of the loss reduction strategies, while the developed economies will provide insights into the more sustainable and modern practices of loss reduction.

The first and foremost criterion of selection of a country is implementation of successful loss reduction strategies/initiatives along with availability of data. The other criteria for selection of a country are

- Population;
- GDP per capita;
- Energy consumption per capita; etc.

Based on the aforementioned criteria the list of countries selected for this study is as follows:

Table 20 List of countries selected for international review

Name of the Country	Population (Mn)	GDP per capita	Per capita electricity consumption
Iran	77.45	4763.07	2194.79
Uganda	37.58	571.85	65.90
Oman	3.63	21944.90	4964.16
Brazil	200.40	11207.58	2198.96

The distribution loss reduction experience in each of these countries has been discussed in subsequent sections.

5.2. Oman

Oman is an Arab country located in the South Eastern coast of the Arabian Peninsula. The structure of electricity sector in Oman comprise of operations viz. generation, power procurement, transmission and distribution with each operation being handled by a single distinguished entity. In 2005, a company, wholly owned by the Government of Oman, was constituted for handling generation, transmission and distribution operations function along with having its presence in the rural areas. The main objective behind formation of this separate entity was to focus primarily upon development of rural areas. The rural pockets were the major areas identified as laggards in terms of operational efficiency and at the same time were averse to the transformations that were taking place in the electricity sector of the country as a whole.

Context

This case study was captured from the research paper published in the World Academy of Science, Engineering and Technology forum on reduction of Power Losses in Distribution Systems of Oman.

Loss reduction initiatives in Oman were primarily taken up due to increasing cost of supplying electricity, shortage in fuel with ever-increasing cost to produce more power and the global warming concerns. The secondary objective was optimal utilization of existing capacity so as to defer intensive capital expenditures for system improvements and expansion.

Oman Electricity Sector saw a major reform with deregulation of the power industry. However, distribution business remained a regulated monopoly. The distribution utilities were facing increased pressures from shareholders and regulatory authorities to improve investment and operational efficiency. In addition, distribution business was witnessing high loss levels which were impacting the overall business performance of the sector. Due to high loss levels, the government authorities were forced to subsidize the distribution business leading to increased financial distress. With this context loss reduction initiatives have been implemented in the country.

Initiatives

A pilot loss distribution strengthening project was undertaken by Mazoon Electricity Company (MZEC) which was further extended to the other distribution utilities of the Country. The project aimed entire value chain of distribution sector for reduction of losses and achieving efficiency gains. The loss reduction program was envisaged across the following aspects:

- Augmentation of existing substation capacity
- Creation of additional sub- station to cater to future demand in long term
- Network reconfiguration and load balancing

The activities implemented for reduction of technical and non-technical loss under this program are summarized as follows:

Technical loss reduction initiatives

The key initiatives adopted for reduction of technical losses were:

- Adding of new transmission lines with appropriate size conductors to reduce system overloading;
- Installing EHV network (Extra High Voltage Networks);
- Revising design specifications/material considerations and loading guidelines for procurement of distribution transformer;
- Developing operational guidelines for improved management of distribution transformers;
- Conducting low-loss distribution transformer research;
- Relocating transformers and substations near to load centers thereby improving HT / LT ratio;
- Re-routing and re-conductoring of feeders with high losses/voltage drops;
- Power factor improvement by installing capacitors;
- Balancing the loads on three - phase networks;
- Developing distributed generation to cater to demand of remote locations;
- Minimizing losses due to weak linkages in distribution network such as jumpers, loose contacts etc.

Non-technical loss reduction initiatives

The key initiatives adopted for reduction of non- technical losses in the distribution system were:

- Installing of smart meters at consumer level for real time monitoring and timely meter reading;
- 100% Metering at all levels i.e. at the feeder level as well as the consumer level;
- Installing underground cables so as to suppress the theft practices prevailing in the area;
- Engaging the community by holding various community meetings and workshops in order to create awareness among people and curbing theft of electricity. Such engagements were focused to educate people about various strategies that can be followed in order to minimize the losses.

Impact

Impact of various initiatives as mentioned above were assessed and it was observed that the implementation of these initiatives lead to a significant improvement in the voltage profile and reduction in technical and non-technical losses in the distribution system. From a financial viewpoint reduction in the losses helped in restoring the confidence of the lenders as well as the private investors and encouraged them to participate in the development of the country's power sector. The following observations were made after implementation of the initiatives:

- The geography in which these initiatives were implemented showed a significant decrease in the loss level in the subsequent year as compared to the previous year.
- In some cases, the actual loss levels recorded were even lower than the targeted loss levels.
- Voltage drops on each feeder were brought down within the allowable tolerance levels.
- The program also assisted in achieving network infrastructure norms as per Distribution System Security Standard (DSSS) followed in Oman.

From economic viewpoint, implementation of program in the Discom led to a manifold decrease in the cost of annual power loss resulting into annual saving of approximately USD 5 million.

Observations

Based on the in-depth analysis of the case study of Oman, it may be inferred that the following loss reduction initiatives have been implemented for distribution loss reduction:

Table 21 Summary of Oman case study

Technical loss reduction		
Type of Initiative	**Whether Undertaken**	
Load Balancing	√	
Network Reconfiguration	√	
DT Management	√	
Power Factor Improvement	√	
Non- technical loss reduction		
	Type of Initiative	**Whether Undertaken**
Energy Accounting	100% Metering	√
	Replacement of Defective Meters	×
Meter Reading	AMR/HHD	×
	Smart Metering	√
Billing	Spot Billing	×
	Appointment of MBC Franchisee	×
Collection Efficiency	Increase in avenues	×
	Increase in Modes	×
Soft Initiatives	Community Campaigns	√
	VDS/IWS etc.	×
	Other initiatives	×

5.3. Iran

Iran is a centrally located country in Western Asia. The electricity industry in Iran is managed by Tavanir, a holding company under the Ministry of Energy, Iran. Tavanir is responsible for the overall management of regional electric companies, generation utilities, distribution utilities, power development company, renewable energy development company, energy efficiency organizations, power plant project management and power plant repairs. In totality, Tavanir is responsible for dealing with the management of all the operations associated with the power sector and caters to approximately 98% demand of electricity in Iran.

Context

The experience shared here is based upon the case study "Distribution Loss Minimization: A case study in a commercial section In Mashhad" presented in the 22nd International Conference on Electricity Distribution, Stockholm.

In early 2011, at the start of the new decade, the Electricity Distribution Sector of Iran was facing a tough time with high electricity distribution losses. A study was conducted to identify the factors attributable to

existing technical and non- technical losses. It was observed that the technical losses were primarily due to poorly designed transformers, transmission and distribution lines and presence of large area under low voltage network. Further non-technical losses were identified majorly due to electricity theft, non- payment of bills by customers, errors in accounting and record- keeping.

In an attempt to reduce these losses, initiatives were taken up primarily in the commercial section of Mashhad Electric Energy Distribution Company and then were further extended to the other utilities of the country.

Initiatives

To begin with, field surveys were conducted to identify high loss making pockets and poor distribution infrastructure. The key characteristics attributable for selection of such areas were high loss levels, traditional network, low accurate metering system and high level of consumption etc. Subsequently, substantial numbers of measures were taken up in order to curb these losses and improve efficiency. The activities implemented for reduction of technical and non-technical losses have been summarized below:

Technical loss reduction initiatives

Key initiatives adopted for reduction of technical losses were:

- Removal of low voltage network: High Tension line was extended nearer to the consumer premises.
- Utilization of pad-mounted transformers: Higher KVA transformers were replaced with lower value pad mounted transformers (Transformer locked in a steel cabinet and placed over a concrete pad)
- Installation of shunt capacitor banks: For Power Factor Correction and reduction of reactive power present in the system.

Non- Technical loss reduction initiatives

Key initiatives undertaken for reduction in non-technical losses were:

- Implementation of AMI system: Installation of smart meters for recording of real time data.
- Implementation of automatic reading of meters: For capturing consumption details and reducing the cost of the billing system.
- Load Management: Ability to turn on and off meters from data management center. Furthermore, limiting the load of consumers
- Alarm management: Any technical or tampering faults in the system were alarmed.

Impact

At the completion of the study it was observed that the distribution loss levels of studied section were brought down considerably from 23.17% before the implementation of the schemes to 3.85% after implementation within a period of one year. In addition, the initiatives undertaken helped the utility in achieving better energy accounting and improving the reliability and the flexibility of the system.

Observations

Based on the deep analysis of the case study of Iran, it may be inferred that the following loss reduction initiatives have been implemented for distribution loss reduction:

Table 22 Summary of Iran case study

Technical loss reduction	
Type of Initiative	Whether Undertaken
Load Balancing	√
Network Reconfiguration	√
DT Management	×
Power Factor Improvement	√
Non- technical loss reduction	
	Type of Initiative / **Whether Undertaken**
Energy Accounting	100% Metering: √
	Replacement of Defective Meters: ×
Meter Reading	AMR: √
	Smart Metering: √
Billing	Spot Billing: ×
	Appointment of MBC Franchisee: ×
Collection Efficiency	Increase in avenues: ×
	Increase in Modes: ×
Soft Initiatives	Community Campaigns: ×
	VDS/IWS etc.: ×
	Other initiatives: ×

5.4. Brazil

Brazil is the largest country of Latin America and one of the fastest growing economies in the world. Brazil has demography and consumer base similar to that of India comprising of a whole mix of rural areas, urban areas, slums etc. The industry structure of the electricity sector of Brazil comprises of generation, transmission and distribution functions with significant private participation in each of them. The sector is regulated by Agência Nacional de Energia Elétrica (ANEEL), an autarchy of the Government of Brazil linked to the Ministry of Mines and Energy.

Context

The present context is based on the case study "Transforming Electricity Consumers into Customers: Case Study of a Slum Electrification and Loss Reduction Project in São Paulo, Brazil" The study was conducted under the joint collaboration of the US Agency of International Development (USAID), the International Copper Association, and AES Eletropaulo, an electricity distribution company in the region of Sao Paulo in 2006.

The study covered the aspects of a project undertaken for electrification of slums in the city of Sao Paulo. The objectives of the project undertaken were to:

- Resolve the long term problems of electricity theft, non- payment and losses plaguing the area,
- Upgrade/ create infrastructure in the area,
- Provide reliable and better quality supply to the residents of Sao Paulo,
- Educate consumers in bringing down their consumptions to affordable levels,
- Enlighten the consumers about the cost incurred by the utility in providing them the service,
- Apprise the consumers about the affordability of the service,
- Make the residents payable for their consumption of electricity,
- Improve the financial viability of the power distribution business,
- Impart knowledge on energy efficiency measures,
- Educate consumers about the in-home safety measures to reduce the risk of electricity related accidents.

A crucial takeaway from this project was a sustainable service model that would meet the needs of consumers in low-income urban areas and could be widely replicated. Major emphasis of the project was on developing and testing new approaches for regularization and improvement of electricity services in the target area.

Initiatives

On careful examination of the causes leading to losses in the system, it was discovered that the losses were basically due to degraded network entailing to electricity theft, higher distribution losses and completely zilch collection efficiency. A substantial number of technical and non- technical loss initiatives were adopted that can be summarized as follows:

Technical loss reduction initiatives

Key initiatives undertaken for reduction of technical losses were as follows:

- Upgradation of existing distribution system and service infrastructure of the concerned area,
- Installation of twisted and bi-coaxial cables with new connections,
- Replacement of the twelve conventional overloaded transformers with more efficient and reliable transformers.

Non-technical loss reduction initiatives

More emphasis was put on reducing the non-technical losses which were observed to be more persistent in the area as compared to the technical losses. A slew of measures as listed below were taken up in order to reduce these losses:

- Waiving off of initial upfront fee for new consumers;
- Setting up of price capped low income tariff for economically weaker section;
- Assisting consumers to prove their eligibility to receive the low income tariff;
- Capping the billed consumption until consumers of the section had been regularized;
- 100% metering in the area for all categories of consumers;
- Installing electronic meters for proper recording of energy consumption and controlling electricity theft;
- Conducting awareness drives wherein the consumers were provided with benefits like efficient light bulbs and replacement of inefficient household appliances like refrigerators, electric showers etc.;

- Upgrading of internal household wiring;
- Holding community campaigns and door to door visits to apprise the residents about the regularization process;
- Suggesting ways to help new consumers in improving their efficiency and affordability of electricity use;
- Replacing the inefficient individual lights installed on the exterior of houses;
- Community engagement to gain support and preparing the community about the upcoming changes by holding frequent community campaigns.

