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# MOZAMBIQUE EDM

## Commercial Loss Reduction Efforts

## Commercial Metering Strategy and Road Map

SRUC PROJECT

CONTRACT NUMBER: AID-OAA-TO-14-00006

**January 31, 2017**

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# SECTOR REFORM AND UTILITY COMMERCIALIZATION PROJECT

## **MOZAMBIQUE EDM: COMMERCIAL LOSS REDUCTION EFFORTS**

### **Commercial Metering Strategy and Road Map**

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DELOITTE CONSULTING LLP**

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## ACRONYMS

The following table provides a list and description of acronyms used in this report.

Acronym	Term
3E	Eclipse Enterprise Edition
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
AMS	Asset Management System
BCLV	Big Clients of Low Voltage
C&I	Commercial and Industrial
CMS	Commercial Management System
CSA	Customer Service Area
CT Ratio	Current Transformer Ratio (ratio between the primary current and the secondary current, i.e., 800:5)
EDM	Electricidade de Moçambique
GIS	Geographic Information Systems
HES	Head End System (AMR or AMI data collection platform)
HV	High Voltage
KPI	Key Performance Indicator
L&G	Landis and Gyr Meter Manufacturer/Vendor
LV	Low Voltage (Customer)
MCC	Meter Control Center
MDMS	Meter Data Management System
MV	Medium Voltage (Customer)
MV-90xi	Current Head End System for Grid and C&I Metering
NCIS	Network Customer Information System
PDT	Portable Data Terminal
SIGEM	Supply, Installation, and Training of an Integrated Business Management System
SOA	Service-Oriented Architecture
SOP	Standard Operating Procedure
VT Ratio	Voltage Transformer Ratio (between the primary voltage and the secondary voltage, i.e., 88000:110)

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## I. EXECUTIVE SUMMARY AND MAIN CONCLUSIONS

This document presents a strategic road map for EDM's commercial metering. The road map recommends nine strategic initiatives that collectively address weaknesses identified along the meter-to-cash value chain during the diagnosis phase (summarized in the Concept Paper). When implemented, these initiatives have the potential to create sustainable capabilities aligned to EDM's strategic vision of achieving sustainable high growth. Given the low level of access to electricity in the country, increasing revenue is a prerequisite for the expansion of power supply to the Mozambican population.

Most specific recommendations embedded in the strategic initiatives involve improving or designing and implementing processes. For example, one of the main initiatives is the development of a loss analytics and management capability. Each strategic intervention has expected impacts in terms of increased revenue (often through the reduction of commercial losses), increased customer satisfaction, increased business intelligence, and/or reduced operating costs.

In terms of the expected effort required to execute the interventions, most require implementation by EDM staff supported by independent strategic planning, monitoring, and quality assurance consultants.

While the strategic initiatives address a myriad of specific strategic, technical, organizational, and/or operational issues identified, overall a number of diagnostic lines emerge from the current state of the commercial metering system at EDM:

- There is lack of reliable data informing various processes, including billing, metering operations, loss calculation, analytics, and related management processes. In some instances like loss calculation and analytics, this requires a major overhaul of the energy balancing process (including investing in meters at feeder level). In others, it requires cleanup of existing databases or renewed data collection efforts (such as the reregistration of all customers to ensure data reliability and minimize the probability of theft and fraud).
- There are major integration gaps between EDM technology systems, including the CMS, the Network Information System (NIS), and the Customer Information System (CIS). Their integration is a prerequisite for EDM to be able to use the required data to conduct virtually all of the processes included in the revenue cycle.
- There is a high level of variation and individuals' discretion in execution of activities, which often results in duplication of efforts (for example, multiple loss reduction plans) or slow execution (such as the meter procurement process). Knowledge of critical activities is often concentrated in a limited number of individuals' hands. This calls for redefining and mapping the full list of processes EDM conducts with the right accountability mechanisms and KPIs.
- EDM has executed and is currently executing projects addressing specific performance gaps. However, several of these initiatives have resulted in negative side effects (such as the inability to conduct reliable energy balancing) or a lack of continuity due to inadequate coordination across departments and assurance along project implementation. EDM needs to reflect on how



to structurally address this recurrent risk through adequate project assurance, as well as how to design a process to ensure transitioning from project closure to EDM's steady state.

- EDM needs to improve and deliver its meter policy. To replace non-split meters (90% of LV customer use integrated, i.e., non-split meters) for AMI split meter for LV clients.
- Related to this, there is a need for EDM to develop a strategic planning and monitoring unit to ensure the identification, design, and coordination of strategic solutions.

The nine initiatives are illustrated in Figure 1 below and continuing on the following page:

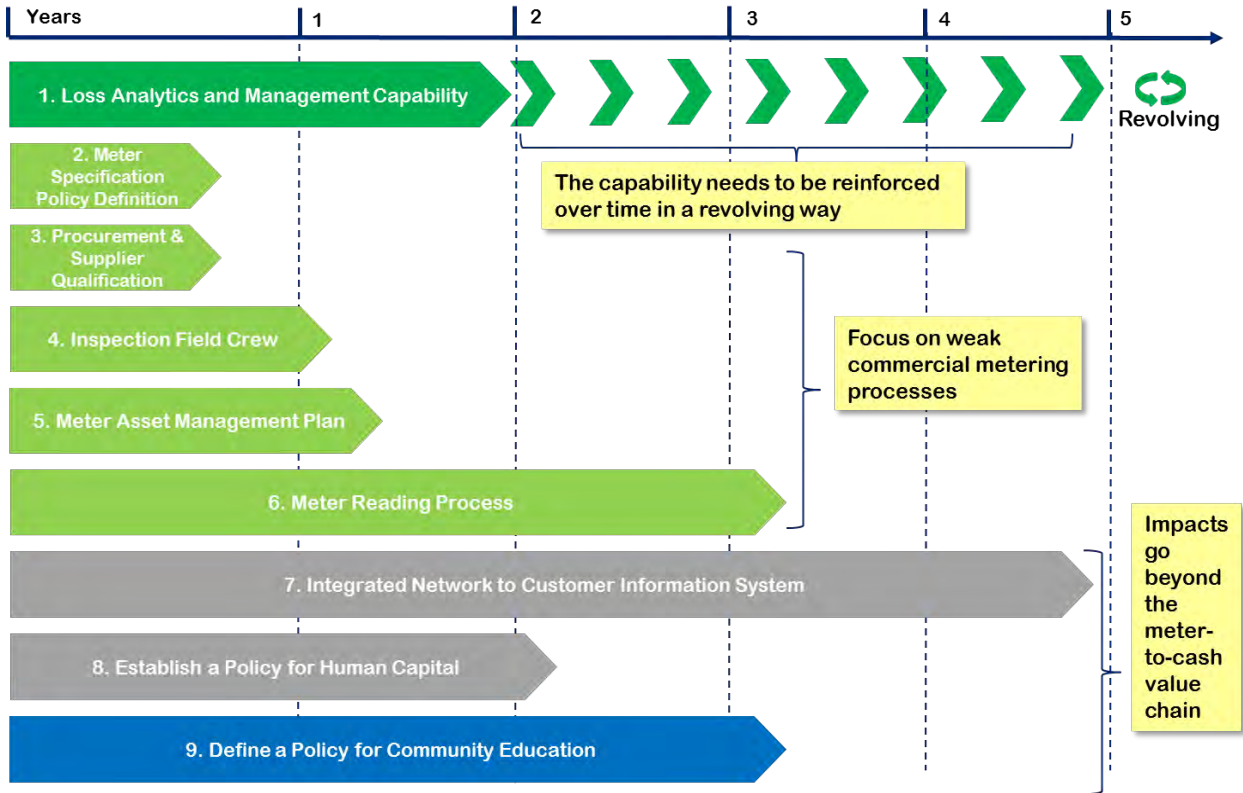
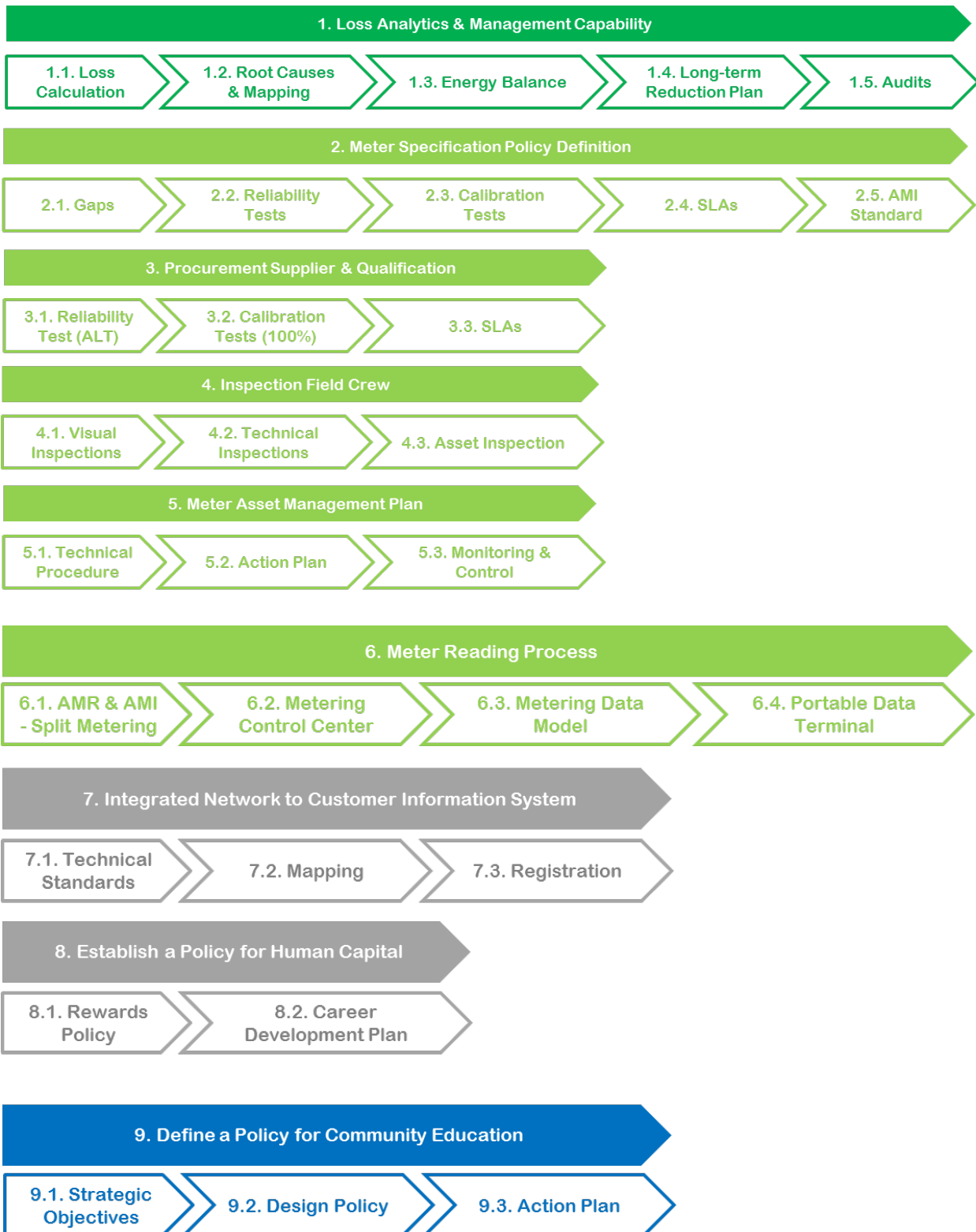


Figure 1 Transformation Map Summary



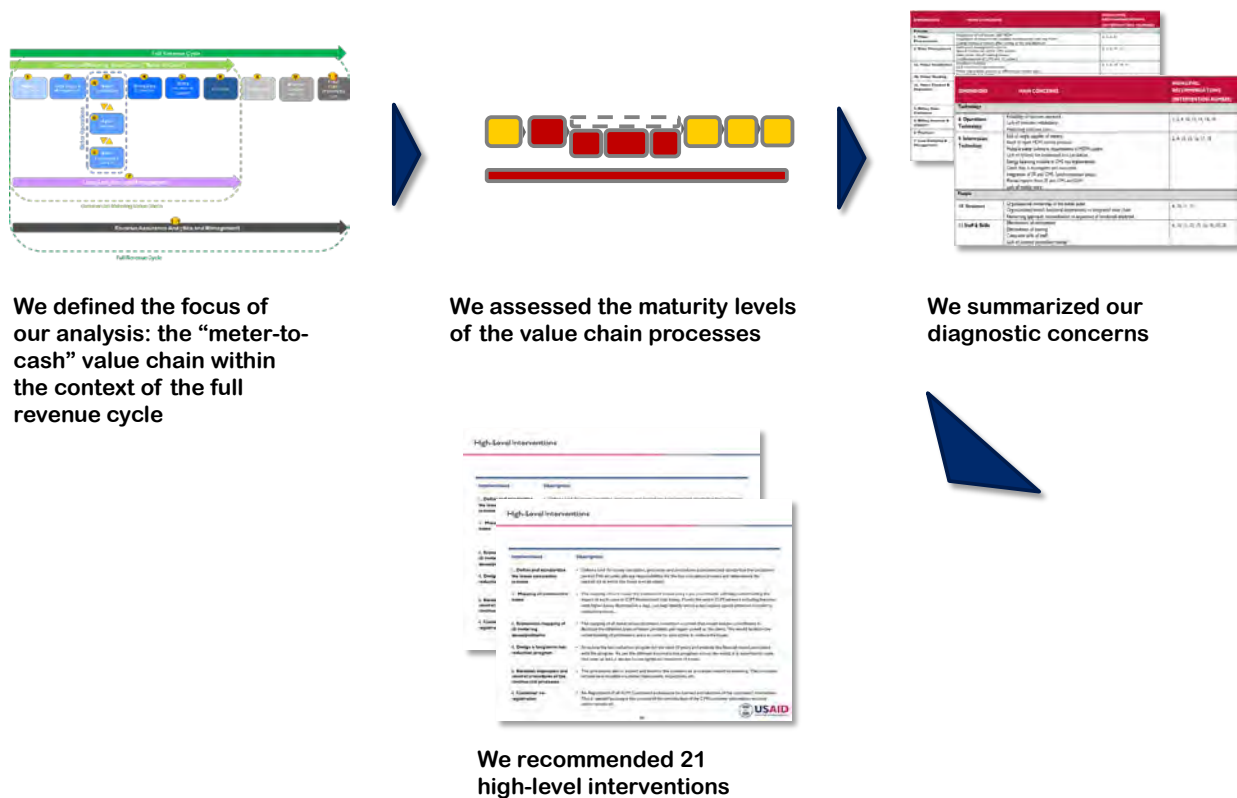
The interactions held during the course of this project suggest that EDM leadership is committed to the strategic development of sustainable capabilities in commercial metering, including developing the relevant people, process, and technology dimensions. This will enable the organization to substantially and sustainably increase revenues; thus, promoting its financial strength.

A critical next step is to develop a business plan that supports operationalization of the strategic initiatives laid out in the road map, including estimation of budgets, execution actions, targets, and resulting estimated reductions in commercial losses.

## 2. INTRODUCTION

The diagnostic of the *as-is* situation of the meter-to-cash value chain was conducted on the basis of information collected from the Commercial Directorate and other relevant directorates, such as Energy Efficiency and Client Services.

The diagnostic was initially described in the Concept Paper, where main concerns were raised and 21 high-level interventions were recommended. An illustration of the *as-is* diagnostic methodology is depicted below:



**Figure 2 As-Is Diagnostic Methodology**

Overall, the diagnostic revealed different stages in the maturity of key processes. The main finding was that the current loss analytics and management process are not *en par* with industry practices. Furthermore, activities were often conducted in the absence of a structured and monitored process. Data management and metering operations were constrained by lack of reliable data, weak or inexistent systems integration (for example, NIS and CIS or customer billing data), uncoordinated actions (slow procurement of smart meters for LV customers likely to be contributing to losses), and duplication of activities (loss reduction action plans).

This combination of challenges illustrates that while there is some degree of notional awareness of the kind of technologies and processes required to be in line with international industry practices exists (for example the need to introduce smart metering technologies for all customers), so far this has not

translated into concerted action to configure activities, assets (IT and OT) and people into sustainable capabilities so as to meet EDM's strategic vision of achieving sustainable high growth over time (hence the deteriorating financial position of the company).

As it happens, currently EDM neither has sight of the root cause of losses nor the operational capacity to respond to the current sources of losses or even to prevent the situation from aggravating as the number of clients (and therefore meters) increases. Therefore, unless urgent and concerted action is taken to prevent an increase in losses, the most likely scenario is that losses increase as the number of deployed meters increases, unless a comprehensive loss reduction analytics and management capability is built in addition to addressing targeted operational bottlenecks along the value chain.

Over and above the increasing volumes that are unpaid, with the recent increases in tariffs and future ones, financial losses are forecasted to increase rapidly to the range of MZN 3-6 Billion annually.

In parallel to its acute and spiraling loss management problem, during the past few years EDM has introduced initiatives to improve key processes, especially those related to the new CMS in addition to the adoption of the strategic decision only to purchase "smart" meters that use AMR or AMI technologies.

When effectively implemented, the strategic initiatives are likely to reduce (but do not remove entirely) the ability of clients to conduct fraudulent practices. However, the absence of adequate preparation, assurance and management capacity has resulted in a number of unexpected loss-increasing and revenue-decreasing complications along the implementation of such initiatives, such as the rollout of faulty / low quality meters, meters that do not integrate well with EDM's technology systems and the forfeit of EDM's former (albeit limited) ability to match customer (e.g., billing) data and network (e.g., power distribution) data and, through this, calculate and identify the root causes of losses.

More generally, there have been some projects aiming at improving specific areas of operational effectiveness. However, in an underlying context of organizational silos and lack of project assurance they have not delivered EDM's corporate strategy and have often had unintended but negative impacts on the company side effects.

This seemingly recurrent "improving-worsening" cycle of performance highlights the need for EDM to avoid piece-meal, *ad hoc*, or uncoordinated approaches to the design and implementation of strategic initiatives. Instead, EDM must identify transformative initiatives that have the potential to generate and sustain results over time by creating sustainable capabilities, rather than short-lived yet unsystematic gains, materially reducing losses, avoiding revenue leakage, reducing operational cost, improving business intelligence, and customer satisfaction.

Following this sustainable capabilities approach and based on the logical and operational dependencies across the 20+ high-level interventions, the road map groups the high-level interventions into 10 strategic initiatives. Interventions that focused on the same process along the value chain were grouped to consolidate their impact.

For each strategic initiative, the following analysis is provided:

- Problem Statement
- Description
- Action Plan
- Expected Impact
- Expected Effort (resources needed for implementation)

The next section (Section 3) presents the sustainable capabilities approached we followed to identify dependencies of interventions so as to group them into strategic interventions and to optimally sequence the interventions based on the expected impact and effort.

The subsequent section of the document (Section 3.4) describes the grouping of the 21+ interventions into nine strategic initiatives. These were formed based on their dependencies and the need for them to collectively create the sustainable capabilities EDM requires to realize its revenue potential from its power sales, ensure customer satisfaction, build business intelligence, and reduce operational costs from managerial decisions that are not based on reliable data.

Section 3.5 presents the impact-effort analysis of the strategic initiatives.

Finally, Section 3.6 presents a list of KPIs that EDM should track in pursuing the recommended strategic initiatives.

### 3. THE SUSTAINABLE CAPABILITIES APPROACH

Strategy is the creation of a unique and valuable position, by deliberately choosing a differentiating set of activities. The essence of strategy is in the activities – choosing to perform activities differently or to perform different activities so as to develop sustainable capabilities. In a non-competitive environment such as the one EDM operates in the objective is not to so much to develop competitive advantages (a “fight” against competitors) but to develop sustainable capabilities (a “fight” of the company with itself to continuously improve results over time within a changing environment).



**Figure 3 Basic Strategic Choices in Strategy Formulation**

Sustainable capability comes from the way activities fit and reinforce one another in a way that is consistent with the company’s strategy.

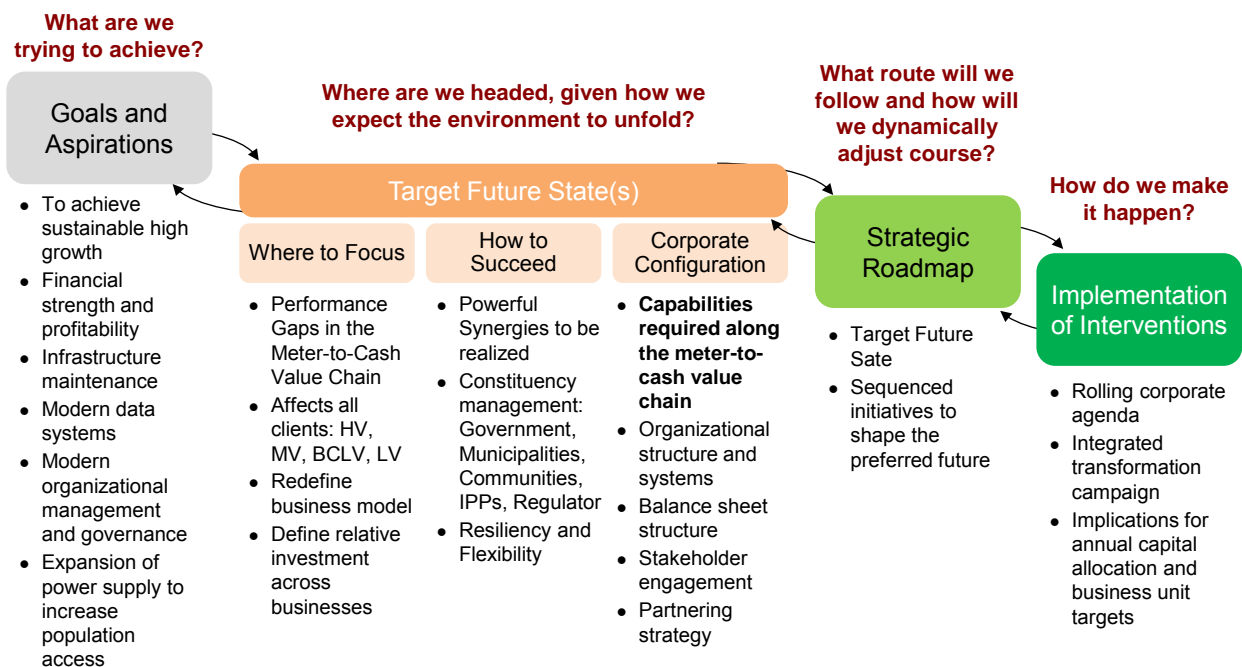
First order it is simple consistency between each activity (and function) and overall goals and aspirations contained in the corporate strategy. EDM’s specific vision for 2015-2019 is “to achieve **sustainable** high growth”. Second order fit occurs when activities are reinforcing between themselves, based on their mutual dependencies. Third-order fit goes beyond activity reinforcement to optimization of effort, identifying the configuration that delivers the highest impact at the lowest obligation of resources required.

Companies with common themes across activities create sustainable capabilities by creating a net of synergistic activities. Critical capabilities are composed of activities ideally organized into processes, people, and assets, including Information Technology and Operational Technology.

The success of a strategy depends on doing many things well and integrating among them. If there is no fit among activities, there is no distinctive strategy and little sustainability. In this case, management reverts to the simpler task of overseeing independent functions.

#### 3.1 CHARACTERISTICS OF THE SUSTAINABLE CAPABILITIES APPROACH

In our ‘Sustainable Capabilities’ approach, value comes from optimizing the whole of the meter-to-cash value chain (within the full revenue cycle) in a way that delivers the goals and aspirations defined in EDM’s corporate strategy. Once the future / target state is identified, the strategic road map provides the optimal path to get there.



**Figure 4 Strategic Cascade of Choices**

The majority of value comes through integrating across functions, systems, and activities. Moreover, customers experience the company as a single entity. However, configuration decisions are not enough. EDM must measure and monitor progress. Connect to internal support systems, e.g., performance and reward systems. Focus on the critical few measures.

It is worth highlighting that superior configuration is not necessarily about cost reduction. Rather it is about delivering customer value effectively and economically; getting more from the same resources and assets and selectively adding value-adding assets and activities or divesting of non-value-added assets or activities.

### 3.2 EDM'S CORPORATE STRATEGY 2015-2019

EDM's vision for 2015-2019 is to achieve sustainable high growth. At its highest level, the strategy defines four strategic pillars:

- 1) Sustainable expansion of the supply of power so as to ensure increased access to power by the Mozambican population
- 2) Sustainable financial strength and profitability to support the expansion of power supply
- 3) Sustainable maintenance of the infrastructure
- 4) Promotion of the adoption of modern data systems, organizational management, and governance



### 3.3 FROM CURRENT STATE TO FUTURE STATE

Figure 5 below summarizes the approach followed in the road map to define strategic initiatives that have the potential of building sustainable capabilities so as to achieve the future state.

