Strategic Roadmap for Implementation of UDAY Scheme

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Abbreviations and Acronyms

ACS	Average Cost of Supply
AMI	Advanced Metering Infrastructure
APDRP	Accelerated Power Development and Reform Programme
ARR	Average Revenue Realisation
AT&C	Aggregate Technical and Commercial
BESCOM	Bangalore Electricity Supply Company Limited
CESC	Chamundeshwari Electricity Supply Corporation Limited
CGS	Central Generating Station
DELP	Domestic Efficiency Lighting Programme
DISCOM	Distribution Company
DT	Distribution Transformer
DTLMS	Distribution Transformer Lifecycle Management System
EV	Electric Vehicle
GoI	Government of India
GoK	Government of Karnataka
IP	Irrigation Pump
IPDS	Integrated Power Development Scheme
IPP	Independent Power Producer
KERC	Karnataka Electricity Regulatory Commission
kV	kiloVolt
KPCL	Karnataka Power Corporation Limited
KPI	Key Performance Indicator
LED	Light Emitting Diode
MESCOM	Mangalore Electricity Supply Company Limited
MoP	Ministry of Power
MoU	Memorandum of Understanding
MU	Million Unit
PCKL	Power Company of Karnataka Limited

PGRS	Public Grievance Redressal System
RAPDRP	Restructured Accelerated Power Development and Reform Programme
RR	Revenue Register
RTPV	Rooftop Photovoltaics
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
UDAY	Ujwal DISCOM Assurance Yojana

Executive Summary

In November 2015, the Government of India (GoI) launched the Ujwal DISCOM Assurance Yojana (UDAY) to improve the financial health of the state-owned power distribution companies (DISCOMs). As of FY15, these DISCOMs were reeling under huge accumulated losses of INR 3.8 lakh crores, with accumulated debt of INR 4.3 lakh crores. The objective of the scheme is to improve the financial and operational efficiencies of the state DISCOMs so as to make them sustainable in the long run. The scheme lists various operational parameters and requires a state-wise strategic roadmap for effective implementation.

This study analyses the concerns/challenges in executing the operational targets set under the UDAY scheme for two DISCOMs in Karnataka, namely, Mangalore Electricity Supply Company Limited (MESCOM) and Chamundeshwari Electricity Supply Corporation Limited (CESC), and provides recommendations for successful implementation of the scheme. Although we analysed two DISCOMs for the purpose of this study, the recommendations could apply to any DISCOM implementing the scheme.

Reducing Aggregate Technical and Commercial (AT&C) losses is a key element in UDAY's strategy for making DISCOMs financially viable. Our analysis revealed issues in the implementation of energy auditing at 11 kiloVolt (kV) feeder level, resulting in inaccurate calculation of AT&C losses. Further, the widening gap between cost incurred and revenue realised demonstrates the need for greater attention to metering of supplies and billing, more robust power purchase planning and an institutional structure, which would enable more transparency and accountability in the sector.

Key recommendations from this study include

- Mandatory compliance with the KERC format for energy auditing at 11 kV feeder level
- Implementing a commercial accountability system/protocol at the feeder level
- Streamlining the meter reading process
- Undertaking the feeder-to-Distribution Transformer (DT) and DT-to-Consumer tagging drive on a priority basis
- Utilising the DT lifecycle management and monitoring system
- Undertaking a feasibility analysis before large-scale implementation of smart meters
- Undertaking a robust demand forecast for better power purchase planning
- Establishing separate power planning cells in the DISCOMs to coordinate with other state nodal agencies
- Formulating successive performance indicators at an operational level.

This study would help the select DISCOMs to understand the field-level challenges associated with the initiatives underlined in the UDAY scheme. The roadmap would aid the DISCOMs in effectively implementing the scheme, resulting in increased operational efficiency.

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Introduction

1. Introduction

A healthy distribution sector is not only needed for an efficient power sector as a whole, but is also critical for the growth of an economy. The distribution sector in India suffers from inherent issues such as high Aggregate Technical and Commercial (AT&C) losses, inefficient infrastructure and the appalling financial health of state-owned distribution companies (DISCOMs). To address the situation, the Government of India (GoI) has been undertaking numerous efforts to improve both operational and financial efficiency of the DISCOMs.

In 2001, GoI launched an operational initiative named Accelerated Power Development and Reform Programme (APDRP) with an aim to reduce AT&C losses to 15% through improvement in the network infrastructure, including universal consumer metering. Some of the factors associated with the failure[1] of APDRP with respect to calculation of AT&C losses included significant deficiencies in maintenance of records; absence of proper guidelines to DISCOM staff and several instances of incorrect reporting of AT&C losses by states. To overcome the limitations of APDRP, the Restructured Accelerated Power Development and Reform Programme (RAPDRP) was introduced in 2008. RAPDRP was also focused on bringing down AT&C losses to 15% by improving the network infrastructure through use of information technology. The RAPDRP, later subsumed in to the Integrated Power Development Scheme (IPDS)[2], introduced in 2013, is yet to achieve its desired objectives and is a work under progress in many states.

The financial initiative - a one-time settlement scheme - was introduced in 2001 to clear outstanding dues to the tune of Rs. 41,000 crores of state DISCOMs. Later in 2012, GoI approved another scheme named Financial Restructuring Plan (FRP) to improve the financial health of DISCOMs, since total accumulated debt had reached Rs. 1.9 lakh crores. Under FRP, state governments had to acquire 50% of the outstanding short-term liabilities of DISCOMs. This was to be converted into bonds, to be issued by DISCOMs to participating lenders, duly backed by the state governments' guarantee. The remaining 50% was to be restructured by rescheduling loans and providing moratorium on principal.

Although both the operational and financial initiatives undertaken by the central and state governments were successful in some areas, they failed to achieve the overall objective of improving the financial health of the Indian power distribution sector, which is still saddled with an outstanding debt of Rs. 4.3 lakh crores (March 2015). The total accumulated losses in the sector reached Rs. 3.8 lakh crores in FY15, an increase of 25% over the accumulated losses incurred up to FY14. Accumulated losses[3] for DISCOMs in Karnataka were Rs. 2,643 crores at the end of FY15.

In another effort to revive the sector, GoI in November 2015 launched the Ujwal DISCOM Assurance Yojana (UDAY) scheme for improvement of the operational and financial health of the state-owned DISCOMs. The scheme is considered an inclusive reform package, which targets both cost- and revenue-side measures for the DISCOMs. It involves a tripartite agreement (Memorandum of Understanding, MoU) between Ministry of Power (MoP), state governments and respective DISCOMs.

[1] CAG Performance Audit Report of Accelerated Power Development and Reform Programme.
[2] The objective of IPDS is to strengthen the sub-transmission and distribution network through metering of DTs/feeders/consumers in the urban areas and strengthen the distribution network through IT enablement. The approved outlay for RAPDRP for completion of targets under IT enablement is being carried forward to IPDS as per CCEA approval dated 21.06.2013.
[3] Karnataka DISCOMs' tariff order 2016.

The scheme outlines specific initiatives to be undertaken by the central government, state government and DISCOMs.

Some of the key operational performance parameters for DISCOMs covered under the UDAY scheme are AT&C loss reduction, mandatory metering, power purchase planning and performance monitoring. Initiatives related to improvement of operational performance are chalked out in consultation with the state government, state DISCOMs and MoP. Since state DISCOMs are responsible for implementing these initiatives in their respective areas, a DISCOM-wise strategic roadmap is needed for effective implementation of the initiatives under the scheme.

In view of the above, CSTEP with support from Shakti Sustainable Energy Foundation has undertaken this study to provide a strategic roadmap for implementation of operational initiatives for two select DISCOMs in Karnataka. The report outlines the status of various initiatives undertaken by DISCOMs, identifies gaps in current practices, and recommends measures to overcome existing challenges, with a roadmap for implementation of the suggested measures.

2
Scope of Study

2. Scope of Study

The UDAY scheme comprises both financial and operational initiatives for improvement of the power sector; however, the states can sign up for improvement of either financial or operational aspects. Currently, 27 states have signed up for the UDAY scheme, Karnataka being one of them (Appendix 1). The state signed the MoU on 16 June 2016 for improvement in only operational efficiency; thus, the scope of this study is limited to providing a roadmap for the operational initiatives covered in the MoU for two DISCOMs in Karnataka, i.e., Mangalore Electricity Supply Company Limited (MESCOM) and Chamundeshwari Electricity Supply Corporation Limited (CESC). The initiatives to be undertaken by DISCOMs for improvement of operational efficiency are listed in the MoU (Appendix 2). They are categorised as high-, medium- and low-priority, in consultation with DISCOM officials [Appendix 3(a) and 3(b)]. The study focuses on the following high-priority initiatives - AT&C loss reduction, power purchase planning and institutional structure (Figure 1).

AT&C Loss Reduction

- Energy Audit (11kV feeder)
- 100% metering
- Smart metering

ACS-ARR Gap

- Power purchase planning
- Quarterly tariff revision

Institutional Structure

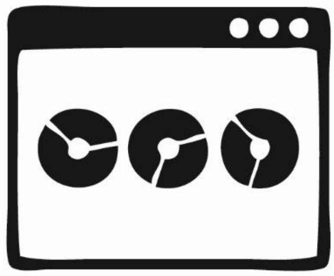
- Devising Key Performance Indicators (KPIs)
- Employee Capacity building
- Performance monitoring
- Centralised customer service centre

Figure 1: High-priority initiatives identified based on stakeholder discussion

- AT&C loss reduction: High AT&C losses have an adverse impact on the revenue flow of DISCOMs. Identifying gaps in current technical and commercial practices, and recommending course correction measures would help in reducing these losses.
- Gap between Average Cost of Supply (ACS) and Average Revenue Realisation (ARR): Power purchase costs account for around 70-80% of the total power supply cost of DISCOMs. It becomes essential for DISCOMs to accurately predict their short-term, medium-term and long-term demands for better power purchase planning. Reducing the average cost of power procurement can be an important factor in reducing the ACS–ARR gap.
- Institutional structure: It is necessary to analyse issues with the current organisational structure and implement innovative business models, which would make the operations more efficient and minimise the gap between cost and revenue.

3

Methodology



3. Methodology

We adopted the following approach to prepare a strategic roadmap for implementation of the UDAY scheme in select DISCOMs in Karnataka:

- **Literature review**
  - Carried out secondary literature review to understand the challenges faced by utilities outside Karnataka in implementing the measures carved out under the UDAY scheme
  - Identified barriers encountered by MESCOM and CESC in implementing the initiatives covered under the UDAY scheme.

- **Stakeholder discussions**
  - Identified nodal persons who were appointed for the implementation of the UDAY scheme in select DISCOMs
  - Met senior officials in the corporate office and employees at the sub-division levels to get a perspective of the operations, from both the top management and ground-level employees
  - Held discussions with other stakeholders involved in the process, such as Karnataka Electricity Regulatory Commission (KERC), Power Company of Karnataka Limited (PCKL), Bangalore Electricity Supply Company Limited (BESCOM), etc.
  - Ranked parameters in high-, medium- and low-priority levels in consultation with stakeholders[4]. A prioritisation matrix is provided in Appendix 3(a) and 3(b) each, along with the status of all the initiatives listed out in the MoU.

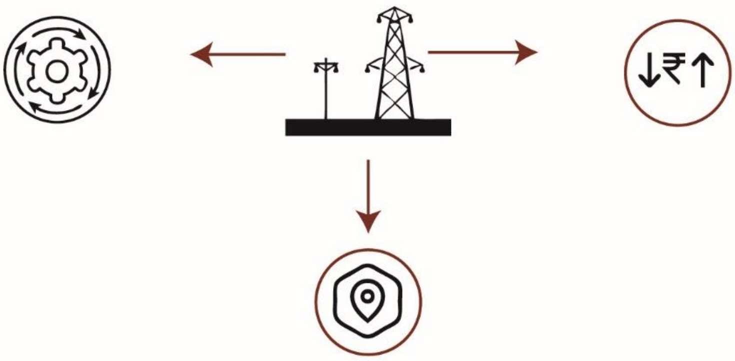
- **Data collection**
  - Collected data on high-priority initiatives for both MESCOM and CESC
  - Collected data for sample feeders in both DISCOMs for analysing the energy audit process at 11 kV feeder level
  - Discussed present institutional structure and other software issues with the DISCOM officials

- **Field audit**
  - The CSTEP field team validated and identified discrepancies in the energy consumption data at feeder and DT levels for select sample feeders. A Junior Engineer was allocated by the DISCOM to provide support during the field audit. This field audit helped in identifying gaps in current energy auditing procedures

[4] In consultation with Director Technical, UDAY nodal officers and Executive Engineers in both DISCOMs.

4

DISCOMs’ Profile



4. DISCOMs' Profiles

4.1. Mangalore Electricity Supply Company Limited

MESCOM, established in 2002, is one of the five distribution companies in Karnataka. It supplies electricity to four districts, namely, Dakshin Kannada, Udupi, Shimoga and Chikmagalur (Figure 2). Dakshin Kannada and Udupi are coastal districts and receive abundant rainfall during the monsoon period, from June to September, with rainfall averaging at more than 4,000 mm every year. Shimoga and Chikmagalur are part of a region known as Malnad (land of hills). These districts receive average rainfall of 1,870 mm. Hilly and coastal regions with high amounts of rainfall, prevalence of plantation crops (such as coconut, areca nut and cashew) and lower concentration of water-intensive crops (such as sugarcane and paddy) have a bearing on the pattern of MESCOM's electricity consumption.

The organisational structure of MESCOM comprises one Operation & Maintenance (O&M) zone in Mangalore, headed by a Chief Engineer (Elec.) (CE). The O&M zone has four O&M circles in Mangalore, Udupi, Shimoga and Chikmagalur, each headed by a Superintendent Engineer (Elec.) (SE). Details of the organisation structure of MESCOM is given in Appendix 4(a).

Districts	Area	Population	Feeders	Base Load	Peak load	LT/HT ratio
4	26,222 sq. km.	62 lakhs	832	640	900	2.4

Figure 2: A brief profile of MESCOM

Source: Stakeholder consultation, MESCOM website

Operational Parameters

MESCOM has 21,52,546 consumers in its jurisdiction. Of this, domestic installations have the highest share, at 75%, followed by agriculture installations (irrigation pumps) at 13% and commercial installations at 9%. Industrial consumers comprise only 1% of the total consumer base, whereas the "Others"[5] category of consumers constitutes 2% of the total consumers in MESCOM's area (Table 1).

The company supplied a total of 4,227 Million Units (MU)[6] of energy and generated total revenue of Rs. 2,363 crores in FY16. As per consumer-category-wise sales (Table 1) in MESCOM in FY16, the domestic sector had the highest share at 32% followed by agriculture sector at 29% and industrial sector at 17%. The remaining 23% was shared between the commercial and "Others" categories, at 12% and 11%, respectively. As far as revenue (Table 1) is concerned, the domestic sector generates the highest revenue, at 26%, followed by industrial units at 22% and agriculture sector at 21%. Further, the commercial sector contributes 18% of the total revenue in MESCOM, followed by 12% from the "Others" category of consumers.

[5] The "Others" category of consumers includes Street lighting, Water supply installations and public lighting, Hospitals and educational institutions, Temporary supply for hoardings and Advertisement boards, and Construction power for industries.
[6] MESCOM tariff order 2017.

Table 1: Consumer-category-wise Installations, Sales (MU) and Revenue (Rs. Cr.) for MESCOM

Consumer Category	Installations (No.)	Sales (MU)	Revenue (Rs. Cr.)
Domestic	16,04,864	1,337	615
Industrial	1,90,681	722	524
Commercial	28,584	510	429
Agriculture	2,78,374	1,213	502
Others	50,043	445	292
Total	21,52,546	4,227	2,363

Source: MESCOM tariff order 2017

MESCOM had an ARR of Rs. 5.59/unit in FY16, against an ACS of Rs. 6.53/unit. This resulted in an ACS–ARR gap of Rs. 0.94/unit in FY16. The revenue gap has occurred as MESCOM could earn only Rs. 2,363 crores as against an annual revenue requirement of Rs. 2,759 crores in FY16, resulting in a revenue gap of Rs. 396 crores. Similarly, MESCOM reported a deficit[7] of Rs. 249 crores (ACS–ARR gap of Rs. 0.66/unit) in FY13. However, there was surplus revenue to the order of Rs. 69 crores, Rs. 86 crores and Rs. 144 crores in FY12, FY14 and FY15, respectively (Figure 3).