Impact

Financial analysis of the results from the perspectives of the company and the consumer provided a measure of the overall impact of the project. The main takeaways of the project were regularization of consumers, successful implementation of energy efficiency measures and creation of new physical infrastructure in the pilot area. The key benefits achieved were:

- Substantially improved revenues due to improved collection efficiency virtually going up from 0% earlier to 68% after regularization;
- Reduction in average electricity consumption within the pilot area to the tune of 40%;
- Reduction in costs to company due to timely payment of electricity dues;
- Reduction in expenditure incurred on account of power purchase;
- Conversion of consumers to metered and paying customers which enabled the utility to collect the low-income subsidy component of the tariff from the Government.

It was concluded that the project's financial success greatly depended upon customer satisfaction and the fact that their upgraded electricity service was worth taking on the new financial burden of their electricity bill.

Observations

There were a number of process lessons that can be readily replicated in the areas with similar demography and consumer base such as India having a large fraction of the population residing in rural and slum areas where electricity theft and non-payment of bills are a common phenomenon. The table below presents an exhaustive list of initiatives taken up the Discom in the purview of this project.

Table 23 Summary of Brazil case study

Technical loss reduction		
Type of Initiative	**Whether Undertaken**	
Load Balancing	×	
Network Reconfiguration	√	
DT Management	×	
Power Factor Improvement	×	
Non- technical loss reduction		
	Type of Initiative	**Whether Undertaken**
Energy Accounting	100% Metering	√
	Replacement of Defective Meters	×
Meter Reading	AMR/HHD	×

	Smart Metering	×
Billing	Spot Billing	×
	Appointment of MBC Franchisee	×
Collection Efficiency	Increase in avenues	√
	Increase in Modes	√
Soft Initiatives	Community Campaigns	√
	VDS/IWS etc.	×
	Other initiatives	×

5.5. Uganda

Uganda is an inland country located in the East of continent of Africa. Uganda is among the very few countries in Africa that have fully embraced the reforms in the electricity sector. These reforms were implemented to improve sector performance and efficiency. The reforms comprised of unbundling and privatization of utilities and creation of an independent regulator. The industry structure in Uganda is divided into generation, transmission and distribution functions each handled by individual licensees and under the control of state authorities. The three functions are regulated by an independent regulatory authority, the Electricity Regulatory Authority (ERA), overseeing the sector. The Government of Uganda (GoU), acting through the Ministry of Energy and Mineral Development (MEMD), implemented a Power Sector Reform and Privatization Policy, resulting in a liberalization of Uganda's power sector. In 2005, under the extent of this policy the distribution function was outsourced to a private entity responsible for repair, upgrade and expansion of the distribution system within the authorized territory for a period of 20 years. In 2005, the Distribution function was taken over by, a private entity, Umeme Ltd. In 2010, it was concluded by the ERA and consented by the Govt. of Uganda that the distribution business requires major overhauling.

Context

The experience shared here is based upon a report titled "Study On Distribution System Losses And Collection Rates By Umeme Ltd". The study portrays the initiatives taken up by the distribution utility and its overall impact on the distribution business.

The GoU made significant efforts to reduce the power sector losses and to make the distribution sector financially viable for doing business. Efforts were made to attract more private participation not only in in the distribution business but also in the generation and transmission business.

A preliminary study was conducted by the Electricity Regulatory Authority (ERA) to assess the ground level reality of the distribution area as well as to prepare a roadmap to bring down the losses persistent in the area within a fixed time frame. The objectives of the study were to:

- Establish technical and non-technical loss levels and estimate the required investments to reduce these losses;
- Propose a loss reduction as well as a collection efficiency trajectory for an initial period of seven years;

- Review and audit of the Billing and Customer Data System and cash collection figures;
- Evaluate the process of recording the meter reading;
- Inspect the physical condition of the meter;
- Check the adequacy and correctness of the meter used;
- Confirm whether the meters were time synchronized or not;
- Evaluate the process followed for collection of payment from the consumers;
- Quantify the impact of the new billing system on loss reduction;
- Review and assess the effectiveness of the loss reduction measures already being implemented by Umeme, including the organizational structure and capital expenditure related to loss reduction;
- Review the impact of the rural electrification program on loss reduction;
- Establish performance indicators to adjudge the performance of the utility;
- Recommend an accelerated capital expenditure plan for refurbishment of existing network.

A rural electrification scheme was machinated by the Government of Uganda (GoU) to reduce the non-technical losses plaguing the area. It was ascertained that the technical losses weren't a major cause of concern as most of the consumers in the rural area had lightly connected loads and the access of the distribution network was also limited. The GoU thus prepared a 7 year strategic plan to reduce the losses due to electricity theft mainly identified in the areas of presence of the Distribution network.

Initiatives

The losses observed were due to technical and non-technical factors. The technical losses were attributable to low rated and degraded transformers, high auxiliary losses and degraded network. Furthermore, the factors responsible for non-technical losses were inefficient meter reading, incapability to achieve 100% metering and lower collection efficiency.

Technical loss reduction initiatives

In the year 2010, the technical loss of distribution network was close to 15%. Technical losses in the system were identified majorly due to transformer imbalance, small conductors, mix of conductors, long sections with small conductors and high loss steel conductors. A significant number of initiatives were taken up by Umeme in order to reduce these losses and to comply by the loss reduction trajectory defined by the Electricity Regulatory Commission. The following technical measures were employed to optimize the distribution losses:

- Installation of low loss transformers ;
- Re-conductoring of overhead lines with larger cross-sectional area conductors;
- Use of lower resistance conductors such as All Aluminum Alloy Conductor (AAAC);
- Installation of cables having larger conductor sizes;
- Use of cables and capacitors with lower dielectric losses;
- Use of a higher sub-transmission system voltage (increasing the rating of 11kV networks to 33kV);
- Establishment of new 132kV substations to augment the supply;
- Reactive power compensation by installation of shunt capacitor banks;
- Introduction of tariffs with maximum demand and/or power factor clauses for medium and large customers;
- Reconfiguration (normally open points) of 11kV feeders to reduce system losses;
- Balancing of load between phases on feeders; and
- Load shifting – reduction of maximum demand through the use of off-peak tariffs.

Non-technical loss reduction initiatives

The technical and commercial loss recorded in 2010 were close to 30%, since the technical losses accounted to only 15.1% of the losses the remaining 14.9% were attributable to non-technical losses. The initiatives undertaken to optimize the non- technical losses were:

- Introduction of the New Customer and Billing System (NCBS) ;
- Metering of millers: Umeme estimated around 3000 millers as customers with a consumption of about 15% of electricity in Uganda and the majority of this electricity being stolen;
- Compulsory bulk metering of target areas such as office blocks, shopping malls, markets etc. identified as areas with high loss levels;
- Introducing automatic meter reading for customers on pilot basis;
- Introducing prepaid metering initially for selected consumers categories;
- Improving the customer power factor by introducing a new tariff having a provision of penalties for poor power factor;
- Frequent audits to check metering integrity;
- Improving loss measurement at feeder and District level;
- Improving meter management;
- Introducing SCADA/DSM system;
- Improving revenue cycle management: meter reading, billing, bill delivery;
- Conducting a Cost of Service Study to estimate the Low voltage losses in the system.
- Introducing flat/wattage billing for street lights.

Apart from implementing the above initiatives introduced a “Feeder Loss Reduction Initiative” whereby each official of the senior management of the Discom was assigned a feeder and was accountable for management of the feeder. The duties of the official included periodic inspection of the feeder site and monitoring implementation of specific action plans envisaged for the feeders. Additionally, the officials also had to participate in monitoring the implementation of the Umeme loss reduction plans at the corporate level. In some cases, the responsibilities associated with the position held in the senior management of the Discom were pre-requisitely enshrined to the job description of the position sought.

Impact

The loss reduction initiatives undertaken by Umeme from 2005, at the time of takeover till 2009 did not show any significant reduction in distribution losses with loss level shooting up to 35% in 2009 as compared to around 31% in 2005. It appeared that the stakeholders initially underestimated the poor condition of the network and also the resilience of the Ugandan customer to resist paying for electricity.

The initiatives adopted in the project helped significantly in optimizing the distribution losses. The key achievements are

- Installation of the New Billing Mechanism helped in achieving a collection efficiency rate of about 67% by the end of the year 2010 from 57% in 2009. Although Umeme encountered some teething problems initially, the New Billing system showed results gradually.
- Umeme developed a comprehensive set of procedures for the connection, disconnection, meter reading data entry and billing activities including the management of revenue meters.
- The installation of statistical meters helped in monitoring feeder performance and identification of defective meters at the time of replacement of meters.
- Introduction of SCADA/ DMS provided the utility with ample response time for timely resolution of complaints and also helped in achieving reduced outage time thereby reducing switching time

for planned outages. SCADA/ DMS system further helped in improving collection of data and network optimization.

- Identification of "Millers" as one of the major consumers of electricity with a considerable consumption remaining unbilled helped substantially in achieving improved energy accounting. Overall, the Distribution losses showed a substantial decrease from 35% prevailing in 2009 to 30% in 2010.

Observations

Based on the in-depth analysis of the case study of Uganda, it may be inferred that the following loss reduction initiatives have been implemented for distribution loss reduction:

Table 24 Summary of Uganda case study

Technical loss reduction		
Type of Initiative	Whether Undertaken	
Load Balancing	√	
Network Reconfiguration	√	
DT Management	×	
Power Factor Improvement	√	
Non- technical loss reduction		
	Type of Initiative	**Whether Undertaken**
Energy Accounting	100% Metering	√
	Replacement of Defective Meters	√
Meter Reading	AMR	√
	Smart Metering	√
Billing	Spot Billing	×
	Appointment of MBC Franchisee	×
Collection Efficiency	Increase in avenues	√
	Increase in Modes	√
Soft Initiatives	Community Campaigns	×
	VDS/IWS etc.	×
	Other initiatives	×

5.6. Key Takeaways of International Experience

Based on the analysis of the international case studies, the following loss reduction initiatives are summarized -

Table 25 Key takeaways from International case studies

	Oman	Iran	Brazil	Uganda
Technical loss reduction				
Load Balancing	√	√		√

		Oman	Iran	Brazil	Uganda
Network Redesign and upgradation	Network Reconfiguration	√	√	√	√
	DT Management	√			
	Power Factor Improvement	√	√		√
Non- technical loss reduction					
Energy Accounting	100% Metering	√	√	√	√
	Replacement of Defective Meters				√
Meter Reading	AMR/HHD		√		√
	Smart Metering	√	√		√
Billing	Spot Billing				
	Appointment of MBC Franchisee				
Collection Efficiency	Increase in avenues			√	√
	Increase in Modes			√	√
Soft Initiatives	Community Campaigns	√		√	
	VDS/IWS etc.				
	Other initiatives				
Impact		Annual saving of ~ USD 5 mn	Losses from 23.17% to 3.85% in just one year	Improved collection efficiency & Reduction in average electricity consumption within pilot area	Losses from 35% to 30% in one year

It can be inferred that network redesign/upgradation and 100% metering were adopted across geographies in order to control the losses. These initiatives can therefore be considered as the backbone of any loss reduction strategy as they provide a technical basis to measure losses accurately, identify their reasons and finally addressing the impending issues.

6. Analysis of loss reduction initiatives

In this section, various loss reduction initiatives have been analyzed to identify the best initiatives which can have maximum impact on each type of loss and for each type of consumer category. A framework has been developed in discussion with the FOR Secretariat, which lays down the parameters for selecting the loss reduction initiatives from various States.

6.1. Overall analysis of Loss reduction initiatives among selected utilities

For carrying out a detailed analysis in this study, 10 states are selected depending on various criteria. N exhaustive list of forty eight loss reduction initiatives were identified which have been adopted across all Indian utilities. Based on the secondary and primary research, we find that except three, all other thirty eight initiatives have been taken by at least one utility selected in this study.