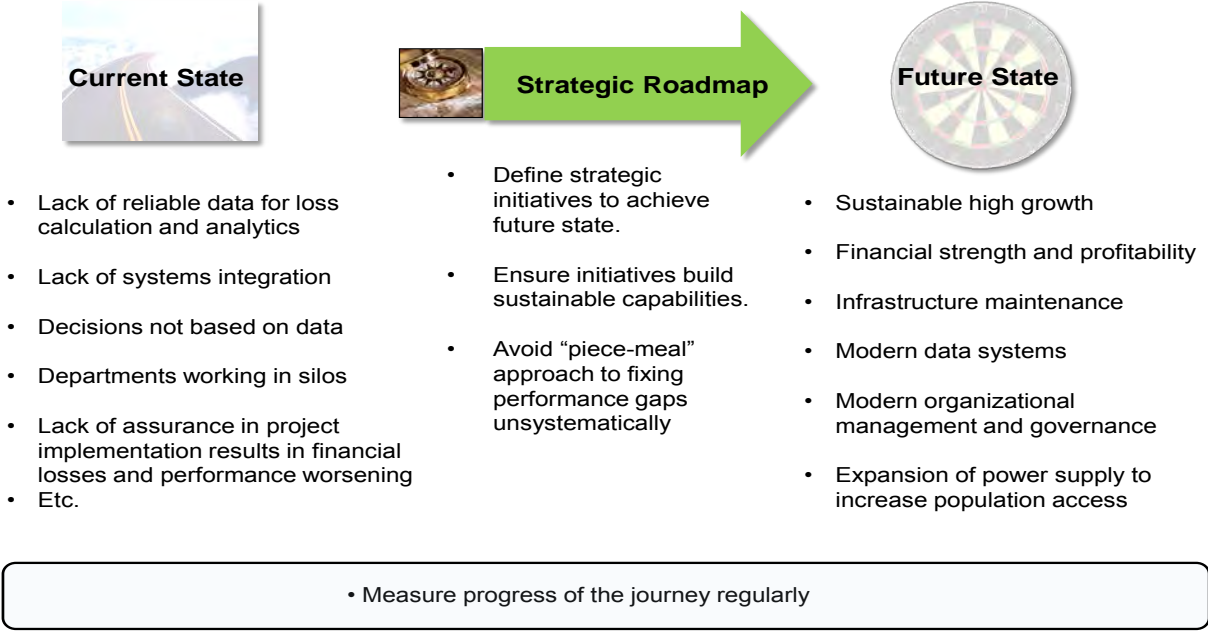


Figure 5 From Current State to Future State through the Strategic Road Map

### 3.4 DEPENDENCIES: GROUPING OF INTERVENTIONS INTO STRATEGIC INITIATIVES

The 21 interventions identified in the concept paper were structured into nine strategic initiatives in a way that is mutually exclusive and collectively exhaustive. Collectively, these nine strategic initiatives address the full list of issues / gaps identified along the meter-to-cash value chain while not overlapping so as to cause repetition or redundancies.

The need to group recommended interventions follows our sustainable capabilities approach.

Addressing specific weaknesses of the meter-to-cash value chain without addressing others is likely to be ineffective as value comes from optimizing the entirety of the chain, not just individual links.



We recommended 21 high-level interventions

We analyzed the dependencies between the 21 recommended interventions and grouped them into 9 strategic initiatives to ensure coherence and maximize the ability of EDM to create sustainable capabilities in its weakest areas in the value chain

Figure 6 From Diagnosis to Prescription

*Ad hoc* interventions adopted while maintaining the current status of core processes in the value chain is likely to result in short-lived gains and unexpected costs, and should, therefore, be avoided.

Interventions included in the initiatives must be reinforcing between themselves, based on their mutual dependencies. For example, the first strategic initiative is to build loss analytics and management capabilities. This initiative consists of four components, namely:

- Define and standardize the losses calculation process
- Mapping of commercial losses
- Design a long-term loss reduction program
- Conduct audit processes along the entire full revenue cycle

The full list of interventions structured into strategic initiatives is presented in Figure 7 below as well as how they map to the meter-to-cash value chain (in Figure 8). In some instances, the interventions go beyond the meter-to-cash value to generate sustainable capabilities that will impact the full revenue cycle.

Concept Paper Intervention Number	High-Level Interventions Identified in the Concept Paper	Strategic Initiative Number	Strategic Initiatives in the Roadmap
1	Define and Standardize the Losses Calculation Process	1	Loss Analytics and Management Capability
2	Mapping of Commercial Losses		
4	Design a Long-term Loss Reduction Program		
21	Conduct Audit Processes along the Entire Full Revenue Cycle	2	Meter Specification Policy Definition
9	Meter Specification Standardization for HV, MV and BCLV clients		
11	Define a Policy for Pre-paid Meters		
19	Define the Meter Lab Structure for Quality Control	3	Procurement & Supplier Qualification
5	Establish Inspection and Control Procedures of the Commercial Processes	4	Inspecton Field Crew
10	Define on-site meter inspection crews	5	Meter Asset Management Plan
3	Systematic Mapping of all Metering Issues/Problems		
7	Define a Process to Verify if the Meters are Operational once removed from the field		
8	Prepare and Plan for Faulty Meter Replacement	6	Meter Reading Process
13	Assurance Program for AMR Roll-out		
14	Establish Redundancy Process for Communication		
15	Metering Control Centre Implementation		
18	Portable Data Terminal Roll-Out		
6	Customer re-registration	7	Integrated Network to Customer Information System
17	GIS Implementation		
16	Systems Integration and Process Design		
12	Establish a Policy for Developing People	8	Establish a Policy for Developing People
20	Define a Policy for Community Education	9	Define a Policy for Community Education

Figure 7 Grouping of Recommended Interventions into Strategic Initiatives

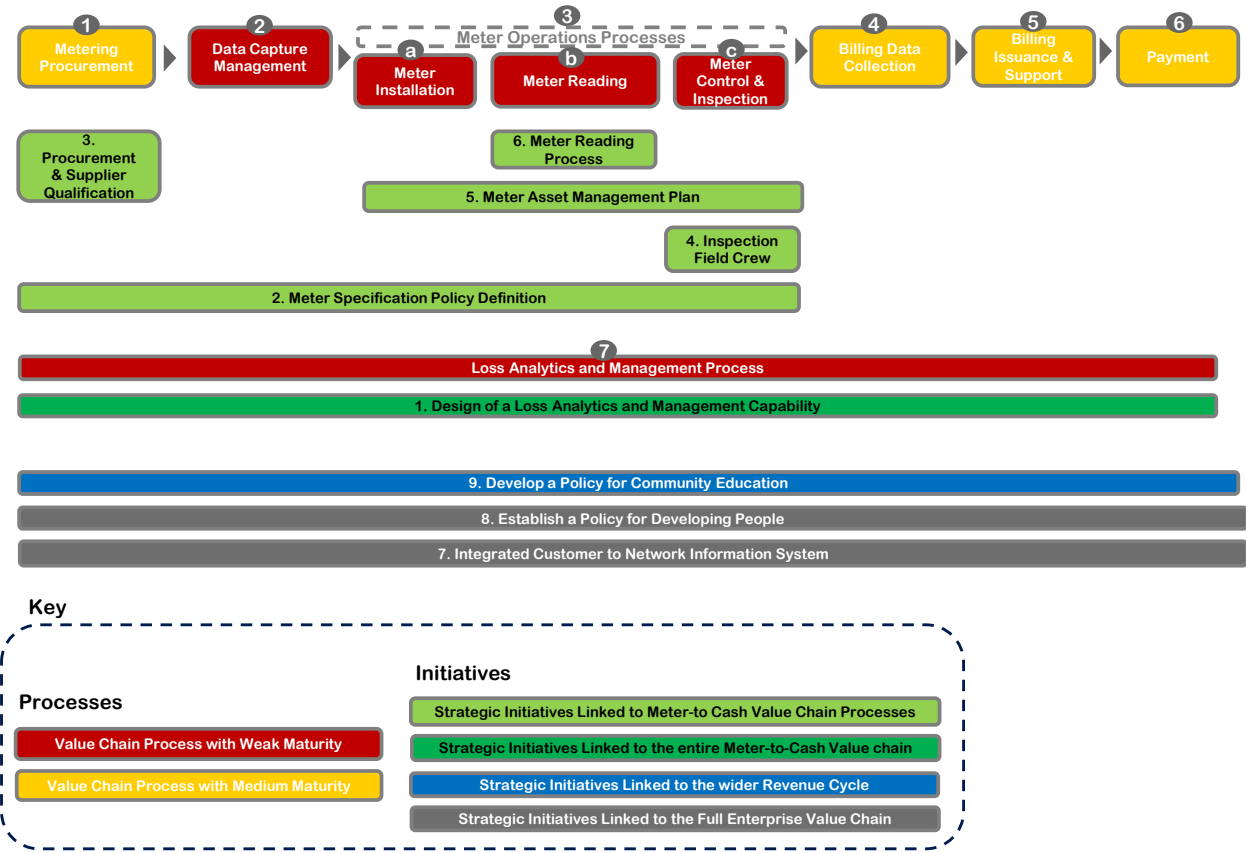


Figure 8 Mapping of Strategic Initiatives Along the Meter-to-Cash Value Chain

### 3.5 EXPECTED IMPACT - EXPECTED EFFORT ANALYSIS

All of the initiatives have important qualitative impacts with related quantitative impacts. However, because of the nascent stage in which many of the loss-reduction and metering processes are at EDM (often lacking consistent process mapping and execution), it would be speculative to forecast financial impacts for each of the strategic initiatives at this point.

Therefore, in the absence of baseline data the road map does not present business cases (but certainly recommends that they are conducted) but rather provides strategic advisory along the two key feasibility dimensions: expected impact and expected effort.

For that purpose, the impact of the initiatives was scored from 1 to 4 (where 1=low, 4=high) based on a weighted-average formula that is aligned to EDM strategic pillars and uses the following weights:

- 1) Revenue increase (30%)
- 2) Customer satisfaction (30%)
- 3) Business intelligence (15%)
- 4) Operational cost reduction (15%)

The expected effort needed (resources and time, equally weighted) were also scored from 1 to 4.

Strategic Initiative Number	Strategic Initiatives in the Rodmap	Impact on EDM				Impact	Business Effort		Effort
		Revenue Increase	Operational Cost Reduction	Business Intelligence	Customer Satisfaction		Resources	Time	
1	Loss Analytics and Management Capability	4	2	4	4	3.7	2	2	2.0
2	Meter Specification Policy Definition	3	4	1	4	3.2	2	2	2.0
3	Procurement & Supplier Qualification	1	3	1	2	1.6	2	2	2.0
4	Inspector Field Crew	4	2	4	3	3.4	3	2	2.5
5	Meter Asset Management Plan	2	4	3	3	2.8	4	3	3.5
6	Meter Reading Process	4	3	4	4	3.9	4	4	4.0
7	Integrated Network to Customer Information System	3	3	4	4	3.5	4	4	4.0
8	Establish a Policy for Human Capital	3	4	4	4	3.6	3	3	3.0
9	Define a Policy for Community Education	3	2	2	4	3.0	4	3	3.5

Figure 9 Scoring of Strategic Initiatives

The impact-effort analysis allows to group initiative in three potential groups:

- 1) Highest Impact-Effort
- 2) Medium Impact-Effort

### 3) Lower Impact-Effort

Scoring was conducted based on our industry experience of how strategic initiatives contribute to key strategic objectives of utilities as well on validation with EDM Commercial Directorate.

The actual scoring is presented in Figure 9 above. The following strategic initiatives have a high impact-to-effort relationship:

- Design of a Loss Analytics and Management Capability
- Establish a Policy for Human Capital
- Inspection Field Crew
- Meter Policy Definition

The above initiatives should be targeted first as they require lower effort and provide equal or higher impact.

The following strategic initiatives have a medium impact-to-effort relationship (reflecting a higher level of effort required when compared to the previous ones)

- Meter Reading Process
- Integrated Network to Customer Information System
- Develop a Policy for Community Education
- Meter Asset Management Plan
- Procurement Supplier Qualification

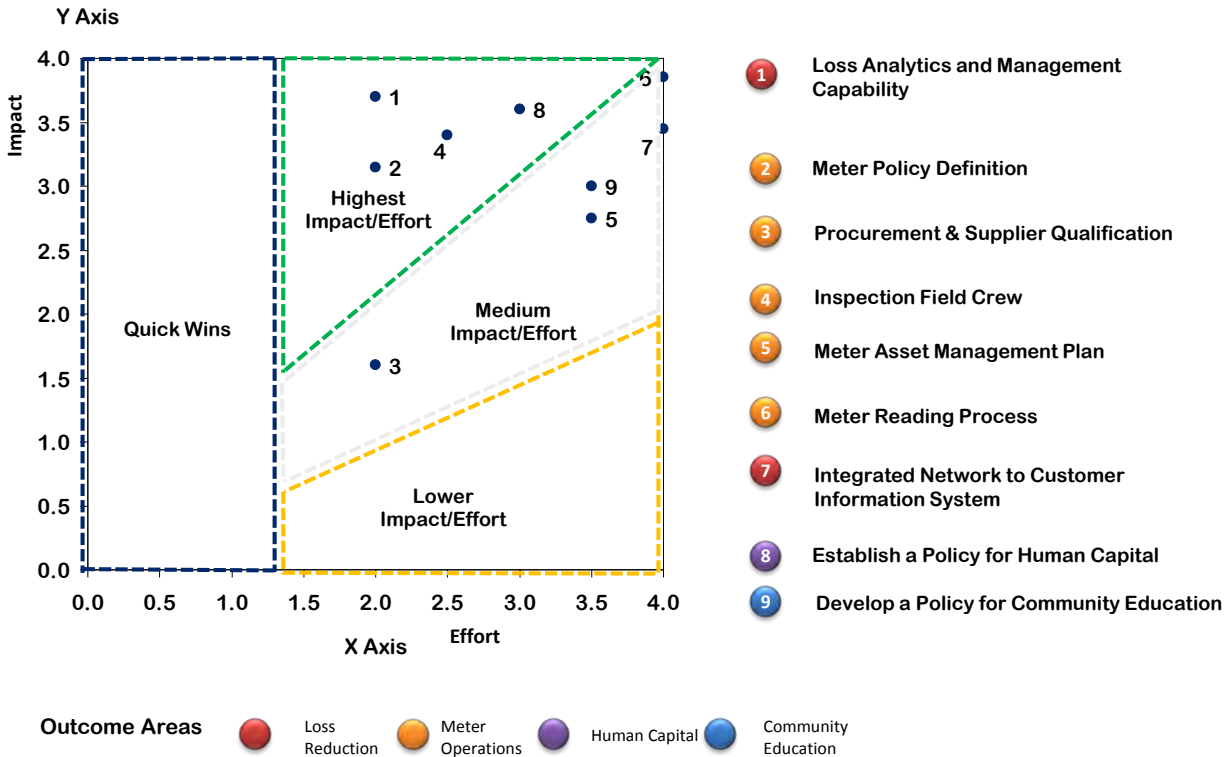


Figure 10 Scoring of Strategic Initiatives

### 3.6 KPIS FOR THE EFFICIENT MANAGEMENT OF THE METERING SYSTEM

EDM is in the process of improving its KPI reporting and analysis maturity through the rollout of a KPI Business Performance System. The KPI Business Performance System will be used to implement and manage the KPIs for loss management. The calculation of the raw measures for the management KPIs is done as part of this solution and replaces the current manual processes.

The Energy Efficiency Directorate (DEE) has compiled a strategy for revenue protection with the following five pillars:

- Education and awareness
- Measurement
- Technology
- Operations
- Reporting

The strategy is a key input into the identification of appropriate operational and management KPIs and an analysis of the current KPIs and recommendation of appropriate KPIs is made in the following section.

### 3.6.1 MEASUREMENT AND OPERATIONS

EDM has a number of KPIs for losses reporting as detailed in Table I on the following page. These KPIs are reported monthly by CSAs, per transmission division (where applicable) and globally. Additional complementary KPIs are recommended for each of the key measures to strengthen the effectiveness of performance management and drive the appropriate organizational behavior.

EDM does not have the ability to perform energy balancing closer to the customer, which means many of the KPIs cannot be applied. It is recommended to prioritize the reestablishment of the customer network link as a key enabler for targeted losses management.

### 3.6.2 EDUCATION AND AWARENESS

At the moment, there are no EDM indicators that measure the education and awareness around losses directly; however, the corporate communication department has some general KPIs regarding EDM.

It is recommended that EDM implements loss campaign-specific KPIs. Similar KPIs have been developed and implemented by other African utilities managing high losses<sup>1</sup>. The following would be the key performance areas:

- *Media Measurements by Independent Assessors:* Independent assessors are employed to assess the impact and effectiveness of campaigns using focus groups and interview. The purpose of the campaigns is to educate and change behavior. Measurement of the change in customer attitude, perception, and behavior should be measured and the appropriate KPIs would be developed with media marketing experts.
- *General Campaign Indicators:* Each campaign would have a different objective to be tracked to measure effectiveness. For example, if the campaign was on increased reporting of theft, the number of reports could be tracked.

Apart from the media and campaign-specific indicators, the losses KPIs (described in the section above) could be tracked with the campaign in mind (especially if it is a geographically targeted campaign).

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<sup>1</sup> M. Maphaka; M. van Kaam; V. Moodley; C. Erwee; K. Landsberg, “Energy Losses Management Programme”, South African Revenue Protection Association, Proceedings of 2010 Convention

EDM Losses KPIs	Recommended Additional KPI for EDM Based on Other Utilities, e.g. Eskom	Rationale
Number of Inspections Carried Out	% Customers inspected per category based on loss intelligence, e.g., large customers, urban / rural, residential / agriculture.	Using the loss analytics solution, inspections can be directed to increase efficiency based on intelligence, i.e., loss analytics or energy balancing. Losses are further stratified and reported on this stratification to provide further granularity in the reporting.
	% Customer inspections based on loss analytics, e.g., <ul style="list-style-type: none"> <li>• Low / no consumption</li> <li>• Disconnected meter supply points continuing to advance</li> </ul>	
	% Customer inspection carried out based on energy balancing	
Number of Frauds Detected	% Frauds detected per category based on loss intelligence, e.g., large customers, urban / rural, residential / agriculture.	Efficiency per category and loss detection method enable prioritization of resources and fine tuning of analytics per strata.
	% Frauds detected based on loss analytics	
	% Frauds detected based on energy balancing	
Technical and Non-Technical Losses per CSA, Transmission Area and Globally	Total losses per customer category, e.g., large customers, urban / rural, residential / agriculture.	Losses per category enable prioritization of resources and identification of appropriate actions.
	% of losses measured through transformer and feeder level energy balancing	Effectiveness of transformer and feeder level energy balancing.
Total Losses at Acquisition Cost	Total losses at the consumer tariff	The losses can be differentiated by tariff category, to obtain more appropriate revenue loss allocation.
<b>Additional</b>		
Energy Balancing and Statistical Metering	% Statistical in-grid meters installed at MV level	Operational measures on the implementation of feeder, transformer level energy balancing, and statistical in-grid meters.
	% Feeders and transformers balanced	
	Accuracy of feeder and transformer balancing, based on inspection effectiveness	
	Number of transformers with losses >30%	

**Table 1 Recommended Additional KPIs for EDM Loss Management**



## 4. ANALYSIS OF STRATEGIC INITIATIVES

The nine strategic initiatives grouped from the 21 concept paper initiatives are described below:

### 4.1 DESIGN OF A LOSS ANALYTICS AND MANAGEMENT CAPABILITY

#### Problem Statement

The loss calculation process must be performed based on predefined criteria and procedures, including data collection required for losses calculation. This procedure must establish the loss calculation process flow and each stage of process must be described in detail. Although EDM has a methodology for total loss calculation, the process must be standardized through a Commercial Department procedure. The recommendations below can be used for guidance in the development of the Commercial Department procedure for losses calculations:

- EDM must standardize the losses calculation process. This includes formula standardization as well as standardization of other elements in the process such as data collection, exceptions, responsibilities matrix.
- EDM must structure the information systems and databases in order to analyze the issues that lead to losses and allow for the respective mapping of root causes. This can be used for guidance in the elaboration of the action plan for combating losses.
- EDM must install meter control points throughout the network to ensure its capability for energy balancing.
- EDM must structure an annual action plan for the next few years in order to achieve loss reduction targets.
- EDM must develop a structured audit procedures in the revenue cycle in order to identify failures in the execution of business processes or vulnerabilities that could lead to revenue losses.

A number of data quality and poor system issues are currently being experienced with the calculation of losses:

- Primary transformer readings. About 20% of transmission metering is done on the primary side of the transformer as opposed to the secondary side. With primary side measurements, the readings would include the transformer losses and, therefore, misrepresent the distribution load and loss.
- EDM does a number of meter estimations for cases where meters are not read or meters are not functioning or available. This is mostly the case for auxiliary power, street lighting, and EDM's own consumption.
- Allocation of prepaid transactions to loss calculation period. With prepaid customers, the consumption is not recorded; however, the transaction is used as proxy.
- Allocation of conventional meter readings to the loss calculation period. This is an issue for conventional metering only, i.e., where register and interval recording does not exist.

- The integration between network information in the NIS and the billing system in the CMS does not exist. The result is that it is not possible (any more) to perform energy balancing at a level lower than the ASC. In the past, energy balancing per substation was possible and this capability was lost due as a result of poor data quality which resulted from implementation challenges in the previous geographic information system (GIS) project and information that was lost with the CMS implementation project.

### Problems with EDM's Current Energy Balancing Calculation

The current EDM process for performing its energy balancing model is inherently manual. The process and key data elements used to perform this calculation are illustrated in Table 2 below:

Item	Energy Balance	Notes
1	Energy from Transmission into the ASC	This is data is provided by DRT and for about 80% of transformers are secondary readings. Data is transported either via AMR or via manual readings. This would include DSP and IPP's. Certain transmission substations supply more than one ASC, e.g., CHIMUARA which supplies both Beira and Quelimane. Here the supply is split based on feeder-level metering.
2	Local Production	These are stand-by generators and the meters are read when the generators are used.
3	Border Village Imports	Supply of energy into EDM from cross-border supplies. In some cases, no meters exist at EDM and the consumption values used are based on invoiced values only.
4	Border Village Exports	Supply of energy to neighboring country villages.
5	Gross Available Energy for Distribution	$(1) + (2) + (3) - (4)$
6	Auxiliary Consumption	Energy used at substations – in some cases these values are estimated.
7	Net Available Energy for Distribution	$(5) - (6)$
8	Street Lighting	Public street lighting supplied by EDM. In some cases, no meters exist or the meter may be faulty and consumption is estimated. Although this is not billed for, it is recorded in CMS.
9	Internal Consumption	Consumption by EDM buildings and facilities. Although this is not billed for, it is recorded in CMS. In some cases, no meters exist or may be faulty and consumption is estimated.
10	Invoiced to Customers	Invoiced consumption extracted from CMS. This should include conventional read customers and prepaid customers. There are current data quality issues with CMS for prepaid data and the prepaid data is extracted from CREDELEC.
11	Distribution Losses	$(7) - (8) - (9) - (10)$

Table 2 Training Development Approach

EDM has the following energy balancing challenges:

- Energy balancing with prepaid transactions in terms of the allocation of the energy purchased to the appropriate month. For example, some of the electricity purchased in February might be consumed in March and likewise. This uncertainty in allocation could lead to under- or over-reporting of losses in any given month.
- Integration between EDM systems (the 3E prepaid vending system and CMS) resulting in significant delays. The impact of these delays is that the consumption extracted from CMS and used for the calculation of losses may be a subset of the actual sales made, i.e.; the losses would be exaggerated due to under-reporting of the sales.
- Tracking of data quality from the source systems is relatively easy to detect in cases where a large amount of customers are affected. However, when fewer customers are involved, the problem may remain undetected for months. This would lead to:
  - Under- and over-reporting of losses and loss management
  - False positives for targeted audits
  - Incorrect conclusions regarding campaigns and interventions
- The integration between the NIS and the CMS is non-existent. The impact is that energy balancing inside the ASCs is not possible at the transformer and / or feeder level. The impact is that a number of loss management information actions are not possible, including:
  - Targeted audits as these audits required intelligence about where losses are high, to increase the impact of those audits
  - Tracking loss interventions at transformer level as customers cannot be linked to a transformer and group-level information analyzed
  - More advanced customer analysis (e.g., spatial stratification, which would assist in directing audits to hotspots)

#### 4.1.1 DEFINE AND STANDARDIZE THE LOSSES CALCULATION PROCESS

##### Description

The procedure for calculating losses should include the following aspects:

- The methodology to be used for losses calculation. This refers to the mathematical formula for calculating losses and the description of all the elements in the calculation.
- Definition of the data required and the source of information to perform the losses calculation. It should be specified on which data will be extracted from physical measurements (and its location) and which data is extracted from information systems (i.e., CMS). Furthermore, the dates to extract the information must also be defined to ensure that the information collected is within the same time frame.
- Definition of the people responsible for data collection. This task should remain with the same people to avoid errors and minimize risks.
- Definition of the procedure to identify which data will be used for loss calculation. The losses could be calculated based on monthly data (month-to-date), data accumulated in the year to the present date (year-to-date), or in the last twelve months (last twelve months). These three different approaches allow for a more precise analysis of the losses evolution and the efficiency in combating losses.

The monthly calculation is less precise as there are problems in the time frame of the information for postpaid customers as the monthly consumption time frame used for billing is usually different to the time frame of a calendar month. To ensure a precise calculation, the time frame must be adjusted using the average daily consumption. Another issue with this approach is related with the prepaid energy bought but not consumed within the month. This may impact the values used in the loss calculation process. EDM must evaluate measures for solving the issue.

The 'last twelve months' approach is recommended as it minimizes the time frame issues and has a more stable value in the long run, helping in the projections of losses.

When delays occur in billing high consumption customers the billing is moved to the subsequent billing time frame. However, an estimation of the unbilled energy must be performed and added to the subsequent billing month to avoid distortion in the historic billing which, if not avoided, will in turn distort the losses calculation.

The commercial procedure must define how the losses are calculated for different purposes within EDM even though only one value will ultimately be reported in the annual report. It is important that the different losses calculations are performed by the same department to ensure consistency and coherence in the calculation process.

See below the different elements of the loss calculation:

- **Vtotal** = This value indicates the energy that enters the transmission network and circulates throughout the entire network as well as what is billed to all of EDM customers.
- **Vdis** = This value indicates the energy that enters the distribution network substations and feeds the MV and LV customers. There must be standardization regarding whether readings are performed *before* or *after* the transformers. The calculation must take into account all the customers under the distribution network (LV and MV).
- I. **VdisLV** = This value indicates the energy that enters the distribution network substations and feeds the MV and LV customers minus energy billed for MV customers. There must be a standardization on whether the readings are performed *before* or *after* the transformers. The calculation takes into account only LV customers billing and assumes that there are no losses for MV customers.
- **Vfeeder** = This value indicates the energy that enters the circuit through readings at the end of the distribution circuit and takes into account the billing of all LV and MV customers under that feeder. This value may vary depending on the feeder configuration and the entry / exit of high energy consumers. This can be unstable in medium- and long-term. However, it is very useful to evaluate the losses per region.

