**IT enabled energy accounting and auditing**

### R-APDRP billing system

**2.1** Under R-APDRP billing system, 17 different modules have been developed and implemented which work in integration with each other. Each module was designed for a specific purpose and was required to be fully functional for automated energy accounting and auditing. Out of these modules, the Energy Audit (EA) module was designed for identifying the loss pockets and taking corrective actions for reduction of AT&C losses.

EA module was designed to collect data of billed energy, billed amount and collection amount from Metering, Billing and Collection (MBC[1]) modules, meter data (Sub-stations, Feeders and Distribution Transformers) from Meter Data Acquisition System[2] (MDAS) module and use Geographic Information System[3] (GIS)-based Consumer Indexing and Asset Mapping database for deriving energy consumption of consumers connected to any node and identify loss pockets within the network area, as depicted in **Chart 2.1**:

**Chart 2.1: Functioning of Energy Audit module**



*Source: Operation manual of the modules of R-APDRP billing system*

A Performance Audit on Re-structured Accelerated Power Development and Reforms Programme (R-APDRP), covering the period 2009-10 to 2015-16, was featured in Chapter-II of the Report No. 06 of 2016 on Public Sector Undertakings (PSUs) of the Comptroller and Auditor General of India for the year ended March 2016[4], Government of Uttar Pradesh. The Performance Audit

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[1] The various modules available in MBC are New Connection, Metering, Billing, Collection, Disconnection, and Customer Care Centre.

[2] Acquire data from metering devices such as sub-station meter, feeder meters, DT meters, and HT/LT consumer meters through modems and without any human intervention.

[3] GIS is a system which captures, stores, analyses, manages, and presents data (*like* sub-stations, feeders, transformers, poles, meters, cables & consumers) linked to the location(s).

[4] Hereinafter referred as **'the Performance Audit Report of 2016'**.

covered various observations related to the implementation of the R-APDRP in the State and the shortcomings commented upon in the above report, still exist.

### *Deficient utilisation of modules resulted in erratic AT&C loss report*

**2.2** Part-A (IT) of R-APDRP provided for preparation of base-line data for the project area covering GIS-based Consumer indexing and Asset mapping of the entire distribution network and Automatic meter reading of DTs, HT Consumers, Feeders and Boundary meters. It included adoption of IT applications for meter reading, billing & collection, energy accounting and auditing without human intervention. As per the agreement entered with Information Technology Implementation Agency (ITIA), IT-based system was scheduled to be established under Part-A within 18 months *i.e.* by July 2011 from the date of award (January 2010) of work whereas the Go-live date of the system was June 2015.

In the Performance Audit Report of 2016 at paragraphs 2.1.10 and 2.1.12, Audit pointed out that the IT-enabled system was not completed by ITIA due to which the baseline data could not be verified by the Third Party Independent Evaluation Agency (TPIEA) upto October 2016. As a result, the town-wise[5] AT&C loss report generated by the system even after declaration of Go-live was erratic, as it ranged between (-) 99.83 *per cent* and 99.92 *per cent* during July 2015 to July 2016 which defeated the objective of eliminating human intervention in energy accounting/auditing.

During the present audit, it was noticed that despite being commented upon in the Performance Audit Report of 2016 and even after lapse of seven years[6], the Company failed to establish the IT-based system and complete the baseline data. The reasons for this state of affairs are non-updation of GIS data of electrical assets, non-tagging of consumers with their hierarchical network of electrical assets and lack of automatic fetching of meter data at MDAS through modems installed at Sub-stations, Feeders, Distribution Transformers (DTs) and HT/LT consumers. As a result, the town-wise[7] AT&C loss report generated through EA module was not accurate and reliable as it ranged between (-) 1,51,15,08,579 *per cent* and 45,240.82 *per cent* during 2018-19. Consequently, the Company was left with no choice but to calculate the AT&C loss manually which defeated the basic objective of elimination of human intervention in energy accounting and auditing in R-APDRP area.

Further, due to lack of baseline data the Company could not utilise the modules *viz.* Energy Audit module, GIS based Consumer Indexing and Asset Mapping module, Asset Management module and GIS-based Integrated Network analysis module. Thus despite incurring expenditure on acquisition of these hardware and software along with the cost of AMC/ATS to the tune of ₹ 40.57 crore **(*Appendix-2.1*)**, incurred during the period 2014-15 to 2018-19, the objective of having accurate and reliable AT&C loss figures could not be fully achieved.