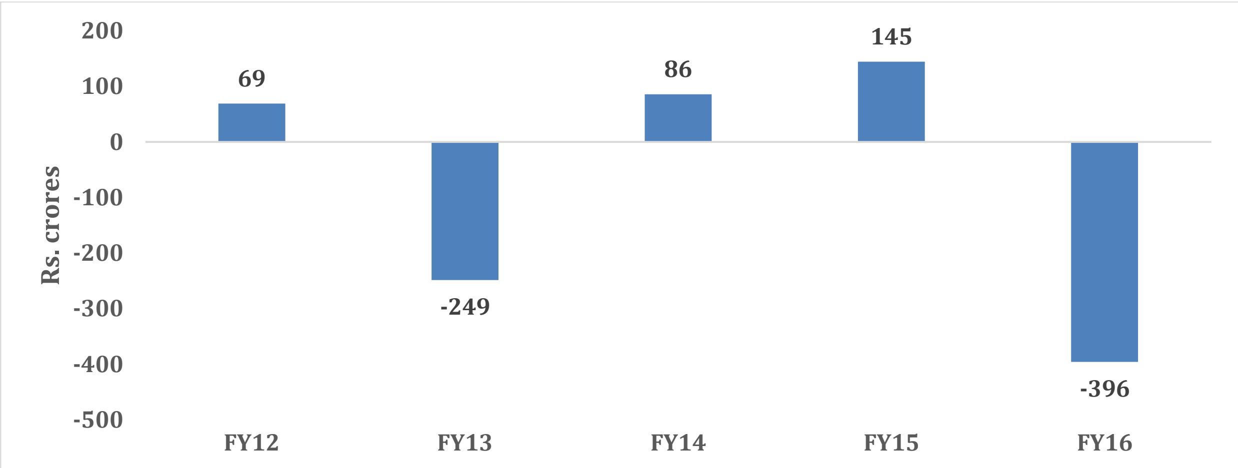


Figure 3: Revenue gap of MESCOM (Rs. Cr.) from FY12 to FY16

Source: MESCOM tariff order 2013, 2014, 2015, 2016 and 2017

AT&C Losses

The MoU signed by MESCOM for the UDAY scheme stipulates an AT&C loss target of 11.7% to be achieved by FY19. However, MESCOM seems to have achieved its target already. As per MESCOM tariff order 2017, the AT&C loss levels in MESCOM stood at 11.5% in FY16. However, the accuracy of these data needs to be validated by a detailed analysis of the loss levels at a division level. Figure 4 shows a division-wise AT&C loss heat map for MESCOM.

[7] MESCOM tariff order 2013, 2014, 2015, 2016 and 2017.

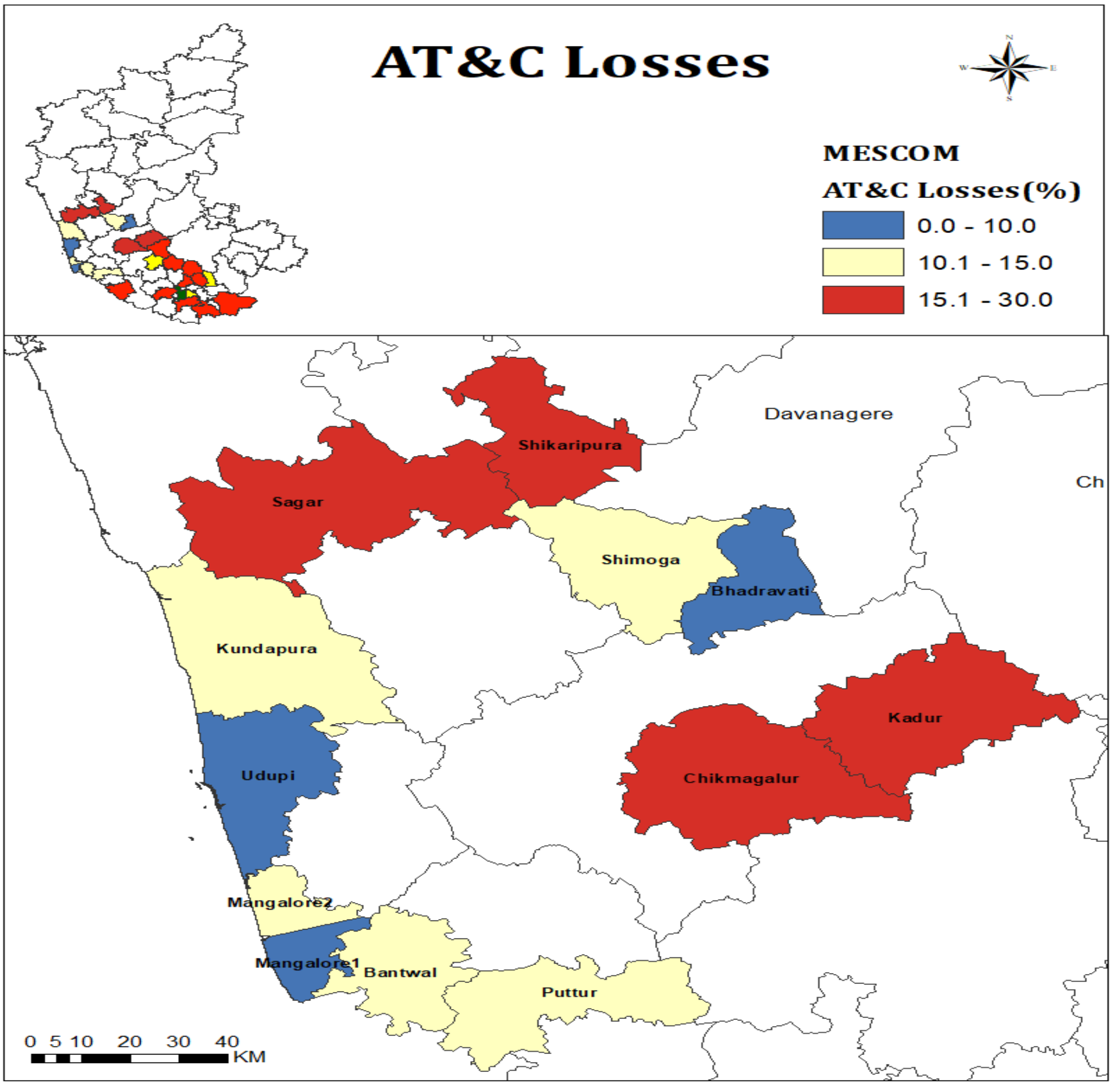


Figure 4: Division-wise AT&C loss heat map for MESCOM in FY16

Source: UDAY MoU between MoP and Karnataka DISCOMs, CSTEP Analysis

Table 2: Division-wise AT&C losses for MESCOM in FY16[8]

Divisions	**Mangalore-1**	**Mangalore-2**	**Puttur**	**Bantwal**
AT&C loss (%)	6.2	10.3	14.5	12.7
Agriculture consumption (% of total consumption)	2%	7%	38%	34%
Industrial consumption (% of total consumption)	24%	34%	6%	13%
Divisions	**Shimoga**	**Bhadravathi**	**Sagar**	**Shikaripura**
AT&C loss (%)	11.3	6.7	26.1	16.6

[8] AT&C loss in UDAY MoU. Division-wise and category-wise demand collection data of FY16, as obtained from MESCOM.

Agriculture consumption (% of total consumption)	24%	18%	61%	84%
Industrial consumption (% of total consumption)	28%	51%	5%	2%
Divisions	**Udupi**	**Kundapura**	**Chikmagalur**	**Kadur**
AT&C loss (%)	9.7	10.3	21.3	25
Agriculture consumption (% of total consumption)	9%	19%	28%	72%
Industrial consumption (% of total consumption)	23%	17%	16%	4%

Source: AT&C loss in UDAY MoU. Division-wise and category-wise demand collection data of FY16, as obtained from MESCOM

Mangalore-1, Udupi and Bhadravathi divisions recorded less than 10% AT&C losses in FY16 (Table 2). The consumer category-wise consumption in these divisions shows that industrial sector consumption constituted 24%, 23% and 51% of the total consumption, as compared with 17% of the overall industrial consumption for MESCOM. This is because of the presence of large-scale industrial units such as Mangalore Refinery and Petro-chemicals Limited (MRPL), Visvesvaraya Iron & Steel Plant (VISL) and Mysore Paper Mills (MPM) in these divisions. On the other hand, agriculture consumption in these divisions is relatively lower, of the order of 2-18%, against 29% of overall agriculture consumption in MESCOM. The data provided in Table 2 indicate a strong negative correlation (–0.71) between industrial consumption and AT&C losses. Hence, it can be inferred that a high proportion of total sales to large-scale industrial units, combined with the small share of the agriculture sector, may result in very low levels of AT&C losses in these divisions. Also, 100% metering of all installations, including Irrigation Pump (IP) sets (particularly in Mangalore and Udupi divisions), appears to contribute to more accurate accounting of sales and has reduced AT&C losses in these divisions.

In contrast, Sagar and Kadur divisions recorded high losses, in the range of 25-26%. While the agriculture consumption in Sagar and Kadur divisions are as high as 61% and 72% of the total consumption, respectively, industrial consumption is quite low, of the order of 4-5%. The data provided in Table 2 indicate a strong positive correlation (0.76) between agriculture consumption and AT&C losses. The high shares of agriculture consumption in these divisions is questionable, considering they fall in high-rainfall area of the Western Ghats region. Reasons for this unusual consumption figures need further examination.

On the other hand, high AT&C losses (21%) were observed in Chikmagalur, even with lower agriculture consumption (28%). This could be due to (i) low billing (26% of the total IP sets are unbilled), and (ii) the hilly nature of the terrain and the high LT-to-HT ratio of the distribution network. Interestingly, in the Shikaripura division, AT&C losses were still at 16.6%, despite 96% billing of the total IP sets. This could be attributed to 16% of the unbilled rural consumption.

High AT&C losses could thus be relatable to a number of factors, including geographical area, terrain, unbilled rural consumption, unbilled IP sets, inaccurate assessment of specific consumption of unmetered IP sets and absence of bulk power supply to industrial units.

Estimation of the consumption by the agriculture sector significantly affects the AT&C loss calculations of a DISCOM, as supply to IP sets in the state is mostly unmetered, except in districts like Dakshin Kannada and Udupi. Since Karnataka provides free power supply to the agriculture sector, the DISCOMs assess the total agriculture consumption and claim subsidy from the state government in lieu of free power supply. The unmetered supply to the agriculture sector provides a scope for DISCOMs to overestimate the assessed consumption figures pertaining to the agriculture sector in order to claim higher subsidy from the state government and also show reduced AT&C loss levels. DISCOM operations could thus be depicted inaccurately, resulting in (a) higher subsidy payment by the government due to overestimated consumption in the absence of meters and (b) reduced AT&C loss figures by understating theft and inaccurate billing.

In addition, unmetered power supply may also lead to wasteful use of energy and water. For instance, many farmers use inefficient, high-capacity agricultural pumps while availing connections for lower sanctioned loads. This leads to wasteful use of electricity and depletion of groundwater level. Going forward, there is merit in completing 100% metering and billing of all installations in an expedited manner along with conducting a detailed assessment of electricity consumption by IP sets. Also, it would be worthwhile to implement the feeder segregation programme in divisions where agricultural consumption is high, in order to get a more accurate assessment of IP set consumption.

Additionally, regularisation of unauthorised IP sets could help MESCOM reduce its losses, especially in divisions where agricultural consumption is high. There are 2,78,171 authorised and 21,331[9] unauthorised IP sets (7% of the total IP sets) in MESCOM. The Government of Karnataka pays for the power supplied to authorised IP sets only at rates determined by KERC. Specific consumption for each IP set is assessed as 4,447[10] units, with the total consumption for authorised IP sets approved by KERC in FY16 as 1,197 MU. It is also to be noted that specific consumption per IP set in MESCOM is lower than that in CESC, at 6,728[11] units. This could be due to the significant presence of mostly rain-fed plantation crops and high rainfall in the area. Regularisation of unauthorised IP sets would increase the total consumption by 95 MU, resulting in a 2% increase in total energy sales from 4,227 MU to 4,322 MU. The increase in energy sales would correspondingly increase the DISCOM's revenue (in the form of subsidy from government) and result in reduction of losses. However, a detailed analysis and physical verification of IP sets via field surveys will help in a more accurate understanding of the impact of regularisation of unauthorised IP sets on AT&C loss reduction.

4.2. Chamundeshwari Electricity Supply Corporation Limited

CESC was formed out of MESCOM in 2005 and was made responsible for supplying electricity to Mysore, Mandya, Chamarajanagara, Kodagu and Hassan districts (Figure 5). The CESC area is predominantly a plain area (except Kodagu district) with average annual rainfall of 1,250 mm, with some areas of water-intensive crops.

Mysore and Hassan districts have a combination of partly plain and hilly terrain. Climate in these districts is favourable for crops like paddy, jowar, ragi, pulses and sugarcane. Mandya and Chamarajanagara, on the other hand, have mainly plain terrain. The climate in these districts is tropical semi-arid, meaning they receive minimal rainfall. Kodagu is a hilly district with most of its

[9] MESCOM: ARR/ERC & Tariff Petition for FY-18: Replies to Preliminary Observation.
[10] MESCOM tariff order 2017.
[11] CESC tariff order 2017.

economy based on plantations and forestry. Predominant crops in this area are coffee, rubber and paddy.

The organisational structure of CESC comprises one O&M zone in Mysore, headed by a Chief Engineer (Elec.). The O&M zone has four O&M circles, each headed by a Superintendent Engineer (Elec.). Details of the organisation structure of CESC is given in Appendix 4(b).

Districts	Area	Population	Feeders	Base Load	Peak load	LT/HT ratio
5	27,772 sq. km.	81.5 lakhs	1,562	1,000	1,200	1.6

Figure 5: A brief profile of CESC

Source: Stakeholder consultation, CESC website

Operational Parameters

CESC has a total of 28,50,039 consumers in its area. Of this, domestic installations have the highest share, at 77%, followed by agriculture installations at 11% and commercial installations at 8%. Industrial consumers comprise only 1% of the total consumer base, whereas the “Others” category of consumers constitutes 3% of the total consumers in the CESC area (Table 3).

The company supplied a total of 5,176 MU[12] of energy and generated total revenue of Rs. 2,756 crores in FY16. As per category-wise sales (Table 3) in CESC in FY16, the agriculture sector[13] had the highest share, at 42%, followed by the domestic sector at 19% and industrial units at 17%. Consumers in the commercial and “Others” categories have consumptions of 7% and 14%, respectively. As far as revenue (Table 3) is concerned, the agricultural sector contributes (given as government subsidy) the highest revenue at 35%, followed by industrial consumers at 22%. The share of revenue from the “Others” category of consumers is 17%, followed by 11% from the commercial sector. Revenue from the agricultural sector is received as subsidy from the state government, which implies that the subsidy component constitutes a substantial portion of the revenue in CESC. Any delay/deviation in the subsidy payments could therefore affect CESC’s revenue adversely.

Table 3: Consumer-category-wise Installations, Sales (MU) and Revenue (Rs. Cr.) for CESC

Consumer Category	Installations (No.)	Sales (MU)	Revenue (Rs. Cr.)
Domestic	21,98,845	1,006	421
Commercial	2,14,783	887	599
Industrial	39,071	367	307
Agriculture	3,24,144	2,173	951
Others	73,196	744	478
Total	28,50,039	1,006	2,756

Source: CESC tariff order 2017

CESC had an ARR of Rs. 5.32/unit in FY16, against an ACS of Rs. 6.28/unit. This resulted in an ACS–ARR gap of Rs. 0.96/unit in FY16. The revenue gap has occurred as CESC could earn only Rs. 2,756

12 CESC tariff order 2017.

13 Agriculture sector includes categories LT-4a, LT-4b, LT-4c(i), LT-4c(ii), HT-3a and HT-3b.

crores as against an annual revenue requirement of Rs. 3,248 crores in FY16, resulting in a revenue gap of Rs. 492 crores. Similarly, CESC reported a deficit[14] of Rs. 48 crores, Rs. 86 crores and Rs. 11 crores in FY 12, FY13 and FY14, respectively. However, there was surplus revenue of the order of Rs. 23 crores in FY15 (Figure 6).