To calculate the losses per region or CSA it is important to verify possible changes in the distribution network configuration that may lead to distortion of the losses. Commercial procedure must take into account other elements that impact the losses calculation, i.e.; define a criteria for customer estimations, street lighting that is not read and non-operational / accessible meters. In case there is energy transported through EDM network to non-EDM customers, the energy must be excluded from the total

losses calculation. Lastly, the procedure must establish the process flow including intervention milestones for data collection and control.

The definition of the loss calculation formula must use the most reliable data available. For total losses calculation where only the difference between measured energy and billed energy is used, it is important to understand the different components in the total billing.

Hence, the total loss can be calculated using the following:

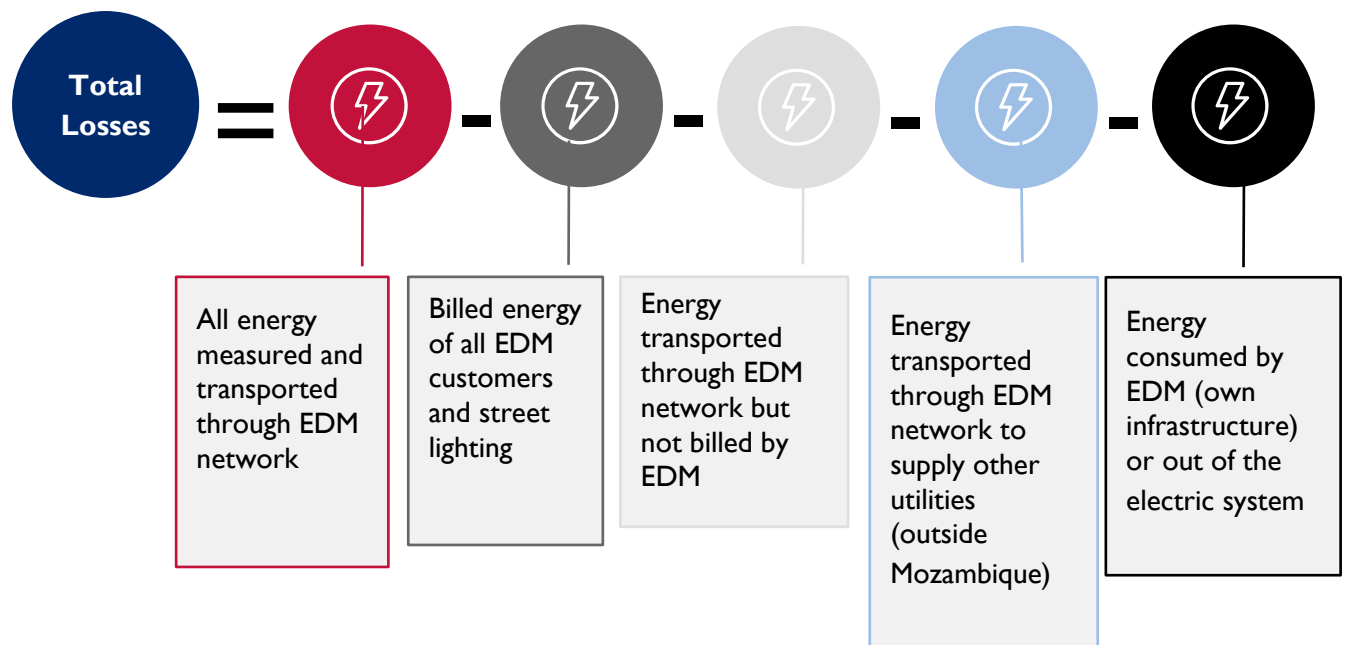
**Ltotal = TEmeasured – TBilled** where,

**TEmeasured** = Sum of all the meter readings in the electric system border in order to measure the total energy transported in the EDM network to its customers. All the meter readings must be synchronized and meter readings process must be performed within the same time frame. In case there is energy transported through EDM network but not billed by EDM, the energy must be measured and subtracted from TBilled.

**TBilled** = Sum of the billed energy at EDM. This includes all EDM customers, street lighting, etc. For places where the energy consumption is either not billed or it is estimated, a criteria must be established to determine the energy associated that will be used to create the TBilled.

The same method is used to calculate Vdis, VdisLV, or Vfeeder.

The total loss calculation, the recommended formula based on international practice is:



**Figure 11 Total Losses Formula**

## **Impact**

The standardization of the loss calculation procedure improves precision when calculating losses. It helps EDM to understand the complexity involved in controlling losses and where the effort is required to identify where possible revenue drops occur in the commercial process. This is the first step is to identify vulnerabilities in EDM internal processes.

The enhanced control of the loss calculation process will provide EDM with a sustainable approach to evaluate the effectiveness of its initiatives to combat losses over time.

Losses are very sensitive to billing time frame variations, whereby the billing time frame can have more or even less than 365 days. To evaluate the loss trends based on billing, there must be a standardization of 365 days to ensure a uniform calculation.

## **Action Plan**

EDM must create a dedicated team with the following responsibilities:

- Coordinate the loss calculation process
- Define the commercial procedure and process flow for losses calculation including the stages to collect and manage data
- Analyze the current situation in commercial losses
- Develop a loss reduction plan and evaluate the results

The team must be composed of engineers and specialized technicians with the ability to analyze data, identify trends, identify new loss causes through statistic processes, develop a relationship with all EDM entities / departments involved in commercial losses, and look for new solutions and technologies available in the market to help combat losses.

## **Resources**

Given the complexity of losses at EDM and the lack of process maturity for calculating and combating losses, the following team and responsibilities is recommended:

- One (1) engineer or specialized technician in loss calculation with the responsibility to oversee the losses evolution and its behavior over time. This includes the following:
  - a. Coordinate data collection for losses calculation and evaluate its quality with periodic audits
  - b. Perform the loss calculation, analyze how losses evolved and their trends
  - c. Evaluate energy that has been added in every action in the current year as well as from previous year's actions
  - d. Estimate the annual losses based on statistics and historical methods
  - e. Perform benchmarking and exchange experience with other utilities similar to EDM

- Three (3) engineers or specialized technicians to study the probability to locate losses and its root causes. This includes the following responsibilities:
  - a. Perform analysis based on historical behavior and the results of loss reduction initiatives to identify regions with high losses and respective root causes. It is also important to perform a qualitative evaluation of the problem to help identify and understand the root causes (i.e., deprived areas, rural areas). This qualitative evaluation also helps to replicate successful interventions, which impacted customer behavior in other similar areas, thereby, allowing for a more effective strategy when combating losses.
  - b. Establish a testing sample of micro areas in all regions with similar characteristics customers and perform targeted inspections to identify fraud and energy theft. This will assist EDM in understanding its customers' behavior, associated problems, and the root causes for losses
  - c. Oversee the entire performance of the revenue cycle with special attention to meter readings (postpaid customers) or energy purchasing (prepaid customers) to the correct billing of all customers and the factoring in of street lighting. The team has the responsibility to ensure revenue protection to minimize commercial losses caused by EDM's internal processes and also evaluate measures in the revenue cycle to avoid further commercial losses
  - d. Evaluate suspicious consumption behavior such as:
    - Customers that don't purchase energy regularly
    - Customers that were disconnected but did not request a reconnection
    - Commercial and industrial customer with consumption outside the common standards
  - e. Exchange of information with other service providers which can help EDM better understand the market and identify customers that have incorrect behavior
  
- Two (2) engineers or specialized technicians to oversee the plan to combat losses. The responsibilities are as follows:
  - a. Evaluate with other team members what actions must be taken based on analysis performed and problems identified in the field
  - b. For every action taken to reduce non-technical losses, the team must estimate the corresponding amount of energy to be added to billing in the current and following years
  - c. Evaluate the total energy to be added to the market as a result of actions taken in the current and previous years. Estimate the amount of losses for the following year based on the current losses and losses forecasts
  - d. Monitor the action plan to ensure effective execution and take action against any deviation from the plan. Evaluate results from implemented interventions throughout the year in order to audit the execution of the action plan
  - e. Define KPIs to control the action plan and produce reports on the achieved results



## 4.1.2 MAPPING OF COMMERCIAL LOSSES

### Description

It is essential for EDM to build a database based on reports of its commercial processes and the field actions of the program to combat commercial losses in order to provide a broad analysis aiming at identifying the probable causes of commercial losses and estimating the size of each problem.

This helps to understand the main factors that generate commercial loss, whether they are caused by EDM, customers' behavior or even external factors such as the economic situation and other events.

Once the main root causes of losses are determined, it is advisable to draw a map of the distribution of losses by root cause, which will support the development of a more effective action plan and better allocate resources and effort in the initiatives that will deliver better outcomes.

### Impact

The correct mapping of the root causes of losses makes it possible to structure a more targeted action plan to combat losses and to more accurately assess the volume of financial and human resources needed to meet the targets set out by EDM for the coming years.

### Action Plan

There are two types of energy losses: technical losses and non-technical losses (also known as commercial losses). Although the focus of this intervention is to identify the causes of non-technical losses, an overview will also be presented to help understand the technical losses that must also be part of the proposed losses map.

#### *1. Main Causes of Technical Losses*

Technical losses are inherent in electrical systems and are caused by the following:

- Moving electrical current through conductors, connections, and electrical equipment such as transformers, meters
- Heat dissipation and coil magnetization

Technical losses are usually not measured but calculated through specialized software that calculates the power flow in the electrical system. The software uses data from the NIS to calculate losses.

It is important to note that in addition to the active energy (kWh) that is billed to all customers, there is also the reactive energy (kVar) that is required for magnetization of transformers and nonlinear loads. The reactive energy is not billed to customers but its usage is limited through penalties for the excess of reactive energy consumption, establishing a minimum power factor allowed according to specific regulations.

If there are no legal restrictions, the meter can measure the apparent energy (KVAh) which is the sum of the active and reactive energy and should provide a higher total billed value.

Considering the complexity of calculating technical losses and its distribution throughout the entire electric system, it is not common to develop plans to reduce technical losses but rather actions to optimize them, such as:

- Establish load limits to feeders and transformers
- Install a capacitor bank to limit the circulation of reactive power
- Reduce the length of electrical circuits, etc.

Actions to reduce technical losses, such as scaling of distribution circuit drivers and replacing conventional transformers with efficient transformers, often require significant investments and long-term returns. The ratio of investment versus the return on reduction of technical losses is disadvantageous, whereby majority of the actions take more than 10 years to recover the investment made.

However, it is important to calculate the technical losses as they should form part of the distribution losses map. Furthermore, commercial losses are always estimated by subtracting the technical losses from the total loss amount.

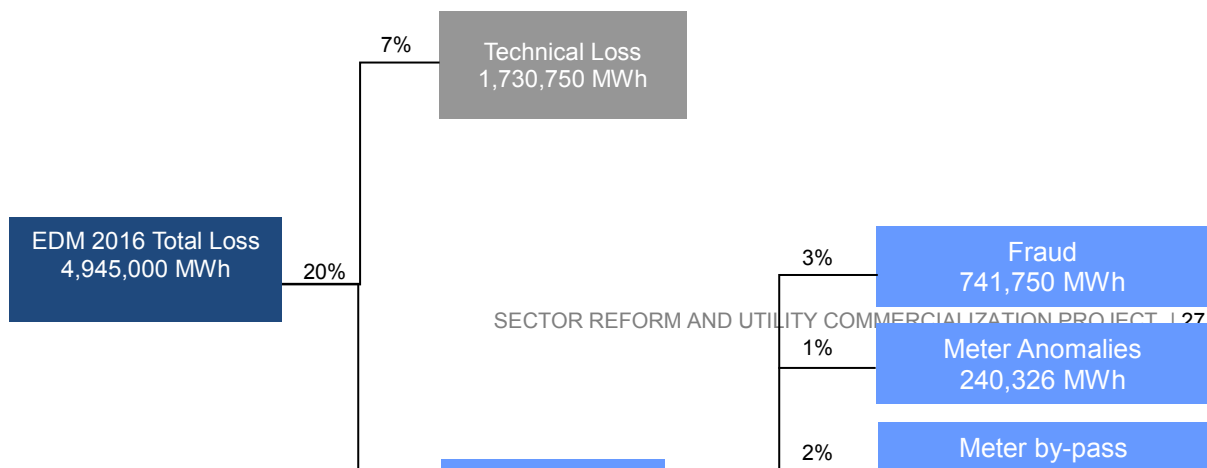
## 2. Main Causes of Non-Technical Losses (Commercial Losses)

Non-technical losses can be caused by different factors such as:

- Unbilled energy consumed by consumers and points of consumption (i.e., street lighting)
- Deficiency in the commercial processes
- Faulty meters

EDM must perform a broad analysis based on available data or through employing specialized professionals to identify the main causes of commercial losses and their contribution to EDM’s total losses.

The below losses map structure was created based on the experience of other utilities with similar problems and business environment to EDM. It illustrates a simulation of EDM’s root causes based on total losses projections for 2016 as well as the 7% of technical losses adopted by EDM:



**Figure 12 EDM's Losses Map Structure**

**Fraud** comprises of the manipulation of meters or metering systems to prevent actual measurement of energy. More complex fraud is usually done by large consumers in the commercial and industrial segments and can be very difficult to detect through routine inspections.

**Meter anomalies** are problems with the meter or measurement systems that cause partial or total loss of energy consumed. These problems are often created due to poor installation / maintenance of the measuring system and faulty meters.

**Meter bypass** is a very common practice in all customer types and can be can be difficult to detect through inspections.

**Direct connections** in the distribution network are connections made directly on the secondary distribution network. It is usually done by non-regulated customers or by EDM customers that use this practice to steal energy.

**Internal process** relates to administrative losses or losses generated by deficiencies in the business processes throughout the revenue cycle. Identifying the accountability of internal losses can be very complex as it involves many processes and different areas across the organization; however, monitoring the performance of business processes is critical to understand where billing losses are occurring and what actions should be taken.

## **Resources**

To ensure the execution of the action plan, the losses program coordination team should be composed of the resources previously suggested.

### **4.1.3 PERFORM THE ENERGY BALANCE CALCULATION**

#### **Description**

EDM needs to identify all the measurement points to measure the energy flow going to consumers and other consumption points (i.e., street lighting), and install adequate meters where needed. For

measurement points that already have meters installed, EDM must ensure that all the meters are operating properly.

The measurement points must be installed in the transmission substations, distribution feeders, and transmission lines that supply energy to other utilities to ensure the energy balance per segment in the distribution feeder level.

Once all the consumers supplied by the distribution feeders are identified, it will be possible to perform the energy balancing per distribution circuit considering the energy measured during a certain period of time, i.e., energy measured per month and the billing of the clients during the same time frame. This allows for identification of feeders with high levels of losses to prioritize actions to combat losses.

### **Impact**

The identification of losses per feeder allows for prioritization of areas to perform targeted losses reduction activities.

### **Action Plan**

To structure this process, EDM must:

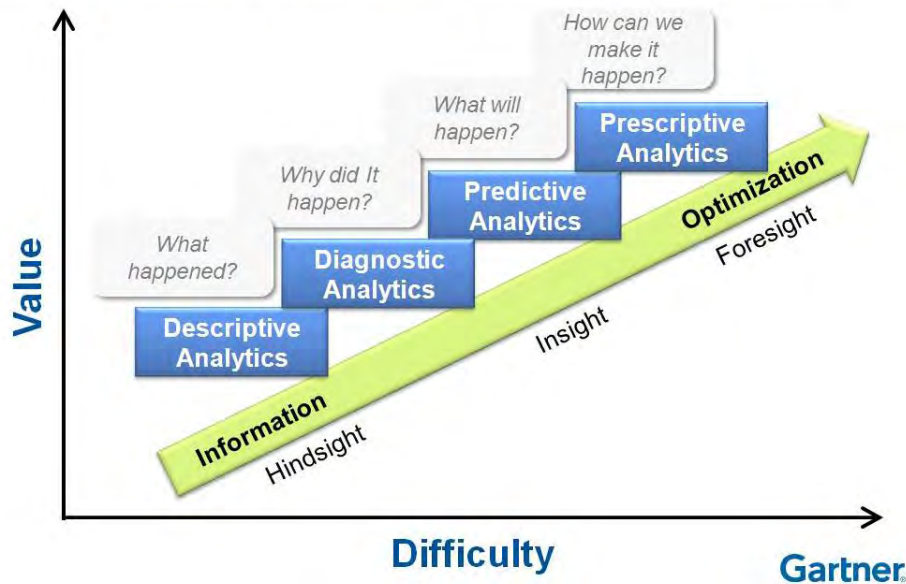
- Identify all points that require control meter installation and the points where adequate meters are installed already installed.
- Acquire and install meters in points without measurement.
- Adjust the meter clocks to register the energy flow in the same time frame.
- Establish a procedure to collect meter readings within the same time frame and the storage of this data in a specific archive. The data will then be forwarded to the area responsible for losses calculation.
- Establish a policy to audit the data collection and storage of meter reading data that will be used to perform the energy balance.

### **Resources**

The investment must be evaluated based on the measurement points available that do not have meters or where meters exist but are not operational. The typical cost for meters used for measurement is around \$500.



## Analytics Are No Longer a Nice to Have



**Figure 14 Analytics Maturity Model from Gartner**

The above figure by Gartner shows the analytics maturity model. At this moment, most of EDM’s effort is focused on the ‘Descriptive Analytics’ phase. The proposed solution is to advance EDM to a higher level of analytics maturity, thereby freeing up loss engineers to apply himself to higher value-add activities.

EDM has a current initiative underway to progress the maturity of KPI management, reporting, and analytics, this proposal would support the existing EDM initiative in order to maximize potential synergies. An insights-driven approach to the solution of loss management is recommended and would comprise the following pillars:

- *Granular Management of Data Quality*: Measurement and management of data quality at a customer level. This is required for granular energy balancing.
- *Automation and Reproducibility of Energy Balancing and Loss Analytics Calculations*: Automated procedures that ensure reproducibility of results, with the required checks and balances and quality assurance mechanisms. Ensuring one version of the truth.
- *Losses Management Reports with Analysis*: Geographically enabled and visually interactive engagement for the losses engineer on the following key topics: calculated losses, energy balancing, customer segmentation, targeted inspection, and loss intervention performance. These quantifiable insights empower the losses engineer with the evidence to support decisions on the allocation of resources, intervention pilot rollout, effectiveness of loss action plans, and technologies.

- *KPIs to Track and Provide Visibility on the EDM Losses Management Programs:* Operational and management data used to track, target setting, and management of losses and corresponding processes.

This ‘Automated Analytics’ solution is composed of the functions highlighted below:

	Collection	Processing	Analysis	Performance
High Level Functions	Data Validation and Marking	Energy Balancing	Losses Visualization	Operational KPI's
	Missing Data Estimation	Stratification	Reporting	Management KPI's
	Staging & Transformation	Analytics Calculation	Exploratory Data Analysis	Performance Tracking

**Figure 15 Functional Description of the Loss Intelligence and Analytics Solution**

The loss intelligence and analysis solution’s functions can be broken into four main categories:

- *Collection:* This function is associated with the incorporation of data into the system, dealing with missing data (imputation) and any staging or transformations to the data as part of input.
- *Processing:* The raw collected data is processed to perform automated feeder-level energy balancing, customer stratification, and calculation of analytics
- *Analysis* –The processed data can now be analyzed, visually interrogated and .reported on.
- *Performance:* Calculation and derivation of operational and management indicators (this would be implemented as KPIs for the critical business processes).

### **Granular Management of Data Quality**

Customer-level transaction data and interval metering data would be ingested in the solution and the adoption of a granular data quality management approach would be essential to ensure identification of upstream impacts on validity, consistency, and completeness of data.

Currently, data quality checks are performed at an aggregate level and do not ensure data quality at higher levels of detail required for month-to-month customer behavior analytics.

Hand-in-hand with the granular checks and balances is comprehensive marking of data quality issues. This would enable auditing, upstream investigation, remedial action, and removal of suspect data from downstream processing.

Missing data estimation and statistical imputation is applied to compensate for marked data points (including those missing). Imputation ensures the maximum usage of information available without introducing “noise” and false information into the results.

Staging and transformation of input data ensures consistency in timing and synchronization of data sets. Calculation period consistency and data availability is a necessary condition for downstream processing. Staging in terms of data sets timing and spatial synchronization is envisaged.

### **Automation and Repeatability of Energy Balancing and Loss Analytics Calculations**

In an environment with large volumes of data and complex transformations, repeatable and auditable energy balancing and loss calculation is only possible through automation. Energy balancing at a feeder level entails the matching of energy into the feeder and consumed by customers on the feeder for a particular period of time. This data may be supplemented with in-grid statistical data collection through permanent or temporary metering. Individual customer transactions are used for the consumption estimation and interval data would be used for the in-grid statistical profiles.

The energy balancing calculation on the surface is straightforward; however, there are many exceptions per region, transformer, and feeder. The appropriate handling of these exceptions makes the process complex and not appropriate for manual calculation.

An automated process would require supervisory action from users to validate results, deal with data exception reporting, initiate calculation procedures and so on. Automation allows loss engineers to focus on controlling the process rather than executing the process.

The types of calculation to be automated would be:

- *Energy Balancing*: Matching of feeder, transformer, and regional load supply with customer consumption to estimate targeted energy loss.
- *Stratification*: Classification of areas and customers into similar groups or strata based on characteristics of behavior, consumption, and loss. The group behavior in the strata becomes the basis for early identification of deviations from the “normal” behavior.
- *Analytics Calculations*: Calculation of analytics relating to customer behavior, load behavior, losses, electrical characteristics of supply, time series progression, etc. Due to the processing requirements, these analytics are pre-calculated through automation to be presented to loss engineers during exploratory data analysis.



## **Insights Generating Reporting and Exploratory Analysis**

The value of the losses analysis solution is delivered through reporting, dash boarding, and exploratory data analysis. Loss engineer gain insights by visually interacting with the results and being able to answer questions about losses, customer behavior, impact of interventions, and changes in data quality as they arise.

Exploratory data analysis is enabled through self-service business intelligence, allowing loss engineers to demonstrate with quantitative evidence their insights to the organization. Modern visual interactive tools enable conveying of insights through dynamic presentations, shareable content, and mobile-enabled consumption.

Reports on loss calculation, energy balancing, and loss analytics would be used operationally to ensure consistency between CSAs and direct-targeted inspections. They would also be used to understand the impact of piloted loss reduction interventions, to quantify the amount of loss reduction obtained, identify crucial success factors, and generate recommendations for rollouts.

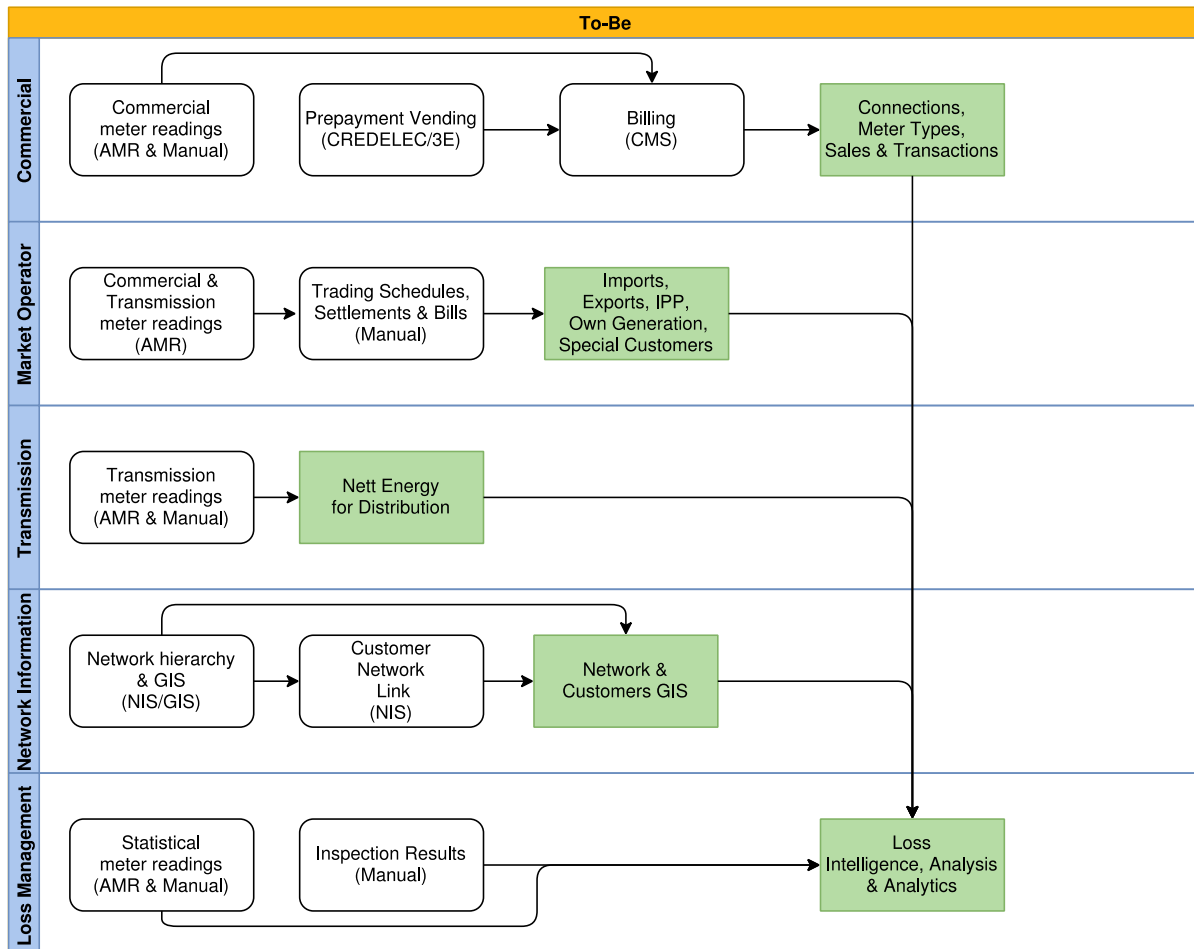
Feeding back into the solution would be:

- The quantity and effectiveness of targeted inspections
- The quantity and effectiveness of blanket inspections
- Details of sites and customers where interventions were piloted
- Details and sites of statistical in-grid metering

This information would then be used to evaluate and fine-tune the tactics for losses management.