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[5] In 43 sampled towns out of total 168 towns covered under R-APDRP.
[6] From the scheduled date of completion of Part-A of R-APDRP *i.e.* July 2011 upto March 2019.
[7] Of total 168 towns under R-APDRP.

In the Exit Conference (March 2021), the Government acknowledged the issue of system generated erratic AT&C report and stated that deficiencies were detected in system generated energy accounting and the issue was being addressed.

***Failure in implementing GIS based consumer indexing and assets mapping module***

**2.3** To start developing a GIS map for power distribution network, Differential Global Positioning System[8] (DGPS)/Global Positioning System (GPS) survey becomes necessary for geo-referencing and mapping the electrical assets on the digital base map. The purpose of the application was to index all the consumers' database with respect to their unique electrical address upto Go-live date (June 2015).

The White Paper[9] provided that to perform correct energy audit and accounting of towns utilising MBC and MDAS data, it is absolutely essential that the towns should have up-to-date GIS asset and consumer information in the GIS repository at the time of Go-live and also during subsequent operation. Therefore, the incremental changes (addition/ deletion/modification) of electrical assets and consumers in GIS repository were also required to be updated in the system.

In the Performance Audit Report of 2016 at paragraph 2.1.19, Audit pointed out that ITIA/DISCOMs did not update GIS data of any of the towns with respect to the changes caused due to release of new connections, disconnections, construction of new sub-stations and lines. In absence of updated data, the objective of correct energy accounting and auditing could not be ensured.

**Chart 2.2: GIS Mapping of Consumers**



*Source: Based on analysis of data provided by the Company*
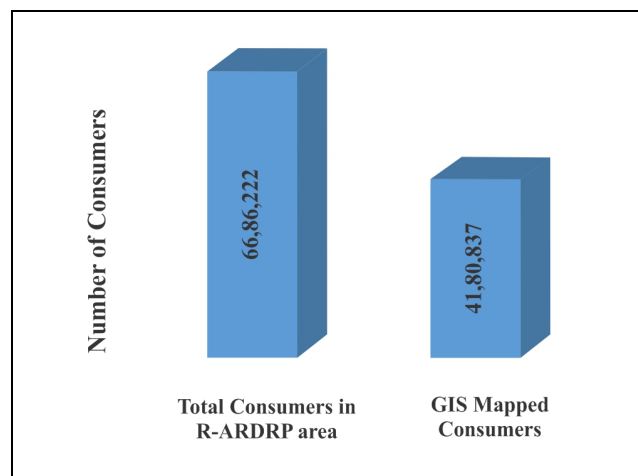
During the present audit, it was again noticed that despite being commented upon in the Performance Audit Report of 2016 and even after a lapse of five years[10] from Go-live of towns the consumer indexing against GIS data of electrical network was not updated as it was done only for 41,80,837 consumers (62.53 *per cent*), out of a total of 66,86,222 consumers available as of March 2019 as depicted in **Chart 2.2**.

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8    A Differential Global Positioning System (DGPS) is an enhancement of Global Positioning System (GPS) which provides improved location accuracy.

9    In December 2013, Ministry of Power (MoP) circulated a White Paper on post Go-live requirement to be performed by State Power Utilities.

10   From the Go-live date of the last town *i.e.* June 2015 upto March 2019.

The audit findings related to consumer indexing and assets mapping are discussed as under:

*(i) Consumer Indexing:*

GIS indexing of all the consumers of R-APDRP area, upto Go-live date, were in the scope of ITIA and thereafter, indexing of new consumers was to be done by the Company either by itself or through outsourcing. But the GIS indexing of 38,90,691 consumers (74.29 *per cent*) out of total 52,36,819 consumers were completed by ITIA, upto Go-live date (June 2015). Further, during July 2015 to March 2019, 14,49,384 new connections were released, but GIS data of only 2,90,134 (20.02 *per cent*) consumers were captured by the divisions ignoring 11,59,250 consumers (79.98 *per cent*), as mentioned in **Table 2.1**:

**Table 2.1: Year-wise status of new connections released and consumer indexing**

| Year | Connections released | Consumer indexing performed | Remaining consumers |
|---|---|---|---|
| 2015 (from July 2015) | 1,83,273 | 56,052 | 1,27,221 |
| 2016 | 3,26,961 | 89,620 | 2,37,341 |
| 2017 | 4,48,912 | 69,270 | 3,54,104 |
| 2018 | 4,23,374 | 73,611 | 3,75,301 |
| 2019 (upto March 19) | 66,864 | 1,581 | 65,283 |
| **Total** | **14,49,384** | **2,90,134** | **11,59,250** |

*Source: Based on analysis of data provided by the Company*

Audit noticed that the Company was unable to update consumer indexing of the remaining consumers and consumers added after July 2015 to March 2019. As a result, the gap between the indexed and non-indexed consumers increased from 25.71 *per cent* in June 2015 to 37.47 *per cent* upto March 2019. For updating consumer indexing, the divisions had also neither sought any assistance from the Executive Engineer/IT or Assistant Engineer/IT[11] nor instructed the spot billing machine (SBM) vendor for the same.