6.1.1. Classification of loss reduction initiatives

Depending on the number of states that have adopted a particular initiative, an analysis has been done and initiatives are classified into four categories:

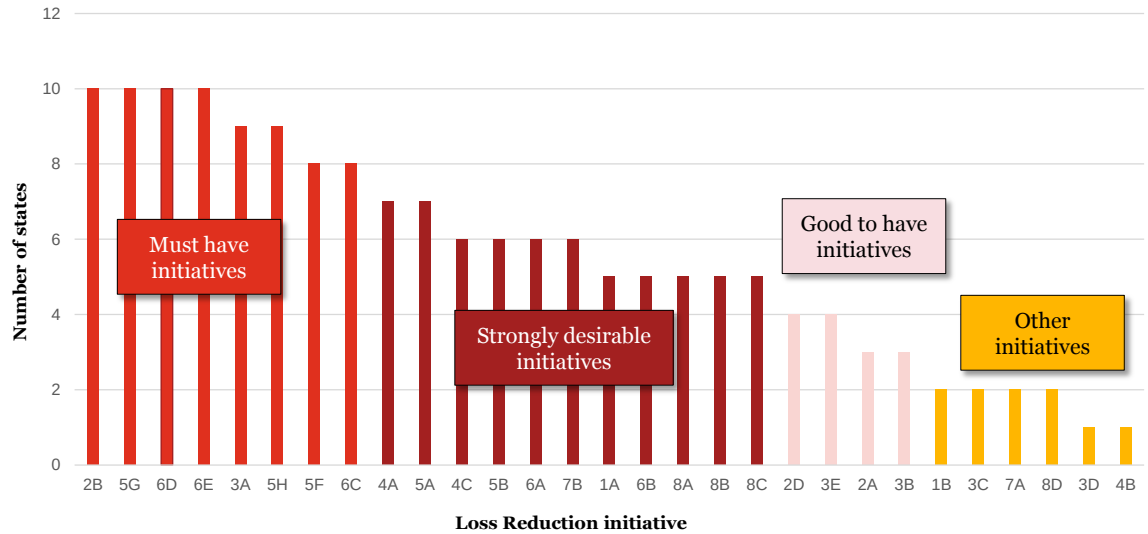
1. ***Must have Initiatives***: Initiatives adopted by 8 or more utilities out of 10 selected utilities.

2. ***Strongly desirable initiatives:*** Initiatives adopted by 5 to 7 utilities out of 10 selected utilities.

3. ***Good to have initiatives***: Initiatives adopted by 3 to 4 utilities out of 10 selected utilities.

4. **Other initiatives**: Initiatives adopted by 2 or less utilities out of 10 selected utilities.

Figure 5 Classification of loss reduction initiatives



Code	Initiative Name
1A	Dedicated police stations / staff
1B	Dedicated courts
2A	Loss reduction focused clauses in Supply Code/ Grid code
2B	Loss reduction based MYT mechanisms
2D	Loss level based tariff design
3A	Constitution of loss monitoring, energy audit, committee/cells etc.
3B	Nomination of feeder managers
3C	Theft reporting consumer incentive schemes
3D	Employee incentive schemes
3E	Employee capacity building with focused programs
4A	Introduction of private participation - DF initiatives/ Privatization
4B	Engagement of local groups - Panchyat/Ex Service League for MBC management
4C	Outsourcing/ Third party monitoring bodies
5A	Implementation of IT application in MBC activities (AMR/HHD/e-mail, sms based intimation
5B	Implementation of IT application in network management activities (SCADA, DMS, OMS etc)
5F	Strengthening of Energy accounting infratstructure - 100% consumer metering
5G	Replacement of defective meters and electromechanical meters
5H	MIS based periodic reporting of unit wise business parameters
6A	Segregation of feeders/Bifurcation of feeders
6B	Implementation of HVDS system
6C	Installation of LT ABC
6D	Improving HT:LT ratio
6E	Substation/DT augmentation
7A	Capital injection
7B	Performance monitoring and review
8A	Consumer communication on loss reduction
8B	Connection regularization scheme/surcharge waiver scheme/interest waiver scheme/VDS etc
8C	Customer feedback program
8D	Transformer Management System

6.1.1.1. Must have Initiatives:

Table 26 List of must have initiatives for utilities

Category	Code	Initiative
Regulatory	2B	Loss reduction based MYT mechanisms
Governance	3A	Constitution of loss monitoring, energy audit, committee/cells etc.
Process Strengthening	5F	Strengthening of Energy accounting infrastructure - 100% consumer metering
	5G	Replacement of defective meters and electromechanical meters
	5H	MIS based periodic reporting of unit wise business parameters
Network Strengthening	6C	Installation of LT ABC
	6D	Improving HT:LT ratio
	6E	Substation/DT augmentation

Indian utilities focused highly on Metering related initiatives like energy accounting infrastructure strengthening by 100 % consumer, DT and Feeder metering, replacement of defective and electro mechanical meters. Meters are the nerve centers for utilities' revenue earning. Every unmetered energy consumption may be a loss to the utility. Building a robust metering infrastructure will help utilities to record and monitor energy accounting activities.

Theft of electricity is a perennial problem across Indian utilities. It is reflected in the collected data also, as 90 % of selected utilities have formed a central vigilance team to monitor theft related losses.

To target technical loss reduction, some initiatives like improving HT/LT ratio, Sub-station and DT augmentation, LT AB cabling are most popular among utilities. These 'must have' initiatives are internal initiatives and key measures to reduce AT&C losses in utilities. All these practices are followed by at least 80-100% utilities selected for this study.

6.1.1.2. Strongly Desirable initiatives

Table 27 List of strongly desirable initiatives

Category	Code	Initiative
Administrative	1A	Dedicated police stations / staff
Competition promotion	4A	Introduction of private participation - DF initiatives/ Privatization
	4C	Outsourcing/ Third party monitoring bodies
Process Strengthening	5A	Implementation of IT application in Metering, Billing and Collection (MBC) activities (AMR/HHD/e-mail, sms based intimation)
	5B	Implementation of IT application in network management activities (SCADA, DMS, OMS etc)
Network Strengthening	6A	Segregation of feeders/Bifurcation of feeders
	6B	Implementation of HVDS system
Government support	7B	Performance monitoring and review
Soft initiatives	8A	Consumer communication on loss reduction
	8B	Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme/VDS etc
	8C	Customer feedback program

Above mentioned second set of initiatives are adopted by 50-70% utilities. Segregation or bifurcation of feeders and HVDS system implementation are two major initiatives under this category to address technical losses.

Implementation of IT application in Metering, Billing and Collection (MBC) activities (AMR/HHD/e-mail, SMS based intimation) and MIS based periodic reporting of unit wise business parameters related to loss reduction are required to analyze the leaky areas, both technical and commercial. Once loss areas are identified, utilities can take informed decision about what loss reduction projects to be taken up. Implementation of IT application in network automation and management activities (like SCADA, DMS and OMS) are supporting activities, required for faster decision making in other loss reduction initiatives. These initiatives are not very popular as these are capital intensive projects.

Administrative and procedural initiatives like constitution of energy audit and loss monitoring committee, performance monitoring and review will help to reap benefits of robust energy accounting system mentioned under must have initiatives.

Privatization of state utilities through distribution franchises and timely rational subsidy support programs by government are policy level initiatives. These initiatives can help to compound the effect of initiatives mentioned above, to reduce utility losses.

6.1.1.3. Good to have initiatives

Table 28 List of good to have initiatives

Category	Code	Initiative
Regulatory initiatives	2A	Loss reduction focused clauses in Supply Code/ Grid code
	2D	Loss level based tariff design
Governance Framework	3B	Nomination of feeder managers
	3E	Employee capacity building with focused programs

Employee capacity building with focused programs, deploying dedicated field staffs in loss management roles, nominating feeder managers and dedicated police stations with staffs are some initiatives required to make employees empowered and keep them engaged in loss reduction initiatives.

Further, some states have started calculating consumer category wise cost of supply based on their respective loss levels. While the practice of deciding retail tariffs based on the cost of supply has not yet picked up, this gives an indication to the regulatory Commissions and utilities for rationalizing the tariff trends.

Above mentioned initiatives are opted by 30-40% utilities sampled for this study. These initiatives will help utilities only when they have implemented some basic loss reduction initiatives effectively.

6.1.1.4. Other Initiatives

Table 29 List of other initiatives

Category	Code	Initiative
Administrative	1B	Dedicated courts
Governance Framework	3C	Theft reporting consumer incentive schemes
	3D	Employee incentive schemes
Competition promotion	4B	Engagement of local groups - Panchyat/Ex Service League for Metering, Billing and Collection (MBC) management
Government support	7A	Capital injection
Soft initiatives	8D	Transformer Management System

This last category of initiatives are less popular among utilities. These initiatives are practiced by not more than 20% of the utilities surveyed.

6.2. State specific analysis for loss reduction

In this section, a framework has been developed in discussion with the FOR secretariat, which identifies a particular State as an ideal case study for tackling a particular type of loss. For instance, this framework can be used to identify the particular state whose respective loss reduction initiatives can help in reducing technical losses for HT consumers.

6.2.1. Framework for state selection for recommended loss reduction initiatives

Each loss reduction initiative has the following three intrinsic characteristics as follows:

6.2.1.1. Targeted type of loss

Under this characteristic, we identify the loss reduction initiative which have been successful in targeting each type of loss (technical, commercial or theft).

- **Initial loss level of 0-15%:** It can be derived that States with initial T&D loss levels of 0-15% would have Technical loss as their majority loss. Therefore it can be assumed that the loss reduction initiatives in these states were targeted towards Technical Losses.
- **Initial loss level of 16-25%:** Similarly states with initial T&D loss levels of 16-25% would have Commercial loss as their majority loss. Therefore it can be assumed that the loss reduction initiatives in these states were targeted towards Commercial Losses.
- **Initial loss level of >26%:** States with initial T&D loss levels of greater than 26% would have unauthorized use of electricity loss as their majority loss. Therefore it can be assumed that the loss reduction initiatives in these states were targeted towards unauthorized use of electricity Losses.

Table 30 Classification of states on target loss

	FY10 Loss	Target loss	States
A	0-15%	Technical	Gujrat, Andhra Pradesh
B	16-25%	Commercial	Uttarakhand, Punjab, Mah, Delhi, Kerala,
C	> 26%	Unauthorized use of electricity	Jharkhand, Assam, Madhya Pradesh

6.2.1.2. Targeted Consumer Category

Under this characteristic, we identify the loss reduction initiative which have been successful in targeting LT or HT type of consumer category. Based on the ratio of HT to LT consumers of the state in FY10, it can be ascertained as to the loss reduction initiatives were targeted towards which type of consumers.

- **LT consumers:** It can be deduced that states where HT/LT sales ratio is below 60%, the loss reduction initiatives were targeted towards LT consumers.
- **HT consumers:** It can be deduced that states where HT/LT sales ratio is above 60%, the loss reduction initiatives were targeted towards HT consumers.

Table 31 Classification of state on target consumer category

	HT/LT sales	Target loss	States
I	0 - 60%	LT consumers	Delhi, Andhra Pradesh, Kerala, Jharkhand
II	> 60%	HT consumers	Uttarakhand, Gujrat, Punjab, Maharashtra, Madhya Pradesh, Assam

6.2.1.3. Effectiveness of loss reduction

Under this characteristic, we identify the loss reduction initiative which have been effective in reducing the overall losses of a utility. Based on the ratio of loss reduction of the state between FY10 and FY13 to loss level in FY10, it can be ascertained how effective the loss reduction initiatives were.