## Business Information Flows

The following figure shows proposed business information flows for the *to-be* losses analysis process:



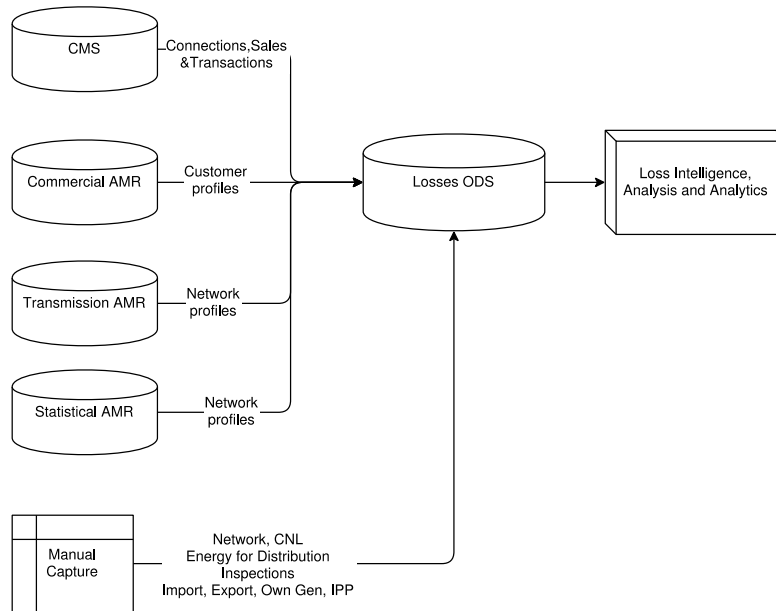
**Figure 16 Business Information Flows for the Loss Intelligence and Analysis Solution**

The intention is to create a single source of all loss management information to facilitate:

- *Loss Intelligence:* Energy balancing, customer stratification
- *Loss Analysis:* Root cause analysis, customer behavior tracking, etc.
- *Loss Analytics:* Indicators for targeted inspections

This aligns with the supply, installation, and Training of an Integrated Business Management System (SIGEM) philosophy of centralized information management to ensure consistent treatment of loss intelligence, analysis, and analytics in the organization. It supports the approach of maximizing skills and resources.

Business flows would be supported by a systems integration approach as shown in the following figure:



**Figure 17 System Integration for the Loss Intelligence and Analysis Solution**

The initial *to-be* integration would be based on two mechanisms:

- *Extract, Transform, Load*: Moving the large volumes of profile, sales, and transaction data from the various source systems into the losses operational data store (ODS)
- *Manual Capture*: Capturing and updating of network information, customer network link, energy available for distribution, inspection results, import, export, own generation, and independent power producers.

The commercial stream comprises the prepaid transactions from that vending system, commercial AMR, and manual meter readings feeding through the CMS. The CMS should be used as the source of information on:

- Customer connections
- Meter types
- Meter readings
- Transactions
- Tariffs
- Sales and revenue

Similarly, the network information stream would deliver information on:

- Network hierarchy
- Network information
- Customer network link

Integration with AMR would be subject to the rollout and implementation of the Huawei HES. It is currently understood that the commercial AMR is prioritized over the transmission AMR conversion. This creates a partial dependency for this solution.

#### 4.1.5 DESIGN A LONG-TERM LOSS REDUCTION PROGRAM

##### **Description**

The annual action plan to combat losses must be structured at least three months before the beginning of the year. The plan must take into account the results of the current action plan as well as the previous years in order to develop a more realistic and effective plan.

The action plan must include market projections in terms of energy consumption as it can have a significant impact in the loss percentages. If the energy consumption increases more than what was projected and the loss reduction results are as expected, the overall losses should have a slightly lower percentage. On the other hand, if the energy consumption decreases more than what was projected and the expected loss reduction remains the same, then the losses should have a higher percentage.

Another important measure to include in the plan is to evaluate the growth of vegetative losses throughout the years and identify actions to reduce it.

##### **Impact**

The lack of a well-structured action plan to combat losses makes it unsuitable to evaluate the human and financial resources required for its execution. Similarly, the lack of systematic monitoring of the results achieved makes it impossible to understand how the losses may change and the impact to EDM.

Loss reduction is one of the main ways to increase billing and consequently EDM's revenue; whereby for each 1% of loss reduction, there is a corresponding increase of 1% in the overall billing.

##### **Action Plan**

In order to structure an effective action plan for combating losses, EDM needs a set of data that it has not yet defined and an evaluation of the human and financial resources required to execute the action plan. Therefore, an action plan containing actual and 'dummy' data should be structured to help EDM in understanding the proposed methodology.

The actions set out in the plan must be based on, and mapped to, the five root causes for EDM losses (as noted in the previous section).

Main actions in combating losses involve field inspections in order to identify fraud, anomalies, bypasses, and direct connection. Additionally, actions for revenue protection and solving issues in commercial processes are also taken into account. See below the description of these actions:

- **Field Inspections**

Set dedicated teams to perform two types of field inspections:

- Teams to perform visual inspections and evaluate less complex problems
- Specialized teams to detect frauds, bypasses, and complex anomalies

Only less complex cases of fraud can be identified through visual inspection. Most cases of fraud require detailed analysis and appropriate equipment to verify the status of the meter.

Some cases of fraud are done by larger consumers and can be identified by analyzing the meter’s inbuilt memory or through data analytics (involving energy balancing). Another strategy adopted to detect fraud is through parallel meter reading for consumption control. Many residential postpaid customers tamper with their meters by installing magnets, tilting the meter, and etc. For prepaid customers, fraud can be difficult to detect unless performing periodic inspections.

Meter anomalies can be detected through both visual and detailed inspections. The anomalies include poor installation and maintenance of the meter, i.e., meter cables with bad connection.

Visually identifying meter bypassing can be a challenging task as the bypass can often times be inside the walls. When done externally, many times the bypass is removed before the inspection takes place. Some utilities including EDM have installed a meter box outside the premises (split metering) to minimize this risk, as shown in the picture on the following page.



**Figure 18 Split Metering**

Another way to detect meter bypass during inspections is through a simple test of switching off all electronic devices at the property and turn them on one-by one and to verify if the meter is measuring the energy consumption as expected.

Internal / administrative losses are identified by monitoring all commercial processes and then performing a detailed analysis of the results. Utilities often create a team for revenue protection that include experienced professionals from all the involved areas / departments. The team is also responsible for the combating losses program coordination.

- ***Direct Connections in Distribution Network***

Most direct connections at EDM are performed by non-regulated consumers resulting from EDM's inability to expand network service to areas not yet electrified. As consumers extend the grid with their own resources, they then tap into the network directly. It is recommended to evaluate the EDM losses from direct connections and calculate the return of investment of regulating these consumers.

There are also EDM-regulated customers that establish direct connections to reduce their energy costs. These 'illegal hooks' must be addressed through educational campaigns in the communities, and in partnership with the police to help identify illegal hooks during their daily patrols. In cases where the utility's field crews are not being effective, an option is to outsource inspection services. The subcontractor could be required to conduct inspections at night when it is more likely to catch illegal hooks in place, and the subcontractor could be remunerated based on their rate of success.

- ***Revenue Protection***

Revenue protection actions comprise of identifying and addressing key issues in the main commercial processes that lead to losses, such as customer registration, meter reading, energy purchasing, and billing of customers. Analysis of these processes indicates that EDM has issues related to customer registration in the CMS, including incomplete registration, missing customers, non-active contracts, and incorrect meter reading data.

Once the actions for combatting losses are defined, EDM should estimate the energy added as a result of each individual action from the plan. If the action has never been performed at EDM, proxy outcomes from other utilities similar to EDM should be used. All added energy must only reflect the period for the next 12 months. Hence, the action plan requires the energy to be added from the previous year's actions to be calculated and the energy to be added from the current year's actions to be estimated (considering the time frame for each action). For planned action, which will be executed throughout the year – such as the field inspections plan – it is reasonable to calculate the energy to be added as six times the average energy added as a result of fraud detection, bypass detection, and direct connection detections. Below are some examples which illustrate the calculation:

**Case I:** Average energy added from the reduction of residential customer fraud = 60 kWh / month. The fraud was solved in August 2015 and the new billing was processed in September 2015.

- Energy Added to the Action Plan 2015:  $4 \times 60 \text{ kWh} = 240 \text{ kWh}$
- Energy to be Added to the Action Plan 2016:  $8 \times 60 \text{ kWh} = 480 \text{ kWh}$

**Case 2:** Average energy added from direct connections = 180 kWh / month. The direct connection was solved in March 2015 and the new billing started in April 2015.

- Energy Added to the Action Plan 2015:  $9 \times 180 \text{ kWh} = 1,620 \text{ kWh}$
- Energy to be Added to Action Plan 2016:  $3 \times 180 \text{ kWh} = 540 \text{ kWh}$

The earlier in the year an action is executed, the more energy it adds to that calendar year. On the other hand, the further to the end of the year an action is executed, the more energy is added to the following calendar year's loss reduction program.

For revenue protection actions, the estimated energy to be added must be calculated based on historic values or through a diagnostic of the revenue cycle problems that lead to billing losses (as the added energy depends on the regularization of the identified problems).

Lastly, below is a simulation of an action plan for 2016 that takes into account the 2015 total losses and 2016 expected billing data for EDM. The qualitative data of actions to reduce losses and the corresponding success rate of these actions is illustrative. The application of this method with real data (or reliable estimations) allows for a forecast of the following year's losses.

### **Simulated 2016 EDM Action Plan for Combating Losses**

Losses Growth: Current commercial losses (13%) will grow as the network expands and new customers are added to the system. As the projections for total billed energy in 2016 show that there will be an increase of 446,000 MWh in comparison with 2015, the losses growth would be  $446,000 \times 0.13 = 57,980 \text{ MWh}$ .

- *Total Completed Inspections:* 65,000 inspections distributed evenly throughout the year (12 months)
- *Inspections Success Rate:* 8% frauds, 3% anomalies and 3% bypass

*Added Energy:* Fraud: 350 kWh; Anomalies: 150 kWh; Bypass: 150 kWh and considering that the inspections will be executed evenly for 12 months, the energy will be added for six months (average).

*Total Added Energy:* Fraud =  $65,000 \times 0.08 \times 0.250 \times 6 \text{ months} = 7,800 \text{ MWh}$ ; Anomalies =  $65,000 \times 0.03 \times 0.15 \times 6 \text{ months} = 1,755 \text{ MWh}$  and Bypass =  $65,000 \times 0.03 \times 6 \text{ months} = 1,755 \text{ MWh}$

*Added Energy through the Regularization of 5,000 Direct Connections:*  $5,000 \times 0.15 \times 6 \text{ months} = 4,500 \text{ MWh}$ .

## Losses Growth

There is no way to accurately measure the growth of losses; however, there are methodologies where one can learn how losses grow annually. Method 1 above is based on the market growth whereas Method 2 is based on new thefts of energy in the existing market. Method 1 is the simplest methodology to follow and should be based on the historical data series of at least the last five years for the percentage of growth of losses and of the growth of the market, whereby the correlation between these two factors is evaluated.

Year	Billed Power	Billed Power Growth Rate (%)	Total Losses	Losses Growth Rate (%)
2007	1,491		469	
2008	1,674	10.93	442	-6.1086
2009	1,847	9.37	562	21.35
2010	2,101	12.09	611	8.02
2011	2,395	12.28	649	5.86
2012	2,725	12.11	725	10.48
2013	3,071	11.27	657	-10.35
2014	3,318	7.44	778	15.55
2015	3,558	6.75	941	17.32
<b>Total</b>		<b>82.23</b>		<b>62.13</b>
<b>Average</b>		<b>10.28</b>		<b>7.77</b>

Table 3 Losses Growth Rate

By examining EDM's historical billing data, on an average 'billed energy' has increased around 10% while losses have increased around 7.8%. Therefore, it is reasonable to project that future losses will increase by 7.8% of the market growth rate projected for future years. The losses growth projected is  $941,000 \text{ MWh} * 0.078 = 73,398 \text{ MWh}$ .

Due to a lack of historical data at EDM, the simulation did not include potential fraud identification, faulty meters, and bypasses identified through simplified inspections. If EDM intends to improve the results through these inspections, the same method used for complex inspections must be adopted for simplified ones.

Total Energy Losses in 2015 (MWh)	941,000
Losses Growth Projections (MWh)	73,398
Added energy through fraud regularization	7,800
Added energy through anomalies regularization	1,755
Added energy through direct connection regularization	4,500
Added energy through bypass regularization	1,755
Added energy through EDM internal processes regularization	500
Total Energy Loss Projections for 2016 (MWh)	998,088



Total Billed Energy Projections for 2016	4,945,000
Total Loss Percentage Projections for 2016	20.18%

**Table 4 Losses Growth Calculation**

## Resources

If EDM already has the required human resources for field inspections and losses coordination for both the quantitative and qualitative perspectives, it is important to estimate the financial resources required for rolling out these actions. Costs include needed new equipment, vehicles, and system implementation for collecting the required data and automating the energy balancing calculation, etc.

### 4.1.6 AUDIT PROCESSES ALONG THE FULL REVENUE CYCLE

#### Problem Statement

EDM does not have any structured audit procedures in the revenue cycle in order to identify failures in the execution of business processes or vulnerabilities that could lead to revenue losses.

#### Description

EDM should structure an annual audit plan in all revenue cycle processes in order to identify failures in the execution of business procedures resulting in revenue losses. The purpose of audits is to identify the need to improve processes or even to train people who are not qualified to perform the work. However, the audits help to hold people accountable for any problems they may cause (i.e., fraud).

#### Impact

Audits will help identify gaps in EDM business procedures and execution failures that lead to revenue losses. In less mature companies with frequent organizational changes such as EDM, audits are important to stabilize the revenue cycle processes.

According to international practices, the audit process in the revenue cycle may reduce billing losses up to 0.1%.

#### Action Plan

In case where EDM does not have a dedicated team to execute the audit processes, it is recommended that this process be introduced via the creation of working groups, who will be trained by the most experienced professionals in the organization. These teams should only operate for a short period of time in order to not compromise the divisions and corresponding work from where the people came from. The objective for these teams is to evaluate the main commercial processes such as customer registration, new customer connections, changing responsibilities resulting from tariff changes, and etc.

Postpaid and the accounting of the energy purchases for the prepaid meters, process for prebilling and billing of all customers, etc. In this audit process, a special focus should be given to how exceptions are handled and resolved in order to assess eventual process deviations or weaknesses in the commercial processes.

The outputs from these audits are reports that describe at a detailed level the root causes of process deviations. The reports should be directed to the respective responsible divisions to ensure issues are addressed effectively. Responsible divisions present corrective action plans to the Commercial Department for the identified problems, and the Commercial Department then monitors the divisions to ensure corrective actions have been taken.

Whenever possible, reports should indicate what energy value was lost (no longer billed) as a result of the process deviations in order to ensure that the department accountable for the combating losses program is able to adequately track the implemented solutions and account for the achieved gains in the plan for combating losses.

In more sophisticated audit processes, the audit report can also include recommendations regarding commercial processes and even changes to the roles and responsibilities for certain activities in order to ensure better accountability over a single process or strengthen the process execution.

## **Resources**

EDM should structure two or three audit teams dedicated to revenue cycle audits with two people with different experiences in each team. The team must conduct year-round planned audits to ensure that all main business processes are audited every year and less strategic processes are audited once every three years. The advantage of maintaining dedicated teams is the specialization of these professionals in EDM's business processes. This increases the chances of identifying problems in business processes and opportunities for improvement.

In cases where EDM does not have sufficient qualified human resources to staff dedicated audit teams, non-dedicated teams should be formed with professionals assigned by the Commercial Directorate to perform regular audits in the revenue cycle. The main processes that impact revenue losses should be audited at least once every two years.

## **4.2 METER SPECIFICATION POLICY DEFINITION**

### **Problem Statement**

There is a lack of documented metering strategy, policy, and standards within EDM. EDM requires a clear vision for their metering strategy and road map for the future implementation of the strategy within the organization. This should cover the metering strategy, policy, and the required standards as well as the future vision of data and asset management.

EDM does currently have a metering policy along with some required standards. While the current policy regarding the procurement and distribution of meters is adequate – based on the current business

practices within the organization – the policy does not necessarily support the organization as a whole and was developed with too narrow a focus. The policy needs to be updated to reflect current on-going loss reduction projects as well as the new requirements.

To fulfil the requirements set out in the policy, standards, procedures, and supporting documents are needed. The development of these documents cannot properly be done in isolation and requires input, involvement, and commitment from a wide group of stakeholders within the organization.

The definition of any form of metering requirements across an organization firstly starts at the establishment of the organizational strategy and vision. Metering is merely a mechanism to assist the organization in achieving these goals. On the following page is a pyramid showing the dependencies between the strategy, policy, standards, and procedures and the organization’s members related to each tier within the hierarchy. All of these should be developed in alignment to the organization strategy and vision.

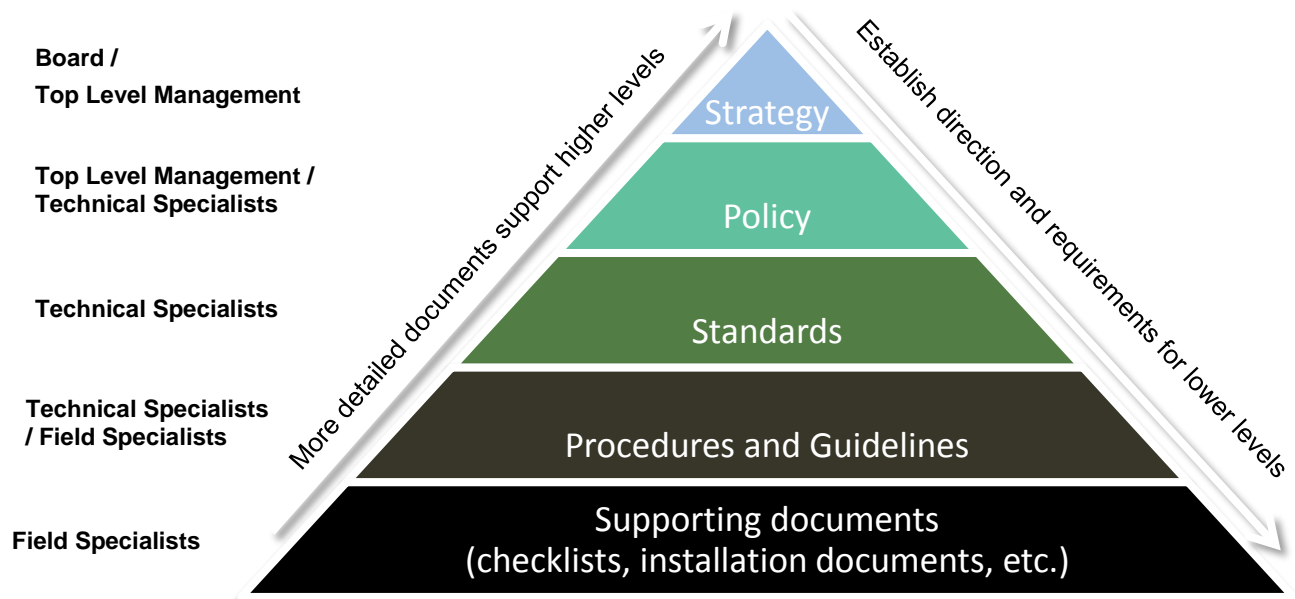


Figure 19 Strategy Pyramid

### Description

The development of a long-term metering strategy with clear identification of goals and required plans for the achievement of the strategy is required. This includes the update and further development of the existing metering policy regarding the metering requirements, along with the metering definitions and standards.

The strategy must cover not only the current situation and available technologies, but also the future direction of technology. The strategy must allow for the inclusion of, or moving to, new technologies (i.e., STS 2 and AMI).

The metering policy provides the basis for all meter procurement, asset handling, standards, and requirements. By having a clear policy on the organization’s metering needs, plans can be made that will

assist in minimizing costs associated to the meter lifecycle as a whole (see further details on Meter Asset Management Plan).

While metering data is primarily viewed as a meter-to-cash value chain requirement, with the depth of information that meters can now provide, the data retrieved from meters extends well beyond the simple process of creating a billing value. Metering policy and standards should; therefore, not be governed by a single domain but should have input and representation from around the organization, ensuring that all organizational needs are met. Having a set of documents (strategy, policy, standards, and procedures) developed within an organization and owned by suitable custodians will create a sense of ownership and is more likely to be adhered to and succeed, compared to a set of documents provided by an external consulting party.

### **Strategy**

A clear strategy and blueprint, or road map, as to the organization's vision regarding metering and meter data management will be drawn up. This strategy document, due to the organizational and cost impacts, needs to be ratified at a board level or at top senior management levels. Strategy is not something that changes quickly and these decisions will have long-term impacts on the organization. Having a clear strategy in regard to this can also help in obtaining the required assistance to achieve the vision developed.

### **Metering Policy and Processes**

Policies need to be established for all of the processes related to the meter lifecycle as a whole, from procurement, supply, maintenance, and operation of the meter, related products, and services. The metering policy should cover the following areas:

#### **Metering Vendor Prequalification**

Prior to EDM procuring meters, it should prequalify meter vendors according to the agreed standards and requirements. This will ensure that only well-established, compliant, and good service track record meter vendors are used. This process results in:

- The development of an approved supplier list and meters: The vetting of suppliers and the associated costs is time consuming and costly; therefore, having an approved supplier list which is reviewed every few years is a cost-effective control measure
- It allows for only a shortlist of preapproved meter vendors to tender for EDM requests. This will optimize EDM tender turnaround times and associated costs

#### **Vendor Service Level Agreements (SLA)**

EDM should review (or establish) the SLAs setup with the meter vendors, looking at supply, operation, and performance of the equipment. The SLA goes beyond any standard vendor guarantee or warranty, and should cover:

- The provided service, warranties, and guarantees
- Responsibilities of each party

- The turnaround and/or delivery times or services (technical enquiry, fault notifications, training, etc.)
- The duration (does it go beyond the warranty / guarantee period)
- Consequences of vendor renegeing or service failure
- The process for dispute resolution
- Costs for the service and payment schedules
- Consequences for EDM failing to pay timeously
- Termination clauses for both EDM and the vendor

### ***Metering Procurement and Distribution***

All the EDM meter standards/policies should incorporate compliance to DLMS/COSEM and IDIS standards. An approved meter list must be created and maintained to include meters compatible with the new Huawei HES (by vendor and model). All future meter procurements and projects should adhere to this list.

A formal procedure needs to be documented in light of the new systems and asset management, to ensure appropriate tracking of the metering equipment and status, from date of purchase to the date of decommission.

### ***Accelerated Lifecycle Testing (ALT)***

Meter evaluation, prior to procurement, must include a full ALT for a sample set of each meter type and model or version. These samples should be provided by the vendor. These tests should be performed by an independent internationally authorized and certified laboratory. Full detailed reports and certificates of all tests performed and their results must be made available to EDM from inspection and verification. ALT should be included in all of the EDM meter standards documents as part of the required compliance. The minimum list of ALT tests to be performed should be set out in each of the appropriate standards.

### ***Meter Calibration Certificates***

The vendor must supply calibration certificates for all meters supplied to EDM as per the defined EDM metering standard. The calibration certificates must be provided by an independent authorized and certified metering calibration laboratory, unless otherwise specified within EDM standards or by mutual agreement with EDM. The meter calibration tests should only be included in the specification if EDM does not have its own Meter Calibration lab.

### ***Meter Installations and Commissioning Procedures***

Standards and procedures should be developed for the installation, testing, and commissioning of meters in the field. Appropriate training of installation staff is required and standard formal training programs need to be developed for staff.

### ***Faulty Meter Testing / Policy and Procedures***

Where meters are determined to be faulty in the field and are replaced, formal procedures for meter change-outs and the handling of faulty meters need to be established, this will avoid that faulty meters are inadvertently redeployed in the field. These tests would only test if the meter is functioning as expected, but would avoid the meter unnecessarily being removed from service and being sent back to a laboratory to be tested.

### ***Meter Installation Audit Policy***

The meter policy currently requires field testing and formal audits to be performed on a cyclical basis depending on the size and type of installation. While the standard field test procedures would be used in a full site audit, the tests would be more extensive and would require high accuracy specialized field test equipment. Formal site audit procedures need to be developed according to the requirements of the installation type and size. Staff need to be trained in the procedures for field auditing as well as on how to use the equipment.

### ***Customer Meter Reading / Billing Policy***

The meter policy defines the required meter reading cycles by installation type and size. The meter policy should be updated to include the communications media and meter reading methods. These should cover AMR dial-up metering, AMR IP-based communications, AMI IP-based communications, and the use of data concentrators.

### ***Field Inspections Policy***

The meter policy requires that meters are inspected on a defined cyclical basis. Formal site inspection and testing procedures should be developed, along with the required supporting documentation. It is recommended that portable tools be used to assist with the site inspection, which will provide GPS capturing, photographic capability, as well as a menu-driven inspection process. This will ensure that the EDM inspectors actually visit the sites and the tools to capture irregularities which can be uploaded to a central system where the data can be analyzed.

### ***Technical Policy***

*Metering Programming:* Currently distribution meters are programmed centrally before distribution and, therefore, only store **secondary quantities**. It is proposed that meters be programmed centrally to store **primary quantities**. Predefined CT/VT ratios may be used to ensure that the meters will not overrange or overflow on a meter read. In the worst case, values may need to be corrected based on changed ratios. Formal commissioning procedures will ensure that the meter CT/VT ratio is correctly updated at the time of installation.