*(ii) Assets Mapping:*

In respect of electrical assets of R-APDRP towns, the Company failed to provide information as on Go-live date and additions therein during the period 2015-16 to 2018-19 along with GIS database containing mapping of all its electrical assets, on the basis of which it can be concluded that the Company did not have the complete information of its electrical assets of R-APDRP towns along with respective GIS database.

Further, during a visit by audit to seven divisions of R-APDRP towns having consumers of only R-APDRP billing system it was observed that the complete electrical assets of the divisions were not updated in the IT system and no efforts were made by the divisions in updating GIS database and maintaining modems installed at meters for getting meter data automatically on the system as out of total available 64 sub-stations, 326 feeders and 8,988 DTs, only 40 sub-stations, 223 feeders and 4,623 DTs were mapped in the system. Out of mapped electrical assets, the meter data of only 34 sub-stations, 154 feeders and 468 DTs were fetched automatically during March 2019 (*Appendix-2.2*).

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[11] One Executive Engineer/IT at zone level and one Assistant Engineer/IT at circle level are posted by the Company for assisting field divisions on IT-related issues.

Due to non-indexing of consumers with the GIS data of the electrical assets, non-updating GIS data of existing electrical assets and lack of automatic fetching of meter data, the Company failed to assess the capacity of the network while releasing new connections, identifying location of the consumer from unique pole ID, performing correct energy accounting and audit and calculating AT&C loss correctly using the system.

The Company accepted (July 2020) the fact and stated that earlier GIS implementation did not have provision of change management, hence the GIS data could not be updated timely and continuously after its completion. Further, in the Exit Conference (March 2021), the Government also acknowledged the deficiencies pointed out and stated that these were being sought to be appropriately addressed.

*Failure in using Assets Management module*

**2.4** The Asset Management (AM) module of the R-APDRP billing system was to provide the Company a centralised database of the entire asset records (purchase information and assets specification) along with its maintenance history, insurance, warranty, depreciation, and disposal records. Using AM module, maintenance & replacement of assets was to be handled effectively thereby reducing O&M cost for the Company and help in organising the maintenance schedules and evaluation of replacement decisions.

In the Performance Audit Report of 2016 at paragraph 2.1.16, Audit pointed out the non-rectification of the shortcoming/deficiency noticed during User Acceptance Testing (UAT) conducted in May 2012 of the Assets Management module.

During the present audit, it was noticed that despite being commented upon in the Performance Audit Report of 2016 and even after lapse of seven years[12], the Company could not rectify the shortcoming/deficiency noticed during UAT and the AM module has never been used as no information related to electrical assets were ever entered into the system by the Company. The reasons analysed during audit were that the Company does not maintain any centralised record related to its electrical assets installed in the field *i.e.* purchase date & time, warranty period, validity of insurance, specifications of installed assets and its maintenance history. Due to non-using of AM module, the Company failed in analysing the life cycle of the assets, managing various depreciation policies, budget for replacement, extensive reporting and compliance of statutory requirements.

The Company accepted (July 2020) the fact and stated that since there was no change management agency and no stores modules available, hence, it failed in utilising the modules earlier.

*Failure in using Network Analysis module*

**2.5** The Company was to utilise the capability of GIS-based Network Analysis (NA) Module in conjunction with other modules/applications, like GIS-based Consumer Indexing and Assets Mapping, Assets Management, MBC, MDAS

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[12] From the scheduled date of completion of Part-A of R-APDRP *i.e.* July 2011 upto March 2019.

and Energy Audit, to perform various actions[13] required on the electrical network for network optimisation, loss reduction and network operation with greater efficiency. Using NA module, the Company was to prepare estimates and diagrams for releasing new connections and calculating technical loss for any of the sections of the network to separate out technical and commercial losses.

In the Performance Audit Report of 2016 at paragraph 2.1.16, Audit pointed out non-rectification of the shortcoming/deficiency noticed during UAT conducted in May 2012 of the Network Analysis module.