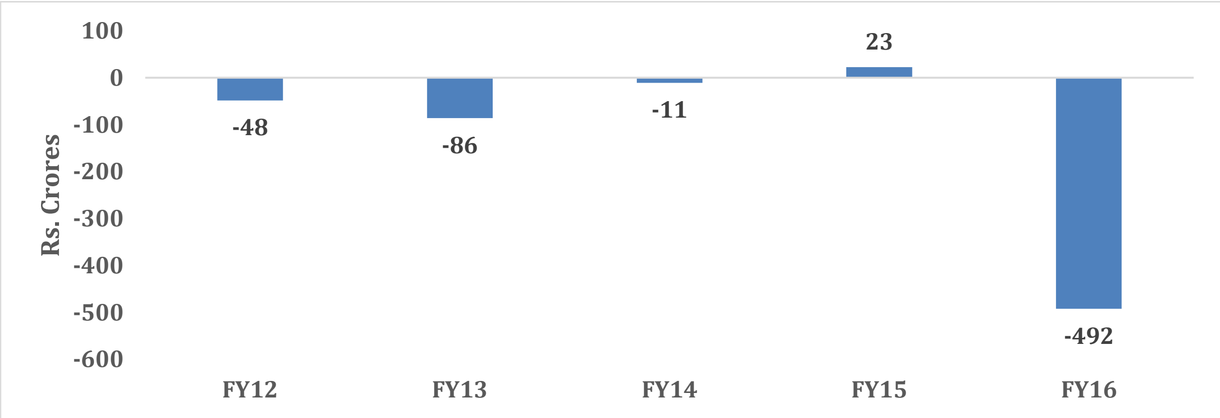


Figure 6: Revenue gap of CESC (Rs. Cr.) from FY12 to FY16

Source: CESC tariff order 2013, 2014, 2015, 2016 and 2017

AT&C Losses

The MoU signed by CESC for the UDAY scheme stipulates an AT&C loss target of 14.5% to be achieved by FY19. As per CESC Tariff order 2017, the AT&C loss level in CESCOM was 17.26% in FY16. Figure 7 shows a division-wise AT&C loss heat map for CESC.

The consumer-category-wise consumption data in the 15 divisions of CESC (Table 4) clearly indicate a pattern, which suggests a strong correlation between the level of AT&C losses and the relative proportion of sales to agricultural and industrial consumers. As can be seen, in 9 out of 11 divisions where AT&C losses exceed 15%, the share of agriculture exceeds 50% of the total sales. A possible explanation for the high AT&C losses being associated with a high proportion of agriculture sector consumption lies in the fact that IP sets are scattered over large rural areas, leading to a higher level of line losses (technical) relative to sales. The limited hours of supply, often with several interruptions, may also be a contributory factor. It is also possible that the methodology adopted by DISCOMs to estimate the quantum of electricity supplied to IP sets results in a significant overestimation of consumption by IP sets.

[14] CESC tariff order 2013, 2014, 2015, 2016 and 2017.

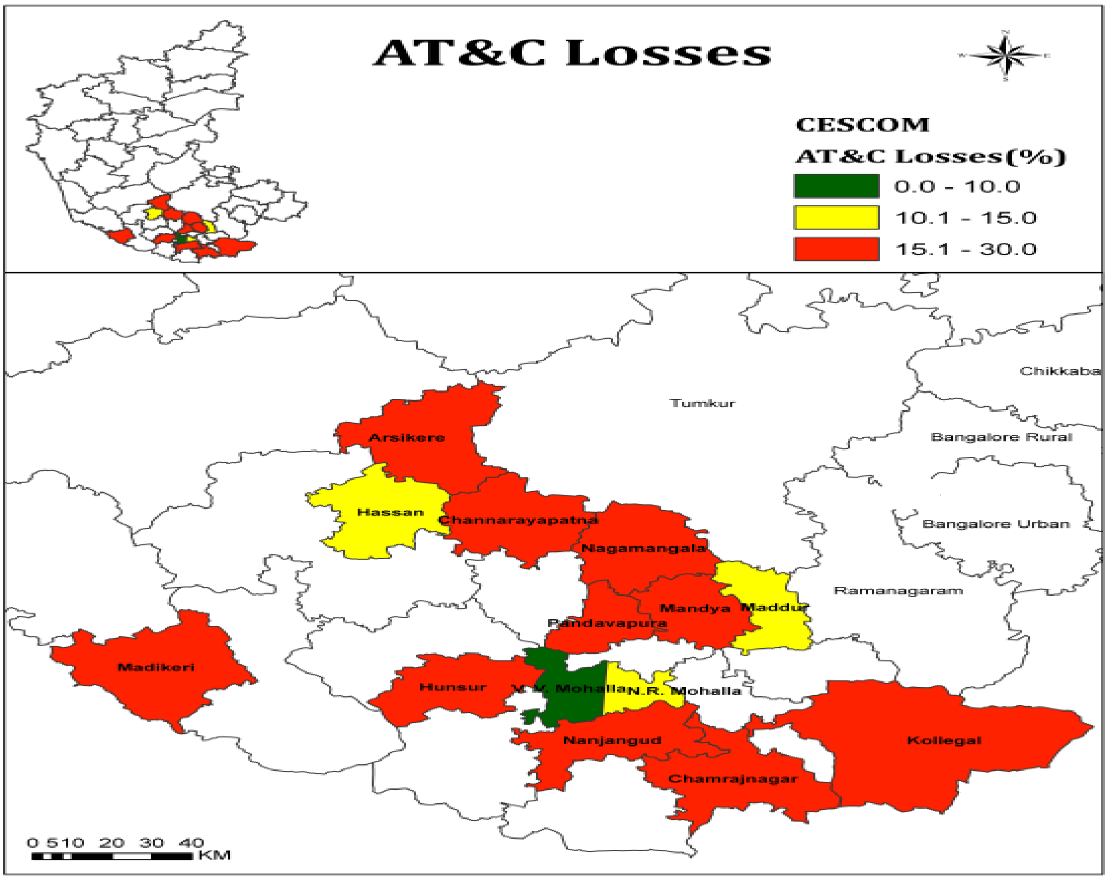


Figure 7: Division-wise AT&C loss heat map for CESC in FY16

Source: UDAY MoU between MoP and Karnataka DISCOMs, CSTEP Analysis

Table 4: Division-wise AT&C losses for CESC in FY16[15]

Divisions	**N.R. Mohalla**	**V.V. Mohalla**	**Nanjangud**	**Hunsur**	**Ch.Nagar**
AT&C loss (%)	14.9	8.4	16.9	19.7	20.1
Agriculture consumption (% of total consumption)	9%	5%	39%	59%	74%
Industrial consumption (% of total consumption)	18%	50%	39%	11%	4%
Divisions	**Maddur**	**Pandavapura**	**Nagamangala**	**Hassan**	**C.R.Patna**
AT&C loss (%)	10.8	16.9	18.2	13.5	19.5
Agriculture consumption (% of total consumption)	37%	73%	78%	37%	77%
Industrial consumption (% of total consumption)	8%	5%	3%	23%	6%
Divisions	**Kollegala**	**Madikeri**	**Mandya**	**Arsikere**	**H.N.Pura**

[15] UDAY monitoring formats (April-June 2016) and division-wise and category-wise demand collection data of FY16 as obtained from CESC.

AT&C Loss (%)	24.3	28.8	20.5	15.1	18.6
Agriculture consumption (% of total consumption)	69%	12%	53%	75%	71%
Industrial consumption (% of total consumption)	2%	11%	7%	3%	3%

Source: UDAY monitoring formats (April-June 2016) and division-wise and category-wise demand collection data of FY16 as obtained from CESC.

The strong correlation between level of agriculture sector consumption, predominantly in rural areas, and AT&C losses also suggests imperfect metering and billing of overall consumption in these areas. In CESC, as well as in other DISCOMs in the state, most domestic consumers are provided with electromechanical meters whose accuracy is not verified regularly. Also, meters in most villages are not read by employees of DISCOMs, but by part-time local retainers called GVPs (Gram Vidyut Pratinidhis) who may have reasons to understate consumption by many consumers. This, combined with unauthorised tapping of electricity, by hooking in some cases, may significantly contribute to high levels of AT&C losses associated with a high proportion of agricultural/rural consumption in CESC districts.

Two divisions where the above relationship between high AT&C losses and a large proportion of agriculture consumption does not hold are Madikeri and Nanjangud divisions. Madikeri, with about 29% of AT&C losses, the highest for any division, has only 12% power sold to agriculture and 11% to industrial consumers. The hilly nature of the terrain and the high LT-to-HT ratio of the distribution network may contribute to the high level of (technical) losses in this division. Also, unlike in other divisions, agriculture feeders have not been separated in this division. It is therefore necessary to undertake a systematic analysis of the feeder-wise and DT-wise data of the energy supplied and compare the same with sector-wise consumption figures to determine the factors leading to the high AT&C losses in this division. In the case of Nanjangud division, where AT&C losses are at 16.9%, agriculture consumption is 39%, which is not much lower than the 50% mark. This division also has industrial units consuming 39% of the total power sold. Thus, whether the high line losses in rural areas with IP sets or the high level of leakage in the industrial supply contributes to high AT&C losses needs further investigation.

In three out of four divisions, which have less than 15% AT&C losses in CESC, the proportion of power consumed by the industrial category is more than the CESC average of 17%. These divisions, i.e., N.R. Mohalla, V.V. Mohalla and Hassan, where the share of industrial consumers ranges between 18% and 50%, also have a high level of urban consumers in the domestic category. V.V. Mohalla is the only division recording losses less than 10%. The low AT&C loss levels in this predominantly urban area with industrial concentration is relatable to high industrial consumption (50% of the total consumption), accurate 100% billing and collection, and low agriculture consumption (5%). The exception in this group is Maddur division with industrial consumption of only 8% (and agriculture accounting for 38%). This calls for further investigation to determine the causes for losses.

Unlike in the case of MESCOM, it is not possible to attribute any part of the AT&C losses in CESC to unauthorised IP sets whose consumption is not eligible for subsidy from the government. The 2017 CESC tariff order by KERC clearly indicates that specific (average) consumption per IP set is based on supply through separated agriculture feeders as recorded at the substation level, which includes consumption by both authorised and unauthorised IP sets. In its order, KERC has also noted that CESC has already given Revenue Register (RR) numbers to almost all unauthorised IP sets and has thus legitimised their consumption. Hence, high AT&C losses in CESC could be relatable to a number of factors, including inefficient collection mechanisms leading to poor collection efficiency, hilly terrain, forest cover, unaccounted losses and inaccurate assessment of specific consumption of IP sets. Further, overestimation of agriculture consumption due to unmetered supply could cover other reasons for high AT&C losses such as low billing and collection, theft, pilferage, etc. Going forward, there will be merit in completing 100% metering and billing of all installations in an expedited manner along with robust collection mechanisms in place. Additionally, use of covered conductors with insulated wires could help improve reliability and avoid theft through direct tapping. Also, specific consumption per IP set could be reduced by use of modern irrigation technologies such as drip irrigation and sprinkler systems.

5

Analysis

5. Analysis

5.1 AT&C Loss Reduction

The concept of Aggregate Technical & Commercial (AT&C) losses was introduced in India in 2001. Before that, Transmission and Distribution (T&D) losses were calculated based on bills issued to consumers and not on the revenue collected. Thus, gaps between billing and collection were not captured accurately in the T&D losses. The concept of AT&C losses was introduced to assess the total losses in the system, including losses due to poor collection. It provides a more realistic picture of energy and revenue loss in the system.

AT&C losses are defined as the difference between energy input and the energy utilised for which payment is collected. Low levels of AT&C losses would mean that a DISCOM is more likely to fully recover the amount spent on each unit of energy sold. Alternatively, the amount spent on purchasing power for any given level of sales could be reduced. With low levels of AT&C losses, revenue is maximised for a given quantity of power, resulting in profitable operation for a DISCOM.

AT&C losses are made up of two components, technical losses and non-technical (commercial) losses. Technical losses are unavoidable and occur due to flow of power through the T&D network. These losses can be reduced to an optimum level through strengthening of the system by measures such as adding lines matching the load, maintaining a low LT-to-HT ratio and installing DTs of right size and capacity to manage the load. The target levels for technical losses as per international standards are 4.25%[16] (Table 5). As per a World Bank report, China and Korea recorded technical losses (achieved) of 5% and 3%, respectively, in 2014.

Table 5: International norms for technical losses in distribution

System Component	Target Loss Level (%)
Distribution Station (33/11 kV)	0.25%
Distribution Primary (11 kV)	3%
Distribution Secondary (11/0.415 kV)	1%
Total technical loss	4.25%

Source: High Voltage Distribution System (HVDS) Analysis for Technical Loss Reduction in Power Distribution System – January 2014

Commercial (non-technical) losses, on the other hand, could be attributed to various reasons such as defective meters, failure in reading all the meters, failure to collect billed revenue, data translation losses in billing and incorrect recording of meter reading by third-party agencies or DISCOM staff. Additionally, theft of electricity due to illegal connections and meter tampering could adversely impact the accounting of actual consumption by consumers.

Average AT&C losses at the national level in India stood at a level of 22.7% in FY15 (as per CEA report of March 2017). There are well-defined ways/methods, such as adoption of a High-Voltage Distribution System (HVDS), use of aerial bunched cables and network reconfiguration[17], through

[16] Conference paper on High Voltage Distribution System (HVDS) Analysis For Technical Loss Reduction In Power Distribution System – January 2014
[17] *International Journal of Engineering Trends and Technology (IJETT)* - Methods to Reduce Aggregate Technical and Commercial (AT&C) Losses.; Volume 4 Issue 5- May 2013

which technical losses can be reduced to an optimum level. Commercial losses can be brought down by effective metering of consumption, accurate billing, 100% serving of bills to consumers and by implementing efficient collection mechanisms to recover dues from consumers. Energy auditing to determine technical and non-technical losses separately has been adopted as a major reform initiative for reducing AT&C losses in Karnataka. KERC mandated energy audit for 11 kV substations in September 2001[18]; however, it was implemented only from June 2003.

5.1.1 Energy Auditing (11 kV feeder)

As per UDAY MoU, each DISCOM must follow a given trajectory to reduce their AT&C losses to a target level by FY2019 [Appendix 3(a) and 3(b)]. Thus, energy auditing at 11 kV feeder level is considered an integral part of this exercise, to help in accurate measurement of losses along with identification of areas of wastage, leakage and inefficient use.

The KERC format provides a detailed description of separate calculation of technical and commercial losses. These losses are then compared with the standard values of technical and commercial losses provided by KERC. In case of significant deviations from the standard values, measures have to be taken by respective DISCOMs to reduce these losses through network improvement and effective monitoring mechanisms.

In the subsequent section, we briefly describe the procedure prescribed by KERC for carrying out this audit. Figure 8 is a visual representation of the format. The detailed format (Excel) mandated by KERC for conducting energy audit is provided in Appendix 5 for reference.