*Meter Schemas:* EDM needs to establish a standard set of schemas based on the different installation types, such as Transmission transformers, Distribution transformers, or Customer Billing. This list of schemas should be documented with an appropriate numbering scheme. The list of schemas should be kept to as few as possible. Meter schemas should be created that provide value to EDM and not

based on the technically capable meters. Meter schemas will determine the number of channels per meter, the different units of measure for each channel, and the metering interval periods.

*Metering Events:* A standard set of metering events should be configured for all meters deployed. A minimum list of these events should ideally include power fail, power restore, voltage phase failure per phase, zero phase current per phase, and total harmonic distortion.

### **Standards Maintenance**

The current EDM standards need to be reviewed. All standards should be reviewed at least every three to five years to ensure they remain current with market trends related to metering, communications, and international standards. Recommended changes to the EDM standards:

- The communication protocols for meters are Huawei HES compliant
- All meters are to be DLMS/COSEM and IDIS compliant.

### **Prepayment Metering**

A few years ago, there was a project whereby the benefits of split prepayment over the traditional in-house (all-in-one) meter implementation was performed. Analysis results from this implementation were very positive and this has been the standard against which all installations have been performed or replaced since this pilot.

More recently, EDM have embarked on a project for the implementation of an AMI metering deployment. The intent is to make these prepayment installations; however, the method of token distribution or adherence to the new STS 101-2 (STS 2) virtual token distribution standard (IEC 62055-52) is not clear at this time.

Strategy, policy, and standards need to be drawn up to cover the changes in traditional prepayment and the adoption of AMI metering within EDM. These documents need to take in to account the type of installation and the applicability of the technology within the local geographic area. To clearly map out a prepayment strategy and policy, both the future vision as well as the current limitations need to be taken into account. On the following page is a view of the functionality available with the STS 2 standard.

4	New STS tokens	Only currency credit token will be required. All other commands are via DLMS/COSEM protocol	Q3 2013	Under development
5	Transfer currency credit tokens via keypad	Same as 4	Q3 2013	Under development
6	Load tariff structures into meter	Via DLMS/COSEM client commands	Product vendors	IEC 62056 suite
7	Transfer currency credit from Master Station	Via DLMS/COSEM client to DLMS/COSEM Token Gateway server in meter	Q4 2013	Under development
8	Load Reactive Power charge structures into meter	Via DLMS/COSEM client commands	Product vendors	IEC 62056 suite
9	Hybrid prepayment system with account not in the meter	Realize as DLMS/COSEM server in any other device where account must reside	Product vendors	IEC 62056 suite
10	Two way secure communication with prepayment meter	Via DLMS/COSEM online communication protocol	Product vendors	IEC 62056 suite
11	Token vending engine with input from CIS and MDMS	Realize with existing systems, but using IEC protocols	Product vendors	IEC 61968 suite
12	Token vendor deposit verification/validation checks	Realize with existing systems, but using IEC protocols	2014/15	IEC 61968 suite
13	Payment transaction records upload to ERP system	Realize with existing systems, but using IEC protocols	Product vendors	IEC 61968 suite
14	Real time transaction data records upload to ERP system	Realize with existing systems, but using IEC protocols	Product vendors	IEC 61968 suite
15	Audit and recon of payment transactions against bank deposits	Realize with existing systems, but using IEC protocols	2014/15	IEC 61968 suite

**Figure 20 STS 2 Standards**

## Impact

Clear direction and directed investments that are aligned to a medium- to long-term strategy. This will minimize wasteful investments and expenditure.

- *Reduced Operational Costs:* The development of clear and defined metering strategy, policy, standards, and operating procedures assists in ensuring organizational alignment. This will reduce costs as a result of streamlined processes, improved operational efficiencies, and better coordination within EDM. It will reduce the cost of non-compliance and cost of rework, and increase the savings due to working efficiently.



## Action Plan

In order to develop a meter specification strategy, there are five crucial phases EDM must consider as illustrated below:

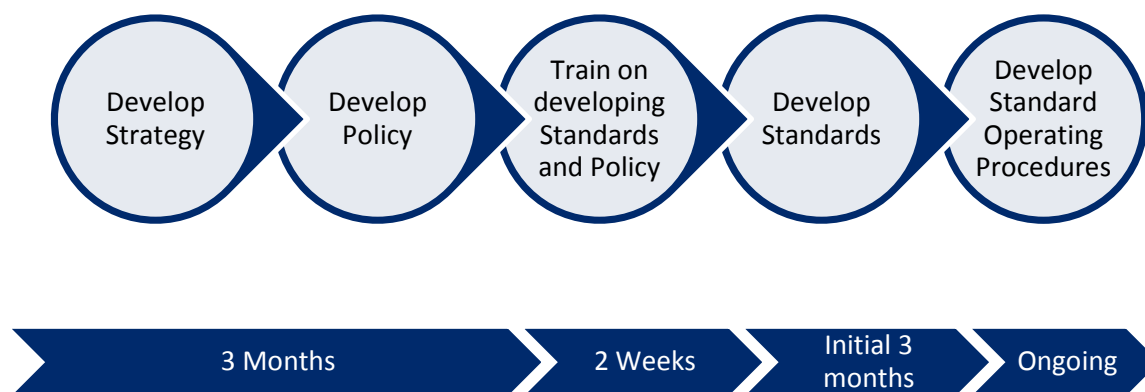


Figure 21 Strategy development phases

- In order to deliver an impact quickly, it is recommended that EDM focus those that are highest priority and will have the greatest impact.
- EDM should develop a clear and concise metering strategy. Part of the strategy needs to be the identification of the custodians for the metering policy and standards documents. A technical committee represented by all affected directorates is recommended (business and technical).
- The development of standards and standard operating procedures is an ongoing and lengthy process. EDM should train a team to develop the required standards and operating procedures. The meter policy, standards, and operating procedures needs to be reviewed and updated to reflect the latest changes and decisions taken by EDM. EDM should establish an internal process for the development and approval of policy and standards.

## Prepayment Action Plan

- 1) It is recommended that the existing standard “EE-SD-00004 - Low Voltage Single Phase Metering Standard - V1.0.docx” be updated to exclude **prepayment** meters. It is possible to do away with this standard all together, should the existing approximately 4% of **credit** based installations be replaced with **prepayment** meters.
- 2) A separate set of standards specifications must be developed for prepayment meters. These specifications must cater for single phase and polyphase meters installations for traditional prepayment meters and split prepayment metering – STS, as well as a standard for AMI style meters with support for STS 1 and STS 2 type tokens.

Strategy, policy, and standards must be developed to set out the requirements for both an off-line prepayment infrastructure (STS 1) and an AMI-based prepaid infrastructure (STS 2).

- 3) It is recommended that all existing prepaid meters be identified by manufacturer and model and their installation. These meters should then be evaluated based on the cost of maintenance and failure rates. This will provide the required information for a planned replacement program based on a justified Return on Investment (ROI) plan and in line with the metering strategy, policy, and standards related to the prepayment metering, taking the planned road map and time frames into account.

## **Resources**

The meter specifications can be defined by EDM's own personnel (engineers and specialized technicians).

## **4.3 PROCUREMENT AND SUPPLIER QUALIFICATION**

### **Problem Statement**

Meter testing to evaluate its performance in terms of calibration and reliability are important point for quality control when purchasing meters. This can be defined in the supplier qualification process. Currently, EDM has not defined a process for supplier qualification.

### **Description**

The supplier qualification consists of establishing requirements that the meter supplier must meet in order to be able to take part in the bidding process. The process includes supplier registration at EDM, providing the required documentation to ensure the supplier's financial and logistic capabilities to provide services to EDM.

In terms of technical qualification, the vendor must provide calibration certificates for all meters supplied to EDM as per the defined EDM metering standard (this should only apply if EDM does not have its own meter calibration laboratory).

EDM must also request the vendor to provide certification of all accelerated life tests (this refers to meter performance under extreme conditions of humidity, temperature, voltage limits, vibration, etc.). To ensure greater quality control, EDM can acquire the module for electric magnetic accelerated life tests.

The above recommendations on meter laboratory as well as the recommendation on acquiring the type-test lab for calibration are described in greater detail in a separate document.

### **Impact**

The supplier qualification ensures faster meter acquisition and reduces the probability of acquiring meters with poor performance and durability.

## **Action Plan**

EDM should preferably invite meter manufacturers to perform the supplier qualification process to provide their equipment to EDM with at least 180 days prior to the equipment delivery date.

It is recommended that an EDM engineer or specialized technician oversees the lab tests, evaluates the results, and if needed, requests for additional testing.

When purchasing meters and other metering equipment, the supplier must provide the Commercial Proposal with details of price, delivery date, form of payment, etc. In addition, the supplier must also provide a Technical Proposal that proves the compliance with the EDM specifications and test reports from specialized laboratories within the specified warranty period.

## **Resources**

EDM must define which department and people with meters and metering equipment experience will be responsible for the supplier qualification process.

## **4.4 INSPECTION FIELD CREW**

### **4.4.1 ESTABLISH INSPECTION FIELD CREW**

#### **Problem Statement**

A key problem encountered in many utilities and experienced in EDM is the lack of regular testing / validation of meter installations. Furthermore, the quality in testing is a challenge. Such inspections are required to ensure that the metering installation is not only in good operation, but correctly installed and maintained in order to ensure accurate measurements. This is because metering installations may become compromised over time due to customer theft, environmental circumstances, or technical failures.

The implementation of appropriate procedural and event-driven inspections and testing will ensure that metering installations are maintained in the required state and ensures a formal program for EDM to continuously engage its customers. This will also assist in minimizing revenue losses resulting from criminal activity and resolving these timeously.

Furthermore, EDM does not have a structured process to audit and control the quality of the inspections performed in the field in order to identify knowledge gaps of the field crews and inadequate execution of procedures.

It was also identified the lack of procedures to inspect new connection and meter replacement in order to minimize measurement problems that compromise the customer billing. Additionally, there is no procedure to perform inspections after 4:00 p.m., which makes it difficult to identify problems such as direct connections from the secondary energy network.



Figure 22 Deloitte Team and EDM Field Crew

## Description

In order to achieve the above, it is necessary for EDM to establish the procedures required for initiating and performing the required inspections and developing the corresponding people to perform these.

- *Installation Commissioning and the Site Audit Follow the Same Process:* EDM requires these procedures for the different types of installation in order to create an official base against which all future testing and auditing can be compared against.
- *Procedural Inspections:* Performed as defined within the EDM metering policy. Based on the type of installation, these are predefined periodic site inspections. Based on staff capacity, these can be monthly, quarterly, half-yearly, yearly, or even longer.
- *Procedural Auditing:* Performed as defined within the EDM metering policy. Based on the type of installation, these are predefined periodic site inspections. Based on staff capacity, these can be monthly, quarterly, half-yearly, yearly, or even longer. Auditing differs from inspections as follows:
  - The team reports directly to the Commercial Director to ensure their independence and establish their authority within EDM
  - The level of detail of the inspection
  - The testing required
  - The length of time required to perform the procedure
  - The level of technical expertise of the staff
  - The equipment required to perform the site audit
- *Emergency Inspection:* A deviation from the standard procedural inspection and is triggered by an event (a potential problem at the site), such as:
  - Customer meter reading dispute
  - Meter event notification
  - Energy usage pattern change
  - Environmental event (i.e., storm)
  - Technical incidents (under / over voltage, power outages, etc.)

- For AMI / AMR metering, lack of communications
- Emergency Auditing: Generally only performed if an Emergency Inspection is performed and it is unable to resolve or adequately answer the event which triggered it.
- Establish specialized teams to perform site inspections and especially site audits which requires specialized staff and equipment. The key differences between the teams performing Inspections vs. Auditing is the level of technical expertise and the complexity of the test equipment required. As such, it is more cost effective to establish more Site Inspection teams than site audit teams.
- Implement procedures which identify potential loss sites which act as the trigger for emergency Inspections or Auditing.

## Detailed Description

To achieve the above, EDM should address and implement the following:

### Meter Policy Review

The current metering policy statements regarding the regular or periodic inspection of sites must be reviewed and updated to reflect EDM requirements per customer segment. EDM must ensure that its interventions are always maximizing revenue recoverability as opposed to increasing operational costs. It is, therefore, recommended that a model be develop to track the cost benefits for ensuring ‘acceptable losses.’ The table below shows a possible review of the site inspection and audits required by meter type.

Residential Type	Inspection	On-Site Calibration Test
Residential Prepaid	Every two years	On exception
Residential AMI	Every five years	On exception
Residential Credit / Postpaid	Every two years	On exception
LV Direct Connect (BCLV)	Every year	Every four years
LV CT Connect (BCLV)	Every year	Every four years

**Table 5 Site Inspections and Audits Required by Meter Type**

It is recommended that EDM use data analytics to identify and focus its resources effectively on the meter installations requiring either an inspection or an audit. This solution will determine loss areas based on prepaid purchase patterns, usage comparison against similar areas, and actual energy usage (sold electricity on 3E / CMS) vs. average energy used per more granular areas (measured using stat meters). This should be part of the monthly audit procedures.

## Focus on MV and HV Customers

The EDM meter policy states that HV meters shall be inspected at different intervals, EDM indents to migrate all of these customers to AMR interval-based metering.

<b>MVA</b>	<b>Inspection</b>	<b>On-Site Calibration Test</b>
10MVA and Above	Every year	Every two years
Between 1MVA and 10MVA	Every year	Every four years
Less Than 1MVA	Every year	Every five years
Grid Metering	Every year	Every five years

**Table 6 MV, HV Inspection Periodicity**

## Develop Documented Metering Procedures

In order to implement the EDM metering policy, procedures must be formally established and indicate the differences in the required inspection and testing based on the type of installation and impact on revenue losses. To implement these procedures, EDM needs to create teams that are suitably qualified and trained in the procedures and use of the equipment.

Procedures for each of the following are required to be developed, along with the requisite training guides for inspection, testing, and auditing.

- *Installation and Commissioning by Installation Type:* For each installation type, a separate commissioning procedure must be created. This procedure must describe the process to be followed and have instructions on the usage, settings, and connections of the associated equipment.
- *Inspection by Installation Type:* A separate inspection procedure must be created per installation type. It must describe the process to be followed and have instructions on the usage, settings, and connections of the associated equipment.
  - This test in its simplest form; this can be a document that must be filled out.
  - However, it is recommended that a ruggedized electronic handheld units (HHU) should be used to perform the capture of information during the inspection. It should guide the field team through a standard set of questions and inspections. On completion, the inspection team can capture either an image of the installation or observed issues. The data should be geotagged to identify the actual site placement and ensure that the inspection team was at the place. The HHU can also optimize the route plan with an inspection route plan. Lastly, the HHU can upload data immediately to the central database (via an online connection) or it can upload daily on return to its docking station
- *Site Testing by Installation Type:* A specific procedure describing the process, instructions on the usage, settings, and connections of the associated equipment. A program is required for capturing the inspection details, equipment for testing the site, and capturing the measured outputs
- *Site Auditing by Installation Type:* A separate auditing procedure must be created. This procedure must describe the process to be followed and have instructions on the usage, settings, and connections of the associated equipment.
  - This test requires a software solution for capturing the site inspection details, perform a site test, and capture the measurement outputs. All of the data captured should be sent up to a central AMS which keeps this information.

The central AMS or can be used for the analysis of specific sites, and to accumulate historic information on specific meter types, failure rates, and problematic sites. The central site will be used to monitor, plan, and report on whether inspections are performed according to policy / standards. It is critical that this planning is performed at least annually for the periodic inspections, testing, and auditing to plan for the required resource availability.

*Team Types:* There are three different types of teams that should be created, each with an increase in the type of skills and competency.

- *Site Inspection Teams:* Required to perform meter readings and visually assess the installation against standard requirements. Current EDM meter reading staff are ideally suited to be part of this team. Since this is the lowest skilled team level, it is possible to create many such teams for site inspections. Outputs from these teams will typically determine whether an emergency site team visit is required. These teams would require an HHU only.
- *Site Test Teams:* Are more qualified and need to be trained on basic electricity and be able to use and understand the measurements obtained from the test equipment. These teams would perform the site inspection procedure and identify and resolve possible faults as well as the periodic site visits as per the metering policy. These teams would typically determine if an emergency site audit is required. They would require the equipment listed below:

Installation Type	Inspection / Test Team Type	Inspection / Site Test Equipment
Residential Prepaid	Basic	Paper/ HHU / Multimeter / Clip-on CT / Test Load
Residential AMI	Basic	
Residential Credit / Postpaid	Basic	
LV Direct Connect (BCLV)	Skilled	Paper/ HHU / Multimeter / Clip-on CT / Test Load
LV CT Connect (BCLV)	Skilled	Meter tester (single phase and Three phase)
MV / LV / Grid Metering	Specialized	Portable computer / Meter Manufacturer software / Test cables / Test Procedure software as per HHU

**Table 7 Required Equipment for Test Teams**

- *Site Audit Teams:* Highly qualified staff capable of working within HV environments. This team must be capable of not only following the required procedures, but also of interpreting the outputs from the complex instrumentation to identify the fault. These teams must be capable of making recommendations to the Commercial Director on the resolution of the problems. These teams are used in periodic audits or "special" audits as defined in the Metering policy as well as in the investigation of customer metering investigations where there are disputes.

Installation Type	Audit Team Type	Audit Equipment (same as Inspection Equipment with the addition of)
Residential Prepaid	Skilled	Single phase meter test / calibration equipment
Residential AMI	Skilled	Single phase meter test / calibration equipment
Residential Credit / Postpaid	Skilled	Single phase meter test / calibration equipment
LV Direct Connect	Specialized	Single or Three phase meter test / calibration equipment -



(BCLV)		Accuracy 1% or 2%
LV CT Connect (BCLV)	Specialized	Single or Three phase meter test / calibration equipment Class 1 or 2
MV / LV / Grid Metering	Specialized	Single or Three phase meter test / calibration equipment Class 0.05 %

**Table 8 Required Equipment for Audit Teams**

### Impact

Addresses revenue losses, network losses, asset costs, and personnel required. Other utilities' experience have shown that the implementation of proper ongoing inspection and auditing of sites ensures sustainable non-technical losses reduction improvement in the order of up to 8% of revenue recovery.

### Action Plan

It is recommended that EDM starts with the training and development of the teams. Firstly, the Inspection teams, then the Test teams and lastly the Audit teams. This ensures the gradual transition in terms of complexity and the reuse of existing EDM skills and teams.

Time frames for the implementation of the each of the teams is expected to take between three and six months, assuming that the required resources are available.

Task	Time Duration for Delivery	Comment
Develop Procedures	3 months	The development of procedures can be performed in parallel with the identification and appointment of the teams.
Appointment of Teams	3 months	
Internal Training	1 month	Internal training is dependent on the appointment of the teams and the development of the procedures.
External Training	2 months	External training can be planned independently of all other activities, but is required prior to the creation of the audit teams.
Equipment Purchase	2 months	Equipment purchase is dependent on the availability of funding and the commercial processes.

**Table 9 Implementation Time Frame**

## Resources

The costs associated to the implementation of this intervention are split in to three categories, namely people costs, training, and equipment costs.

### *Staffing Costs:*

- Development and documentation of the policies and procedures required.
- Identification and appointment of suitably qualified staff to cater for the three types of required teams.

### *Training Costs:*

- External training for Field installation testing and auditing, and establishment of equipment training. EDM should adopt train-the-trainer approach in order to pass this training on to others within EDM.
  - Internal training on field inspection and testing and test equipment training.
-

*Equipment Costs:*

- The equipment costs are average unit costs based on the equipment required per Team Type.

<b>Team Type</b>	<b>Equipment List</b>	<b>Price (USD)</b>
Inspection Team	Ruggedized Handheld Unit with GPS	
	Software for capturing information	
	Total per team	
Test Team	Ruggedized Handheld Unit with GPS	
	Software for capturing information	
	Multimeter	
	Clip-on CT	
	Test Load	
	Single phase meter verifier	4,000
	Three- phase meter verifier	5,000
	Ruggedized notebook for communicating with the meter	2,000
	Total per team	
Audit Team	Ruggedized Handheld Unit with GPS	
	Software for capturing information	
	Multimeter	
	Single phase meter verifier (LV)	4,000
	Three phase meter verifier (LV)	5,000
	Ruggedized notebook for communicating with the meter	
	Single or three phase meter test / calibration equipment Class 1 or 2	8,000
	Single or three phase meter test / calibration equipment Class 0.05 %	10,000
	Total per team	

**Table 10 Equipment Cost**

Based on the EDM need to establish different inspections levels there would be two types of inspections:

- Visual inspections to enhance the relationship with the customers and be able to identify eventual problems
- Specialized inspections to verify if the meter is operating properly and if there are meter anomalies / bypass

Although the above procedure is based on international best practices, EDM can start the process with a minimum number of inspections to obtain the expected results. Thereby, see below the suggested resources:

- a. Based on a minimum productivity of 200 inspections per month for each specialized inspection team, there would be a minimum of 2,200 inspections per year. Having a total of 65,000 inspections per year to verify frauds and anomalies, EDM would require at least 34 dedicated teams to perform the inspections.

EDM must evaluate and define how many technicians needed to be dedicated to these inspections and also the costs associated in hiring new technicians. Another possibility is to perform turnover of administrative personnel to avoid additional operational costs.

- b. For visual inspections, the productivity can be set to 20 daily inspections per team, therefore, approximately 4,500 inspections per year, per team. Based on the need to visit at least half of the EDM clients per year (750,000), around 170 teams are necessary. Since this task does not require specialized technicians, EDM can make use of the technician that were in charge of distributing bills to LV customers prior to Credelec implementation.
- c. For asset management inspections, due to its complexity, there is the need to test the meters in the field. Each team's productivity is around five inspections per day (1,300 inspections per year). Thus, an initial sample of 6,500 meters would require six teams.

Hence, the recommended number of inspection teams is 210 that may have different skillsets depending on the type of inspection to be performed. The number of vehicles and equipment for inspections must be defined based on the approach of the inspections (whether the teams would perform inspections individually or in groups).

#### 4.4.2 ELITE TEAMS TO AUDIT THE QUALITY OF INSPECTIONS

##### **Description**

A common problem in inspection programs is the poor quality and compliance of the inspections. This is caused due to lack of technical capabilities and inadequate procedures. An international practice is the establishment of highly specialized teams to preform field audits and also providing training and support to the inspections teams.

To ensure enhanced control, the inspection teams should remain under the client service area (CSA) and the Elite team should respond directly to Commercial Directorate.

##### **Impact**

- The Elite team audits and their contribution to the inspection plan help in the improvement of the inspections quality, as well as reduction in corruption practices.

- The team is able to identify knowledge and skills gaps and provide training and oversee the operations in order to overcome the gaps.

### Action Plan

Conduct a wide assessment to evaluate the technicians available to perform inspections ensuring that the technicians with higher technical capability and skills are selected to be part of the Elite team.

This assessment must take into account the historic performance of the evaluated technicians.

### Resources

It is recommended the creation of four elite teams composed of highly specialized technicians. The technicians must undergo a massive and qualified training on the meter operations performed by EDM's own specialized professionals or through the hiring of specialized companies.

## 4.5 METER ASSET MANAGEMENT PLAN

### Problem Statement

Currently, there is no systematic process in EDM that tracks the meter assets in an asset lifecycle manner. This includes not only the procurement process and decommissioning processes, but also the complete cycle of receiving of the asset, the testing, distribution, installation, and disposal.

In addition to this, there is no formal process in which meter faults or meter failures are logged or managed. This appears to be a reactionary process, rather than a planned or formal process. There is also no system in place that logs all interventions during the meter asset lifecycle, such as inspections, audits, testing, and configuration information.

This is a critical requirement to properly manage the meter during its operational life, to minimize costs associated with improper asset management and to support the revenue assurance (loss management) process.

### Description

This intervention is focused on the development of the required policies and procedures required to manage

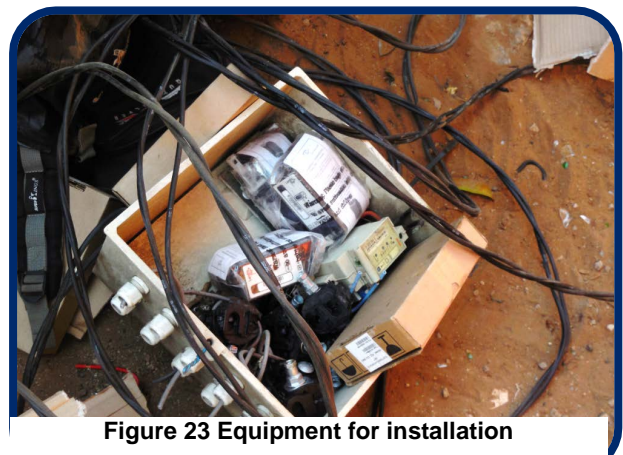
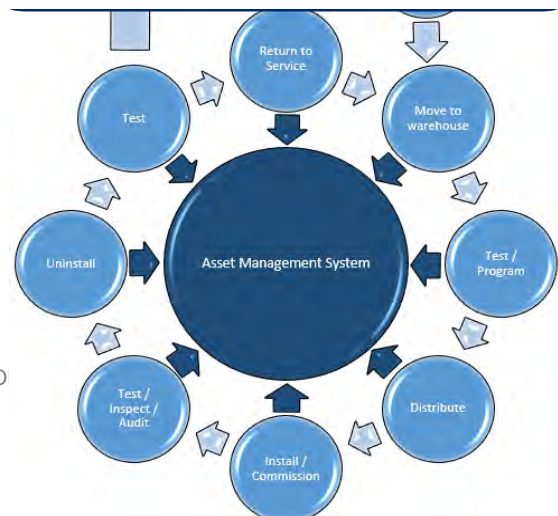


Figure 23 Equipment for installation



the maintenance of all meter asset data in the AMS through the asset lifecycle.

A separate Meter Asset Lifecycle process document should be compiled and can be used as a companion document to many of the standards and standard operating procedures. The process is commonly referred to as the Acquire-to-Retire process and covers all of the steps in asset management from the purchasing of the meter to the disposal of the asset. A simple view of this process can be seen in the diagram below:

The 'acquire-to-retain' process actually starts prior to the receipt of meters and can include many additional steps other than those defined or shown in the diagram.