During the present Audit, it was noticed that despite being commented upon in the Performance Audit Report of 2016 and even after lapse of seven years[14] the Company could not rectify the shortcoming/deficiency noticed during UAT and also failed in utilising the NA module for performing efficient management of the electrical assets, checking network capabilities, preparing network diagrams and estimates while releasing new connections and calculating technical loss of any of R-APDRP area. Reasons analysed during audit were non-maintenance of up-to-date GIS repository of electrical assets and non-indexing of consumers, non-updation of entire electrical assets' database in AM module, non-mapping of rates of Cost Data Book and Rural Electrification & Secondary System Planning Organisation (RESSPO) schedule and non-maintenance of modem for communicating meter data at MDAS of sub-stations, feeders and DTs by the Company.

The Company accepted (July 2020) the fact and stated that the NA module was developed at the stage when State Utilities were starting to adopt online processes for the first time and it is very hard to imagine and expect new users who are experiencing a green field implementation for the first time to be able to adopt all the processes at once over a short period of time.

*Ineffective Meter Data Acquisition System (MDAS)*

**2.6** The White Paper provided that the Company needs to carry out regular maintenance of meter/modem to minimise/avoid failure rates which will increase the life of equipment as well as reduce the chances of failure in severe conditions prevailing in the field and will ultimately reduce the maintenance cost.

In the Performance Audit Report of 2016 at paragraphs 2.1.14 and 2.1.15, Audit pointed out that in 43 test checked towns, the objective of MDAS to acquire meter data automatically without human intervention was defeated as 18 *per cent* sub-stations were not communicating data automatically and eight *per cent* feeders and 57 *per cent* DTs were not updated in MDAS as of March 2016. Further, data of only 16 *per cent* of DTs were being received on

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[13] Creation and editing of network, load flow and voltage drop analysis, fault analysis and protection coordination, optimisation studies (*like* capacitor placement, network reconfiguration, conductor up-gradation, express feeder, load balancing and load allocation), network design reports, cost estimates, financial analysis, integration with new connection module for checking the network capability, augmentation requirement on upstream side, creating extensive "what-if" studies and calculating technical loss for any section.

[14] From the scheduled date of completion of Part-A of R-APDRP *i.e.* July 2011 upto March 2019.

MDAS. Due to deficient data communication, the DISCOMs were compelled to fill the gaps in energy data through manual entries which defeated the objective of eliminating human intervention in energy accounting/auditing.

During the present audit, it was noticed that the deficiencies pointed out in the Performance Audit Report of 2016 still existed as only 70 *per cent* meters were available on MDAS and only 19.71 *per cent* meters were communicating the meter data. On analysis of MDAS report of March 2019, Audit noticed that the availability and readability of meters installed at DTs, Feeders and Ring fencing was still very poor, as a result of which data from these meters could not be acquired through IT system. The summary of system metering and availability at MDAS is mentioned in **Table 2.2**:

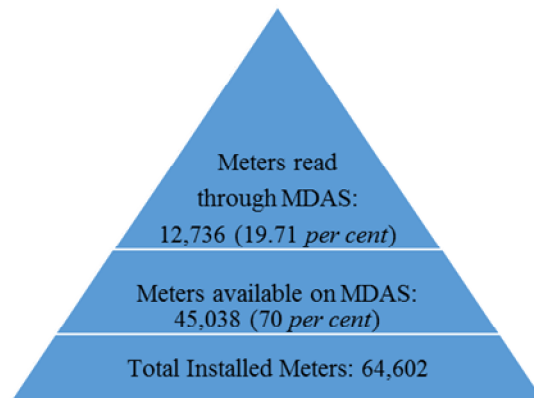**Table 2.2: Summary of Status of system metering available at MDAS**