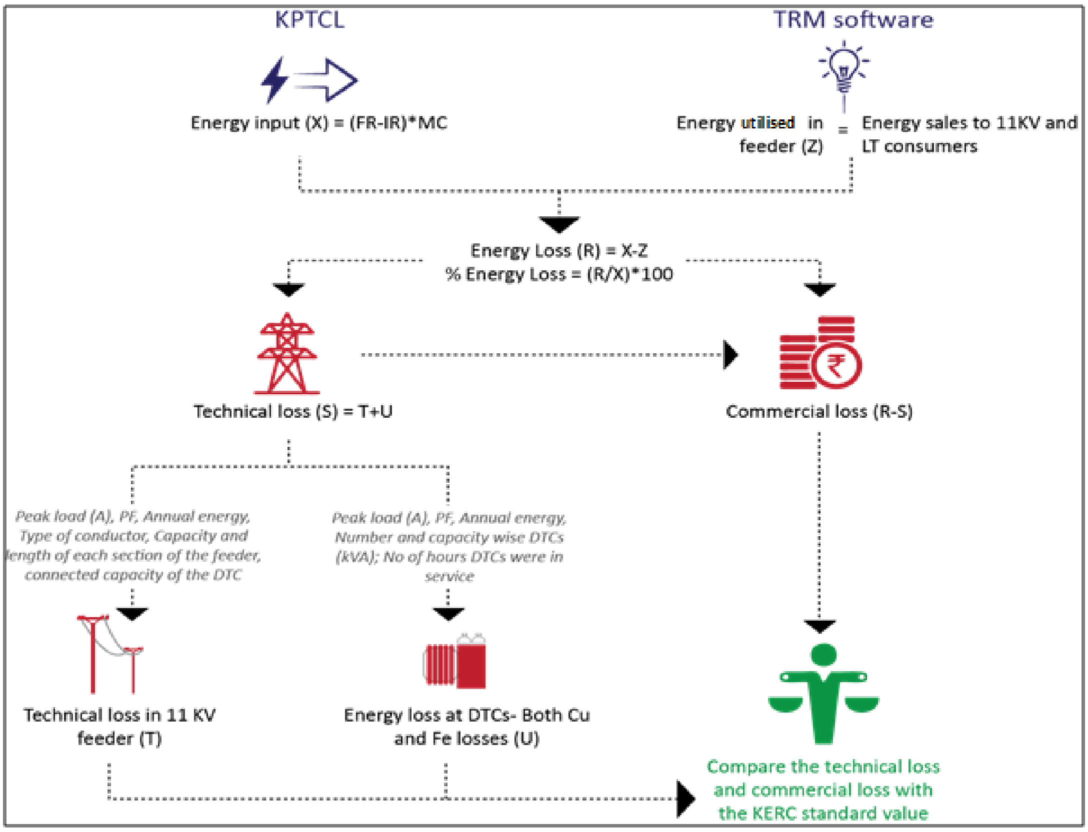


Figure 8: KERC format of energy auditing at 11 kV feeder level

[18] CAG Audit Report No. 4 (Commercial) for the year ended 31 March 2011.

Source: KERC, CSTEP

The energy input (X) to a feeder is calculated based on the initial and final readings recorded in the meter over a period of one month. The difference between the energy input and the energy utilised is the energy loss (R). The energy utilised (Z) is calculated from the energy billed to high-tension (HT) and low-tension (LT) consumers. As per the methodology of the Power Finance Corporation (PFC), the energy utilised is calculated based on the payment collected against the energy input. However, as per KERC format, the energy utilised is calculated on the basis of the energy billed. AT&C loss calculation on account of billed energy would be more feasible, because the energy input for which payment is not collected is termed as revenue due or receivables, which could be recovered at a later date.

Energy Input (X) = (Final Reading – Initial Reading) * Meter constant

Energy Loss (R) = Energy Input (X) – Energy Utilised (Z)

Technical losses (S) are calculated at 11 kV feeder and DT levels. Technical losses at feeder level (termed "T" in the equation below) are calculated on the basis of inputs such as peak load, type of conductor, capacity and length of each section of the conductor, and connected capacity of the DTs. Technical losses, both copper and iron losses, at DT level (termed "U" in the equation below) are calculated based on the number of hours DTs were in service, peak load, power factor, and number and capacity of DTs. Summation of technical losses at both 11 kV feeder and DTs is the total technical losses of the feeder.

Technical Loss (S) = Technical loss at 11 kV feeder (T) + Technical loss at DTs (Copper and Iron loss) (U)

The difference between total energy loss (R) and technical loss (S) is the commercial loss. It is calculated as Commercial loss (Y) = Energy Loss (R) – Technical Loss (S)

A simplified schematic representation of the 11kV-feeder-level analysis is shown in Figure 9.

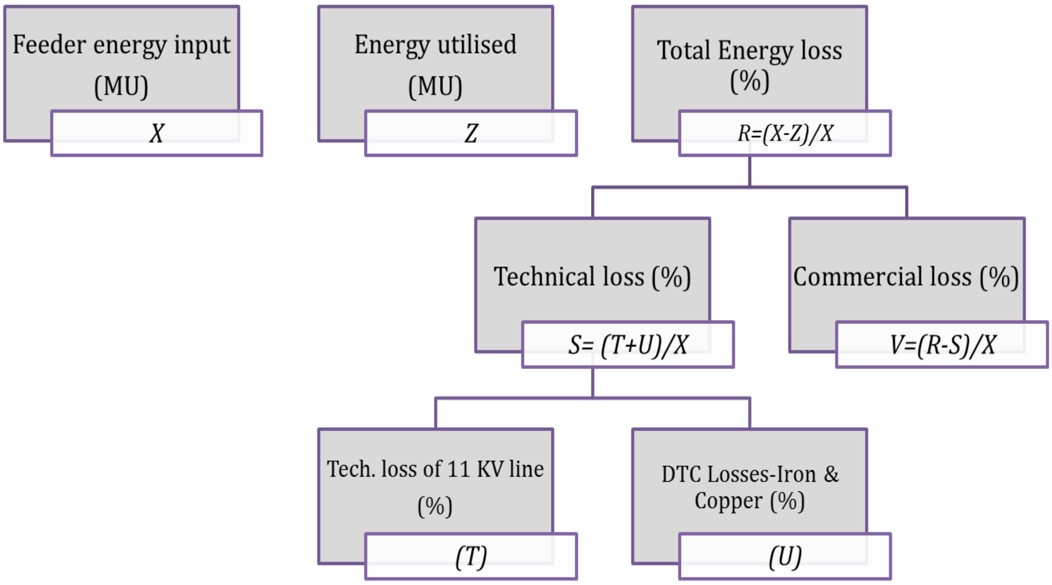


Figure 9: Schematic representation of 11kV-feeder-level analysis

Source: KERC, CSTEP

Analysis

Our study revealed that energy audit in DISCOMs is not carried out for all 11 kV feeders. While the KERC format has a provision to show technical and commercial losses separately, only total energy losses (*R*) are reported by DISCOMs.

A sample analysis for select feeders was conducted by the CSTEP field team. The analysis showed that technical losses were within KERC's permissible limits (1.5-3.5%). However, commercial losses ranged from 30% to 45%, which is far above permissible limits (<1%) prescribed by KERC. In some cases, the data made available pointed to negative technical and commercial losses, indicating that the measurement of losses was inaccurate. This necessitates robust quality control and monitoring mechanisms to ensure that data are accurate and reliable.

Issues

Based on our scrutiny of field data, we identified the following issues (Figure 10) which will impact the accuracy of accounting of consumption:

- *Data entry*: Partial information of consumer's consumption data, for some feeders, in the portal
- *Tagging*:
  - Incomplete tagging (feeder to DT and DT to consumer)
  - Consumption data for a few consumers that are physically connected to one feeder were, however, reflected under another feeder in the database
  - Mismatch in DT-consumer mapping in the database and physical connectivity of DTs and associated consumers
  - Lack of updation of asset information in the database, especially when assets like old/failed DTs are replaced with new/high-capacity DTs.
- *Feeder switching*:
  - Energy reported (as utilised in the feeder) was higher than the input energy fed into the feeder. This means that supply from more than one feeder is received by consumers tagged to a given feeder.
- *Actual operating hours of DTs* were not recorded. We gathered from field audits that some of the DTs connected were idle/faulty and the same was not reflected in the database
- *Lack of time synchronisation*: We noticed that DT copper and iron losses are calculated on a yearly basis, whereas overall feeder losses are calculated monthly. Due to this, DT losses are prorated to calculate month-wise losses, which may impact the accuracy of estimates of technical losses at DT level.

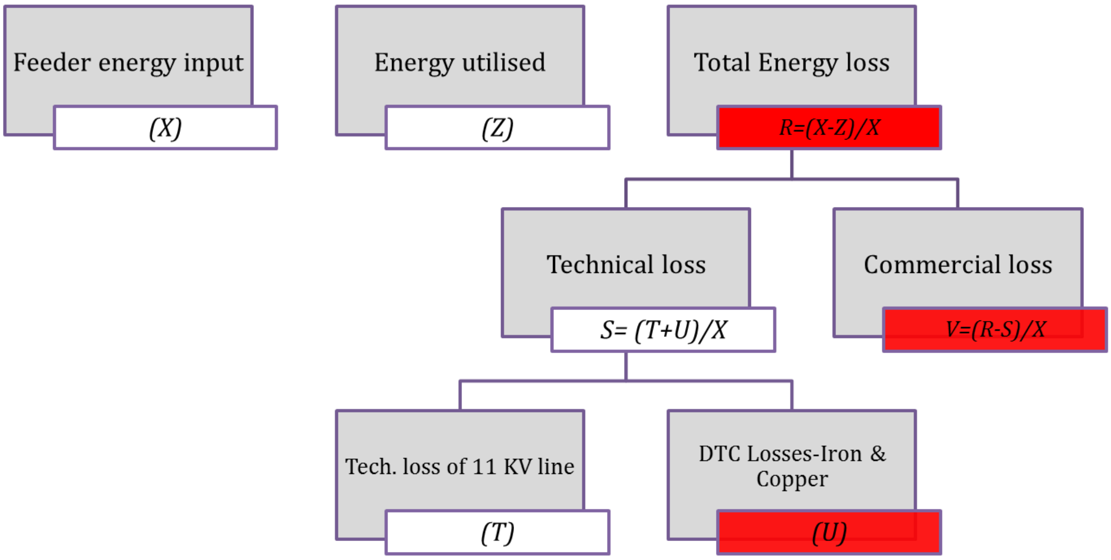


Figure 10: Feeder-level analysis for a sample feeder based on DISCOM data

Source: KERC, CSTEP

Suggested Measures

During the field audit exercise (carried out by CSTEP), readings for a feeder and connected DTs were recorded on two different days spanning one month. For consumers connected to these DTs, consumption for the same time period was obtained from the bills provided by the DISCOM. It was found that the AT&C loss calculated (based on readings taken during the field survey) did not match the calculations done on the basis of data extracted from the portal. The discrepancy in the AT&C loss figures could be attributed to a number of factors such as inaccurate data entry, incomplete consumer indexing, faulty or idle DT, absence of boundary meters, etc., as discussed above.

We recommend the following measures for effective energy auditing (Figure 11 and Figure 12):

- *Compliance*: Mandatory compliance to KERC format for energy auditing at 11 kV feeder level in all subdivisions
- *One-time tagging drive*: Most of the errors occur due to inaccurate mapping of feeders to DTs and DTs to consumers. It is recommended to have a tagging drive in which all consumers and DTs are mapped within a stipulated timeframe. Considering every consumer meter is read within one month for a billing cycle, it is estimated that the entire tagging of consumers to DTs could be completed in one month or one billing cycle. Therefore, both CESC with a total of 94,258 DTs and MESCOM with a total of 54,056 DTs can complete the mapping of all DTs in one month. It is recommended that teams of DISCOM field employees (including linemen, GVPs) led by a JE be assigned the task of mapping DTs and consumers. This could be verified and validated by a third party in the following month. Rotation of JEs for tagging and feeder auditing can be considered for ensuring strict adherence to the tagging methodology and timelines.
- *Continuous updation*: The system/database of DTs and connected consumers should be updated on a continuous basis
- *Installation of boundary meters*: Installation of boundary meters should be mandated in every subdivision in order to record energy received from each 11 kV feeder distinctly. This will help in correct estimation of energy input from each feeder in a given area. Also, energy input

and energy utilised need to be captured on a regular basis in the database for accurate calculation of feeder-wise losses during feeder switching

- *Synchronisation of feeder, DT and consumer readings:* Readings of the feeder and DT meters should be recorded at a defined frequency so as to identify any mismatch in feeder, DT and consumer meter readings. In any given billing cycle, the total energy consumption as recorded at the consumer level must correspond to the readings of DT meters and the input energy at the feeder level, with only the technical losses accounting for the difference. Any abnormal difference may point to inaccurate recording/billing of energy consumed. As an illustration, the following methodology can be adopted:
    - Step 1: Record reading of feeder and connected DT meter on the same day
    - Step 2: Record DT reading on 1st of every month (Morning)
    - Step 3: Record the readings of all consumers connected to the particular DT on the same day
    - Step 4: Record DT reading again on the same day after all consumer readings are read
    - Step 5: Repeat the DT and consumer meter reading after one week or any specified number of days
    - Step 6: Average of two DT readings over the period should roughly correspond to the sum of consumption of all consumers connected to the DT during that period
    - Step 7: Identify discrepancy (if any)
    - Step 8: Follow the same methodology for comparison of feeders and DT meter readings.
- *Feeders as Sales and Service Unit (SSU):* In order to achieve financial viability in the distribution sector, it is important to ensure complete accountability of each operating unit in the system. At present, commercial accountability is centralised at the Board level or at the corporate office level of each DISCOM. It is vital to introduce commercial accountability in a decentralised manner as part of the organisational structure of the DISCOMs. This would require the input energy of each feeder being related to the billed consumption, with the concerned staff made accountable for any discrepancy. This would enable revenue maximisation for a given input of energy, thus minimising leakage of revenue through AT&C losses.

  It is suggested that the management of the distribution network under each 11 kV feeder be made the responsibility of a sales and service team headed by a Feeder Manager (Junior Engineer/Assistant Engineer). This team should be equipped to meet most of the O&M needs of the network and also be accountable for billing and collection of revenue. The Sales and Service Unit (SSU) can then be treated as a profit centre, and the profit/ loss of this SSU should be calculated based on the total input energy handled by the SSU at an assigned cost and the total amount billed based on the sales of this input energy. Any abnormal difference between the two should be explained by the Feeder Manager. The Feeder Manager should take necessary actions to reduce discrepancies in input energy and sold energy. These SSUs should use geospatial-based information tools for mapping their assets, location of meters and complete consumer profiles. Additionally, sufficient field-level staff would help in better management of the Unit.