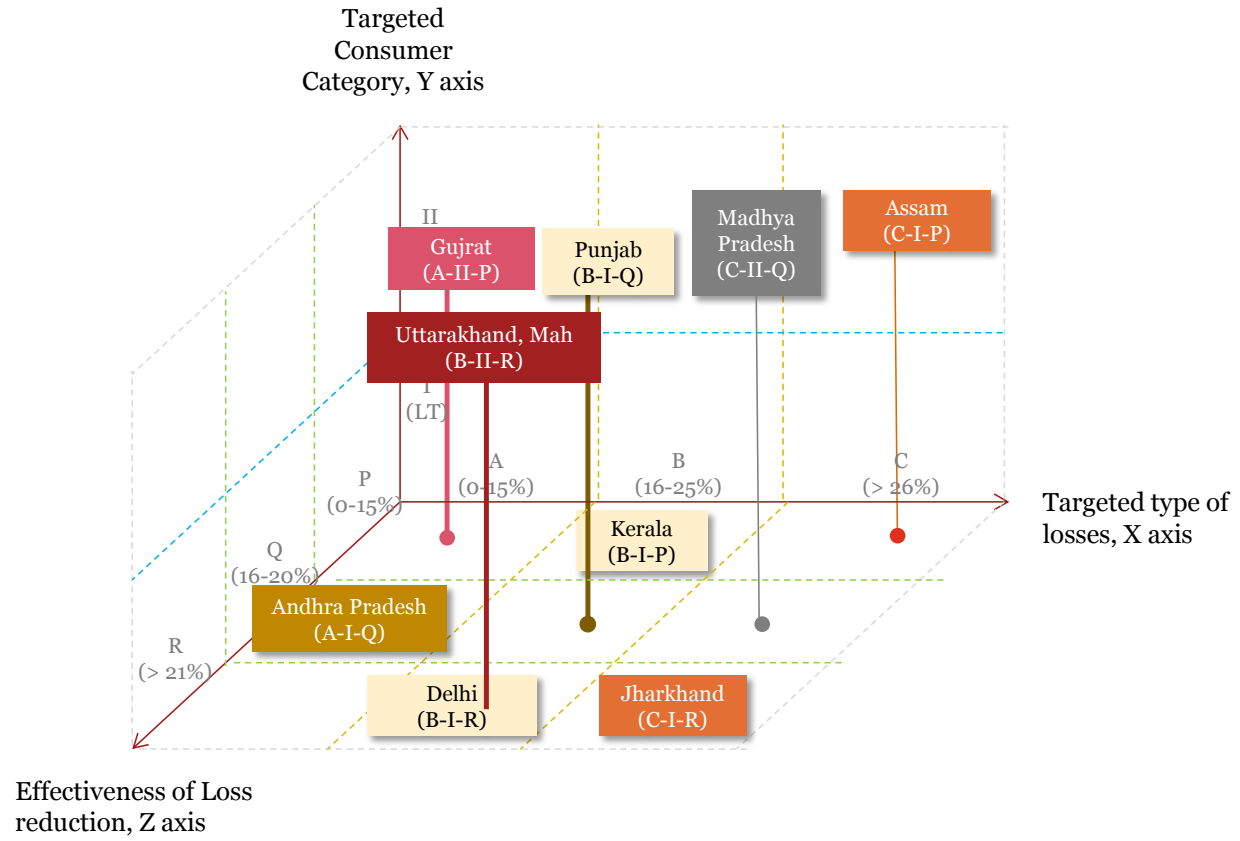
- **Ratio of loss reduction 0–15%:** It can be derived that in states where the loss reduction ratio is less than 15%, the effectiveness of the loss reduction initiatives was low.
- **Ratio of loss reduction 16–25%:** It can be derived that in states where the loss reduction ratio is between 16% and 25%, the effectiveness of the loss reduction initiatives was moderate.
- **Ratio of loss reduction >26%:** It can be derived that in states where the loss reduction ratio is greater than 26%, the effectiveness of the loss reduction initiatives was high.

Table 32 Classification of states on effectiveness of loss reduction

	Ratio of Loss reduction	Effectiveness	States
P	0-15%	Low	Gujrat, Kerala, Assam,
Q	16-20%	Moderate	Punjab, Andhra Pradesh, Madhya Pradesh
R	> 21%	High	Uttarakhand, Mah, Delhi, Jharkhand

Depending on which sector the State falls in, the loss reduction initiatives taken in that particular state can be adopted as effective loss reduction strategy for the consumer type and loss type. This is represented in a three dimensional diagram, as shown below.

Figure 6 State Specific analysis of loss reduction initiatives



6.2.2. Identification of recommended loss reduction initiatives

Based on the framework discussed in the previous section, the recommended loss reduction initiatives for various types of losses and consumers are represented in the table below. While a particular state is selected as an ideal case study for reduction of a particular type of loss, we can observe that at any given point of time a utility may take several simultaneous initiatives, to not only address the primary type of loss but other types of losses as well. Therefore in states like Gujarat, which has been selected as an ideal case study for reduction of technical HT losses, several initiatives have been adopted for commercial loss reduction as well, like theft reporting consumer incentives etc. Therefore initiatives which primarily have the potential to target the respective type of losses have been highlighted in green in the table.

Table 33 Recommended loss reduction initiatives

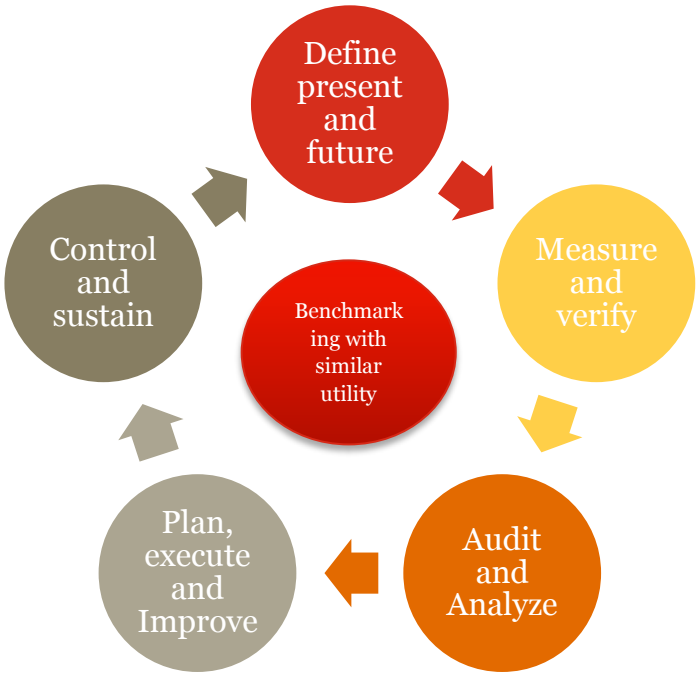
Aspect	Aspect Type	Initiatives	Uttarakhand	Gujarat	Maharashtra	Andhra Pradesh	Delhi	Jharkhand	Madhya Pradesh
Type of Loss Reduction for which this state can be case study			Commercial HT	Technical HT	Commercial HT	Technical LT	Commercial LT	Unauthorized use LT	Unauthorized use HT
Administrative initiatives	External	Dedicated police stations / staff		✓	✓		✓		
		Dedicated courts					✓		
Regulatory initiatives	External	Loss reduction focused clauses in Supply Code/ Grid code			✓			✓	✓
		Loss reduction based MYT mechanisms	✓	✓	✓	✓	✓	✓	✓
		Loss level based tariff design			✓	✓			✓
Governance framework	Internal	Constitution of loss monitoring, energy audit etc. committee/cells	✓	✓	✓	✓	✓		✓
		Nomination of feeder managers		✓	✓	✓			
		Theft reporting consumer incentive schemes		✓			✓		
		Employee incentive schemes			✓				
		Employee capacity building with focused programs			✓		✓		✓
Competition promotion/ cost optimization	External	Introduction of private participation - DF initiatives/ Privatization	✓	✓	✓		✓	✓	✓
		Engagement of local groups - Panchayat/Ex Service League for MBC management							
		Outsourcing/ Third party monitoring bodies	✓		✓		✓		✓
Process strengthening	Internal	Implementation of IT application in MBC activities (AMR/HHD/e-mail, sms based intimation	✓		✓	✓	✓		✓

Aspect	Aspect Type	Initiatives	Uttarakhand	Gujarat	Maharashtra	Andhra Pradesh	Delhi	Jharkhand	Madhya Pradesh
Type of Loss Reduction for which this state can be case study			Commercial HT	Technical HT	Commercial HT	Technical LT	Commercial LT	Unauthorized use LT	Unauthorized use HT
		Implementation of IT application in network management activities (SCADA, DMS, OMS etc.)		✓	✓	✓	✓		✓
		Strengthening of Energy accounting infrastructure - 100% consumer metering	✓	✓	✓	✓	✓		✓
		Replacement of defective meters and electromechanical meters	✓	✓	✓	✓	✓	✓	✓
		MIS based periodic reporting of unit wise business parameters	✓	✓	✓	✓	✓		✓
Network strengthening/ Technical loss reduction	Internal	Segregation of feeders/Bifurcation of feeders		✓	✓	✓		✓	✓
		Implementation of HVDS system		✓	✓		✓		✓
		Installation of LT ABC	✓	✓	✓		✓	✓	✓
		Improving HT:LT ratio	✓	✓	✓	✓	✓	✓	✓
		Substation/DT augmentation	✓	✓	✓	✓	✓	✓	✓
Government support	External	Capital injection				✓			
		Performance monitoring and review			✓		✓		✓
Soft initiatives	Internal	Consumer communication on loss reduction			✓		✓		✓
		Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme/VDS etc	✓	✓	✓		✓		✓
		Customer feedback program			✓	✓	✓		
		Transformer Management System							✓

7. Development of loss reduction strategy

To develop a loss reduction strategy, a five step framework can be followed: Define present and future, Measure and Verify, Audit and Analyze, Plan and Improve, Control and sustain. This section proposes at each level, the popular and effective initiatives taken by selected utilities. Only the 'must have', the 'strongly desired' and the 'good to have' initiatives have been considered for development of loss reduction strategy.

Figure 7 Steps in Loss Reduction Strategy



7.1. Define 'As Is' Loss situation and desired 'To Be' state

To address loss reduction issue in a utility, the first step is to define the problem as a comprehensive and compelling business case for every stakeholder i.e. consumer, owner and employees.

Various financial restructuring schemes and MYT regulations of the Commissions define an overall AT&C or T&D loss reduction trajectory for Discoms, in order to qualify for government grants or to allow losses to be passed in retail tariff.

However in order to ensure efficient utilization of the government grants and compliance to the overall **loss reduction trajectory**, the Discoms should define a detailed loss reduction trajectory for each type of loss i.e. Technical, Non-Technical and Collection loss. These particular trajectories could be based on current level of losses, capital expenditure made in the past and future capital expenditure planned.

7.2. Measurement of Loss and Verification

The losses occurred in the distribution system, from injection point to consumer metering, are defined as distribution losses. At a broad level, the distribution losses are calculated as per the following formula:

T&D losses = *Energy input in the Discom periphery – energy billed, or*

AT&C losses = *Energy input in the Discom periphery – energy collected*

The components of losses can be measured as follows -

Technical losses: Exist in the network due to equipment design and overall network configuration. These cannot be zero and at best can be optimized to a certain minimum level.

> ***Technical Loss*** = *Energy input in the Discom periphery – Energy Consumed in the Distribution Network, or*
>
> ***Technical Loss*** = *[Energy input at the Discom periphery – (DT level consumption+ sum of sales to consumer on HT)] + LT technical loss*

Non-Technical losses: Occur due to incorrect energy accounting, defective energy meters, theft of electricity etc. It may also be defined as difference of energy injected in the Discom periphery and the sum of energy sales to the end consumers and technical loss.

> ***Non-Technical Loss (level 1)*** = *Energy Consumed in the Distribution Network – Energy billed to consumers, or*
>
> ***Non-technical loss (level 1)*** = *Energy input in the Discom periphery – (technical loss + energy sales)*

The non-recovery of billed revenue is another key component of the non-technical losses. The same is measured as collection efficiency and is integrated with the distribution losses to calculate the aggregate technical & commercial losses (AT&C). This second level of non-technical losses are calculated as per the below formula:

> ***Non-Technical Loss (level 2)*** = *Energy billed to consumers – Energy collected from consumers, or*
>
> ***Non-technical loss (level 2)*** = *100% - [billing efficiency (%)*collection efficiency (%)]*
>
> *Where billing efficiency=100% - distribution losses (%)*

In order to calculate the above mentioned losses, the following information needs to be measured by the utilities –

- **Input Energy at Discom Periphery =**

  Energy Generated – Auxiliary Consumption + Energy Purchased (Gross) – (Energy Traded/Inter State sales)

- **Energy Consumed in the Distribution Network =**

(Energy sold to all categories of consumers) - (Energy traded / Interstate sale)