| DISCOM | System Meter | Installed under R-APDRP (as per final closure) | Available on MDAS | Ping Status (Blanks): non-Read Meters | Last Read during 2011-2018 | Last Read 2019 | Last Reading Percentage |
|---|---|---|---|---|---|---|---|
| DVVNL | DT | 10,035 | 8,626 | 1,602 | 4,595 | 2,429 | 28.16 |
| | Feeder | 1,457 | 962 | 139 | 137 | 686 | 71.31 |
| | Ring Fencing | 72 | 21 | 3 | 16 | 2 | 9.52 |
| | **Total** | **11,564** | **9,609** | **1,744** | **4,748** | **3,117** | **32.44** |
| MVVNL | DT | 10,586 | 5,486 | 1,224 | 2,804 | 1,458 | 26.58 |
| | Feeder | 2,701 | 1,349 | 616 | 208 | 525 | 38.92 |
| | Ring Fencing | 166 | 0 | 0 | 0 | 0 | 0.00 |
| | **Total** | **13,453** | **6,835** | **1,840** | **3,012** | **1,983** | **29.01** |
| PVVNL | DT | 22,984 | 17,226 | 5,596 | 7,667 | 3,963 | 23.01 |
| | Feeder | 11,939 | 3,153 | 675 | 812 | 1,666 | 52.84 |
| | Ring Fencing | 0 | 0 | 0 | 0 | 0 | 0.00 |
| | **Total** | **34,923** | **20,379** | **6,271** | **8,479** | **5,629** | **27.62** |
| PUVNL | DT | 4,175 | 7,263 | 1,048 | 4,654 | 1,561 | 21.49 |
| | Feeder | 237 | 948 | 461 | 41 | 446 | 47.05 |
| | Ring Fencing | 250 | 4 | 2 | 2 | 0 | 0.00 |
| | **Total** | **4,662** | **8,215** | **1,511** | **4,697** | **2,007** | **43.05** |
| **Grand Total** | | **64,602** | **45,038** | **11,366** | **20,936** | **12,736** | **19.71** |

*Source: Based on analysis of data provided by the Company*

From the above MDAS report Audit noticed that:

- Out of total 64,602 system meters installed under R-APDRP, only 45,038 meters (70 *per cent*) were available on MDAS.

**Chart 2.3: Meter installed and read through MDAS**



Meters read through MDAS: 12,736 (19.71 *per cent*)

Meters available on MDAS: 45,038 (70 *per cent*)

Total Installed Meters: 64,602

*Source: Based on analysis of data provided by the Company*

- Out of total 64,602 installed meters, only 12,736 meters (19.71 *per cent*) were readable through MDAS system.

- Out of total 45,038 meters available at MDAS, 11,366 meters (25 *per cent*) was never read through the system.

- Further, the meter data of only 1,52,561 HT/LT consumers, out of total 66,86,222 consumers were being read remotely.



**Meter installed at Distribution Transformer under EDD, Chibramau not connected to modem**

Despite incurring expenditure of ₹ 27.80 crore for installation of modems at feeders and DTs, the Company failed to acquire complete meter data automatically and remotely to avoid human intervention in calculating AT&C loss accurately and generating MIS report of exceptions to monitor important distribution parameters[15] for planning, monitoring and taking corrective actions on the business activities.

The Company stated (July 2020) that DT metering is a tough field job and maintaining it remained a huge challenge due to reasons of frequent DT outages, changes and maintenance requirements. It further stated that modem failure was rectified by M/s HCL Technologies Limited whenever required.

The reply is not convincing as the Company failed to synchronise its activities of meter repair/replacement with the reconnection and repair/replacement of modem. Further, the ITIA failed to maintain connections of 11,366 meters, as the reading of these meters were never fetched by MDAS.

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[15] MIS report of overload and underload DTs, Sub-station wise DT unbalance report, feeder to DT- Technical & Distribution losses etc.

*Loss of grant as reliable Base Line Data system was not established*

**2.7** The Part-A (IT) of R-APDRP was scheduled to be completed (June 2012) within three years from the sanction (June 2009) of the project but the same was extended upto March 2019. Under Part-A (IT), 100 *per cent* funds for the project were to be provided in the form of interest bearing loan from Ministry of Power (MoP), Government of India (GoI) to be converted into grant once the establishment of reliable and automated sustainable system for collection of baseline data was achieved and verified by an independent agency[16] appointed (March 2013) by MoP through the Nodal Agency[17].

In the Performance Audit Report of 2016 at paragraph 2.1.10, Audit pointed out that ITIA could not establish the IT-enabled system under Part-A within the stipulated period of 18 months from award (January 2010) and only 90 *per cent* work was completed despite completion of five years upto June 2015. Further, in paragraph 2.1.12, Audit also commented on the remote chances of conversion of loan of ₹ 474.50 crore into grant due to non-completion of Part-A of R-APDRP and non-verification of baseline data by TPIEA.