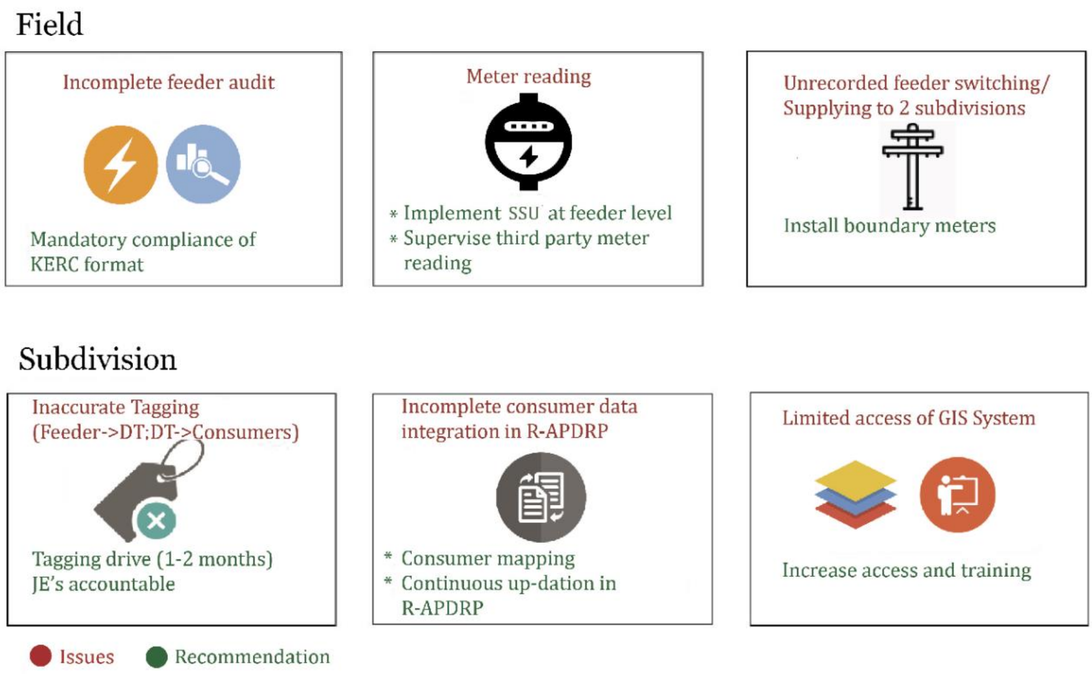


Figure 11: Energy Auditing - Issues and recommendations

Source: Stakeholder consultation and CSTEP analysis

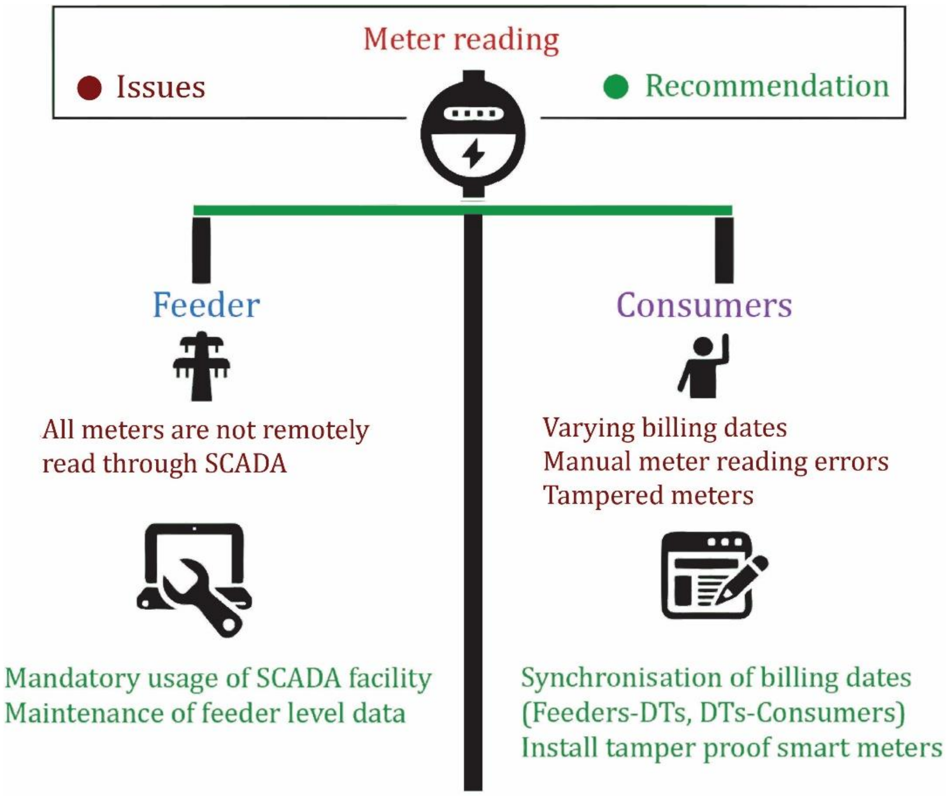


Figure 12: Meter Reading - Issues and recommendations

Source: Stakeholder consultation and CSTEP analysis

5.1.2 DT Metering and DT Asset Registry

DT is one of the most vital assets in any distribution network. It acts as an important link between a DISCOM's network and a consumer. Despite this, frequent failures of transformers are common in many DISCOMs, leading to disruption in power supply. DISCOMs incur huge expenditure towards repair and replacement of DTs. As per Indian Electricals and Electronics Manufacturers Association (IEEMA), the average annual transformer failure rate in the country is 13%; about 70%[19] of these failed transformers are repaired and the balance 30% is replaced. The additional cost burden on the power sector due to failed transformers at the national level is estimated at about Rs. 5,000 crores[4] (repair, Rs. 3,000 crores; replacement, Rs. 2,000 crores).This added burden on the power sector can be avoided by efficiently maintaining transformers. This would also improve the quality of service to the consumers greatly by avoiding frequent interruptions in power supply.

Analysis

DT Monitoring: The failure rate of DTs in MESCOM and CESC lies in the range of 10-11%. As per MESCOM and CESC annual reports, CESC incurred a total cost of Rs. 60 crores for repair and replacement of failed transformers in FY15, whereas the cost incurred by MESCOM was Rs. 29 crores. At present, reasons for transformer failures are recorded on an Excel spreadsheet named "DT asset register". According to the information on the register, the majority of the transformer failures were attributed to conditions of overloading.

DT Metering and Meter Reading: As per the MoU signed among state DISCOMs, GoK and MoP, 100% DT metering is one of the targets to be achieved by DISCOMs by March 2018. DTs are to be equipped with Advanced Metering Infrastructure (AMI) meters, which have a communication system to enable recording readings from remote locations. This would result in reduction of associated meter reading costs to DISCOMs due to reduced visits by meter readers.

At the time of the study (March 2017), 100% metering of DTs was not achieved in either of the DISCOMs. While MESCOM had 70% of 54,056 DTs metered, only 30% of the 94,258 DTs were metered in CESC. The meters installed, in most cases, were not of AMI type.

Issues

Based on our field visits and discussions, the following issues were identified:

- *Meter reading*: During field verification of an 11 kV feeder, it was found that, although all the DTs connected to this particular feeder were installed with AMI meters with a communication system, the meters did not communicate with the control centre effectively. Despite installation of AMI meters for each DT, a meter reader is sent to record the readings from all DTs every month. In some cases, DTs were in inaccessible locations, and often DT meters were located at a height, making it difficult for the meter reader to record readings. This resulted in inaccurate meter readings for some consumers in the database
- *Consumer mapping*: New consumers were not mapped with DTs to update the database on a continuous basis. Also, faulty DTs, when replaced with higher capacity DTs, did not have any consumers mapped to them
- *DT asset register*: While the reasons for the failure of transformers are recorded in asset registers maintained by DISCOMs, the records did not contain adequate details in many cases. Important parameters such as DT make, DT code, date of service and date of failure were not

[19] 8th Annual Conference on "Power Distribution in India": Issues & Challenges; Strategies & Solutions.

recorded in a majority of the cases. In a few cases, the information entered was not validated. For instance, we observed that the date of failure of transformer was not consistent with its date commissioning for a few DTs

- *DT monitoring:* Apart from overloading, poor maintenance, improper fuse protection, oil leakage, lack of a quality assurance plan, etc., are a few other technical issues, which lead to the failure of DTs. Based on our discussions at the subdivision level, most of these issues were identified only after the failure of the transformer. Adequate preventive maintenance is not evident in many cases
- *Third-party contracts for meter reading:* DISCOMs generally outsource meter reading to an external agency and a mechanism to periodically validate the data entered by these third-party agencies is not in place.

Suggested Measures

Based on the issues highlighted, the following measures are recommended for an effective DT monitoring setup :

- *Consumer indexing using a web-based visualisation platform*: Accurate mapping of consumers to respective DTs should be mandated and enforced. A geospatial-enabled visualisation platform along with a mobile app could be utilised by field-level staff for
    - Effective tracking of DT locations and capacities along with respective consumers connected to the DTs. With addition of new consumers, the system can be updated as required
    - DT monitoring and maintenance.

  CSTEP has developed a platform to illustrate the above. A snapshot of the platform is provided in Figure 13 and Figure 14 . The red circles represent DTs and the yellow boxes represent consumers connected to particular DTs.

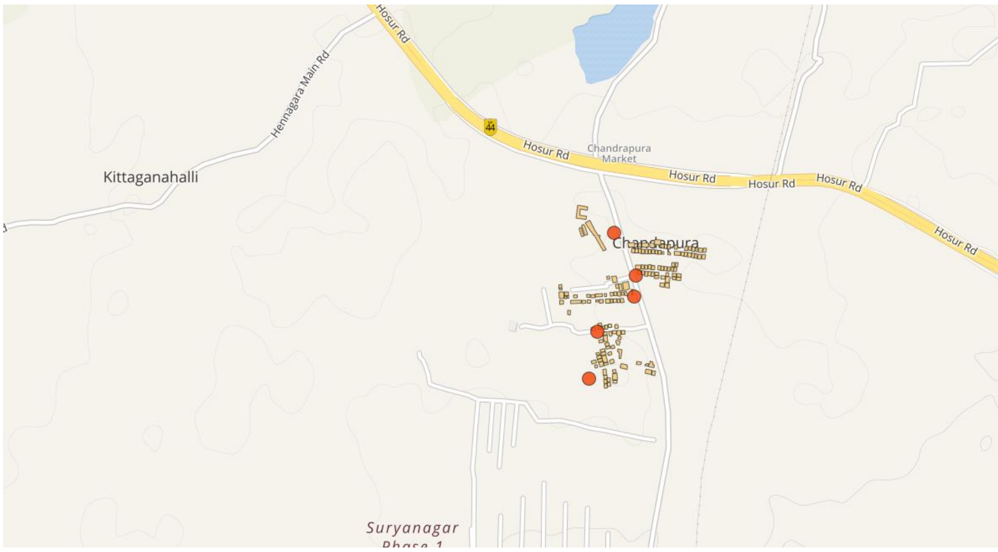


Figure 13: CSTEP tool for geospatial visualisation of DTs and consumers

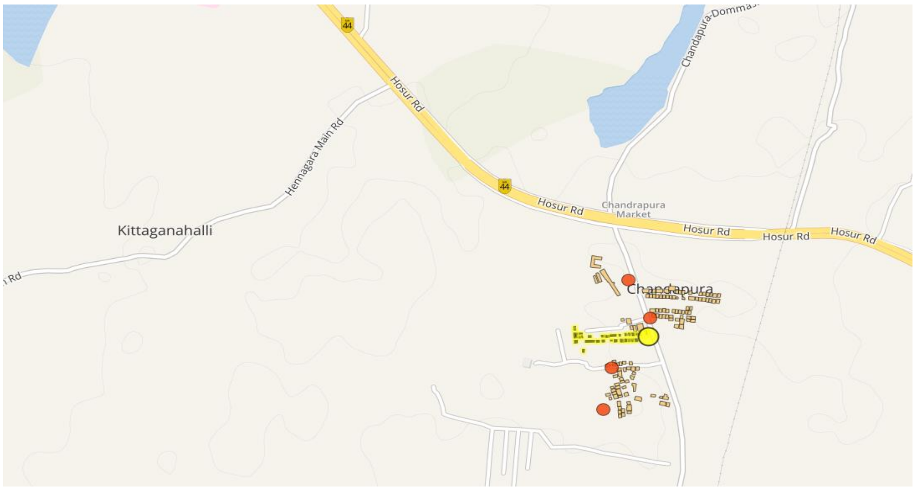


Figure 14 : Tool snapshot highlighting DTs and connected consumers

- *Distribution Transformer Lifecycle Management System (DTLMS)*: An online system to track the performance of all DTs throughout their lifecycle helps in tracking operational parameters such as oil level, oil temperature, ambient temperature, load parameters, etc. In case of any deviations from the permissible limit, the system would provide alerts to utility officials prompting immediate attention. This preventive maintenance would help in reducing the DT failure rate along with reduction in the capital expenditure (capex) incurred on the replacement of the failed transformers. This capex can, in turn, be utilised better by DISCOMs for upgrading their network infrastructure. Figure 15 shows issues and recommendations associated with DT metering and asset registry.

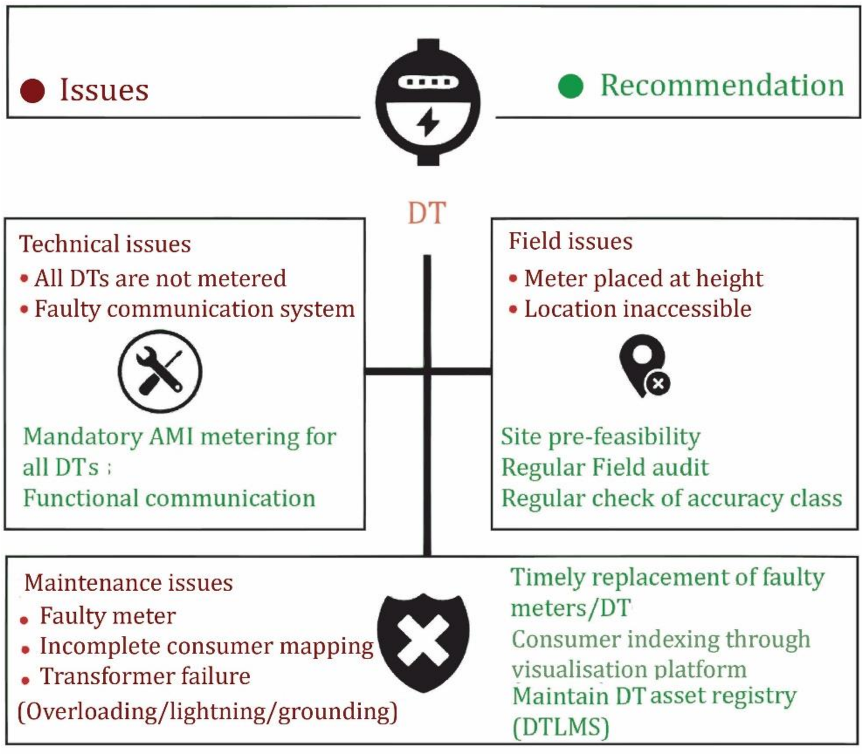


Figure 15: DT Metering and Asset Registry - Issues and recommendations

Source: Stakeholder consultation and CSTEP analysis

5.1.3 Smart Metering

A smart meter is an electronic device for two-way communication between the meter and the central distribution network. The meter records the consumption of electricity by the user in short intervals and communicates this recording to the central system for monitoring and billing. It is envisaged that once all consumers have installed smart meters, accurate measurement of losses would be possible, aiding in the reduction of AT&C losses by undertaking measures to identify and plug any leakages. In addition to reduction of AT&C losses, smart metering will also aid in peak load management, outage management and tamper detection.

Since meter reading is a critical activity for measuring loss levels in distribution, it would be useful to bring all consumer categories under the smart metering initiative. However, the UDAY scheme mandates the installation of smart meters for consumers with greater than 500 kWh consumption by December 2017 and for consumers with consumption more than 200 kWh by December 2019. This entails that none of the consumers in rural areas will be covered under the smart grid initiative. However, for effective energy audit, all consumers are required to be metered. The scope (in terms of target consumers) of implementing smart grid initiatives thus needs to be revisited. In the alternative, a more rigorous system of meter reading combined with replacement of the electro-mechanical meters with more accurate meters can help in reducing loss levels in the rural areas.

Analysis

Based on the analysis conducted for the two DISCOMs, it was found that a piece-meal approach has been adopted for implementation of the smart metering initiative. In MESCOM, a small pilot project was undertaken in 2010 for implementation of smart meters. The project was implemented in Mangalore city to monitor and control the loads of 100 consumers connected to two DTs along with controllability options in two street-light circuits.

In CESC, the smart metering project was undertaken in a part of one division in Mysore in 2013, and the work is in progress in its area of service. The project involves installation of smart meters in the premises of 21,824 consumers (10% of total consumers in Mysore city), with a good mix of residential, commercial, industrial and agricultural consumers, including 512 IP sets. It covers over 14 feeders and 473 distribution transformers, and accounting for input energy of 151.89 MU. Functionalities of peak load management and outage management are sought to be achieved by implementing AMI for residential consumers and industrial consumers, besides integration of distributed generation/micro-grid integration. CESC is planning to implement smart meters for other areas based on the results of implementation of this pilot project.

Issues

Following were some of the barriers for the implementation of smart metering projects on a large scale:

- *Large investment*: Implementation of a smart meter system entails significant investment for a DISCOM. The investment made has to be justified through earning of incremental revenue with changes made in the system. As per estimates of the Indian Smart Grid Forum (ISGF)[20], installation of smart meters for one million consumers would involve a total expenditure of Rs. 490 crores assuming a smart meter cost of Rs. 4,000/per consumer. This would result in annual savings of Rs. 126 crores for a DISCOM. The savings accrued will be in terms of

[20] ISGF White Paper on AMI Rollout Strategy and Cost-Benefit Analysis for India.

reduced meter reading cost, reduced data entry cost for bill generation, reduced cost for disconnections/reconnections, faster detection of dead meters in the system, reduction in AT&C losses and DT failure rate, and reduction in peak power purchase cost

- *Replacement of existing meters*: Existing meters have to be replaced with smart meters for implementation of this initiative. The cost associated with the dismantling of existing meters should be taken into consideration
- *Lack of proper infrastructure & communication technology:* Consumers with consumption of greater than 500 units are dispersed and not confined to one division or area. Deployment of a communication network to cover widely dispersed consumers and localities with difficult terrains can be challenging to DISCOMs
- *Integration of devices*: With increasing number of consumers who are dispersed over a wider geographical area, integration of various devices becomes complicated.

Suggested Measures

In order to mitigate issues related to the implementation of smart meters, the following measures are suggested:

- *Streamlining the energy auditing process*: In order to have a successful outcome from the smart metering initiative, all DTs should be installed with smart meters, which could record real-time data remotely. This could be periodically tallied with the summation of the meter readings of the consumers connected to those DTs. This would help in identifying leakages in the system and aid in reduction of AT&C losses.