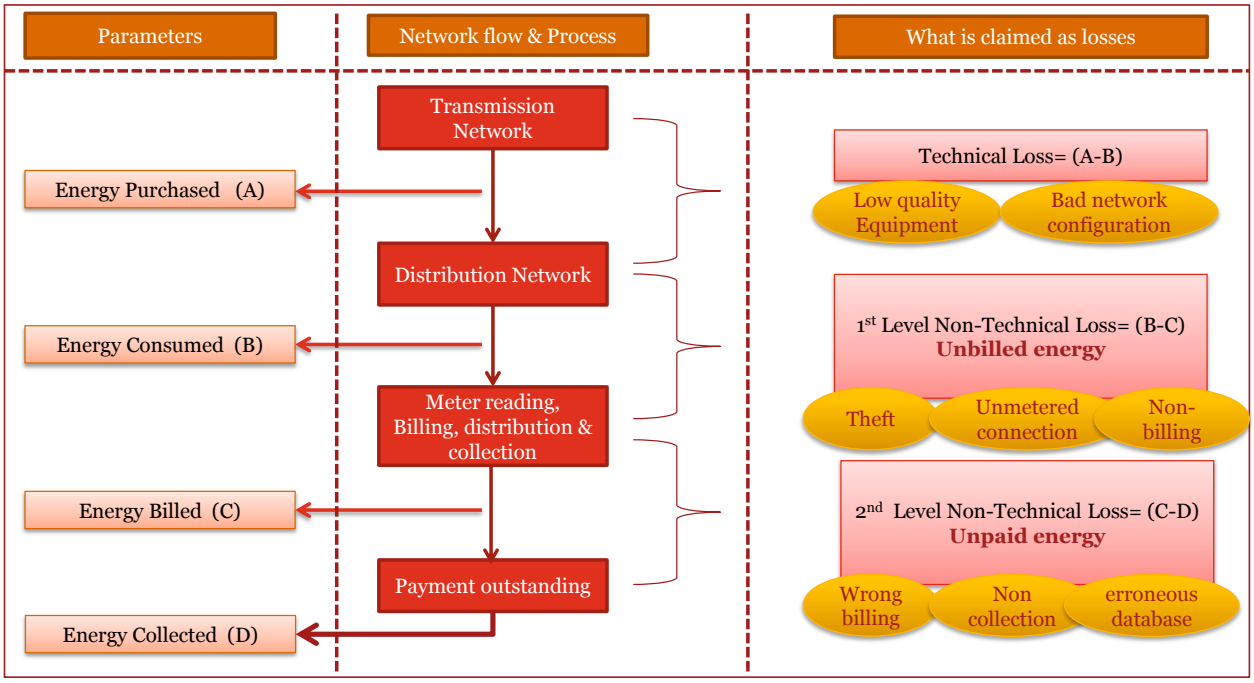
- **Energy Billed to consumers =**

  Units from Meter recordings + Unmetered Sales + Assessment based sales + Theft Cases

- **Energy Collected from consumers =**

  Units for which payments are realized

Figure 8 Measurement of loss



7.2.1. Pre-requisite of accurate loss measurement

- *Ring-fencing of licensed area electrical network:*

Electrical ring fencing of whole area is required through installation of import/export meters at the boundary of those lines that are feeding outside as well as inside the area of the utility. Import/export meters on the dedicated feeder emanating from sub-stations located within area but feeding outside licensed area and on 33/11 kV GSS LILO/tie lines are to be installed to cover the interfacing points between utility's network and other network.

- *Meter installation, calibration and maintenance:*

Meters are the watchmen for energy flow in power distribution network. An accurate meter can keep record of every unit of energy. So it is necessary to install meters at different network points like: consumer end, DTs, feeders etc. Regular calibration and maintenance of meters will ensure accurate functioning of meters and identify the faulty meters to be replaced.

- *Data gathering and recording:*

Recording correct meter reading is of utmost importance to maintain the hygiene of the energy accounting. To do this, a robust meter data management system (MDMS) is required. This MDMS should be supported by efficient meter data reading and billing process.

- Development of a computation method or acceptable estimates:

A computational method should be developed to calculate the technical losses and commercial losses separately. Previously mentioned formulas are to be incorporated in this method. Required assumptions should be in acceptable limit to estimate the losses. Regular audit and cross checking will help to address the issues with data measurement, recording and reporting issues.

7.2.2. Loss verification

Only ensuring loss measurement will not help to estimate actual energy loss unless state regulators have a strong loss verification process is in place. Loss measurement is a complex process composed of many sub-processes leaving room for system or manual error like faulty meter, wrong data reading and recording etc. This error has to be minimized through proper verification and audit process.

7.2.2.1. Verification of energy input

In order to verify the energy input figures of a utility, the appropriate Commissions would require the following set of information –

i. Power purchase details from generating stations

ii. Energy injected figures by SLDC

For verification of the energy input, the appropriate Commission can direct State Load Dispatch Centre (SLDC) to submit the energy input for the Petitioner/Utility during the relevant time period. These figures can then be compared to figures of energy input submitted by petitioner to check for any discrepancies.

Further the appropriate Commission can direct the Petitioner to submit month wise station wise power purchase details along with the bills, which can then be compared against Monthly Regional Energy Accounts prepared by relevant authority like SLDC, RLDC or Regional Power Committee.

7.2.2.2. Verification of Energy Billed

For the verification of energy billed figures of utility, the Commission would require the following set of information –

i. Category wise consumption pattern of metered consumers

ii. Billing database of utility

iii. Penalty charges for theft cases

iv. Past arrears for consumers

v. Consumer wise ABR

The energy billed figure consists of billed units from meter reading, unmetered sales, assessment based sales and theft cases. The methodologies for their verification can be as follows:

- **Metered consumers –** For the verification of energy billed from Metered Consumers, the billing database of the utility can be analysed for:
    - **Identifying Ghost Consumers –** Consumers with consistently high past arrears or invalid geographical mapping, can be ghost consumers created for the purpose of inflating the billed units, while keeping the collection amount lower. This would lower the T&D losses amount for the utility.
    - **Consumers with very low ABR –** All the consumers within same consumer category should have Average Billing Rate (ABR) in a similar range.
- **Unmetered consumers –** For the verification of energy billed from Unmetered Consumers, the category wise consumption pattern of unmetered consumers can be compared to category wise consumption pattern of metered consumers of respective consumer categories, to check if they are in the similar range. The energy billed in unmetered sales could have been inflated to hide losses.
- **Assessment based consumers –** For the verification of energy billed from Assessment based sales, the billing database can be analyzed to look for spikes in energy billed, particularly in the months of November or December. In these particular months, the utility could inflate the assessment based sales to hide higher losses during the tariff filling period and then later reconcile them in subsequent bills of consumers.
- **Theft cases -** In theft cases, as a penalty on the defaulter, the amount collected is double the amount due in original bill. For the purpose of calculating energy billed from this amount collected, the entire amount collected should not be divided by the ABR, to avoid double counting of energy units.

7.2.2.3. Verification of Energy Collection

For the verification of energy collection figures of utility, the appropriate Commission would require the following set of information –

i. Month wise collection details (category wise)

ii. Daily collection details

iii. Daily bank statements of Discom

The petitioner/utility can collect revenue from consumers from three sources as follows:

- Branches of utility or Collection centers
- Online payments made on utility's website
- 3rd party agents like bank or post office

The daily collection details from the above mentioned sources should match with the bank statements of the utility, allowing the appropriate Commission to verify the revenue collected figure claimed by the utility.

7.2.3. Initiatives identified for loss measurement and verification

Following the analysis from section 6 of this report, we can conclude that the following initiatives are most popular among utilities to measure losses:

1. Strengthening of Energy accounting infrastructure by 100% consumer metering, DT metering and feeder metering.

2. Replacement of defective and electromechanical meters.

3. Customer feedback program to identify potential problems in network.

7.3. Energy Audit and analysis

The key to efficient revenue management for any electricity distribution utility is proper and prompt accounting of the energy inflow and outflow at various voltage levels in the electrical network and the subsequent energy consumption by the end customers. Energy accounting in power sector involves evolving procedures and checks to account for energy from generating stations down to customer level.

7.3.1. Multi-level Audit

For systematic monitoring and targeted reduction of the technical and commercial losses, the task of cent percent energy accounting at all levels starting from energy input at distribution periphery up to consumer level is essential for a distribution utility. In order to meet the desired outcomes, four integrated levels of loss measurement shall be required as follows:

i. Company level energy audit: The main purpose of energy accounting at the company level is to cross check the company's energy input against energy input details provided by the Transmission unit. Utilities like UHBVN of Haryana undertakes a company level energy audit.

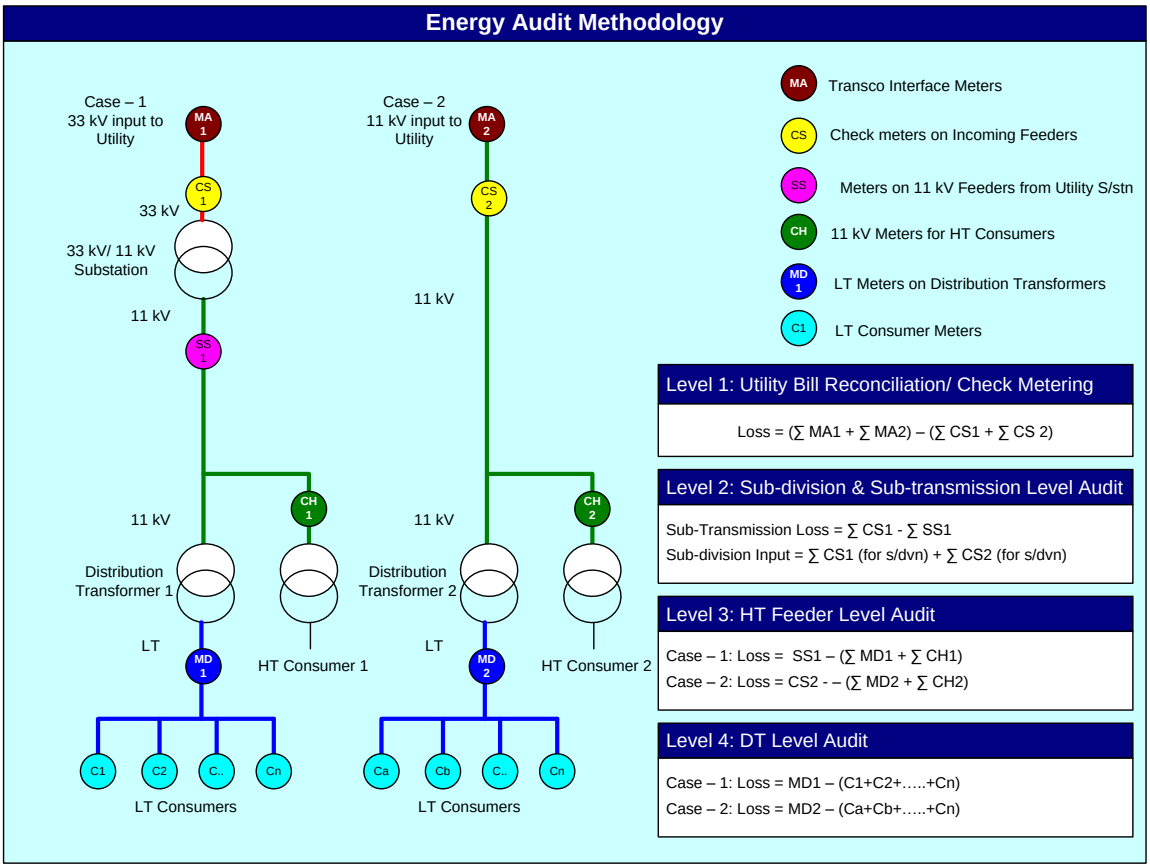
ii. Sub-transmission level energy audit and Division/sub-division level energy measurement: The purpose of the sub-transmission level energy audit is to ascertain extent of technical losses taking place from procurement to dispatching in the 11KV feeders (i.e. substation level). Sub-division level audit shall help in segregating losses for each administrative unit of the company for performance analysis.

iii. Feeder level energy audit: Feeder level audit shall help in ascertaining losses in each 11 kV feeder taking place from point of dispatch up to the HT consumers and distribution transformer level. In addition to identifying 11KV feeders with high technical losses, this also helps in identifying leakages/ thefts taking place at the HT consumer level.

iv. Distribution Transformer level energy audit: This involves calculation of percentage unbilled energy / units lost at each DT, in order to monitor and prioritize the loss reduction efforts for yielding the best results.

The schematic below shows a representation of the four levels of energy audit described above.

Figure 9 Energy audit methodology



For an efficient energy accounting and audit, following are pre-requisites:

a. Adequacy of metering at input point, at each voltage or transformation level.

   i. Ensure energy input points of licensed area are metered.

   ii. This shall include installation of meters :-

   - On incoming lines of 33/11 kV GSS located within area.
   - On 33 kV, 11 kV feeders emanating from sub-station located outside project area but supplying power to HT/LT consumers located within area.

b. Electrical ring fencing of whole area required through installation of :

   i. Import/export meters at the boundary of those lines that are feeding outside as well as inside the area.

   ii. Import/export meters on the dedicated feeder emanating from sub-stations located within area but feeding outside licensed area.

   iii. Import/export meters on 33/11 kV GSS LILO/tie lines.

c. Every customer and element in the network should have a unique electrical address. This shall identify the customer's complete chain of electricity supply from the bulk supply point to the LT pole through which the service line is extended to the consumer's delivery point/ premise.

d. Segregating feeders with un-metered consumers: Agricultural consumers are not completely metered in a state. Energy audit cannot be performed on any feeder/ distribution transformer where any such consumer exists due to uncertainty regarding units supplied to such consumers. Moreover, the billing for such connections is done on normative basis thus; all units supplied may not be equal to energy billed. In such case, it becomes important for a distribution utility to segregate feeders with un-metered agricultural connections.

e. Need to have an Energy Audit Cell (EAC) with defined roles and adequate resources. Key responsibility of the EAC is to ensure timely and accurate energy accounting and audit with the co-ordination from the operations staff.

f. Preparation of a comprehensive energy accounting and audit plan to incorporate:

- Synchronisation of billing cycles to energy input: Monthly and bimonthly billing cycle consumptions in the monthly energy accounts. Should be able to provide data like sales, revenue billed and collected for entire area. Sales data can be extracted for a feeder or for a distribution centres (DCs) as whole.