For this intervention, only the identified steps will be focused on.

- *Pre-Acquisition:* The pre-acquisition, although not shown above, is a key planning component of the meter lifecycle as it defines what and how many meter assets need to be acquired. Much of this process will be supported by information supplied from the steps shown in the diagram and discussed in the steps below. The Meter Policy must be updated to cover the pre-acquisition requirements, with particular reference to the qualification of vendors and meters.
    - *Procurement of Assets:* The procurement process follows on the pre-acquisition process and provides the formal process of the acquisition of meters. The procurement processes must be updated to cover the pre-acquisition requirements.
    - *Receipt of the Meter Asset:* Taking receipt of the meter asset starts with the agreed delivery date. The meters should remain the asset of the vendor until EDM is completely satisfied with the state and correctness of the meters supplied. The procurement processes must be updated to cover the meter receipt requirements to ensure that this is covered contractually.
  - *Sample Testing:* Before EDM takes actual delivery, a test sample of the meters should be performed. Based on the meter type and volume received, this could be a small percentage (2%-5%), or all of the meters. This needs to be established within the meter policy and the procurement process. This should form part of the procurement contractual agreement. These meters will be put through the full technical testing as defined within the appropriate metering standard. Meter batches or meters that fail the test should be rejected and delivery itself should not take place, as defined in the contractual agreement.
- If the meters are found to pass all of the functional and technical tests as specified in the contract, then the process of on-boarding these meter assets is started.
- *Warehouse (On-Boarding):* This is the first step in a repeating cycle for the meter. The initial on-boarding of the meters includes the capturing of all the relevant details of the meters as provided by the vendor. The vendor should provide the required information in an electronic format to allow for the easy on-boarding of the meters into the AMS.

**Figure 24 Acquire-to-Retire Process**

At this point all information relevant to the new asset is captured on to the AMS. The AMS should be updated to include the information and results of the meters that were tested for acceptance.

- *Testing / Programming:* This is an optional test process to ensure that meters are working prior to distribution to other depots for installation. Although this does add an overhead to the process, it is something that has to be performed prior to installation. It can either be performed centrally prior to sending to a depot, or at the depot prior to installation. The benefit of the additional testing ensures that only working meters are distributed. The costs of testing can outweigh the costs of receipt of non-working meters.

The booking out of the meter for testing from the warehouse must be updated in the AMS. Similarly, the results of the testing must be updated in the AMS.

The meter test procedures must be updated to include this level of tests. These tests could be as simple as seeing if the meter powers up to complex testing of meter accuracy. This may be dependent on several factors, such as meter type, meter state (new or refurbished), and the time the meter has spent in the warehouse.

Where required, the meter will now be programmed with the appropriate metering schema prior to distribution. This meter schema is defined by the standard for the type of meter and installation. The details of the tests and updates to the meter must be captured on the AMS.

- *Distribution:* When the meter is sent to a depot, all details of the shipment must be captured on the AMS to note who sent the asset and to where it was sent.

On receipt of the asset, the receiver must update the AMS to indicate that asset was received and whether the condition was acceptable. The receiver may perform testing of the meter prior to booking it in to local storage. If this is done, then the results of the testing must be updated in the AMS, as well as the place the meter was tested. The meter test procedure must be updated to include the required tests to be performed, if applicable.

- *Installation:* During installation all installation details and verification of the asset information must be captured. This information must be uploaded to the AMS. This information should include a geo-tag to indicate where the meter was installed. All of these steps should be covered in the Installation Commissioning procedure.
- *Testing / Inspection / Audit:* During the period that the meter is installed at a location, it will undergo a series of tests, inspections and audits, according to the metering policy and related standards for the installation type. Each of these inspections, tests, and audit visits and their results should be captured on the AMS.

All of these steps should be covered in the relevant metering procedures defined for Inspection, Testing and Auditing per installation type.



**Figure 25 Current Testing Unit in Maputo**

- *Remove from Installation:* Where a meter is found to be faulty or is suspect, it is removed from the installation. The procedure covering meter replacement or meter uninstallation must include the requirements for updating the AMS. This includes, but is not limited to, the date of removal, the reasons for replacement, fault type, and meter closing readings (if available).

The details of what must be captured and the process to be followed must be covered in the procedure documents for meter replacement or uninstallation. Once the meter is uninstalled, the AMS must be updated as to where the meter is taken or is sent. The procedures for uninstallation and testing will determine if this will be done locally, sent to an external party or to the central distribution site for action.

- *Test / Refurbish:* Once a meter is uninstalled, a decision must be made as to whether the meter can be put back into service, or if the meter is to be decommissioned and disposed of. In order to determine this the appropriate testing needs to be performed. These tests must be covered in the meter test procedure documents for testing of meters taken out of service.

The results of the tests and the decision as to whether the meter can be refurbished and put back in to service or not, must be captured in the AMS. If the meter is to be disposed of, then the meter will be placed in the disposal path, otherwise the meter will go back in to the meter lifecycle process, ready for distribution to the next depot for installation. The AMS must be updated at all times to indicate where the meter is physically located.

- *Disposal:* The disposal process for meters must be defined as it has commercial impacts. Whether the asset is destroyed or sold off, the details of the disposal must be captured on the AMS. Similarly the asset status must be updated to indicate that the asset is no longer active or effective on the asset register. Ideally, the details of the asset and its lifecycle should not be deleted from the AMS



as this can provide valuable information for the analysis of meter performance, meter failure rates, failure reasons, and life expectancy. The loss of this information could severely limit the benefits of capturing this information on the AMS.

- *Inventory*: The inventory is a process that aims to verify if all meters purchased and that were not used are properly stored in a warehouse and if the meters used to meet customers' needs are registered in CMS system. It is recommended that EDM performs the inventory of the meters at least once a year.

## **Impact**

The long-term benefits of this are the identification of various meter faults and fault types, which can lead to considerable cost savings by ensuring that only suitable meters are purchased and that meters are maintained in an appropriate manner. Asset and fault information will also allow for the prediction of meter failures for existing installed equipment and will assist in the planning for their replacement before the actual failure occurs. This is important as meter failures can lead to not only interruption in supply to consumers, but also to revenue losses, depending on the type of failure.

As an example of inadequate meter performance identified at EDM is the STAR prepaid meters performance. These meters allow the energy to be supplied even after the credit is over (the relay does not open to cut the energy supply). It is estimated that there are 37000 STAR meters in the field that need to be replaced as soon as possible. The energy to be added from this initiative must be calculated using the average energy consumption from similar customers within the area in which the meter is installed.

Furthermore, the meter asset management will assist EDM in the following:

- The refinement of meter specifications
- Meter procurement decisions
- Meter asset control
- Effective meter maintenance plan implementation
- Consistent logging of meter faults
- Easy integration to network or GIS systems to map the physical location

## **Action Plan**

The implementation of the Meter Asset Lifecycle process is very closely linked to the Meter Specification Policy Definition intervention, as many of the policies and standards defined in this intervention will be influenced by the requirement to implement the updates for the AMS.

This intervention would run in parallel with the Meter Specification Policy Definition intervention. Although the implementation is dependent on the implementation of the AMS by the SIGEM team, the development of the required documentation is not. It is understood that the AMS implementation is planned for roll-out during 2017, although the exact dates are unconfirmed.

## **Resources**

The deployment of a suitable and operational AMS is a prerequisite of the long-term sustainable implementation of this intervention. However, alternative short-term options can be provided.

Most of the resources required in the short-term for this intervention are based on man-hour costs and cannot be accurately identified up front.

## **4.6 METER READING PROCESS**

### **Problem Statement**

EDM's objectives should ensure that the entire process for acquiring data for postpaid customers should be automated, without human intervention, in order to improve meter reading quality and avoid the manipulation of data. This will, in turn, result in significant improvements to EDM's billing and revenue collection.

Furthermore, before sending the readings to the CMS system for billing, there is a need to evaluate and control the reading collection process, in order to ensure that readings are not lost as a result of communication meter faults. EDM is considering meter reading systems and centers for reading, such as the MCC for data capture and processing of meter readings, which will consider the different manufacturer communication protocols from different manufacturers. This standardized integration layer will ensure that all meter readings are standardized to a format acceptable by the CMS for correct billing

Therefore, it is critical for EDM to assess and design the necessary interventions required to ensure the successful implementation of these new systems, as well as the roll out of the AMR program. The AMR program is focused on the MV clients, 6,000 customers, which are responsible for 40% of EDM's clients.



Figure 26 AMR Meter installed

Other utilities with similar projects have encountered the following challenges in AMR rollouts:

- *Poor Process Execution with Inadequate Controls:* Resulting in poor data quality, incorrectly captured CT ratios, incorrectly billed customers and associated lost revenue, and incorrectly configured meters.
- *Poor Program Management:* Vendor-driven projects tend to result in a lack of rigor, unproven techniques result in poor management and coordination of what is otherwise a complex program with significant impact across the organization.
- *Poor Quality Installations:* Resulting in incorrect meter configuration, unsafe installations, increased meter failure, and poor meter communications.
- *Solution Immaturity:* EDM needs to ensure “future proofs” what is currently being implemented.
- *Vendor Dependence:* The multiple vendors involved should not drive the overall solution. They need to be seen as commodities and “modules” that can be swapped in the future if needed.
- *Information Management:* Without adequate Information Management approach, EDM will end up with significant amounts of data that is unusable to execute revenue critical processes and will impact EDM’s business and its customers.
- *Cyber Security:* Any small misstep can lead to significant public perception problems.

Furthermore, the lack of robust communication services for smart metering (category B2B and B2C) may lead to the following EDM challenges.

- Once EDM scales its smart metering solution, telecommunications will become the most important element and a critical failure point. The key lesson from various other projects arose

from not realizing the importance of telecommunications and not being prepared to deal with the challenges associated with significant telecommunication volumes, which eventually resulted in project failure. Furthermore, telecommunications often does not work at all or adequately on-site because of poor vendor coverage. As a result, most other projects faced reduced confidence in smart metering, increased costs associated with additional visits, and required interventions to ensure operational telecommunications.

- Effectively managing operations and costs associated with a large number of SIMs is complex, with the following functions being difficult to perform: effective oversight and control over fraudulent communication (fraud is detected very late in the process), ability to do bulk just-in time activations, temporarily suspend a service or restore service to a SIM, and effective service-level management of telecommunication provider

Additionally, the use of the Mobile Reading Device (TPL) to address challenges with automated reading for postpaid customers where it was not possible to collect automated readings. This addresses challenges, such as avoiding faults associated with human interventions. The TPL can assist in the identification of possible data capture errors and indicate values that are out of the acceptable parameter ranges established by EDM.



**Figure 27 Paper-Based Procedures**

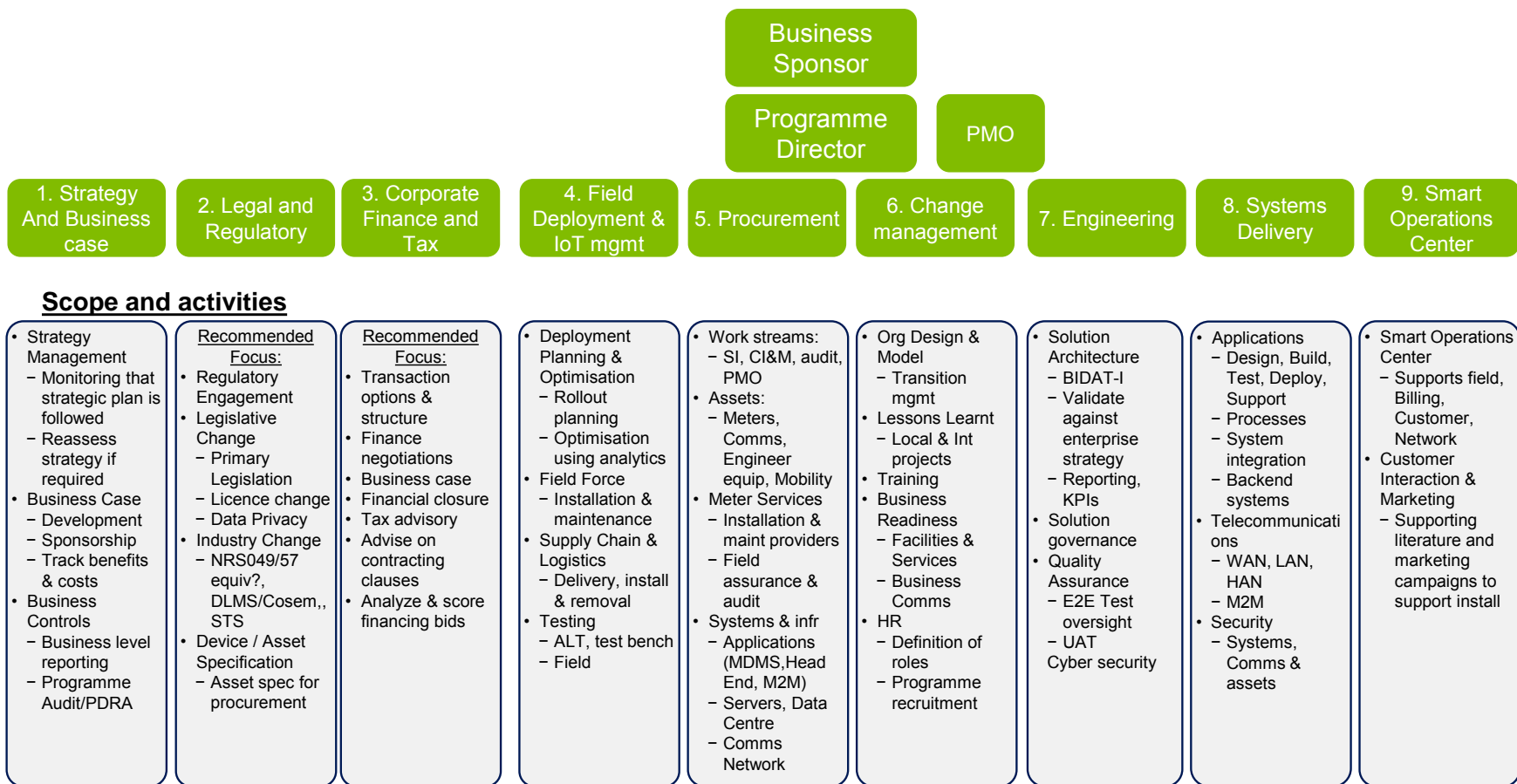
#### **4.6.1 ASSURE THE ROLL-OUT OF AMR PROGRAM**

##### **Description**

EDM should setup an EDM AMR rollout program management office, in order to:

- Effectively focus on risk management: EDM should establish a proper program governance structure to mitigate the delivery risks to such revenue critical program. Furthermore, this is a new capability for EDM and utilities in general, which makes it critical to mitigate the change management associated with effectively preparing the business for adopting the new technology.
- Ensure adequate focus on additional value-enabling opportunities on the back of the implementation of this Smart technology. Smart metering projects are the enabling of Smart Grids business cases and will allow EDM many new use-cases. EDM should be in control of shaping what and how these innovations are incorporated into the business, as opposed to treating this as a pure metering project. As such, EDM should ensure that it has a clearly aligned strategy that addresses the business needs and has a road map for implementing additional value-enabling initiatives on the back of this smart technology.

- Provide a structured program that addresses all elements of an AMR rollout. For example, it is often the case that cybersecurity is something that is forgotten.
- Ensure adequate focus on maintaining a customer-driven focus, by addressing their concerns, clarifications, and helping them understand what impact this new technology will have on them. It is often the case that the customer impact is overlooked, resulting in poor adoption or buy-in to the new solutions.



**Figure 28 Smart Metering Streams**

This recommended best practice program management methodology for smart metering projects is based on a depth of other similar experiences and brings a number of lessons learned from various clients. These should be leveraged in order to ensure that EDM does not make the same mistakes and benefits in terms of improved timelines, reduced costs, and improved quality. The recommended focus for EDM is discussed below:

## **1. Strategy and Business Case**

- Produce road map of target business capabilities with corresponding justification for all interventions through supporting business cases. This must ensure a strong focus on: Prepaid road map (given EDM's strong prepaid drive, consolidation / simplification of technologies, time-of-use tariffs, two-way power flows thereby allowing clients to sell back to the grid, etc.).
- Ensure implementation road map that allows for incremental value realization, quick-wins, modular investment, and reuse of infrastructure.
- Business-case development: risk mitigation planning whereby contingencies are built in the cost model, and ensure the business model takes growth into consideration.
- Focus on providing centralization, oversight, and governance over the program budget and underlying business case results.
- Implement a benefits realization monitoring capability to track whether the target value is being realized. E.g., oversight over deployment of functionality not tied to an attainable business case.

## **2. Legal, Regulatory, and Donor Management**

- Be thoughtful and proactive on the discussion with the regulator with issues related to how time of use should be implemented and enforcement of penalty payment.
- Plan for rapid incident response with the clients where the meters are installed.
- Ensure compliance with funding requirements and provide adequate visibility / reporting.
- Plan on reporting a large number of KPIs / metrics across the board from meter installations to outreach events.

## **3. Corporate Finance and Tax**

- Maximize corporate tax benefits associated with local manufacturing, use of local labor, benefits associated with the import of technology, and incorporate asset depreciation into the balance sheet to minimize tax.
- Make use of certain international borrowing funds that leverage preferential rates for new technologies such as smart metering.

## **4. Field Deployment and IoT Management**

- EDM should deploy a field rollout program management capability to oversee the field work conducted by the vendors and the installation subcontractors. Lack thereof impacts quality, financial accountability, and management of the vendor / subcontractor, as well as schedule

and budget. Furthermore, it is good for EDM to have oversight and to be present when its customers are engaged.

- Integration between the Field Deployment, Marketing, community communications, and Media teams are critical – all customers should be reached out to through multiple mediums. A leading practice is to document in a centralized tool showing the first-day meter install date in each geographic area, and the required outreach activities that need to take place within specified date range thresholds.

## **5. Procurement**

- It is critical to look at the entire solution when choosing vendors and understand product maturity and interoperability.
- It is important to structure contracts around delivery of the required outcome vs. the specific product, but the onus on the vendor to subcontract the underlying complexity and commit to the outcome.
- As a result of the consolidation that has been happening in the sector, there are many solution vendors who do not have proven experience in either the metering, Telecoms, or systems required for smart metering. This presents a sizable risk for EDM, which needs to be accounted for in the procurement of these services and technologies.
- Technology Obsolescence Risks: One Utility deployed 52,000 meters, which had firmware issues and had to be manually replaced, as the firmware was not upgradable over the network.
- Utility stakeholders not involved in procurement processes can cause roadblocks at key milestones.

## **6. Change Management**

- Limited focus in change management causes both internal resistance, as well as client issues.
- Smart metering represents a business transformation; therefore, a concerted change management focus ensures EDM approaches it differently than just a technology adoption. The following components are key elements: technology adoption, business process redesign, and impacts to the individual.
- It is important to effectively manage the potential organizational changes arising from this technology, specifically on how individual jobs and / or roles may be impacted.

## **7. Engineering**

- Create a well-defined governance and accountability model with clear lines of authority and decision making across executive and management layers of the program, which is critical in laying the appropriate foundation for the program.
- In order to ensure interoperability, standardization, and future proofing the solution, it is critical for EDM to have a central solution architecture function, which makes solution



- decisions, defines specifications / standards, and plays the assurance role to ensure that the vendors comply to the requirements and blueprint designed by EDM.
- There is significant complexity in ensuring integration of multiple different meter manufactures into a single solution and a continuous challenge for utilities. EDM needs to ensure system integration between the between the Huawei Meter Data Management (MDM) Solution and the various meter-specific HES. This standardization, design and blueprint needs to be effectively designed and well understood by the EDM solution architecture team to future-proof the solution
  - Although the Business drives decisions, technical leadership representation must be present to vet decisions from a technical perspective. This would perform an assurance role related to: quality of the delivered solution, monitoring of KPIs (performance, errors, meter failure, robustness of communications, etc.). this would serve as input into decision making to ensure solution performs within design specifications

## **8. Systems Delivery**

- Secure appropriate levels of sponsorship and support from the program sponsors and executives to have the PMO function serve on behalf of leadership in helping to coordinate and manage daily operations of the program – otherwise the PMO will be seen simply as project administration and not truly the group responsible for overall execution of the program.
- System integration between the various new solutions introduced – MDM, telecoms monitoring systems, and meter-specific head ends (HES) – as well as the legacy systems, such as CMS, GIAF, NCIS, and 3E, are critical. EDM needs to manage and monitor how the integration is done carefully, in order to ensure that EDM can take over the management thereof, and that future integrations can be easily delivered with minimal dependency on the vendor.
- Establish at least one full-time director-level resource to act as the overall PMO lead to oversee daily program operations to push the team, support issues resolution, and avoid any leadership vacuum and delayed decision making.
- Establishing robust and centralized program control functions to coordinate, manage, and facilitate the daily coordination for delivery of the program’s objectives / goals up front will bolster the ability of the PMO drive success for the program.
- Security can be looked at by the utility as secondary to meeting business requirements and operational functionality. As such, risks are not properly identified and mitigated which could lead to rework and compliance issues after the systems and infrastructure are deployed. The security threads of work should be fully integrated into each phase of the AMI deployment.

## **9. Smart Operations Center**

- Tools for knowledge exchange and increased call center interactivity, via interactive voice response (IVR) systems, help to reduce costs, enhance resolution rates, and boost customer satisfaction.

## Impact

- *Reduce Revenue Losses Associated with Poor Program Implementation of Meter Replacement Program for EDM's Large Customers:*
  - Other utility experience indicates that poor data management and lack of program controls in a smart metering program that can result in revenue losses with 10% to 20% of the impacted customer base where smart meters are installed. Experience indicates that this loss can continue for the entire financial year, when eventually the losses are noticed and affect the subsequent financial years' budget. These challenges arise as a result of poor monitoring and control throughout the project and post-implementation. This loss could be significant for EDM given that the smart meter program is targeting EDM's large customers that account for 40% of EDM's total revenue
  - Poor oversight and control of the solution and the rollout could result in duplicate costs associated with unplanned for replacement of solution components, duplication of solution components, throw-away of solution components, etc. These costs are significant as smart metering solutions are expensive. It is preferred for EDM to invest once, and to ensure sufficient time in future-proofing the solution to minimize unnecessary expenditure. These unplanned costs will be aggravated when EDM eventually scales the solution.
  - To avoid escalating costs, EDM should require of meter vendors provide an assurance that a maximum of 3% of their meters could fail. They also should require a meter warranty for a period of one year. Utilities who do not effectively manage these KPIs and do not hold meter vendors to account within the typical contract SLAs, will have to pay unnecessarily for an increased number of meter replacements, which would otherwise have been covered by the contract.
  
- *Ensure Vendor Accountability to Contracted Scope:*
  - Vendors need to be effectively managed to the contract in order to avoid unnecessary costs, and to ensure they deliver the targeted value prior to EDM making payment.
  
- *Ensure Adequate Hand-over to EDM Avoiding Post-Implementation Risks:*
  - There are typically significant costs associated with utilities not having adequate skills to manage the solution post-implementation. It is important that EDM ensures adequate structures and effort during project execution to ensure that all the necessary processes, systems, and capacity building to avoid large post-implementation costs.
  - Provides centralized oversight, execution consistency and coordination across all work streams focused in reducing risks and improves handoffs between work streams (IT, business, engineering, EDM divisions, and vendors).
  - Improves overall quality of program deliverables, standardized reporting / performance metrics.