- *Feasibility analysis*:
  - The decision on implementation of smart meters should be based on thorough feasibility studies, taking into account DISCOM requirements and cost of smart meters. For instance, it might not be worth implementing smart metering in areas with high industrial consumption as there would be low levels of losses, to begin with
  - As a first step, an entire section office could be selected based on a representative mix of residential, commercial, industrial and rural consumers for a pilot project
  - An impact assessment of the pilot projects should be carried out based on parameters such as inter-operability, meter quality, communication technology (range and feasibility), customer satisfaction levels and utility benefits. Based on the impact assessment of the pilot project and the lessons learnt, large scale roll-out of the scheme could be explored.

5.2 Power Purchase Planning

Power purchase cost accounts for about 70-80% of the annual revenue requirement of DISCOMs. The total cost incurred on the supply of power to consumers depends largely on the amount spent on purchase of power. Thus, it is very important to have an efficient process for power procurement planning, without which the financial health of DISCOMs could be impacted adversely. Distribution companies procure power from various sources to ensure power supply to their consumers. The sources of power include central and state generating stations, independent power producers (IPPs) and power exchanges. In Karnataka, power purchase on behalf of DISCOMs is carried out by the Power Company of Karnataka Limited (PCKL). It is a special-purpose vehicle[21] set up by GoK to

[21] http://www.pckl.co.in/frmAboutUs.aspx.

supplement the efforts of Karnataka Power Corporation Limited (KPCL) in capacity addition and procurement of power on a long-term basis. PCKL is now engaged in buying power on a short-term basis as well, based on specific requirement of DISCOMs. Figure 16 indicates the % share of source-wise purchase by all five DISCOMs in Karnataka in FY16. The state-owned thermal and hydro plants contributed 40% to the supply in FY16. Around 28% came from the state's share in Central Generating Stations (CGSs) and 9% from non-conventional sources (NCEs). The balance requirement was met through purchase from major IPPs (13%) and short/medium-term purchases (10%). Karnataka purchased around 4,824 MU of energy from the short-term market in FY16, which is 8% of its total requirement.

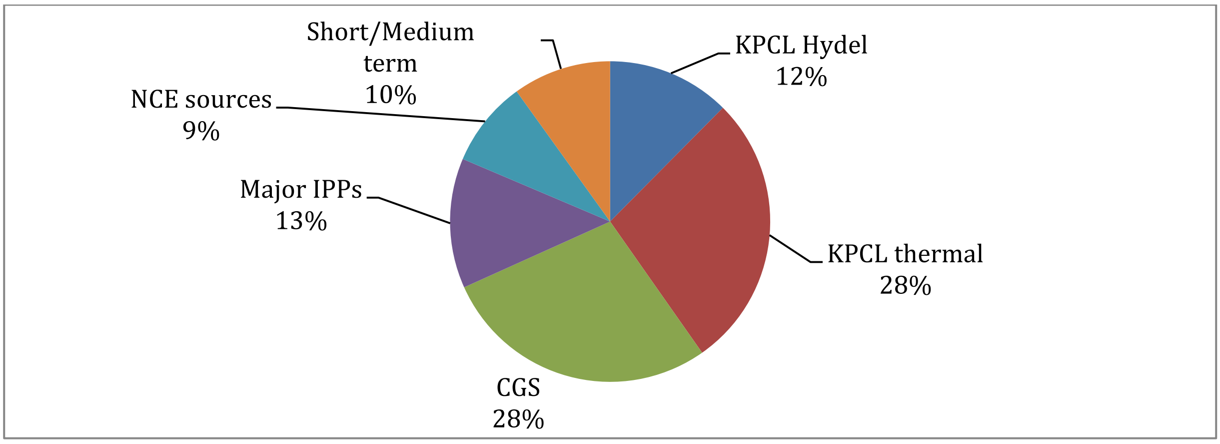


Figure 16: Source-wise purchase of Karnataka DISCOMs in FY16

Source: KERC Annual Report FY16

Analysis

The power purchase cost for MESCOM and CESC comprised 73% and 74%, respectively, of their annual revenue requirements in FY16. Also, the power purchase cost for both DISCOMs increased by around 30% in FY16. While the cost for MESCOM increased to Rs. 4.44/unit in FY16 from Rs. 3.43/unit in FY15 ( ), the cost for CESC increased to Rs. 4.22/unit in FY16 as compared with Rs. 3.43/unit in FY15 (Figure 18).

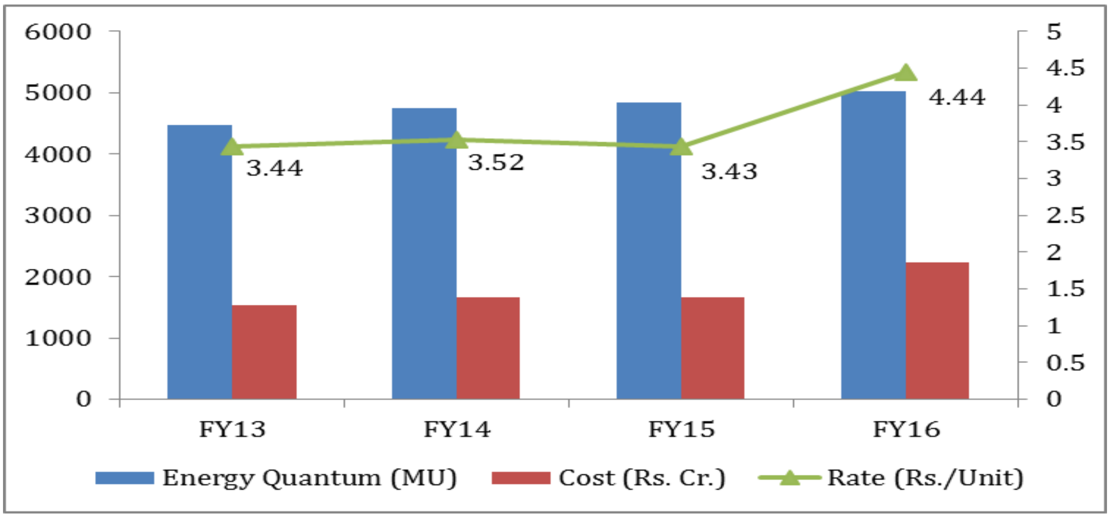


Figure 17: Power purchase quantum (MU), Cost (Rs. Cr.) and Rate (Rs./unit) of MESCOM

Source: MESCOM tariff order 2014, 2015, 2016 and 2017

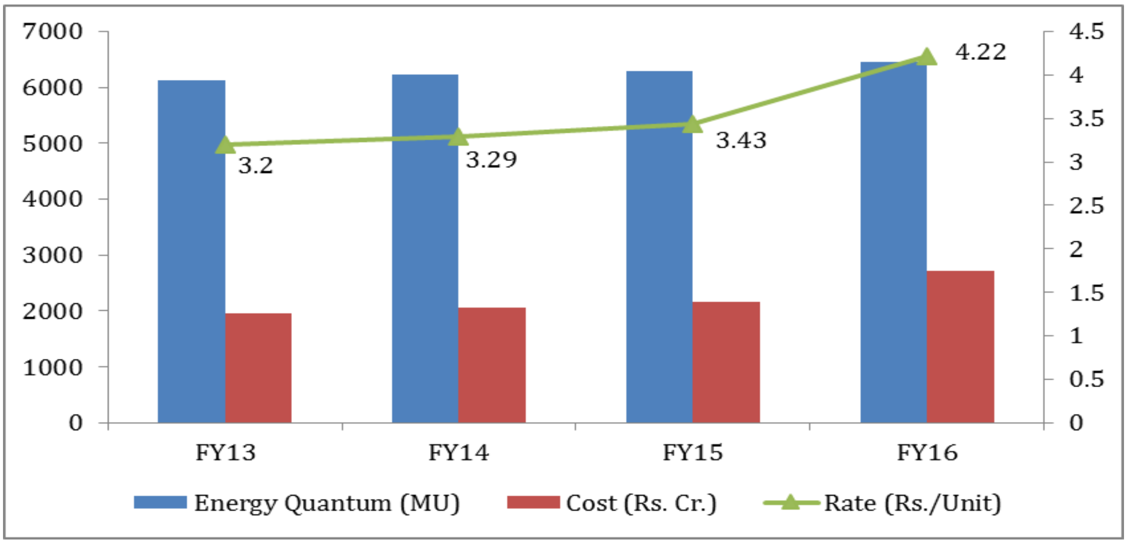


Figure 18: Power purchase quantum (MU), Cost (Rs. Cr.) and Rate (Rs./unit) of CESC

Source: CESC tariff order 2014, 2015, 2016 and 2017

As can be seen from Table 6 and Table 7, state-owned hydel and thermal units could not supply as per approved generation. Because of this, DISCOMs had to compensate for the supply shortfall from other sources (Figure 19 and Figure 20). Both DISCOMs managed to procure short-term power at the commission-approved rate of Rs. 5.30/unit, but in quantities much greater than those estimated for the year. This led to increase in power purchase cost as the allocated power from long-term sources was not available to meet the demand. While MESCOM had to purchase 565 MU of short-term power at a cost of Rs. 287 crores (against Rs. 59 crores approved by the commission), CESC purchased 481 MU at a cost of Rs. 249 crores (against Rs. 84 crores approved by the commission) in FY16. This additional purchase of short-term power led to an increase of Rs. 0.68/unit in the average power purchase cost[22] for MESCOM and of Rs. 0.82/unit[23] for CESC in FY16.

However, had KPCL-owned hydel and thermal generation units supplied power as estimated earlier, MESCOM and CESC would have incurred a cost of only Rs. 189 crores (against Rs. 287 crores) and Rs. 135 crores (against Rs. 249 crores), respectively. This would have resulted in a saving of Rs. 98 crores (Rs. 0.19/unit) for MESCOM and Rs. 114 crores (Rs. 0.18/unit) for CESC. Poor monsoons appear to have reduced the generation of KPCL's hydropower units, whereas non-availability of coal and other technical reasons contributed to the shortfall in thermal generation.

Table 6: CESC-approved and actual power purchase quantum (MU) and Cost (Rs./unit) in FY16

Source	Approved (MU)	Approved (Rs./unit)	Actual (MU)	Actual (Rs./unit)
KPCL hydel	1,829.7	0.5	1,030.9	1.1
KPCL thermal	1,826.3	3.9	1,314.0	4.5
CGS	1,549.8	3.0	1,724.1	3.1
Major IPPs	970.2	4.1	991.8	4.2
NCE sources	628.0	3.8	469.9	3.6
Short/medium term	159.4	5.3	480.6	5.2
Total	6,984.5	3.4	6,444.9	4.2

Source: CESC tariff order 2017

22 MESCOM tariff order 2017.
23 CESC tariff order 2017.

Table 7: MESCOM-approved and actual power purchase quantum (MU) and Cost (Rs./unit) in FY16

	Approved (MU)	Approved (Rs./unit)	Actual (MU)	Actual (Rs./unit)
KPCL hydel	869.3	0.7	541.1	1.5
KPCL thermal	2,064.8	3.9	1,734.7	4.4
CGS	1,009.4	3.2	1,165.5	3.3
Major IPPs	373.2	4.1	381.5	4.2
NCE sources	842.7	3.7	554.2	3.8
Short/medium term	112.7	5.3	520.3	5.3
Total	5,287.6	3.8	5,027.7	4.44

Source: MESCOM tariff order 2017

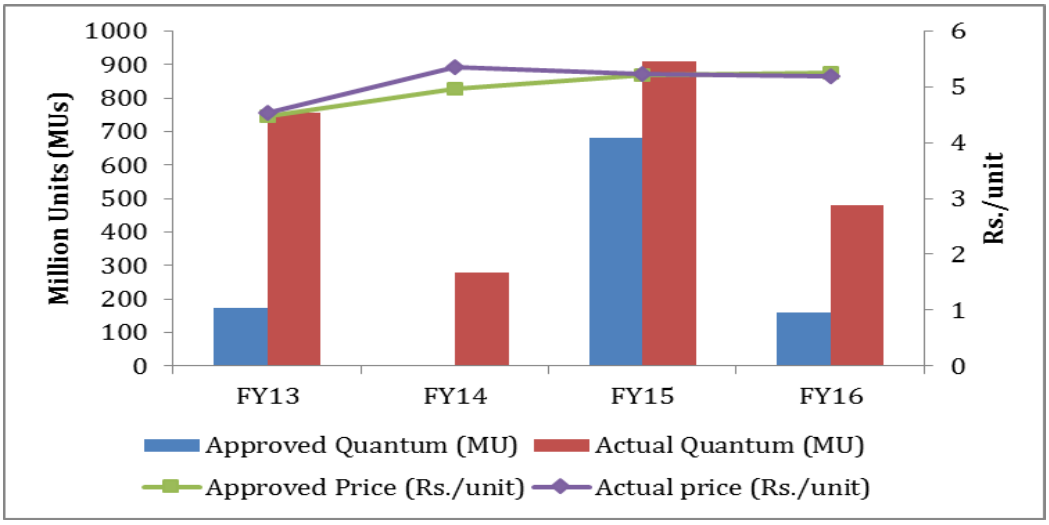


Figure 19: CESC-approved and actual short-term power quantum and price for last 4 years

Source: CESC tariff order 2014, 2015, 2016 and 2017

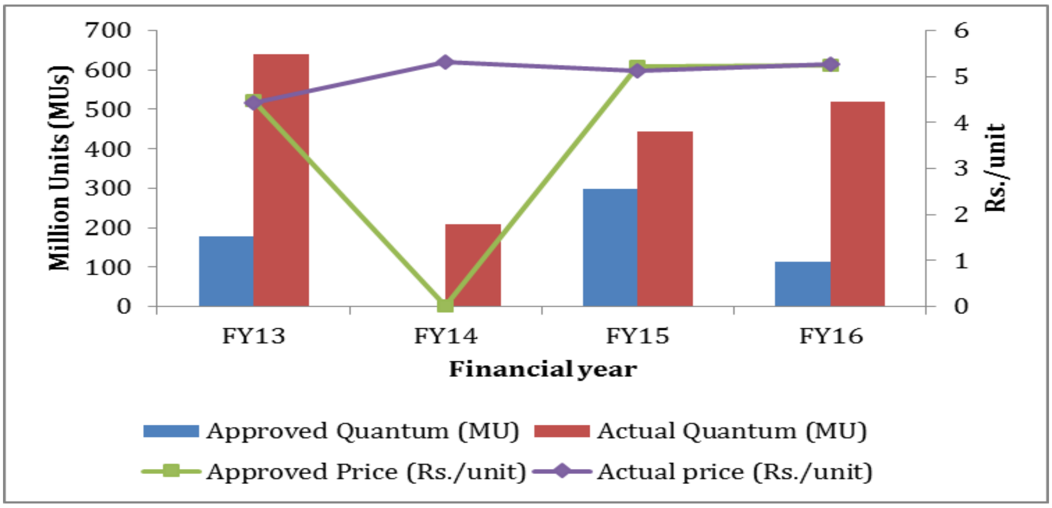


Figure 20: MESCOM-approved and actual short-term power quantum and price for last 4 years

Source: MESCOM tariff order 2014, 2015, 2016 and 2017

Issues

We identified the following issues which is impacting DISCOMs power purchase planning:

- *Shortfall in generation from allocated sources:* The state-owned thermal and hydro power generating stations could not provide the required energy. Also, the energy supplied from the generation plants was at a higher cost than approved, perhaps due to the increased fixed-cost burden per unit generated. In order to fill the shortfall, DISCOMs had to buy power from other sources, leading to increase in power purchase cost
- *Unavailability of transmission corridor:* As per CERC annual short-term market report FY16, power trading prices in the southern region have been high due to transmission congestion between the southern region and other regions. Hence, low-cost power from northern and western regions was not transported to the southern region, due to which DISCOMs had to purchase high-cost power from short-term markets. Earlier, Karnataka had entered short-term contracts with Gujarat. However, import of power was not sustained due to non-availability of a transmission corridor from the western zone to the southern zone
- *Demand forecasting*: State DISCOMs typically assess the energy demand for the future years either internally or with the help of consultants. As per the tariff order 2017, a difference of the order of 5% and 10% was observed between projected sales and actual sales for MESCOM and CESC, respectively.