- Logical consumer grouping for the purpose of meter reading spread across two months. This shall assist in the monthly energy accounts. In a scenario where the consumer grouping is uneven, there may be variations in loss levels of the same feeder/DT for two consecutive months.

- Appropriate energy accounting methodology: to include time mismatch, especially in case of DT level accounting, between reading taken from the DT meter and the time taken in completion of meter reading of all consumers attached to a particular DT. It is pertinent to mention that in an ideal energy accounting system, the DT readings and the combined readings of all corresponding consumer meters should be taken at the same time. Automatic meter reading (AMR) implementation can help to take remote meter readings of multiple meters at same time, seated at a control centre. If AMR can be implemented at Feeder, DT and HT consumer level, it will make energy audit easier and less tedious process.

Appropriate linkage with metering plan to ensure corrective actions should be undertaken within specified timelines.

7.3.2. Initiatives Identified for Energy audit and analysis

The following initiatives should attract attention for audit and analysis purpose:

1. Implementation of IT application in Metering, Billing and Collection (MBC) activities (AMR/HHD/e-mail, sums based intimation).

2. MIS based periodic reporting of unit wise business parameters.

3. Implementation of IT application in network management activities (SCADA, DMS, OMS etc.).

4. Deploying a Central level vigilance team.

7.4. Plan, execute and improve

The earlier steps of 'Measurement of Loss & Verification' and 'Energy Audit & analysis' will help utilities to identify loss areas and root causes for high losses in such areas. Based on this information they can plan suitable activities to mitigate the issues coming out of analysis phase. A comprehensive loss reduction plan would then have to be formulated with activities/initiatives defined for each type of loss, to be targeted by the utility.

7.4.1. Initiatives identified for planning, execution and improvement

All the initiatives can be divided into two part 1 Planning and part 2 Execution and Improvement.

7.4.1.1. Initiatives for Planning

In order to plan for loss reduction in a phased manner and to ensure the right type of loss is targeted by various initiatives, the following initiatives can be adopted by the utilities -

1. L*oss reduction based MYT mechanism* - the MYT mechanism may built in suitable incentives for targeted loss reduction.

2. Capital injection – in order to prepare a fresh base for utilities, free of part liabilities, for planning future operational efficiency improvement programs, the government may inject capital into the utilities or subsume their existing losses.

3. Employee capacity building with focused programs – employees need to be prepared and the capacity of various institutions needs to be strengthened in the planning stage to ensure smooth implementation of various initiatives.

These are the most important initiative to ensure funding for other initiatives.

7.4.1.2. Initiatives for Execution and Improve

7.4.1.2.1. Initiatives for Technical Loss reduction

Based on the analysis of various loss reduction initiatives adopted in various Indian states, the following initiatives (must have and strongly desired) have been shortlisted as popular and effective strategies in technical loss reduction –

- ***Network strengthening***
    - Improving HT:LT ratio
    - Substation/DT augmentation
    - Segregation/Bifurcation of feeders
    - Implementation of HVDS system
- **Other**
    - DF initiatives/ Privatization to promote competition

- Loss based tariff design

7.4.1.2.2. Initiatives for Commercial Loss reduction

Based on the analysis of various loss reduction initiatives adopted in various Indian states, the following initiatives have been shortlisted as effective strategies in commercial loss reduction –

1. Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme/VDS etc. and

2. Outsourcing strategy and implementation

3. Installation of LT ABC

7.5. Control and Sustain

For continuous improvement, the following initiatives are required to control and sustain the successful loss reduction strategies:

1. Constitution of loss monitoring, energy audit etc. committee/cells

2. Performance monitoring and review

3. Dedicated police stations and staff

4. Nomination of feeder managers

5. Dedicated field level loss management roles

6. Consumer communication on loss reduction

7.6. Benchmarking with Similar Utilities

At all the steps mentioned above, the loss levels and the strategies to reduce them should be benchmarked with loss reduction journey of a similar utility. The similarity should be matched against three parameters as follows -

1. Type of loss level

2. Initial HT/LT ratio, and

3. Effectiveness of initiatives for the selected utility

8. Summary of recommendations

Based on the analysis performed in this report, of the loss reduction strategies by various Indian Discoms and international geographies, the following can be concluded:

- Despite of several state sponsored schemes and various initiatives being adopted by utilities over the last decade, the issue of high loss levels continue to bleed the Discoms to financial losses. To improve upon this situation, a focused effort is required to identify root causes of losses and then formulate a strategy to target those losses.

- In order to identify the root cause of losses, component wise losses need to be measured using energy accounting techniques. Each component of loss can have different root cause and therefore would require a different strategy to tackle them.

- In order to maximize the benefits of various loss reduction initiatives, the Discoms need to prepare a detailed ***Loss Reduction Strategy*** consisting of steps as follows –

    - Defining present status and future target of losses.

    - Measurement and Verification of losses: State Electricity Regulators need to adopt methods to measure and verify the loss figures being reported and ensure the availability of requisite data for the same. As discussed in section 7.2.2 of this report, this can be performed through verification of energy input, energy billed and energy collected. Further based on the analysis of loss reduction initiatives adopted by various states, Strengthening of Energy accounting infrastructure by 100% consumer metering, DT metering and feeder metering, Replacement of defective and electromechanical meters are some of the shortlisted initiatives which can help in accurate measurement and verification of losses.

    - Energy Audit and Analysis of network: For systematic monitoring and targeted reduction of the technical and commercial losses, the task of cent percent energy accounting at all levels starting from energy input at distribution periphery up to consumer level is essential for a distribution utility. As discussed in section 7.3.1 of this report, energy audit is required at four integrated levels of Company, Division, Feeder and Distribution Transformer. Further based on the analysis of loss reduction initiatives adopted by various states, implementation of IT application in Metering, Billing and Collection (MBC) activities (AMR/HHD/e-mail, sums based intimation), MIS based periodic reporting of unit wise business parameters, implementation of IT application in network management activities (SCADA, DMS, OMS etc.) and deploying a Central level vigilance team are some of the shortlisted initiatives which can help in energy audit and analysis of network.

    - Planning, Execution & Improvement: For each type of loss, the Discom need to select appropriate loss reduction initiative based on their capex requirement, loss levels and consumer types. Thereafter the Discoms need to plan and execute these initiatives accordingly to maximize their impact on loss levels. Based on the analysis of various loss reduction initiatives adopted by various states, certain initiatives have been shortlisted in section 7.4 of this report for the reduction of technical and commercial losses. Initiatives like Improving HT:LT ratio, Substation/DT augmentation, Segregation/Bifurcation of feeders and Implementation of HVDS system can be used for improving technical losses. Similarly initiatives like Connection regularization scheme/surcharge waiver of scheme/interest waiver scheme/VDS, Outsourcing strategy and installation of LT ABC can be used for improving commercial losses.

- Control and Sustain losses: For continuous improvement and to prevent future increase in loss levels, certain initiatives are required to control and sustain the successful loss reduction strategies. Based on the analysis of the loss reduction initiatives adopted by various states as discussed in section 7.5 of this report, initiatives like constitution of loss monitoring, energy audit etc. committee/cells, performance monitoring, dedicated police stations, nomination of feeder managers, dedicated field level loss management roles and consumer communication on loss reduction can be adopted for controlling and sustaining loss levels.

- Benchmarking with similar utilities: For all the steps mentioned above, the loss levels and the strategies to reduce them should be benchmarked with the loss reduction journey of a similar utility.

- Based on the overall analysis of loss reduction initiatives, each Discom should prioritize their resources towards implementation of initiatives in the order of must have initiatives, strongly desirable initiatives, good to have initiatives and other initiatives to tackle each type of loss. Such prioritization has been done in section 6.1.1 of this report.

- In order to quantify the impact of various loss reduction initiatives being carried out, the Discoms can perform pilot studies in smaller areas, similar to the one done by Punjab for quantifying the benefits of meter replacement as described in the section 4.3.3 of this report.

9. Appendices

9.1. Appendix A- State wise details of AT&C loss reduction (FY 04 to FY 13), present AT&C loss (FY 13), agriculture sales (FY 13) and industrial sales (FY 13)

Region	States	Decrease in AT&C loss (FY 04 to FY 13)	AT&C Losses (FY 13)	% Agriculture sales (FY 13)	% Industrial sales (FY 13)
Northern	Delhi	33.92%	15%	0%	10%
	Uttarakhand	20.30%	23%	4%	56%
	J&K	7.92%	61%	6%	18%
	Punjab	7.86%	18%	29%	34%
	Haryana	7.75%	33%	29%	27%
	HP	-0.26%	10%	1%	53%
	UP	0.48%	43%	18%	15%
Eastern and North Eastern	Manipur	-15.76%	85%	0%	7%
	Tripura	-19.03%	34%	4%	4%
	Arunachal Pradesh	-44.00%	60%	0%	34%
	Sikkim	13.04%	54%	2%	13%
	Meghalaya	12.71%	27%	0%	40%
	Assam	11.50%	32%	0%	22%
	Nagaland	-19.75%	75%	0%	4%
	Mizoram	10.89%	28%	0%	1%
	Bihar	11.63%	55%	5%	23%
	Jharkhand	14.98%	47%	1%	36%
	Orissa	0.66%	43%	2%	51%
	WB	-1.56%	34%	5%	30%
Southern	Karnataka	6.87%	21%	37%	22%
	AP	2.89%	14%	31%	29%
	Tamil Nadu	-0.08%	21%	21%	24%
	Kerala	22.21%	11%	2%	30%
Western	Gujarat	15.61%	20%	26%	42%
	MP	10.37%	31%	34%	24%
	Chhattisgarh	5.87%	25%	13%	34%
	Maharashtra	17.00%	22%	25%	43%
	Goa	7.14%	14%	1%	52%
	Rajasthan	24.43%	20%	43%	23%

9.2. Appendix B- Data Template for primary data collection

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discom level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned return on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW No. of consumers covered - No. of meters installed - Meter reading technology -													
2	Others	Meter replacement	No. of consumers covered - Old &Defective meters covered - Meter relocation outside consumer premises - Type of meter installed -													

3	Technical	Network redesigning	No. of220kv/132kV/66kv /11kv S/s installed - Capacity of substations - Pre and post : HT/LT ratio - 11 KV line conductor type (pre and post) - 11kv feeders installed-													
4	Non-Technical	Installation of LT ABC	Type of installation - Type of cable - Level of implementation - KMs of cable installed -													
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Frequency of Scheme- Targets vis a vis achievements - Arrears collected -													

9.3. Appendix C – List of documents referred for this study

1. Southern power distribution company of A.P. Limited, ARR & Tariff Proposals for Retail Supply Business for FY 2012-13
2. Southern power distribution company of A.P. Limited, Aggregate Revenue Requirement and Retail supply business for the FY 2015-16
3. Draft Report on Diagnostic Study in Transmission and Distribution utilities of Assam, February 2013
4. Order dated 09 April 2015 of Assam Electricity Regulatory Commission against petition number 6/2015
5. Executive Summary based on TPDDL's Petition for True up for FY 2013-14, APR for FY 2014-15 and ARR for FY 2015-16
6. Order on TRUE UP for FY 2008-09 & FY 2009-10 and ARR for FY 2011-12 NDPL
7. Tariff Order Truing up for FY 2013-14 and Determination of Tariff for FY 2015-16 For Madhya Gujarat Vij Company Limited (MGVCL)
8. Tariff Order Truing up for FY 2012-13 and Determination of Tariff for FY 2014-15 For Madhya Gujarat Vij Company Limited (MGVCL)
9. Tariff Order Truing up for FY 2011-12 and Determination of Tariff for FY 2013-14 For Madhya Gujarat Vij Company Limited (MGVCL)
10. Tariff Order Truing up for FY 2010-11 and Determination of Tariff for FY 2012-13 For Madhya Gujarat Vij Company Limited (MGVCL)
11. Business Plan for MYT second control period FY 2011-12 to 2015-16, Madhya Gujarat Vij Company Limited (MGVCL)
12. Petition for true--up for FY 2011--12,, annual revenue requirement for FY 2012--13, MYT for control period FY 2013--14 to FY 2015—16 & tariff determination for FY 2013—14, JSEB
13. Tariff Order on Annual Revenue Requirement for FY 2007-08, FY 2008-09, FY 2009-10, FY 2010-11 and FY 2011-12 and Determination of Provisional Tariff for FY 2011-12 for Jharkhand State Electricity Board
14. Application for approval of the Aggregate Revenue Requirement and Expected Revenue from Charges for the year 2011-12, Kerala State Electricity Board
15. Kerala State Electricity Board Limited, Aggregate Revenue Requirement & Expected Revenue From Charges For FY 2014-15
16. Application for approval of the Aggregate Revenue Requirement and Expected Revenue from Charges for the year 2010-11, Kerala State Electricity Board
17. Application for approval of the Aggregate Revenue Requirement and Expected Revenue from Charges for the year 2013-14, Kerala State Electricity Board