## Action Plan

Our recommended approach follows a proven methodology of getting the basics right and then scaling the meter rollout accordingly:

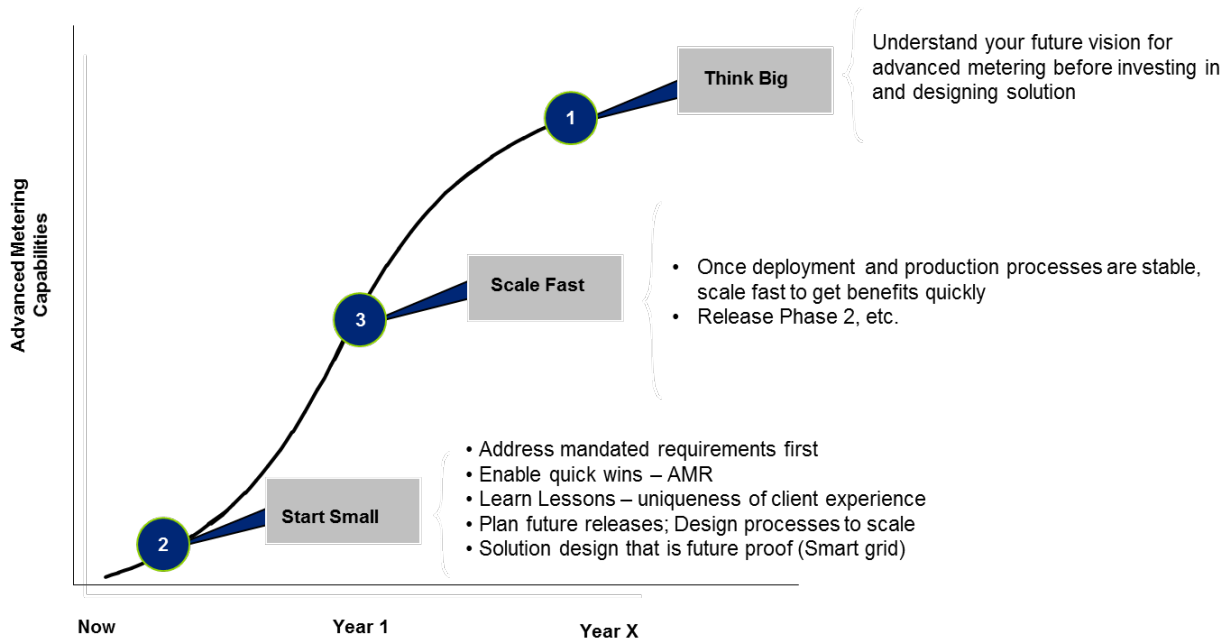
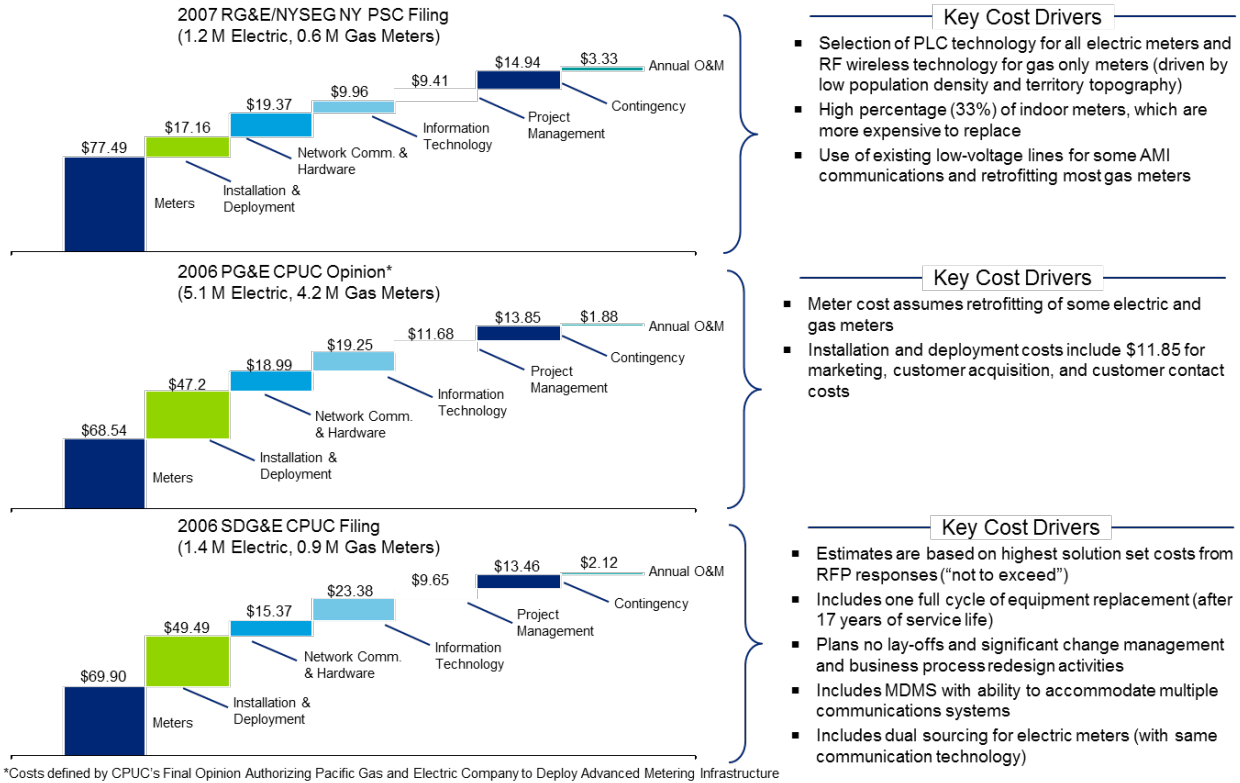


Figure 29 Census-Proposed Solution

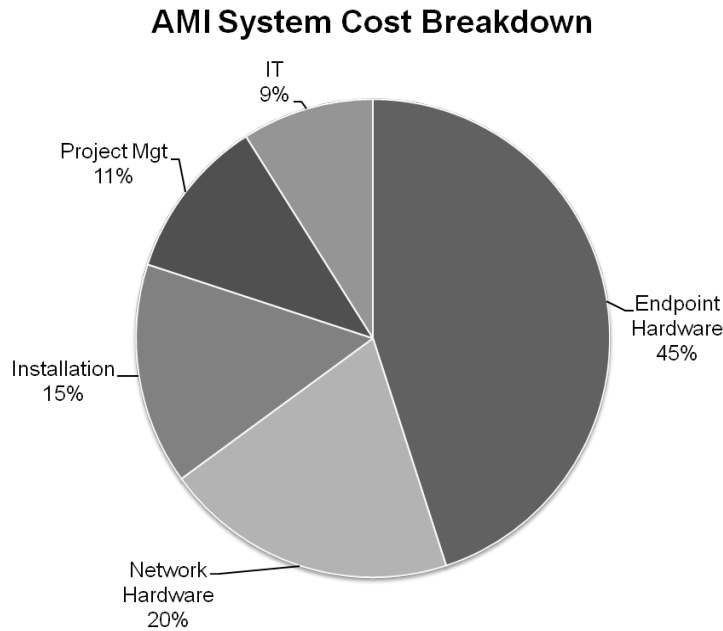
## Resources

EDM should budget similar values to what other utilities have typically budgeted for PMO and IT activities for smart metering programs. These two studies are presented below in detail. Therefore, it is recommended that EDM budget approximately 10% of the total program costs for PMO. Furthermore, it is recommended that EDM budget 9% of the total program costs to IT, which incorporates IT system integration.



**Figure 30 Smart Meter Programs Budget**

The costs breakdown of a smart metering program according to Gartner:



**Figure 31 Smart Metering Cost Breakdown**

## 4.6.2 ROBUST COMMUNICATIONS

### Description

- *Enable Multiple Communication Approaches:* Looking at Various Communication solutions, such as PLC and 3G to communicate with the meters, this is critical to accommodate possible field scenarios where certain telecommunication solutions do not work and to ensure that going forward EDM is flexible to choose whatever technology ends up being the most reliable and cost effective.
- *Deploy a Telecommunications Network Management System (NMS):* Also known as a Network Operations Centre (NOC), this system will ensure that EDM is able to monitor and evaluate the QoS associated with communication network and is informed timeously of issues associated with this revenue critical process. It minimizes revenue drop as a result of network and telecommunications issues through improved operational management and assurance.
- *Setup an SLA with the Telecommunication Service Providers:* Self-explanatory.
- *Deploy a Security manager:* This system is required to manage the security keys associated with the meter and the head end. It ensures security measures are in place for accessing meter data. It allows for controls, authentication and encryption, device and User management, and for cyber and physical security standards.
- *Setup a Telecommunications Planning and Engineering Capability:* This will provide a strategy and planning capability for smart metering and other telecommunication requirements, e.g., what technology (PLC, 3G, fiber, etc.) and where, which vendors? What services, what cost points? It will execute and manage telecommunication projects required for smart metering? It will manage the supply chain and procurement of the telecommunication services. From a network engineering perspective, it will perform Network Traffic Analysis, Network Cost Modeling, Network architecture planning, and design / build / test Services for telecommunication services.

### Impact

- Effective cost management, operational management, and real-time monitoring for a large number of SIMs
- Improve operational management of the telecommunications and smart metering solution, such as a connectivity platform for managing SIMs
- Improved Security features and control
- Reduce costs associated with poor billing processes resulting from failed communications
- Ensure communication failover and telecommunications vendor independence should be there for poor telecommunication coverage in certain areas.

### Action Plan

- Enforce dual SIM modems for the meters
- Setup Network Operation Center (NOC)

## Resources

EDM must create a dedicated team to be part Network Operation Center. The team should be composed of one (1) NOC engineer and two (2) technicians. The team would be responsible for ensuring the robustness of the EDM communication.

### 4.6.3 METERING CONTROL CENTER IMPLEMENTATION

#### Description

While establishing a Meter Control Center (MCC) that is already part of the current AMR project being implemented by EDM, this recommendation focuses on the need to only implement one MCC that should be located centrally (i.e., Maputo city).

This approach gives EDM the ability to have a centralized intelligence architecture. The centralized architecture of the MCC should communicate with all data concentrators and AMR / AMI meters that include BCLV, Medium- and High-Voltage customers.

This intelligence unit should be responsible for coordinating operations, monitoring meter readings and identifying customer's suspicious behavior across the 16 CSAs, as illustrated in Figure 32 on the following page.

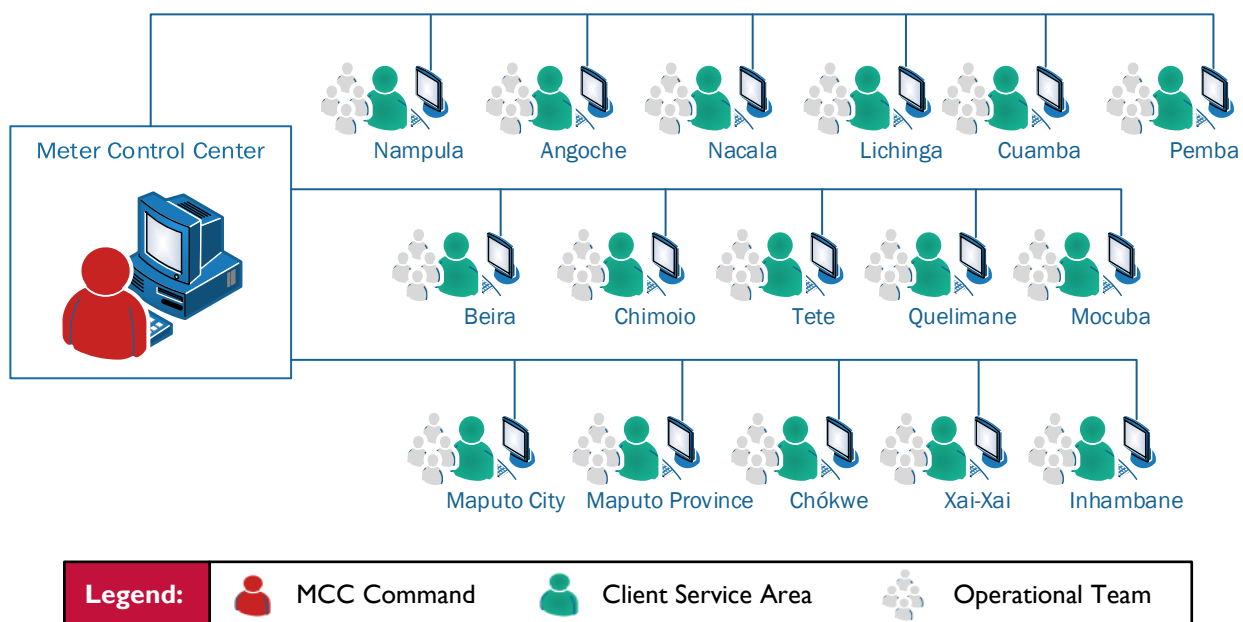






Figure 32 Proposed MCC Structure

As part of the recommendations for MCC field and operational services, the central intelligence team should be responsible for the following:

- Running AMR applications (MDM and head end)
- Analyzing processing exceptions / issues
- Requesting field investigations for meters that are suspected to be damaged / malfunctioning
- Monitor network communications and investigate issues

The typical capabilities and roles that are recommended for the EDM MCC (based on international experience) are indicated in Figure 33 on the following page.

Shift Supervisor	NOC Engineer	NOC IT	NOC Operator
			
<p>The Shift Supervisor works weekdays and on-call, ensuring adequate staffing and emergency responses. Performs as a subject matter expert for the Operators of the NOC.</p>	<p>The NOC Engineer works weekdays and on-call to properly support the NOC Operators and the business customers</p>	<p>The NOC IT analysts work weekdays and on-call to support NOC Operators; the Engineers; and business customers.</p>	<p>The NOC Operator works shift work to provide 24x7 operations.</p>
<p>The Shift Supervisor will have the knowledge of a NOC operator and the holistic view of the Engineer</p>	<p>The NOC Engineer will have a detailed understanding of all aspects of the software used in the NOC</p>	<p>Has detailed understanding of application configuration; optimization; and interfaces. Supports engineers in device integration and management.</p>	<p>Has an intimate knowledge of the monitored devices; interaction of IT and PD systems; diagnostics and troubleshooting.</p>

**Figure 33 Typical MCC Capabilities**

## Impact

The implementation of one MCC has the following impact:

- *Cost Reduction:* The standardized procedure helps considerably in reducing the need for large operational teams or human intervention to address issues.
- *Uniformity in Action:* The centralized command unit establishes uniformity in action throughout EDM operations and the centralization of critical thinking and analytical skills in one division, which equally serves all ASCs, as opposed to having “average” skills spread out. This centralized intelligence improves the effectiveness of operations across the entire commercial metering value chain and will significantly contribute to the reduction of losses while not duplicating capabilities.
- *Improved Quality of Work:* The standardized procedure and enhanced supervision can lead to an improvement in terms of work quality, organizational efficiency, and improved accountability of EDM’s CSAs. Furthermore, there is an enhanced ability to retain highly skilled staff.
- *Improved Coordination:* The centralized intelligence unit facilitates better coordination among various operations. This enables direct control and supervision, which results in less conflict of authority and duplication of work.

## Action Plan

- The implementation of the MCC has already been defined under the AMR project. However, this recommendation affects the implementation approach of centralization. As such, a full operating model should be defined for this unit in terms of mandate, business processes, governance operations between various EDM business units, including the CSAs, DIC, DEF, and distribution; the technology tools they will use; and the organizational structure with the corresponding roles and responsibilities.
- Create the MCC and the intelligence team responsible for its operations to evaluate the issues and improvement opportunities.
- Create operational teams in each of the 16 CSAs, which are dedicated to receive instructions from the MCC.
- Align tasks and define responsibilities for each of the CSA operational teams.
- The central intelligence team should produce monthly reports on the issues identified in the metering system and the measures taken to overcome these issues.

## Resources

- The single MCC implementation requires dedicated operational teams in each of the 16 CSAs to respond to the MCC's instructions and commands. The number of teams in each CSA may vary according to the number of customers and the demand in a given area.
- The central intelligence team in the MCC should be composed of highly skilled staff with in-depth knowledge in the meter reading processes, the metering systems, data analytics, and to troubleshoot telecommunication issues.

### 4.6.4 PORTABLE DATA TERMINAL ROLL-OUT

#### Description

The Portable Data Terminal (PDT) is an electronic device that can be used to enter or retrieve data from a database or system. The EDM CMS allows the integration of PDTs as a means to collect meter reading. PDTs can offer the following functionality:

- Search functionality
- Download itinerary
- Meter reading collection
- Perform inquiries
- Perform validations
- Reorganize the route order



## Impact

- *Improved Meter Reading Accuracy and Productivity:* The introduction of data in the PDT instead of manual data capture can minimize the risk of incorrect meter readings that can lead to incorrect bills
- *Efficient Metering:* Helps to identify anomalies in the meter reading process by giving an alert in case reading values are not within the acceptable parameters established by EDM
- *Tampering Reduction:* Reduced losses resulting from minimized customer tampering of meters and increased operational efficiencies associated with automation of the meter reading process

## Action Plan

- EDM must perform an assessment to identify and prioritize the priority areas for the PDT roll-out
- The PDT specification must be developed and must address EDM's operational requirements
- Issue a tender to assess and purchase a solution that is compatible with EDM's architecture
- Purchase the initial lot and perform acceptance testing
- As part of the initial rollout, EDM should ensure adequate training and oversight of the PDT performance

## Resources

The table below illustrates the number of PDTs required for each CSA and the estimated cost in US Dollars (USD):

CSA	Number of Devices	Cost per CSA (USD)
Maputo Cidade	51	25,500
Maputo Provincia	46	23,000
Chókwe	12	6,000
Xai-Xai	12	6,000
Inhambane	12	6,000
Beira	25	12,500
Chimoio	14	7,000
Tete	13	6,500
Quelimane	11	5,500
Mocuba	10	5,000

<b>CSA</b>	<b>Number of Devices</b>	<b>Cost per CSA (USD)</b>
Nampula	21	10,500
Angoche	3	1,500
Nacala	13	6,500
Lichinga	6	3,000
Cuamba	4	2,000
Pemba	11	5,500
<b>Total</b>	<b>264</b>	<b>132,000</b>

**Table 11 PDT Required in Each CSA**

Further costs associated with EDM staff training on the PDT must also be considered.

## **4.7 INTEGRATED NETWORK TO CUSTOMER INFORMATION SYSTEM**

### **Problem Statement**

*Customer Re-Registration:* Historically, EDM has run with multiple billing systems keeping separate sets of customer information. These systems have recently been consolidated into a single system, namely the Indra in CMS.

Since these systems were managed and maintained independently over many years with lack of standard auditing and customer account maintenance, it is possible that there were changes to customer information that are not current, or correct, on the systems prior to the migration. Also, since there were key fields in the systems that were duplicated or were mismatched during the migration of the master data to the CMS system, the chances of there being at least some loss of data or incorrect linkage of meter records to customers is reasonably high.

The impact of this is potential revenue loss and incorrect billing due to loss of, or corruption of, customer account records.

*GIS:* EDM has implemented the GIS in a pilot phase in Maputo, Matola, Beira, and Nampula, but it is not fully operational due to the following registration problems:

- Inadequate equipment reference number
- Lack of cartographic data in some regions
- Rotation of personnel
- Outdated data in the database, etc.

*System Integration:* EDM has specific system integration problems that affect the operations performance throughout the meter to cash EDM value chain:

- *Synchronization Delay Between the Eclipse Enterprise Edition (3E) and the CMS:* The 3E, which is the system responsible for the prepaid purchases and the CMS that contains the customers' database are presenting synchronization delays. The integration between two systems has not been done correctly which has led to over three months of delay.
- *Integration of the Meter Data Management (MDM) and the CMS:* The new MDM system which is an element of the AMR solution has not been integrated with the CMS. As per the current status, the Huawei team is still in the process of integrating both systems. There is a risk that this is not done correctly or with EDM ensuring adequate control.
- *Meter Protocols with the MDM System:* Although EDM has agreed with Huawei to implement an open protocol for integration between the meters and MDM, there have been challenges in integrating the existing L&G meters with the MDM system. There is a risk of integration of future meters compliant with the EDM-selected DLMS / COSEM standard.
- *DataMart Platform to Enable Centralized Analytics Across the Meter-to-Cash Value Chain:* There is currently no platform to integrate all data across the meter-to-cash value chain into a single DataMart in order to produce centralized analytics. There is currently an EDM KPI project, which aims to deliver this capability. It is important that the KPI project caters for the EDM analytics requirements.

Furthermore, there is no Enterprise Service Bus (ESB) architecture that would integrate the existing, as well as the new systems in a service-oriented architecture (SOA). This would replace the point-to-point integration between systems that is currently being in use at EDM. The point-to-point integration becomes hard to manage over time as it results in custom integration code being spread among applications (i.e., CMS, 3E, MDM) with no central way to monitor or troubleshoot. This is often referred to as "spaghetti code" and does not scale because it creates tight dependencies between applications.

The image below exemplifies the current point-to-point integration:

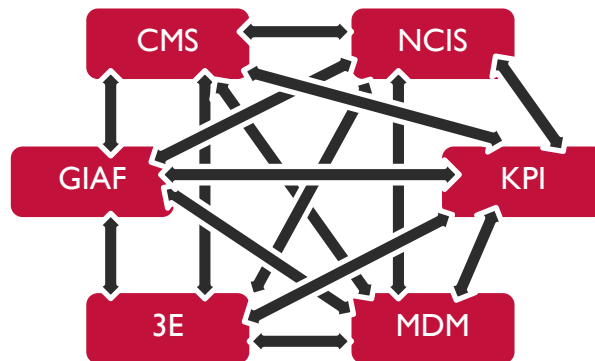


Figure 34 Current Point-to-Point Integration

#### 4.7.1 CUSTOMER REREGISTRATION

##### Description

Two options have been considered for the customer reregistration process. The first option is to perform an extensive clean-up of the existing data in the CMS system and the second option is to perform a complete census of all installations.

##### Data Clean-Up

A data clean-up would require less staff, easier to manage, and require less time than a complete installation census. While there are benefits to be obtained from a data clean-up, it is believed that the time and effort in performing a clean-up of the existing data will still leave gaps in information.

Should the confidence levels in the correctness of the data in the CMS and Credelec / Eclipse systems be high and the confidence that the problems in the field are capable of being managed by other business processes, then this approach would be recommended.

However, this is not the case and the data clean-up will not pick up many of the error conditions that are identified during a complete census, even with the use of complex data analytics.

##### Complete Installation Census

It is; therefore, recommended that, to create a new baseline from which to work, a complete on-the-ground installation census be performed. This will allow for the updating of all of the required CMS customer detail, as well as all Asset Management information related to the installations.

A complete on-the-ground installation census will require a large number of suitably qualified teams to be able to perform the census within a reasonable amount of time. The duration for the completion of the census is important to ensure consistency and completeness of data, particularly if EDM operational

staff are part of the census team as this could have a negative impact on the availability of the staff for other purposes.

The census will create a baseline for all of the customer and asset information. This set of data will be verified, added to, and maintained with every site inspection performed as per the procedures defined within the previous intervention.

This links in well with the establishment of the inspection teams described in the previous intervention. Ideally members of these teams will be part of the census teams (or be the census team) and this would also form part of their training and their first task. It is; however, envisaged that there will be more census teams required than inspections teams, so not all census teams may have an inspection team member in it. This would be dependent on the time frame for the census and the implementation method. Typical issues a census will identify that a data clean-up will not are noted in Table 12 below.

Installation Issue	Comment
Faulty Meter	These are installations with obvious faults in the meter. This can include displays not working and supply failing to disconnect
Damaged / Failed Meter	This is obvious damage that the meter has received and is not in working condition
Tampered Meter	This is identified by meter seals that have been broken or covers having been removed
Meter Test Mode	This ensures that meters are in measurement mode and not in a test mode. Test mode often leads to free supply of electricity to a customer
Disconnected Supply	These are installations to which electricity no longer supplied. The meter may exist; however, there is no load connected any longer
Unmetered Supply	These are installations where meters may not be installed or do not currently exist on the Credelec / Eclipse or CMS system
Meter Bypass	These are installations where the meter has be either completely or partially by-passed

**Table 12 Data Clean-Up Issues**

By performing a complete census, the following will be achieved:

- Update all customer information to the current consumer / owner information
- Ensure that the correct meters are allocated to the correct addresses / contracts / accounts
- Update all asset information on the AMS
- Identify installations where a test or audit needs to be performed
- Identify installations where meters need to be replaced
- Identify the exact site and placement of the meter
- Identify customer to network linkage

Benefits that will be achieved are:

- Ensure correct information on the billing systems
- Reduction of losses due to installation problems being identified as above
- Identification of installations to network linkage (if this test is performed)
- Geo-tagging of installations for future identification of the site
- Support load and loss analysis of installations by area and / or network
- Support asset analysis of transformers and networks

**Detailed:**

A complete census of customer metering installations is a complex process and needs to be planned carefully and have all of the required support infrastructure in place for it to successfully retrieve and process all of the data required. In order to perform the census, a managed process for the data capturing must be established. Appropriate systems need to be put in place to upload the data to a central system. Proper data validations must be performed on the data and only once verified, this data will be passed on to update the appropriate systems, such as the CMS, Credelec / Eclipse, and the AMS.

Figure 35 on the following page shows the proposed solution of the census and related systems.



**Figure 35 Census Proposed Solution**

System	Description	Integration
Census Central Data	This is the central store of all of the master data	CCD to other systems

CMS	The central billing system	CMS to CCD CCD to CMS
Credelec / Eclipse	The prepayment system	Credelec / Eclipse to CCD CCD to Eclipse / Credelec
Asset Management	This is the AMS, which is currently not defined in EDM	CCD to Asset Management
Network / GIS System	This is the network system, allowing mapping of installations to transformer and / or network components.	CCD to Network / GIS
Other Systems	Since the census system is intended to remain in place after the initial census, it is possible that future integrations will be required.	Undefined

**Table 13 System Integration**

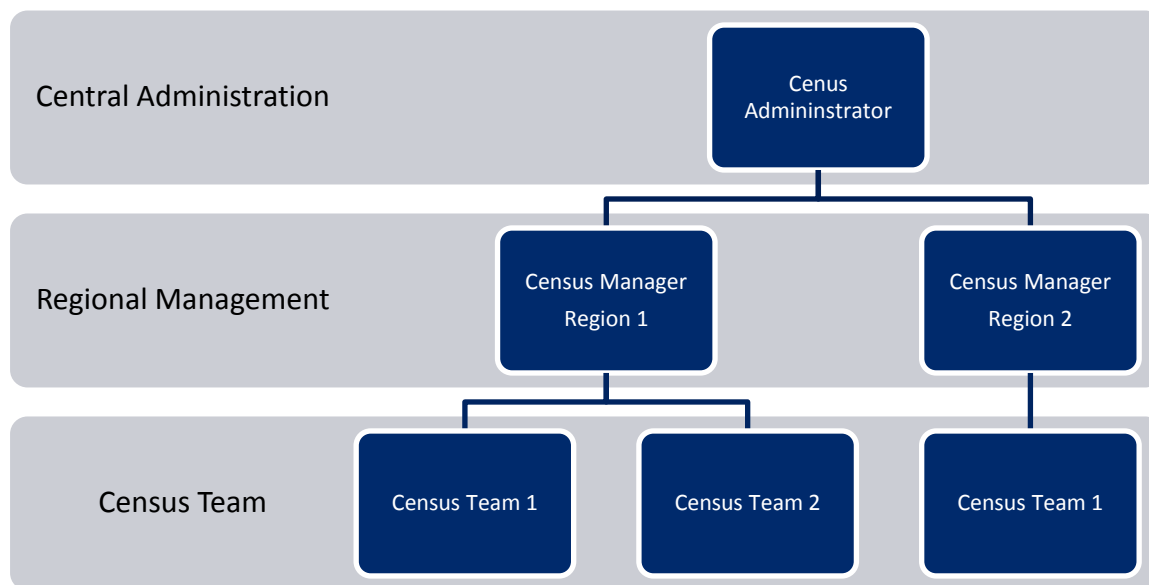
### **Developing the Census Management Structures**

Performing a census is not a trivial exercise and needs to be planned appropriately. Due to this being a national census, a proper management structure and operational process must be developed. It is proposed that a central management office is established with at least one census management office established per region. This will allow for local assistance with any customer or installation enquiries and the use of EDM staff within the audit will avoid additional costs of travel and accommodation.