Suggested Measures

Following measures are recommended for an efficient power procurement plan for DISCOMs:

- *Demand forecast*: The demand forecast carried out by DISCOMs is mainly based on the historical pattern (CAGR, trend analysis) of consumption for different categories of consumers. Based on these projections, the power procurement is carried out. However, in view of the central government's initiative of providing 24X7 power for all, it is critical to assess the demand after considering factors such as the pent-up demand for power. Further, other factors like consumer behaviour, appliance growth, efficiency, technological improvements [such as Rooftop Photovoltaic (RTPV), Light Emitting Diode (LED) and Electric Vehicles (EV)] should also be taken into account
- *Power banking*[24]: DISCOMs could also resort to power banking arrangements wherein the state could smoothen the seasonal variations by supplying energy during surplus situations (in the month of June/July for Karnataka) to other states, which experience deficit situation during these months. The power banking arrangement with an available transmission corridor could be helpful in mitigating issues related to variations in demand due to seasonal conditions
- *Separate power planning cell in DISCOMs:* It would be advisable to establish a power planning cell in each DISCOM. This cell could support the demand forecasting exercise and coordinate with other state nodal agencies.

5.3 Institutional Structure

A good strategic plan for an organisation includes identification of performance indicators, which can translate strategy into manageable operational actions for employees. Measures to improve the efficiency of DISCOMs can be initiated by devising Key Performance Indicators[25] (KPIs) for field-level

[24] This is an arrangement wherein two utilities/states trade power to match the seasonal variations in surplus and deficit situations. Banking is a cashless transaction, wherein no tariff needs to be paid for the energy availed/supplied.
[25] Key Performance Indicator (KPI) is a measurable value, which demonstrates how effectively a company is achieving its key business objectives.

functionaries, carrying out employee capacity building exercises and establishing a centralised customer service centre. These are explained in the subsequent subsections.

5.3.1 Devising Key Performance Indicators

While high-level KPIs focus on the overall performance of the organisation, indicators at subordinate levels would be required to make the processes more effective. For instance, AT&C loss reduction as a high-level KPI gives an indication of the overall health of a DISCOM. At the subdivision and O&M/field levels, some of the KPIs could include reduction of DT failure rate, division-wise monitoring of SAIDI and SAIFI, improvement in billing and collection efficiency, and a streamlined process of releasing new connections.

In order to meet the objective of providing reliable and quality power supply, it is important to focus on capacity building of the DISCOM employees for keeping them updated with the latest technological developments and know-how. MESCOM and CESC have a working strength of about 5,551 and 5,548 employees, respectively. In FY16, a total of 361 MESCOM employees participated in such training programmes and a cost of Rs. 14.8 lakhs was incurred. In CESC, around 615 employees participated in such training programmes in FY16 with a total training expenditure of Rs. 38.51 lakhs.

Issues

Currently, an Annual Confidential Report (ACR) is prepared detailing the work carried out by each employee in that particular year. The ACR is based on Karnataka Electricity Board Employees' Service (Conduct) Regulations (1988). This ACR is a self-evaluation report, which is filled-in by each employee and approved by the manager after one-on-one discussion with the employee. Some of the issues in institutional structure include:

- *Roles and responsibilities*: There is neither a systematic performance-monitoring mechanism nor a formal goal setting process in either DISCOMs. Based on the discussions, we gathered that tasks are not clearly defined and/or are not completed within the stipulated timeframe, adversely impacting the performance of the unit
- *Huge vacancy:* As per the annual reports, there were 3,235 and 4,863 vacant posts at all levels of employees for MESCOM and CESC, respectively, in FY16. This is against the sanctioned posts of 8,786 in MESCOM and 10,411 in CESC
- *Meter reading:* For recording meter readings, the DISCOMs engage third-party agencies and GVPs. Since there is no supervisory mechanism for checking the accuracy of the recordings, it sometimes leads to incorrect estimation of AT&C losses
- *Lack of rewards and recognition:* There are no rewards/recognitions for ensuring better performance
- *Training:* Only 7% (361/5,551) and 11% (615/5,548) of the total working strength participated in the training programmes in MESCOM and CESC, respectively.

Suggested Measures

- *Communication of business objective*: It is very important to communicate business objectives to employees at all levels so they feel engaged with the organisation and feel accountable to achieve the desired business objective
- *Set targets*: Adopt SMART, i.e., Specific, Measurable, Achievable, Relevant and Time bound principles for carving out KPIs as illustrated in Figure 21.

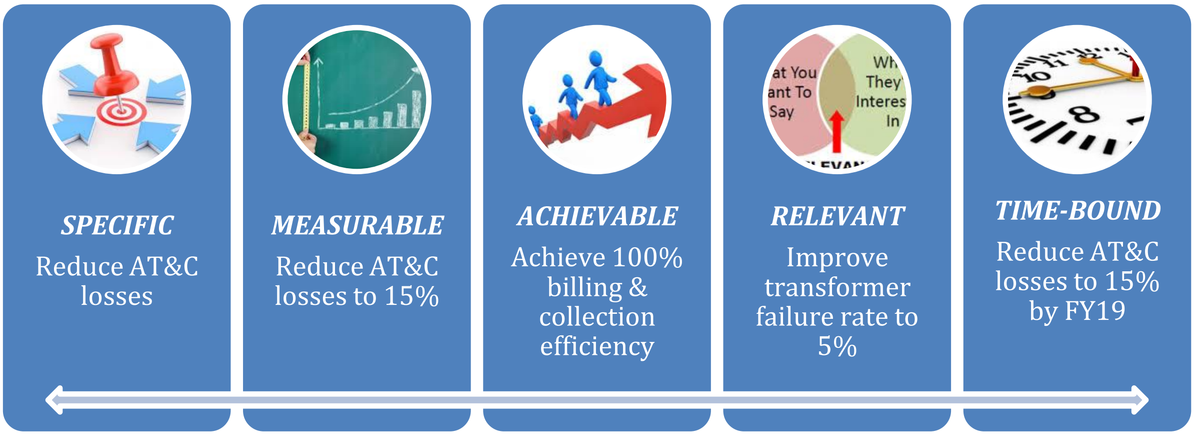


Figure 21: Illustration of SMART KPI

- *Recruitment:* Both DISCOMs need to recruit more manpower to fill the huge vacancies so as to meet the objective of providing reliable and quality power to its consumers. Manpower shortage could be handled by outsourcing some of the maintenance operations. Along with that, it could be a good idea to explore a franchisee model in some areas for network maintenance and operations
- *Formulation of successive KPIs*: KPIs at each level should be formulated keeping in mind the overall business objective. Figure 22 illustrates the formulation of field-level performance indicators. Figure 23 provides best practice in formulation of successive KPIs.

Superintendent Engineer (SE)

Circle level: Reduce AT&C loss to 15%	Chair meeting on Energy Audit report for high loss feeders

↓

Executive engineer (EE) & Accounts Officer (AO)

Reduce DTC failure rate to 5%	Improve Billing & Collection efficiency to 100%	Bi-weekly report on energy audit

↓

Assistant Executive Engineer (AEE) and Assistant Accounts Officer(AAO)

Periodic recording of DTC loading pattern	Release of new connections	Efficient collection mechanisms (Vigilance teams/.meter testing kits etc)	Tagging Validation

↓

Assistant engineer/Junior Engineer (AE/JE)- Feeder manager

DTC preventive maintenance	Defective meter replacement/meter relocation	Recovery of arrears	Tagging: Feeder to DTC & DTC-Consumer

Figure 22: Level-wise successive KPIs

Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL) has become the first DISCOM to earn profits under the UDAY scheme. One of the initiatives adopted by this DISCOM was the formulation of successive KPIs. AT&C loss reduction was the organisational KPI, whereas successive field-level KPIs were finalised by considering both commercial and technical aspects.

Figure 23: Best practice in formulation of KPIs

- *Accountability:* Currently field-level employees are mainly accountable for ensuring that the end consumers receive electricity supply with minimum operational glitches. However, a sales and service unit concept at the feeder level, where each Feeder Manager is made responsible for realisation of revenue, could be a supervisory mechanism for an effective meter reading process
- *Reward and recognition:* A reward and recognition system would help in encouraging the employees to improve their performance as per the requirements/expectations set by the organisation. Various reward schemes, such as spot awards, best subdivision award, outstanding achiever award, etc., can be used to motivate the employees. Alternatively, disincentive mechanisms could be put in place to penalise employees for under-performance
- *Training needs identification and impact assessment*: Training gaps need to be identified for each employee in consultation with his/her reporting officer. It is to be ensured that all employees are covered under a training programme. Usefulness of the training programmes could be assessed by monitoring employees' performance before and after the training. DISCOMs could establish their own training facilities to train staff at the field level.

5.3.2 Centralised Customer Call Centre

In the year 2000, a customer charter was formulated by Karnataka Power Transmission Corporation Limited (KPTCL), which included provisions on complaints handling and redressal standards, consumers' right to information and consumer grievance handling procedure. As per this charter, a complaint can be lodged at the Central Consumer Complaints Division (CCCD). KERC has also mandated the establishment of centralised customer call centres in every DISCOM.

In CESC[26], a centralised customer call centre was launched under RAPDRP. Consumers can call 1912 to register their electricity-related complaints. IVRS facility is provided for consumers to know their complaint status, etc. A web-based Public Grievance Redressal System (PGRS) was installed in CESC in September 2015, enabling fast complaint registration and redressal at the customer care centre (http://www.cescmysorepgrs.com). The software has a provision for registering consumer complaints through helpline, SMS, email and web. As per information on the PGRS portal, CESC received a total of 73,584 complaints in FY16, out of which 73,533 were resolved.

In MESCOM[27], 24 Hours Consumer Service Centres have been opened in major cities and towns. A centralised customer care centre was also established in Mangalore recently. Also, a customer service helpline for lodging complaints was launched in 2008. A Public Grievance (PG) Cell, headed by Manager (PG Cell), was established in the corporate office under the direct control of the Managing Director. During the year 2015-16, the PG Cell received 340 written complaints, out of which 92.35%, i.e., 314, were resolved.

The total number of complaints received by CESC and MESCOM in FY16 were 73,584 and 945, respectively, as compared with 9,60,047 complaints received by BESCOM. The complaints received in BESCOM, CESC and MESCOM were 9%, 3% and 0.04%, respectively, of the total consumer base in these DISCOMs. These data compel one to analyse the effectiveness of the PGRS system established in both MESCOM and CESC along with consumer awareness levels.

[26] CESC annual report FY15-16.
[27] MESCOM annual report FY15-16.

Issues

We identified the following issues impacting the functioning of a centralised customer service centre:

- *Benchmarking with other utilities:* There is no benchmarking of initiatives against other DISCOMs to gauge the effectiveness of such initiatives
- *Monitoring of the customer service centre:* The functioning of the customer service centres is not monitored frequently to review customers' perception about the service provided, follow-up and remedial action taken by DISCOMs
- *Measuring customer satisfaction*: There have been no initiatives undertaken by either DISCOMs to measure customer satisfaction levels, based on services like easier modes of payment or a new metering regime.

Suggested Measures

Following measures are recommended to have a robust customer service strategy:

- *Assessment parameters*: After setting up a customer care centre, it is vital to assess its performance on a regular basis. Some of the parameters for assessing the performance of a customer care centre are shown in Figure 24

- *Measuring customer satisfaction:* Both MESCOM and CESC should carry out studies seeking feedback from consumers and DISCOM employees with respect to the overall performance of the DISCOMs (Figure 25).

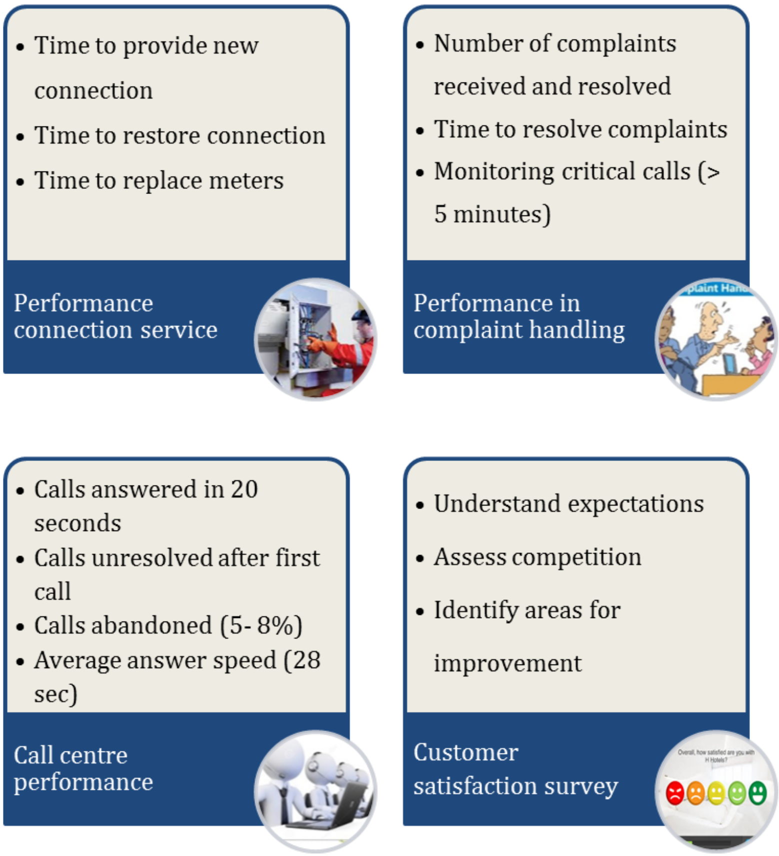


Figure 24: Assessment parameters for Customer service centre

BESCOM, through a civil society organisation - Public Affairs Centre (PAC) - undertook a study in 2013 soliciting feedback from consumers and employees to understand the effectiveness of the services provided by the DISCOM. This study provided consumers' feedback on various services provided by BESCOM, such as getting a new connection, receiving accurate and timely monthly bills, and improvement in quality of service. Similar feedback was solicited from employees on the benefits provided by the organisation, such as allotment of safety tools, training programmes, support from higher officials/management, etc. Based on the feedback received, PAC recommended certain solutions, which were used by the management to take corrective steps and improve its services and responsiveness to its consumers.

Figure 25: Best practice on customer satisfaction Index

6

Roadmap for Implementation

6. Roadmap for Implementation

The key focus of this study is to assess issues/concerns with respect to implementation of the initiatives listed under the UDAY scheme. We have prepared a strategic roadmap outlining initiatives, which could be implemented in the short term (1-3 months), medium term (4-6 months) and long term (6-12 months). These are summarised in Table 8 and visually represented in Figure 26.