18. Application for approval of the Aggregate Revenue Requirement and Expected Revenue from Charges for the year 2012-13, Kerala State Electricity Board

19. Final True up for FY 2010-11, Aggregate Revenue Requirement of FY 2011-12 and FY 2012-13, Tariff Determination for FY 2012-13 and Revision in Schedule of Charges, Maharashtra Electricity Regulatory Commission

20. Petition of Maharashtra State Electricity Distribution Co. Ltd. for approval of Multi Year Tariff for Second Control Period FY 2013-14 to FY 2015-16

21. Presentation on Problems before Mahavitaran Action Plan, Achievements & Future Plans Towards Reforms

22. Presentation on MSEDCL's Mission statement and Ten Point Action Plan

23. Presentation of Chief Engineer's Review Meet of MahaVitran on 5th August 2006

24. Maharashtra State Electricity Distribution Company Ltd.'s (MSEDCL) Petition for Truing Up for FY 2008-09, Annual Performance Review for FY 2009-10 and Aggregate Revenue Requirement and Tariff Determination for FY 2010-11

25. Maharashtra State Electricity Distribution Company Ltd.'s (MSEDCL) Petition for Truing Up for FY 2007-08, Annual Performance Review for FY 2008-09 and Tariff Determination for FY 2009-10

26. Petition filed by Maharashtra State Electricity Distribution Company Limited seeking Final True Up for FY 2009-10 and Annual Performance Review for FY 2010-11

27. Annual Revenue Requirement And Tariff Proposal Petition For FY 2015-16, Madhya Pradesh Power Management Company Limited

28. Aggregate Revenue Requirement And Retail Supply Tariff Order For FY 2013-14, Madhya Pradesh Electricity Regulatory Commission

29. Annual Revenue Requirement And Tariff Proposal Petition For FY 2015-16, Madhya Pradesh Power Management Company Limited

30. Filing Of Revised ARR For Retail Supply And Distribution Business For 2011-12 Before The Madhya Pradesh Electricity Regulatory Commission, Bhopal

31. Annual Revenue Requirement Filed By The Punjab State Power Corporation Limited For The Financial Year 2013-14

32. Assam Electricity Regulatory Commission (AERC) Tariff Order FY 2013-14 To FY 2015-16

33. Order on Annual Performance Review for FY 2013-14 and Determination of ARR and Tariff for FY 2014-15 for Power Development Department (Distribution), Govt. of J&K

34. Aggregate Revenue Requirement And Tariff Order for FY 2014-15 For Department of Power Government of Arunachal Pradesh

35. Order On Performance Review For Fy 2013-14 And Determination Of Aggregate Revenue Requirement And Tariff For Retail Sale Of Electricity For FY 2014-15 Of North Bihar Power Distribution Company Limited (NBPDCL)

36. Order On Performance Review For FY 2013-14 And Determination Of Aggregate Revenue Requirement And Tariff For Retail Sale Of Electricity For FY 2014-15 Of South Bihar Power Distribution Company Limited (SBPDCL)

37. Nagaland Electricity Regulatory Commission Tariff Order FY 2014-15

38. True-up of FY 2011-12, Review of ARR of FY 2012-13 & Determination of Aggregate Revenue Requirement & Retail Tariff for FY 2013-14, Tripura State Electricity Corporation Limited

39. Order Of The West Bengal Electricity Regulatory Commission For The Year 2013 – 2014

40. Final True up of JSEB for FY 2003-04 to FY 2010-11 and MYT Order for Generation Business for First Control Period (FY 2012-13 to FY2015-16

41. Tariff Order Truing up for FY 2012-13 and Determination of Tariff for FY 2014-15 For Uttar Gujarat Vij Company Limited (UGVCL)

42. Tariff Order Truing up for FY 2012-13 and Determination of Tariff for FY 2014-15 For Madhya Gujarat Vij Company Limited (MGVCL)

43. Tariff Order Truing up for FY 2012-13 and Determination of Tariff for FY 2014-15 For Paschim Gujarat Vij Company Limited (PGVCL)

44. Tariff Order Truing up for FY 2012-13 and Determination of Tariff for FY 2014-15 For Dakshin Gujarat Vij Company Limited (DGVCL)

45. Tariff Order 2014-15 For Electricity Department Government Of Manipur

46. Kerala State Electricity Regulatory Commission Annual Revenue Requirements (ARR), Expected Revenue From Charges (ERC) And Tariff Order For KSEBL - 2014-15

47. Tariff Order 2014-15 For Electricity Department Government Of Mizoram

48. Sikkim State Electricity Regulatory Commission TARIFF ORDER FY 2014-15

49. Determination Of Aggregate Revenue Requirement (ARR) And Tariff For FY 2014-15 And Petition For True-Up Of ARR And Revenue For The Financial Years 2008-09 To 2011-12 For Dakshinanchal Vidyut Vitran Nigam Limited

50. Joint Electricity Regulatory Commission (JERC), Annual Report 2013-14

51. Joint Electricity Regulatory Commission (JERC), Annual Report 2012-13

52. Assam Electricity Regulatory Commission (AERC) Tariff Order Truing Up Of FY 2013-14 Apr Of FY 2014-15, ARR And Tariff For FY 2015-16

53. Determination of true-up of Aggregate Revenue Requirement for FY 2009-10 based on the true-up applications filed by Madhya Pradesh Poorv Kshetra Vidyut Vitaran Company Ltd. (East Discom), Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Ltd. (Central Discom) and Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Ltd. (West Discom) under Multi Year Tariff Principles.

9.4. Appendix D – primary data collected from state utilities

State Gujrat

Utility Madhya Gujrat Vidyut Co. Ltd.

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned return on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW No. of consumers covered - 458 Nos No. of meters installed - 458 nos Meter reading technology - GSM/GPRS	MGVCL field offices.	No. of circles - 5 No. of Divisons - 18 No. of sub divisions - 105	Continuous	01-04-08	till date	0.46	0.46					Good	1. System up gradation 2. Meter reading time is reduced and reading of all such consumers can be taken on fixed Date and time every month 3. Reduction in labor

2	Others	Meter replacement	No. of consumers covered - 1307645 nOS Old &Defective meters covered - 1104439 nos Meter relocation outside consumer premises - 203206 nos Type of meter installed - Static	MGVCL field offices.	No. of circles - 5 No. of Divisons - 18 No. of sub divisions - 105	Continuous	01-04-08	till date	110.44	110.44	Good
3	Technical	Network redesigning	No. of220kv/132kV/66kv/11kv S/s installed - 61 Nos Capacity of substations - 3295 MVA Pre and post : HT/LT ratio - 1.47 reduce to 1.26 11 KV line conductor type (pre and post) - Overhead 11kv feeders installed-341 nos.	MGVCL field offices.	No. of circles - 5 No. of Divisons - 18 No. of sub divisions - 105	Continuous	01-04-05	01-03-15	627.65	627.65	Good
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - 10x35mem2,3Cx35 mem2 & 3C50MM2 Level of implementation - decentralised KMs of cable installed - 16441 km	MGVCL field offices.	No. of circles - 5 No. of Divisons - 18 No. of sub divisions - 105	Continuous	01-04-06	till date	103.64	103.64	Good

5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Frequency of Scheme- One Time Settlement Scheme (OTS) Targets vis a vis achievements - Arrears collected As the scheme envisaged waiver/recovery of certain amount depending on the outstanding amount of arrears of different categories of consumers, there was no specific target prescribed.	Revenue & Technical Sections of MGVCL field offices.	No. of circles - 5 No. of Divisons - 18 No. of sub divisions - 105	Yes	01-04-12	01-12-12	N.A.	N.A.	Good	Very old outstanding of Permanently Disconnected consumers lying dull in the system have been realized. Further, new connections can also be released to needy consumers who have deprived of power connections due to non

State	Gujrat
Utility	Dakshin Gujrat Vidyut Co. Ltd.

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW No. of consumers covered - 13321 No. of meters installed - 9986 Meter reading technology - GSM/GPRS	Revenue and Technical Section of DGVCL field office	No. of circles - 4 No. of Divisons - 19 No. of sub divisions - 117	Yes	2010-11	2014-15								1. System upgradation 2. Meter reading time is reduced and reading of all such consumers can be taken on fixed date and time
2	Others	Meter Replacement	No. of consumers covered - 33354235 Old &Defective meters covered - 415840 Meter relocation outside consumer premises - 4239 Type of meter installed - Quality/Static	DGVCL Field office	No. of circles - 4 No. of Divisons - 19 No. of sub divisions - 117	Yes	2010-11	2014-15	200.56	166.33	15%	9.33%			Good	

3	Technical	Network redesigning	No. of220kv/132kV/66 kv/11kv S/s installed - 788 Capacity of substations - Pre and post : HT/LT ratio - 0.80 11 KV line conductor type (pre and post) -55 sq mm 11kv feeders installed - 687	DGVCL Field office	No. of circles - 4 No. of Divisons - 19 No. of sub divisions - 117	Yes	2010-11	2014-15						Good	
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - ABC Level of implementation - KMs of cable installed - 6982 km	DGVCL Field office	No. of circles - 4 No. of Divisons - 19 No. of sub divisions - 117	Yes	2010-11	2014-15	200.56	166.33	15%	9.33%		Good	
5	Soft initiative	Interest on arrears waive off scheme	Arrear collected - 1198.25 Lakhs	Revenue and Technical Section of DGVCL field office	No. of circles - 4 No. of Divisons - 19 No. of sub divisions - 117	Yes	01-04-12	01-12-12						Good	Very old outstanding of Permanently Disconnected consumers lying dull in the system have been realized. Further, new connections can also be released to needy consume

rs who have deprived of power connectio ns due to non

State	Gujrat
Utility	Uttar Gujrat Vidyut Co. Ltd.

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW No. of consumers covered - 2871 No. of meters installed - 2871 Meter reading technology - GSM/GPRS	Commercial/Projects/ Planning	No. of circles - 4 No. of Divisons - 21 No. of sub divisions - 128		01-01-05	till date	No DPR	2.87						
2	Others	Meter Replacement	No. of consumers covered - 844004 Old &Defective meters covered - 227739 Meter relocation outside consumer premises - 4090 Type of meter installed - Static	Commercial/Projects/ Planning	No. of circles - 4 No. of Divisons - 21 No. of sub divisions - 128		01-01-11	till date	No DPR	80.57						

3	Technical	Network redesigning	No. of 11kv/440kv s/s installed - 123468/199268 Capacity of substations - 8545980 / 11112233 Pre and post : HT/LT ratio - 1.14 / 1.31	Commercial/projects/ planning/field	No. of circles - 4 No. of Divisons - 21 No. of sub divisions - 128	01-01-11	till date	No DPR	1564.39
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - LT ABC Level of implementation - 899.71 Km / 2323.55 Km Pre and post : ACSR to LT AB cable ratio - 68.48 / 29.48	Commercial/projects/ planning/field	No. of circles - 4 No. of Divisons - 21 No. of sub divisions - 128	01-01-11	till date	No DPR	23.26
5	Soft initiative	Interest on arrears waive off scheme	Arrear collected - 1198.25 Lakhs	Commercial/projects/ planning/field	No. of circles - 4 No. of Divisons - 21 No. of sub divisions - 128	01-01-10	till date	No DPR	-

State	Gujrat
Utility	Paschim Gujrat Vidyut Co. Ltd.