During the present audit, it was noticed that the Company executed Part-A of R-APDRP at a cost of ₹ 662.75 crore out of which ₹ 474.68 crore in the form of loan was provided by MoP upto March 2019 whereas the remaining fund of ₹ 188.07 crore was managed from own source. The Power Finance Corporation (PFC) restricted (June 2019) the conversion of interest accrued on loan into grant upto September 2017 due to non-completion of the project within the stipulated time and verification of the same by the TPIEA. This may result into financial burden on the Company as the chances of release of the remaining amount of ₹ 188.07 crore and conversion of total released fund *i.e.* ₹ 474.68 crore along with interest accrued upto September 2017 into grant remained remote. Further, the DISCOMs had to bear the financial burden of interest after September 2017 to March 2019.

The Company stated (July 2020) that delay in TPIEA audit cannot be attributed to the DISCOMs alone. Final fund requirement and closure report have already been submitted to PFC which is in the process of finalising it.

The reply is not acceptable as due to delay in completion of Part-A (IT) of R-APDRP by the Company, the TPIEA verification was delayed. Also, the audit finding confirmed the lack of progress towards a reliable and automated sustainable system for collection of baseline data without which such TPIEA verification is not feasible.

*Incorrect submissions before Power Finance Corporation*

**2.8** PFC obtained declarations from the DISCOMs in Annexure-C related to 'Completion of Part-A (IT) Project' wherein the following declarations were made by the DISCOMs:

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[16] National Thermal Power Corporation Limited was appointed (March 2013) as Third Party Independent Evaluation Agency by Power Finance Corporation (PFC).

[17] PFC was the 'Nodal Agency' for the operationalisation and implementation of the R-APDRP, under the guidance of the MoP.

**(i)** The installed IT system in the towns is linked with all consumers of the towns and captures revenue and energy data for all of them.

**(ii)** All the new connections are released and disconnection made through IT system and delta updates in assets and consumers are being done on continuous basis in the IT system.

**(iii)** GIS survey has been carried out by ITIA by following DGPS methodology.

**(iv)** The system has the capability to generate Energy Audit Report upto DT level and AT&C loss report of the town from the IT system.

Audit noticed that the DISCOMs have made incorrect certification/declaration of completion of IT project before PFC as discussed below:

**(i)** LMV-3, 7, 8, 9 & 10 categories of consumers were not linked with the installed IT system and were being billed manually as discussed in paragraph 4.2.11.

**(ii)** New connections were issued without indexing of consumer against the GIS of electrical assets as discussed in paragraph 2.3 (i).

**(iii)** Due to non-updation of GIS database and improper communications from meters/modems installed at Sub-stations/Feeders/DTs, the Energy Audit Report and AT&C loss report generated were erratic and meaningless as discussed in paragraph 2.2.

In the Exit Conference (March 2021), the Company accepted the audit observation and stated that unmetered connections of various Government departments or units like street light, State tube wells (STW) etc. were yet to be fully updated in the IT system. The Government stated that the percentage of these consumers vis-a-vis the total consumers is small.

**Non R-APDRP billing systems**

**2.9** Unlike R-APDRP billing system, the modules like Energy Audit, MDAS, GIS based consumer and electrical assets mapping were not provided in the non R-APDRP billing system.

Audit noticed that in absence of these modules the Company could not automate the IT billing system based Energy Audit and calculation of AT&C losses of the areas where Non R-APDRP billing system is implemented. Thus, lack of IT billing system based automated Energy Audit and calculation of AT&C losses also encouraged human intervention.

> **Conclusion**

**Despite being commented in CAG's Performance Audit Report No. 06 of 2016 and even after lapse of seven years from the scheduled date of completion of Part-A of R-APDRP, the Company failed to complete/update the baseline data of consumers, electrical assets and automated metering. Hence, the Company could not utilise GIS based Consumer Indexing & Assets Mapping module, Assets Management module, Network Analysis module, Meter Data Acquisition System and Energy Audit module. As a result, the system generated AT&C loss report was highly erratic defeating the primary objective of automated calculation of the AT&C loss without human intervention. Further, in the Non R-APDRP billing system, there is no automated system of energy accounting, auditing and for generating AT&C loss report.**

**Recommendations**

| Recommendation Number | Recommendation | Response of Government |
|---|---|---|
| 1 | **The Company should complete and update the baseline data of consumers and electrical assets on priority basis in a strict time bound manner so that accurate AT&C loss report is generated automatically without human intervention.** | **Accepted** |
| 2 | **Automated reading through MDAS should be specifically improved from the abysmally low level of 19.71 *per cent*. Without automated metering the objective of acquiring accurate, reliable data for baselining, measuring and billing electricity consumption and AT&C losses cannot be achieved.** | **Response awaited** |