Table 8: Implementation roadmap for DISCOMs

Recommendations	Responsibility	Timeline	Frequency/Action item
AT&C Loss Reduction			
Comply with KERC format for energy auditing	Sub-Division (Assistant Executive Engineer)	Short term	To be reported on a monthly basis
Conduct tagging drive for Feeder to DT and DT to Consumer	Junior Engineer	Short term	To be updated every quarter for new updation
Implement SSU concept at feeder level	Feeder Manager (Assistant Engineer/Junior Engineer)	Long term	Report on high-loss feeders to be submitted every month
Implement a Distribution Transformer Lifecycle Management System (DTLMS)	Executive Engineer	Short term	To be updated every month
Implement Consumer Indexing through use of a geospatial visualisation platform	Executive Engineer	Medium term	To be updated every quarter
Conduct feasibility analysis for smart meter implementation	Superintendent Engineer	Long term	Pilot study for select section offices
ACS–ARR Gap			
Establish a power planning cell	Superintendent Engineer	Medium term	Coordination among agencies to be done every month
Conduct demand forecasting	Superintendent/ Executive Engineer	Medium term	Considering 24*7 power supply and accurate IP set consumption
Institutional Structure			
Formulate KPIs for employees at operational level	Human resources/Public relations officer	Short term	To be updated on a half-yearly basis
Conduct customer satisfaction survey	Human resources/Public relations officer	Long term	To be undertaken every quarter

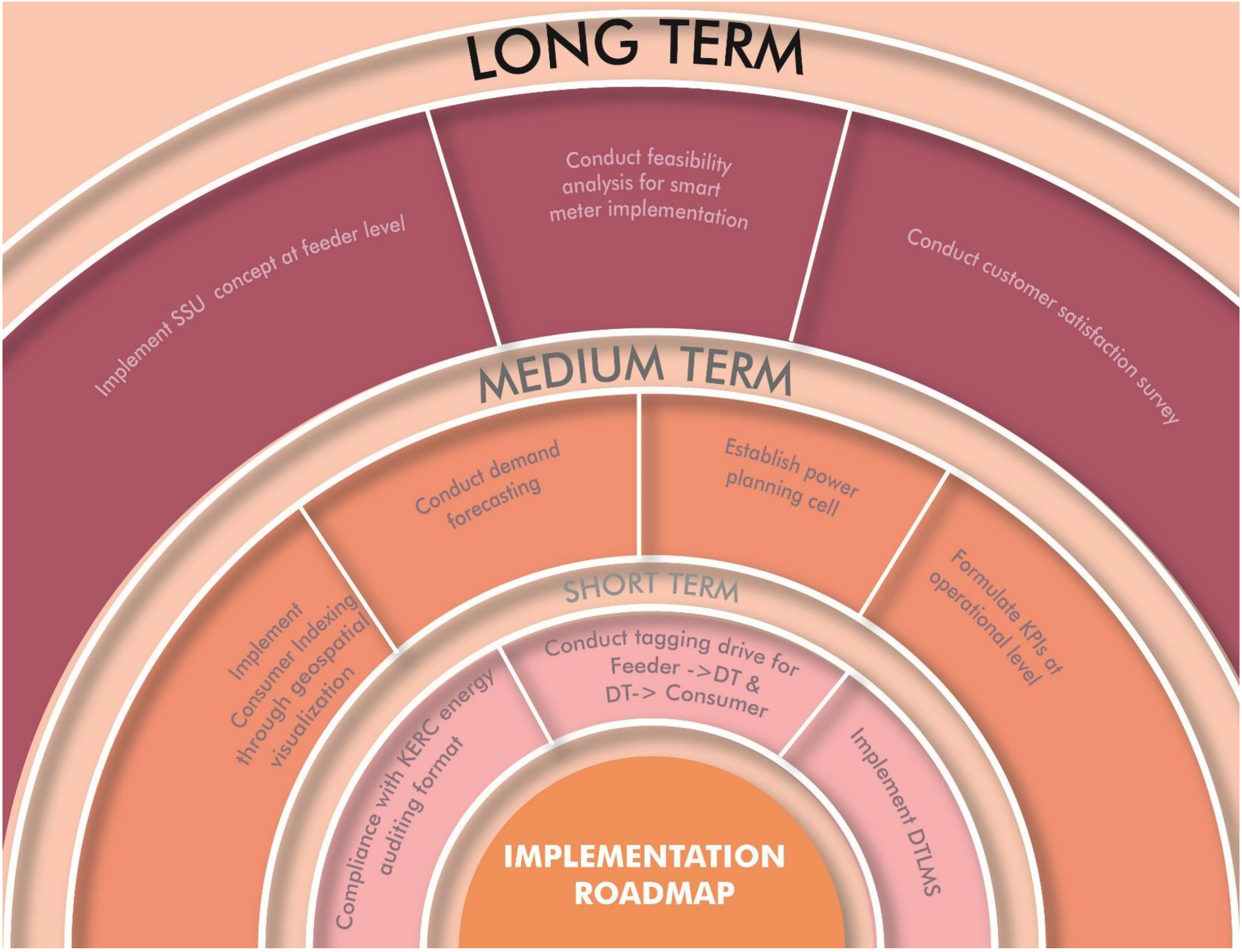


Figure 26: UDAY implementation roadmap for DISCOMs

7. APPENDIX

Appendix 1: Current Status of UDAY Scheme

#	States	Operational	Financial	Accumulated Losses as of Sept. 2015 (Rs. Cr.)	Outstanding Debt as of Sept. 2015 (Rs. Cr.)	Bonds Issued (Rs. Cr.)	AT&C Losses (FY15-16)
1	Karnataka	✓					18.06%
2	Uttarakhand	✓					17.00%
3	Mizoram	✓					36.74%
4	Kerala	✓					11.57%
5	Arunachal Pradesh	✓					57.74%
6	Tripura	✓					33.80%
7	Pondicherry	✓					19.88%
8	Manipur	✓					44.20%
9	Goa	✓					21.06%
10	Gujarat	✓					14.50%
11	Sikkim	✓					37.13%
12	Uttar Pradesh	✓	✓	70,738	53,211	49,847	32.36%
13	Maharashtra	✓	✓	7,087	22,097	4,960	17.31%
14	Himachal Pradesh	✓	✓	2,117	3,854	2,891	13.85%
15	Haryana	✓	✓	29,029	34,600	25,951	28.05%

16	Jharkhand	✓	✓	305	7,215	6,136	35.00%
17	Chhattisgarh	✓	✓	5,571	1,740	870	21.00%
18	Punjab	✓	✓	3,374	20,838	15,629	16.16%
19	Madhya Pradesh	✓	✓	30,282	34,739		26.27%
20	Andhra Pradesh	✓	✓	10,307	14,721	8,256	APEPDCL: 5.46% APSPDCL: 11.29%
21	J&K	✓	✓	3,914	3,538	3,538	56%
22	Rajasthan	✓	✓	81,411	80,530	72,090	Ajmer: 24% Jaipur: 28% Jodhpur: 22.4%
23	Bihar	✓	✓	3,183	3,109	3,109	North Bihar: 40% South Bihar: 44%
24	Assam	✓	✓	2,985	1,510		22.49%
25	Telangana	✓	✓	9,875	11,897	6,910	TSSPDCL: 14.11% TSNPDCL: 12.84%
26	Tamil Nadu	✓	✓	55,821	81,312	14,000	14.58%
27	Meghalaya			961	167		36.50%
	Total			**3,16,960**	**3,75,077**	**2,14,187**	

Appendix 2: MoU List of Operational Initiatives to be undertaken by State DISCOMs

Initiatives
Loss reduction
Reducing AT&C losses to 14.20% by FY19
Preparing loss reduction targets at subdivision/division/circle/zonal levels
Undertaking a name & shame campaign to control power theft from time to time
Implementing performance monitoring and management system MIS
Achieving 100% distribution transformer metering by 2018
Undertaking energy audit at 11 kV level in rural areas
Completing a feeder improvement programme for network strengthening and optimisation by March 2018
Completing physical feeder segregation by March 2018
Installing smart meters for all consumers other than agricultural consumers consuming above 500 units/month by December 2017 and above 200 units/month by December 2019
Providing electricity access to unconnected households
Implementing ERP systems for better and effective inventory management, personnel management, accounts management, etc., by March 2018
Demand-side management and energy efficiency
Providing LED for domestic and other categories of consumers under Domestic Efficiency Lighting Programme (DELP)
Undertaking consumer awareness programmes for optimum utilisation of resources
Installing star-rated water pumps for drinking water installations
Implementing the PAT scheme of BEE for improving energy efficiency in industries
Tariff measures
Quarterly tariff increase to offset fuel price increase
Timely filing of tariff petition before KERC
Timely preparation of annual accounts
Increase employee engagement
Initiating capacity building of employees to enhance technical, managerial and professional capabilities
Devising key performance indicators
Customer service strategy
Setting up a centralised customer call centre for timely resolution of complaints
Introducing more avenues to consumers for bill payment
Procuring power through a transparent process of competitive bidding

Appendix 3(a): MESCOM Prioritisation Matrix

High Medium Low

Initiatives	Target (Timeline)	Status (As on March 2017)	Priority
AT&C Losses			
Loss reduction targets (sub-levels)	11.7% by FY19	FY16 AT&C loss: 12.9%	
100% DT metering	Total DTs – 54,056 (March 2018)	Metered: 37,726	
Energy audit (11 kV)	Rural feeders: 527	Audited: 45	
Feeder improvement programme	Total feeders: 818 (March 2018)	Achievement: 76	
Physical feeder segregation - NJY	March 2018	Not yet initiated	
Smart metering	>500 Units: Dec 2017 (72,408) >200 Units: Dec 2019 (1,07,935)	NIL	
Name & shame campaign	Through social media: 2,184	732	
ACS–ARR Gap			
Power procurement through competitive bidding	Continuous process	Done through PCKL	
Quarterly tariff revisions and timely filing of petition	Continuous process	Ongoing	
Institutional Structure			
Employee capacity building	Continuous process	Training programmes conducted	
Devising KPIs	Continuous process	Not yet initiated	
Performance monitoring and MIS	Continuous process	Preliminary stage	
ERP system	Continuous process		
Customer Service			
Centralised customer call centre		Established in Mangalore city	

More bill payment avenues		Being established (ATP, mobile app, post office collection centres)	
Energy Efficiency and Access			
LED distribution	85,21,000	30,09,629	
PAT scheme for BEE		Not yet initiated	
Electricity access to unconnected households	0.83 lakh, FY19	Electrified: 0	

Appendix 3(b): CESC Prioritisation Matrix

High Medium Low

Initiatives	Target (Timeline)	Status (As on March 2017)	Priority
AT&C Losses			
Loss reduction targets (sub-levels)	14.5% by Mar 2019	FY16 AT&C loss: 16.22 %	
100% DT metering	Total DTs – 94,258 March 2018	Metered: 28,912	
Energy audit (11 kV)	Ongoing	Total rural feeders: 1,000 Achievement: 1,000	
Feeder improvement programme	March 2018	Feeders for improvement: 405 Achievement: 25	
Physical feeder segregation - NJY	March 2018	Total Agri feeders: 427 Achievement: 347	
Smart metering	>500 Units: Dec 2017 >200 Units: Dec 2019	Pilot project in 1 subdivision	
Name & shame campaign	Continuous process	Arrears =>1 lakh being processed	
ACS–ARR Gap			
Power procurement through competitive bidding	Continuous process	Done through PCKL	
Quarterly tariff revisions and timely filing of petition	Continuous process	Ongoing	
Institutional Structure			
Employee capacity building	Continuous process	Training programmes conducted	
Devising KPIs	Continuous process	Not yet initiated	

Performance monitoring and MIS	Continuous process	MIS dept. established	
ERP system	Continuous process	Under progress (MMS, HRMS, FMS, PGRS, DTLMS)	
Customer Service			
Centralised customer call centre		Established in corporate office in Mysore	
More bill payment avenues		Being established (ATP, mobile app, post office collection centres)	
Energy Efficiency and Access			
LED distribution		25,80,400 LEDs distributed	
PAT scheme for BEE		3 initiatives - Ag DSM, DELP and DEEP	
Electricity access to unconnected households	1.9 lakh; FY19	Electrified: 0.61 lakh	

Appendix 4(a): Organisation Structure of MESCOM

The organisational structure of MESCOM comprises one Operation & Maintenance (O&M) zone in Mangalore, headed by a Chief Engineer (Elec.) (CE), and four O&M circles under the O&M zone in Mangalore, Udupi, Shimoga and Chikmagalur, each headed by a Superintendent Engineer (Elec.) (SE). The zone is an administrative office responsible for the overall direction of the DISCOM's operations, whereas the circle offices oversee the functioning of the jurisdictional divisions and subdivisions. There are 12 O&M divisions under MESCOM, each headed by an Executive Engineer (EE). O&M divisions are further divided into 57 O&M subdivisions[28], each headed by an Assistant Executive Engineer (AEE). Each sub-divisional office consists of around 2-3 O&M section offices to ensure reliable distribution of power in its jurisdictional area. MESCOM has around 221 O&M[29] units in its jurisdiction each headed by an Assistant Engineer (AE) or a Junior Engineer (JE). The section offices are the base-level offices serving as the primary link between the consumer and the company, and looking after the O&M of the distribution system (Figure 27).

[28] MESCOM tariff order 2017.
[29] MESCOM tariff order 2017.

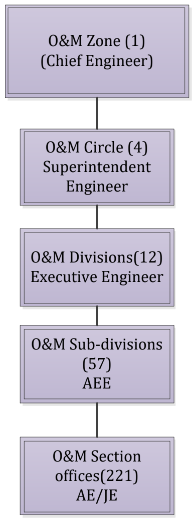


Figure 27: Organisation Structure of MESCOM

Appendix 4(b): Organisation Structure of CESC

The organisational structure of CESC comprises one O&M zone in Mysore, headed by a Chief Engineer (Elec.), and four O&M circles under the O&M zone, each headed by a Superintendent Engineer (Elec.). There are 15 O&M divisions, each headed by an Executive Engineer. The O&M divisions are further divided into 61 O&M subdivisions, each headed by an Assistant Executive Engineer (AEE). Each sub-divisional office consists of around 2-3 O&M section offices to ensure reliable distribution of power in its jurisdictional area. CESC has around 257 O&M section offices, each headed by an Assistant Engineer (AE) or a Junior Engineer (JE) (Figure 28).

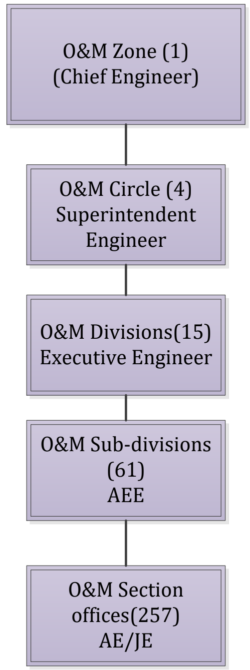


Figure 28: Organisation Structure of CESC

Appendix 5: Detailed Excel Format for KERC Energy Audit at 11 kV Level

Month-wise 11 kV feeder-wise Energy Audit	
Name of the Sub-station	
Name of 11kV Feeder	
Number of DTs in the Feeder	
Name of the Sub-division/Division	

Month and Year		**Apr-15**					
#	**Particulars**		**Feeder-1**	**Feeder-2**	**Feeder-3**	**Feeder-4**	**Feeder-5**
1	**Energy input to 11 kV feeder at substation (MU)**	X = Y * C					
a)	*Present reading at the substation*	A					
b)	*Previous reading at the substation*	B					
c)	*Difference*	Y = (A - B)					
d)	*Meter Constant*	C					
2	**Energy Utilised in feeder - MU**	Z = (D + E)					
a)	*Energy Sales to all 11 kV consumers*	D					
b)	*Energy delivered to L.T. System from all the DTs in MU*	E					
3	**Total energy loss MU**	**R = (X - Z)**					
4	**% Energy Loss**	**(R/X) * 100**					
5	**Total Technical losses in 11 kV feeder in MU**	**S = (T + U)**					
a)	****Technical loss of 11 kV line as per computation (to be done once in a year) in MU*	T					
b)	*Technical Copper and Iron losses in all the DTs in MU*	U					
c)	**% Technical loss**	**(U/X) * 100**					
d)	**Commercial Loss MU**	**V = (R - S)**					
	% Commercial loss	**(V/X) * 100**					
Permissible % losses in the distribution system							
6	% Technical loss in 11 kV line	< 3.5%					
7	% Loss in DTs (Copper + Iron)	< 1.5%					
8	% Commercial loss of L.T. Distribution	< 1%					
Note							
*****Load and energy input to DT during the preceding financial year from April-2014 to March-2015**							
Interdivisional transfer of energy through boundary meters shall be considered while conducting energy audit							

Standard Template for Energy Loss Assessment of DTs for a Typical 11 kV Feeder		
#	Particulars	Values/Details
1	*Number of hours the Transformer is charged during 12 months at 8 hours per day	
2	**Peak current in Amps	
3	****Power factor	
4	Peak load in kW	
5	Peak load in kVA	
6	***The energy input to feeder during 12 months period in kWh	
7	Load factor	
8	Loss Load factor	
9	DTs loading	

DT Losses													
10	Capacity-wise DTs in kVA	Numbers	Total kVA	*****Rated Losses (W)		Number of hrs the DTs were in Service	Loading on DTs	Iron Losses		Copper Losses		Total DT Losses	
				Iron Losses	Copper Losses			kWh	% Losses	kWh	% Losses	kWh	% Losses
a)	16			80	475								
b)	25			100	685								

c)	63			180	1,235								
d)	100			260	1,760								
e)	250			620	3,700								
f)	315			740	4,200								
g)	500			1,100	6,500								
h)	750			1,500	10,000								
i)	**Total**												
Note													
*1	Number of hours the feeder is charged shall be actual number of hours the feeder is charged.												
**2	Peak load of the feeder in Amps during the year as per the record of the substation												
***3	Energy input to the feeder during the year at the substation												
****4	Power factor recorded at the substation during the peak load during the year												
5	Peak Load in kW & kVA, Load Factor and Loss load factors are computed by using the respective formulae												
*****6	The rated Iron and copper losses of the transformers are taken from the POs of the DISCOMs. If any change is found the same may be corrected												

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