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned return on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW	Commercial /Projects/ Planning			2010-11	2014-15	1.31							
2	Others	Meter Replacement	No. of consumers covered - 1746631 Defective meters covered - 425600 Meter relocation outside consumer premises - Details not available Type of meter installed - Static	Commercial /Projects/ Planning	No. of circles - 11 No. of Divisons - 45 No. of sub divisions - 237	Yes	2010-11	2014-15	44.68							

3	Technical	Network redesigning	No. of 33/11 KV S/s installed - In PGVCL no such S/S is commissioned. Capacity of substations - NA Pre and post : HT/LT ratio - 0.83(Pre) and 1.11(Post) 11 KV line conductor type (pre and post) - Bare Over head Average feeder loading (pre and post) - 146(Pre) and 106(Pre) Average DT capacity (Pre and post) - 52KVA(Pre) and 31 KVA(Post)	Commercial /projects/ planning/field	No. of circles - 11 No. of Divisons - 45 No. of sub divisions - 237	Yes	2010-11	2014-15	556.73	428.19
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - LT Arial Bunched over head cable Level of implementation - Decentralised KMs of cable installed - 15672 Pre and post : ACSR to LT AB cable ratio - 183(Pre) and 25(Post)	Commercial /projects/ planning/field	No. of circles - 11 No. of Divisons - 45 No. of sub divisions - 237	Yes	2010-11	2014-15	200.6	

5	Soft initiative	Interest on arrears waive off scheme	Arrear collected (Settled Amount)- 5450.03 Lacs Frequency of scheme - as per scheduled by GSLSA Targets vis a vis achievements -	Field	No. of circles - 11 No. of Divisons - 43 No. of subdivisions- 224	No	04-01-10	31-03-15
6	Soft initiative	Amnesty	Arrear collected - 1663.39 Lacs Frequency of scheme - 1	Field	No. of circes - 11 No. of Divisons - 43 No. of sub divisions - 224	Yes	29-03-12	31-12-12

State	Jharkhand
Utility	JBVNL

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW - No olconsumers covered . 249 No. of meters installed - 550 (approx.) Meter reading technology - Manual/GSM	Commercial / Project / Planning (SYSTEM PLANNING)	No. of circles - N/A No. of Divisions - 6 (Six) No. of subdivisions • N/A	Yes	01-05-08	01-07-13	11.13	20.34			15.5% on equity	15.5% on equity		
2	Others	Meter replacement	No of consumers - 249 Deflective meters covered - all existing electromechnical Meter replaced outside consumer premises - 12 Type of meter installed - electronic	Commercial / project , Planning (SYSTEM PLANNING)	No. of circles - N/A No. of Divisions - 6 (Six) No. of subdivisions • N/A	Yes	01-05-08	01-07-13					15.5% on equity	15.5% on equity		

3	Technical	Network redesigning	No. of220kv/132kV/66 kv/11kv S/s installed - 61 Nos Capacity of substations - 3295 MVA Pre and post : HT/LT ratio - 1.47 reduce to 1.26 11 KV line conductor type (pre and post) - Overhead 11kv feeders installed-341 nos.	Commercial / project , Planning (SYSTEM PLANNING)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - 10x35mem2,3Cx35 mem2 & 3C50MM2 Level of implementation - decentralised KMs of cable installed - 16441 km	Commercial / project , Planning (SYSTEM PLANNING)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Frequency of Scheme- One Time Settlement Scheme (OTS) Targets vis a vis achievements - Arrears collected As the scheme envisaged waiver/recovery of certain amount depending on the outstanding amount of arrears of different categories of consumers, there was no specific target prescribed.	Commercial / project , Planning (SYSTEM PLANNING)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

State	Kerala
Utility	KSEB

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR System for consumers above 100 KW No. of consumers covered - 2899 No. of meters installed Meter reading technology		No. of circles - 25 No. of divisions - 75 No. of sub divisions - 211	No	01-01-09	01-01-15								
2	Others	Meter replacement	No. of consumer covered - 58335 Dfective meters covered - 2457147 Meter relocaton outside consumer premises - 23578 Type of meter installed - Static		No. of circles - 25 No. of divisions - 75 No. of sub divisions - 211	No										

3	Technical	Network redesigning	No. of 33/11 KV S/Stn. Installed - 247 Capacity of Sub-Stations - 2182 Pre and post: HT/LT ratio - 5.87 / 4.9 Average feeder loading - 86.5A Average DT Capacity (Pre and Post) - 124.6 / 123.3	No. of circles - 25 No. of divisions - 75 No. of sub divisions - 211	No
4	Non Technical	Installation of LT ABC	Type of Installation - Overhead Type Cable - XLPE Level of implementation - decentralised	No. of circles - 25 No. of divisions - 75 No. of sub divisions - 211	No
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Arrear collected - 10.78 cr Frequency of Scheme - one time Targets vis a vis achievements	No. of circles - 25 No. of divisions - 75 No. of sub divisions - 211	Yes

State	Maharashtra
Utility	MSEDCL

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR System for consumers above 100 KW No. of consumers covered - No. of meters installed - 69526 Meter reading technology													
2	Others	Meter replacement	No. of consumer covered - 1580347 Dfective meters covered - Meter relocaton outside consumer premises - Type of meter installed -													
3	Technical	Network redesigning														
4	Non Technical	Installation of LT ABC	Type of Installation - Overhead Type Cable - XLPE Level of implementation - decentralised km of cables - 119193 km													

5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Arrear collected - 417 cr Frequency of Scheme - one time Targets vis a vis achievements

State	Maharashtra
Utility	BEST

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR System for consumers above 100 KW No. of consumers covered - 315 No. of meters installed - 315 Meter reading technology - GSM	Meter and Customer Care Departments		No	01-01-10									
2	Others	Meter replacement	No. of consumer covered - 1580347 Dfective meters covered - Meter relocaton outside consumer premises - Type of meter installed -	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Technical	Network redesigning		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Non Technical	Installation of LT ABC	Type of Installation - Overhead Type Cable - XLPE Level of implementation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

			- decentralised km of cables - 119193 km													
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Arrear collected - 417 cr Frequency of Scheme - one time Targets vis a vis achievements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

State	Maharashtra
Utility	Reliance Infra

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR System for consumers above 100 KW No. of consumers covered - 549 HT, 2789 LT No. of meters installed - 3338	In-house	No. of circles - NA No. of Divisions - 5 No. of sub divisions - 18 Units	Yes	01-01-10	01-01-15	N/A	3.49						
2	Others	Meter replacement	No. of consumer covered - 1580347 Dfective meters covered - Meter relocaton outside consumer premises - Type of meter installed -	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Technical	Network redesigning		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

4	Non Technical	Installation of LT ABC	Installation of Theft Proof Pillars - 227 Installation of Theft Aversion Box# with tripping circuits - 250 Installation of Service meters- 650	In-house	No. of Divisons - 2	No	01-01-11	on going	N/A	5.37						
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Arrear collected - 417 cr Frequency of Scheme - one time Targets vis a vis achievements	In-house	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

State	Maharashtra
Utility	Tata

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR System for consumers above 100 KW No. of consumers covered - 11214 No. of meters installed - 4000 Meter reading technology - GPRS/RF	Metering Department	N/A	No	01-01-11		33	11						
2	Others	Meter replacement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Technical	Network redesigning	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Non Technical	Installation of LT ABC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Soft initiatives	Interest on arrear waiver scheme	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

State	Punjab
Utility	PSPCL

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned return on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR System for consumers above 100 KW No. of consumers covered - 5024 No. of meters installed - Meter reading technology - GPRS	IT, PSPCL	No. of circles - 21 No. of divisions - 60 No. of sub divisions - 166	Yes	01-01-10	01-04-15	272.53	155						
2	Others	Meter replacement	No. of consumer covered - 17.29 lac Dfective meters covered - Meter relocaton outside consumer premises. Type of meter installed	RE&AP DRP & DS Office	No. of circles - 18	No	01-01-13	In progress	1005.27	256.87						
3	Technical	Network redesigning	No. of 33/11 KV S/Stn. Installed - 186072 Capacity of Sub-Stations Pre and post: HT/LT ratio 11 KV line conductor type core and post Average feeder loading (pre and post) Average DT Capacity (Pre and Post)	RE&AP DRP & DS Office	No. of circles - 14 No. of divisions - 33 No. of sub divisions -	Yes	01-01-09	01-12-12	1303.04	1165.99	10 to 20%	11.28% to 19.29%				

4	Others	Meter replacement	No. of consumer covered - 11.09 lac Dfective meters covered - Meter relocaton outside consumer premises. Type of meter installed	RE&APDRP	No. of circles - 21 No. of divisions - 59 No. of sub divisions - 163	No	01-01-13	01-01-16	1632.7	434.54						
5	Technical	Network redesigning	No. of 33/11 KV S/Stn. Installed - 2 Capacity of Sub-Stations Pre and post: HT/LT ratio 11 KV line conductor type core and post Average feeder loading (pre and post) Average DT Capacity (Pre and Post)	RE&APDRP	No. of circles - 21 No. of divisions - 59 No. of sub divisions - 163	No	01-01-13	01-01-16								
6	Non Technical	Installation of LT ABC	Type of Installation Overhead/undergroung Type Cable level of implementation Corporate/decentralised Kms of cable installed pre and post ASCR to LT AB Cable ratio		No. of circles - 21 No. of divisions - 59 No. of sub divisions - 163	No	01-01-13	01-01-16								
7	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Arrear collected Frequency of Scheme Targets vis a vis achievements	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

State	Uttarakhand
Utility	UPCL

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW No. of consumers covered - 7100 No. of meters installed - 7100 Meter reading technology - GSM	Commercial	No. of circles - 12 No. of Divisons - 32 No. of sub divisions - 91	Yes	01-01-09	01-01-13	4.82	4.82						
2	Others	Meter replacement	No. of consumers covered - 1765534 Defective meters covered - 328500 Replacement of IDF meters - 328500	Field	No. of circles - 12 No. of Divisons - All No. of sub divisions - All	Yes	2010-11	2014-15	43.725	43.725						
	Others	Meter replacement	No. of consumers covered - 1765534 Defective meters covered - 455339 Replacement of IDF meters - 455339	Project	No. of circles - 11 No. of Divisons - 26 No. of sub divisions - 75	No	18-10-11	01-03-17	29.38		upto 15%		IRR > 10%			

3	Technical	Network redesigning	No. of 33/11 KV S/s installed - 26 Capacity of substations - 24/61/62/16/31 MVA	Project		Yes	01-01-10	01-01-15	84.5	84.5
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - Level of implementation - decentralised KMs of cable installed - 4503 KM Pre and post : ACSR to LT AB cable ratio -	Field/Project		No	18-10-11	01-03-17	243.17	85.29
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	Arrear collected - 98.41 Inetrest waived off - 36.27 Frequency of scheme - Targets vis a vis achievements -	Field	No. of circles - All No. of Divisons - All No. of sub divisions - All	N/A	04-01-11	14-08-15		

State	Assam
Utility	APDCL

S. No.	Area of Initiative	Name of the Initiative/Scheme	Brief scope of work	Implementing office	Geographical coverage	Scheme completed	Starting Year	Ending Year	Planned cost (INR Crores) (As per accounts Present status)	Actual cost (INR Crores) (As per accounts Present status)	Planned loss reduction through the initiative/scheme at Discomm level (%) as per DPR	Actual loss reduction at discom level post implementation (As assessed by the Discom)	Planned retun on investment AS per DPR)	Actual return on investment as assessed by the Discom)	Ranking of the schemes as assessed by Discom	Reason for rank
1	Others	AMR Scheme	Installation of AMR system for consumers above 100 KW No. of consumers covered - 4700 Nos No. of meters installed - 4497 nos Meter reading technology - AMR	APDCL	No. of circles - 19 No. of Divisons - 41 No. of sub divisions - 91	No	01-01-11	till date	43.2							
2	Others	Meter replacement	No. of consumers covered - 7.5 lacs Old &Defective meters covered - 178487 Meter relocation outside consumer premises - N/A Type of meter installed - Fully Static	APDCL	No. of circles - 19 No. of Divisons - 41 No. of sub divisions - 91	Yes	01-01-13	till date	62.28							

3	Technical	Network redesigning	No. of 33/11kv S/s installed - 190 Capacity of substations - 1360 MVA Pre and post : HT/LT ratio - 2.5 to 2.25	APDCL	No. of circles - 19 No. of Divisons - 44 No. of sub divisions - 155				1604	
4	Non Technical	Installation of LT ABC	Type of installation - Overhead Type of cable - ABC Level of implementation - corporate KMs of cable installed - 1628 km	APDCL	No. of circles - 19 No. of Divisons - 44 No. of sub divisions - 155	Continuous	01-01-11	01-01-15		
5	Soft initiatives	Interest on arrear waive off scheme: Amnesty Scheme - 2012 by GoG.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A