The central management office is responsible for the establishment and maintenance of the central database, as well as the coordination with all regional management offices.

The regional offices are responsible for the management and scheduling of the local census teams and ensuring that the census data is loaded to the central census server.

The number of teams per region will be determined based mainly on the known number of customers in the region.



**Figure 36 Registration Management Map**

### **Customer Education**

Prior to performing the census, it is important to notify customers in the area about the census so as to avoid problems with customers regarding providing the information and gaining access to installations. This can be achieved by radio or television advertising, distribution of leaflets at vending systems (prepaid), inclusion with bills (postpaid), or by using any community forums, should these exist.



It is possible to even provide a reward for customers who willingly assist with the census, such as a free electricity token of reasonable value to them or a rebate on their bill. This would be dependent on the expected reception of such a census.

### **Using Existing Systems for Data Validation Versus a Blind Census**

There are two options for performing a census, the first being a blind door-to-door walk down the street and the second using existing data from the CMS and Credelec / Eclipse systems for planning the census routes.

- **Blind Census:** A blind census requires users to walk up and down the streets looking for different installations against which data capture needs to be performed. This can be very time consuming and many installations may be missed.
- **Planned Route:** Using the data on the CMS and Credelec / Eclipse systems, it is possible to plan a route for the teams to follow for performing the census. This is more structured and efficient; however, teams may be too focused on the route and may miss installations not on the systems.
- **Combining Both:** It is *recommended* that a combined approach be followed, where the known data is used to plan the routes efficiently. However, teams need to look for the installations themselves.

The handheld unit software will notify users if they have missed a known installation in the area. In this way, teams are focused on looking for installations on predefined routes, but are not guided directly to the installation itself. This means they need to be constantly on the lookout for possible installations.

Where data is captured against a known meter, immediate onsite verification of the known data can be performed and tagged as Verified, Updated, or New.

These validations will need to be built into the software on the handheld devices.

### **Designing the Data Capture Process**

The whole data capture and processing of data must be electronic, allowing for on-site validations of data fields, captured values, and the uploading of the data to a central system. The use of



ruggedized handheld devices is required for this.

Based on the data to be captured, the census capture forms need to be carefully designed. Standard software used for this kind of data capture allows for the development of custom forms per implementation. The handheld software takes the team through a series of forms, prompting the team to capture the required information.

**Figure 37 Data Capture Process**

Based on entered data, the team may be prompted by further questions for additional information or for verification of the data entered.

The benefits of capturing data via this means ensures that data can be validated by data entry field at data capture time. This assists in ensuring that the data captured is correct and valid (i.e., telephone numbers, meter serial numbers, email addresses, etc. are validated against known valid structures).

The capture processes will need to be designed and developed, based on the field data capture software product chosen. The forms development, form sequences and data capture processes will need to be developed to cater for capturing information related to:

- Account holder details (property owner)
- Consumer details (where the consumer is not the property owner)
- Physical Installation
- Transformer to Installation

The processes for data upload must be defined and implemented. This refers specifically to the mechanism for uploading of captured data from the HHU to the central server and the download of master data and route information from the central server to the HHU.

Data validations need to be defined and implemented. This is for validation of the data captured on the HHU and for data uploaded to the central server.

A census progress monitoring and reporting process must be defined and implemented. This covers not only the day-to-day management and upload rates from teams and areas, but also the management of the census program overall. Typical indicators that should be monitored and managed are:

- Installations per day per team
- Percentage area complete (estimation based on the known number of customers in the area)
- Percentage census complete (estimation based on the total known number of customers)
- Problems encountered
- Problem resolution

Integration into the related systems must be developed, to ensure that the data received is up to date and that the updated and correct data can be provided back to the master or primary systems. This integration must; therefore, be bidirectional. Systems impacted include, but are not limited to:

- CMS: Customer billing system
- Credelec / Eclipse: Customer prepayment system
- Asset Management: Currently undefined

### ***Developing the Census Teams***

One of the last steps before implementation is the creation of the Census Teams. These teams need to be made up of suitably capable persons and must be trained in the data capture process and the procedures to be followed.

The number of teams needs to be identified, which will be based on a combination of the number of customers in an area, the geographical area to be covered, and the time frame within which the census is to be completed. The longer the time period, the less the number of teams required and *vice versa*.

The benefit of performing the census over a longer time period, is that more use of EDM operational staff and inspection teams. This means that the experience and knowledge obtained will remain within the organization after the census and can be used on an ongoing basis to keep the master data up to date.

Census teams will need to be trained on identifying the following while doing their routes:

- *Unmetered Supplies*: These are supply points where the electricity is being consumed, but no metering exists.
- *Unreadable*: These are meters that can either not be identified, due to screens not being readable or nameplates not being able to be read.
- *Faulty Meters*: These are meters where the meter is not displaying anything on the screen, but electricity is still being supplied. This could also be where the meter trip switch is off, but electricity is still being supplied.
- *Damaged Meters*: These are meters that are fully functional, but where there is noticeable physical damage to the installation or the meter housing.
- *By-passed Meters*: These are installations where some or no energy is being shown by the meter, but the consumer premises indicates high usage of energy.
- *Electricity Theft*: These are direct illegal connections, where a consumer is connected to the electricity network, but no formal installation exists.
- *Dealing with Hostile Consumers*: Census teams will need to be provided with mechanisms on dealing with hostile consumers. Particularly where there is obvious electricity theft of some means as described above.
- *Dealing with Unavailable Consumers*: There are a number of reasons why consumers may not be available during the census and this must be taken into account during the census.
  - *Refusal to Cooperate*: Some users may refuse to cooperate or allow entry where the meter is on the consumers' property.
  - *Never Available*: Nobody is at home due to work or other reasons.
  - *Holiday Homes*: There are many holiday homes that are infrequently inhabited.

The required and suitable equipment for the census must be defined and obtained. Users must be trained in the use and maintenance of the equipment (i.e., charging requirements), as well as the processes surrounding the capturing of data onto the equipment, the uploading of the data to the central system, and the downloading of new data for the next route work schedule.

There are always exceptions within a process which cannot be identified up front. A method for dealing with these must be provided, ensuring that the Census Team are not placed in an unsecure or potentially dangerous environment.

## Impact

A re-registration of all EDM consumers will ensure the correct customer / consumer information is available for the billing systems. This is particularly needed in the context of the introduction of the CMS where customer information was lost, corrupted, and / or misplaced. This will ensure correct billing to the correct account reducing billing data errors for postpaid customers, as well as overall loss analytics and management.

This will enable loss reduction through effective control and inspection of meters in the field where supply of electricity is currently not being correctly measured due to theft, by-passing, or faulty meters.

Including the Installation-to-Transformer tests in the census process will enable the updating of the Customer and Network Systems.

## Action Plan

The time frame for implementing such a census is dependent on a number of criteria and as such cannot be provided as an accurate estimate. A reasonable time frame would be in the order of six months to one year, based on the costs and resources deployed.

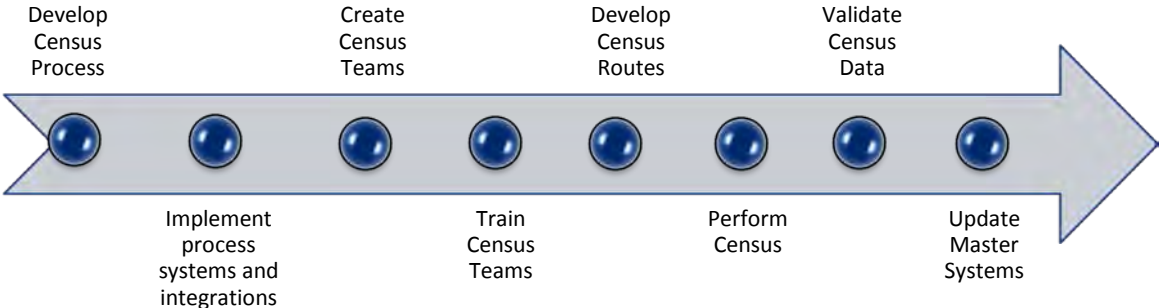
The implementation plan would include the following steps and excludes the commercial process of obtaining software and equipment. Parts of the steps defined below can be done in parallel.

Census Steps	Step Description	Step Duration (months)
Develop the Census process	Develop the processes and procedures for implementing the census	3
Implement Process systems and integration	Software implementation and system integration development	3
Create Census teams	Identify and appoint teams and management structures	1.5
Train Census Teams	Train teams and management in the processes and use of the equipment	0.5
Develop Census Routes	Plan the routes that users will follow for the on-the-ground	1

	walk-throughs for daily routes	
Perform Census	This is the actual on-the-ground time the team takes to acquire all of the relevant data	6
Validate Census Data	This is an ongoing validation process that happens from the receipt of the first set of data	System based
Update Master Systems	This can be an on-going or batch process during or after the census period	System based

**Table 14 Implementation Plan Steps**

Post the census, the process should be handed over to the Site Inspection teams for an ongoing data



**Figure 38 Ongoing Validation Process**

validation process.

**Resources**

Costs associated with an implementation of this type are difficult to identify at this time, as they are dependent on implementation options. Using the developed inspection teams over a longer period of time would be the most cost-effective method and ongoing sustainable option, but may not achieve the short-term organizational goals.

A dedicated census team approach would be more costly, but would be able to have an impact in a shorter time period.

The cost benefits of the two approaches needs to be performed to identify the best option for EDM, taking into account the potential revenue recovery (loss) versus the cost of census implementation.

The costs have been split into three major components, System, Central Operation, and Census / Inspection teams.

- *Systems Costs*: The system costs cover the development of all of the system components required to capture and upload all of the field data into a central system. These costs would have to be incurred, irrespective of the census implementation method.
- *Central Operations*: The central operations cover all of the running costs of the central system. Note that no allocation of additional office space or similar costs are included as the assumption is that these costs will be internal EDM costs and not direct operational costs. The central operations include the management costs of regional managers.
- *Census / Inspection Teams*: The Census or Inspections teams are the persons actually responsible for the collection of field information and are likely to form the bulk of the actual project costs.

System Component	Description	Qty
Census Software license	This is the software designed specifically for capture of field data in forms, via hand held devices.	1
Census Server Hardware	This covers the hardware, database and operating system licenses required.	1
Census Form Configuration	Every field capture form needs to be defined, along with all of the relevant filed validations and configured on to the system. This can be as simple as a single page, or an extremely complex multi-form process.	Unknown
System Integration	There are five currently defined systems that the central census system can integrate with. Two of these systems are currently undefined in EDM, namely the Asset Manager and the Network / GIS system.	3
Census Developer	These persons are skilled in these software packages and are able to develop the required forms.	3

**Table 15 System Costs**

Team Component	Description	Qty
Census Administrator	This is the census project administrator responsible for all management and reporting on the project	1
Regional Census Managers	These are regional census managers responsible for ensuring that the local census teams are performing their tasks as required.	9
Census Team Support Staff	These are dedicated central support staff available to assist census teams in the field who are experiencing problems.	3
Census Data Analyst	This person is responsible for ensuring that the data is correctly analyzed and actions all exceptions	1 or 2
Census Developer	This person is responsible for monitoring and maintaining the system during the period of the census and possibly afterwards as well.	1

**Table 16 Central Operational Team costs**

Team Component	Description	Qty
Team Leader	This is the senior member of the team responsible for all on-site decisions	1
Team Support	This is a support member	1 or 2
Handheld Unit	This is the data capture device with supporting charging and connectivity software	
Software License	Per HHU there is a license cost that needs to be included.	Unknown
Additional Hardware	This includes additional test and measurement equipment, based on the intent behind the census, i.e., site loading and transformer linking.	Unknown
Travel	Travel to and from sites will be required	Unknown
Accommodation	Where teams need to be away from home, accommodation costs will be incurred.	Unknown
Out Allowance	When teams are away from home, sustenance or out allowances needs to be paid.	Unknown

**Table 17 Per Census Team Costs**

**4.7.2 GIS IMPLEMENTATION**

**Description**

EDM is structuring a new Network Customer Information System (NCIS) project to register all EDM assets using geo-tagging to replace the old GIS. The NCIS should use the same software used in the GIS implementation called dpPower from DigPro. The software license renewal must be performed as it expires in 2018.

It must be defined whether the data from the current GIS will remain in the database or it needs an update process before the NCIS implementation.

**Impact**

The geo-tagging registration allows for efficient planning of the distribution system, expansion projects, distribution network improvements, asset management, and contributes towards different activities to combat losses, such as consistent client registration, field inspections, meter problems mapping, etc.

For an effective NCIS system, EDM must ensure that the database is kept updated.

## Action Plan

The geo-tagging registration can be very beneficial for EDM; however, it is a complex task and requires a well-structured implementation plan and execution.

Thus, see below some crucial steps to ensure a well-structured implementation plan and execution of the NCIS:

1. The technical department must elaborate a procedure to ensure the referencing of all assets (electric poles, transformers, meters, etc.) to ensure its identification during the NCIS registration. It is recommended the introduction of an alphanumeric reference to help in identifying and distinguishing the asset with ease. If the asset is removed from the field and reinstalled in another location, its important guarantee that the removal of the previous reference and introduction of the new one.
2. The technical department must perform data collection of all electric parameters as defined in the dpPower software specification such as conductors resistance and reactance, transformers technical data, etc. to allow for technical loss calculation using the dpPower integrated component.
3. The technical department must perform the registration of the entire geographical area where the NCIS will be implemented.
4. The project coordination team must evaluate and ensure that all the human and financial resources are available prior to the NCIS implementation.
5. The project coordination team must elaborate an execution plan based on resources available, establishing the geographical area, and the deadline for registration. To ensure an effective registration, it is important to verify all the dates required (as stated above) before performing the registration.
6. The technical department must establish teams to perform the registration or, if outsourcing, provide the necessary training. Furthermore, appropriate equipment must be provided to ensure that the registration process is properly executed.
7. EDM must create a quality control team to verify through sample testing to check if the work was correctly done, identify problems, and to take measures to correct them. The team is responsible to ensure an alignment between the different areas / departments involved in the process, i.e., ensure that the CMS billing system is updated when a meter is reinstalled in the field.
8. EDM must structure teams responsible ensuring that the NCIS database is always updated. It includes new registrations and maintenance of the current database such as expansion projects, network distribution maintenance, new meter installations, or meter replacement.
9. EDM must create a crisis management committee to identify problems and provide solutions to quickly overcome them to not compromise the execution and quality of the NCIS. Usually, this committee is composed of people from the main involved areas.
10. The coordination team must define:
  - KPIs used to manage the project implementation
  - Management reports and their periodicity.



## Resources

As EDM already possesses a geo-tagging software, the only remaining task is to identify the resources required to:

- Perform the mapping
- Establish a team for registration quality control
- Acquire GPS equipment to perform the registration.

The resources needed will vary according to the project duration. Based on the significant investment required and the complexity in executing and monitoring the registration, a geo-tagging project usually takes more than five years to be implemented.

### 4.7.3 SYSTEM INTEGRATION

#### Description

##### Resolve Immediate System Integration Solution

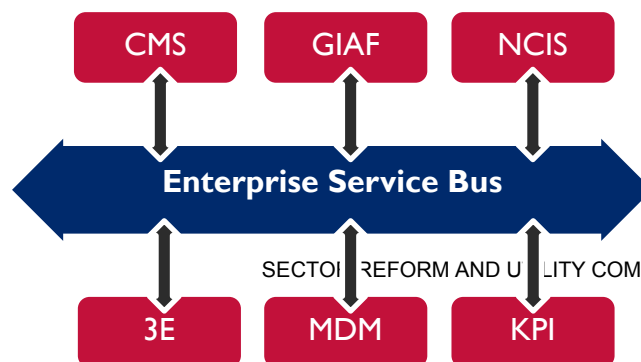
EDM must solve the existing integration problems between systems as identified in the problem statement. As part of this exercise, EDM must ensure that all the systems integration are well documented, thereby ensuring that EDM is able to sustain this going forward, without depending on the vendor.

To ensure that the integration process minimizes risk, it is important to create a dedicated team to support and ensure that the system integration is performing adequately. EDM must also ensure a Service Level Agreement (SLAs) between the different external system owners and EDM.

#### End-State Solution

An ESB is an architecture that consists of rules and principles for integrating numerous applications together over a common bus-like infrastructure thereby minimizing complexity and costs of many point-to-point interfaces between each system. The common communication bus avoids the need for many integration points between systems as well as simplifies the process of integration as any new system communicates without the dependency or knowledge of other systems bus.

The image below exemplifies the benefits of introducing an ESB in terms of simplifying the integration between systems, when comparing with point to point:



**Figure 39 Enterprise Service Bus for EDM**

## **Impact**

Benefits of the immediate interventions:

- Ensure the business is able to have an integrated view of the business and the data used to run the business.
- EDM will have confidence in the systems resulting from improved data quality.
- Operational efficiencies associated with improved, regular and automated control of key business data, such as revenue collected and the calculation of losses. Also there will be enhanced system performance, and improved information flow.
- Reduced operational costs associated with supporting the systems associated with efficiencies in system data management.

Benefits of the end-state interventions:

- Lower cost to develop future integrations, resulting from reuse of interfaces and the ESB as opposed to expensive and repetitive point-to-point integration as it is currently the case, reduced long-term investment resulting from significant reuse.
- The ESB will allow EDM to easily scale in delivering future requirements, based on standards based integration and reuse of interfaces. This will also be of lower cost to deliver future business requirements as there is significant reuse.
- Reduced enterprise Risk and improved management and control of the EDM systems, architecture, and introduction of new systems. EDM is significantly impacted every time a new systems is introduced, because there is no process to “integrate” into an EDM architecture. An ESB ensures that EDM determines the end-state solution not the vendor.
- Centrally managed integration with easy tracking of SLAs and system performance.

## **Action Plan**

Immediate Interventions:

- Create an EDM Technical System Integration team that can effectively manage the existing enterprise systems integration.
- Resolve existing system integration problems using the EDM technical team as well as the vendors for the problematic systems, namely 3E, CMS, and the MDM. Make sure EDM’s team is part of this process to ensure knowledge transfer
- It is critical that the EDM system integration team, Jointly with these vendors produce design documentation and specifications for all the business critical interfaces

- Formalize an SLA specification between the following systems: the MDM and the CMS, the 3E system and the CMS, this includes enhancing the solution to collect additional data that allows the SLA for the specific interfaces to be effectively managed and for the EDM team to effectively support the day-to-day operations.

End-State Interventions:

- Define an EDM appropriate System integration strategy according to the desired maturity and business needs. In the strategy definition process, EDM must take into account the following points:

- **Maturity Assessment:** The maturity model illustrated below captures the key elements of an SOA a maturity curve, it sets out the building blocks for EDM’s maturity road map.

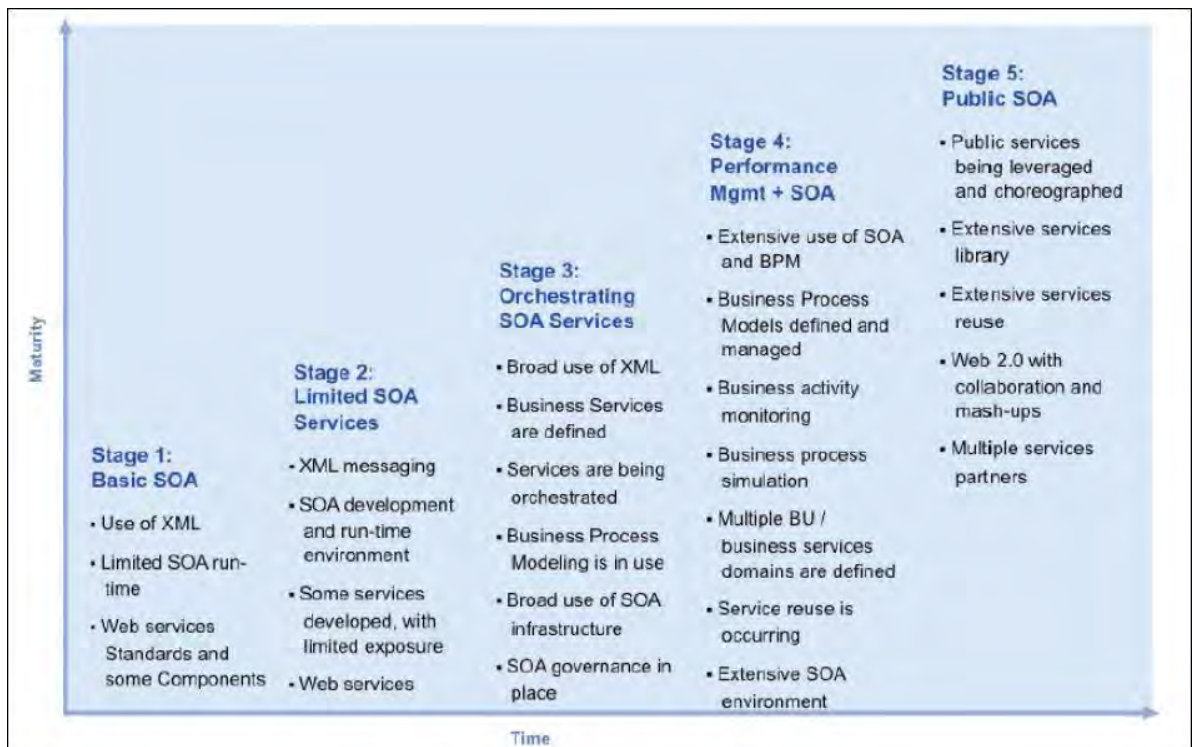


Figure 40 Maturity Map for System Integration

- **SOA Capability Framework** shown below allows EDM to select what capabilities patterns, principles, functional, and non-functional capabilities are required for EDM to successfully implement the ESB. However, this implementation is a journey whereby only the key elements are initially selected and implemented. This prioritization of certain capabilities is typically driven by the desired SOA maturity discussed previously.

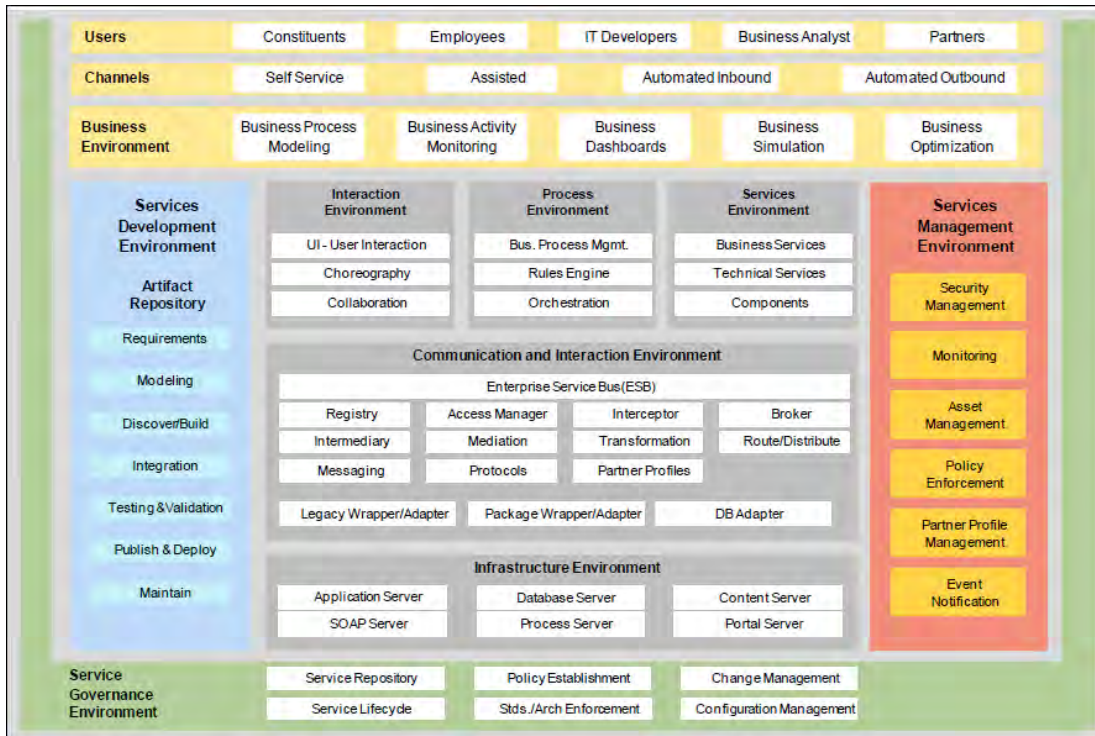


Figure 41 SOA Capability Framework

- **Define the EDM SOA Road Map and Business Case:** Which will set out the journey of what will be built and the accompanying business case that justifies the cost/benefit and the prioritization of EDM interfaces
- **Select the Fit for Purpose SOA Technology Platform:** After EDM has successfully designed how it will implement the ESB within a SOA framework, justified the target business value and has setup the EDM the System Integration team; it is recommended that EDM then select the purpose fit ESB platform through a RFP process. It is recommended that this RFP should be issued to the market for the following key scope areas: the technology product, the implementation, and building internal EDM capability to support the new technology. It is critical for the selected vendor to help develop the EDM system integration team in order to support and operate the new technology.
- **Implement the ESB with Only a Selection of Interfaces:** the implementation should start with a small phase whereby an initial set of interfaces are integrated using the ESB platform. This will help to minimize the risk failures and impacting business critical processes while allowing sufficient time for the EDM organization to mature and build the internal capabilities within the proposed EDM system integration team to support this new solution. Subsequent implementation phases should integrate the remaining business critical interfaces once the organization is mature enough to deal with the new technology and the change.

## Resources

Immediate Intervention Resources:

- To ensure that current integration problems are properly addressed, EDM should create a dedicated system integration team. This specialized team should develop in-depth knowledge on: the existing integration points, EDM's technical architecture, the system integration SLAs both internally and externally, and all the documentation required to support them.

End-State Intervention Resources:

- As per the resources in the intervention above, EDM must create a technical team dedicated to effectively manage the systems integration. This includes existing as well as new integration processes.

EDM needs the system integration specialists to design the system integration strategy and design the appropriate road map.

## 4.8 ESTABLISH A POLICY FOR HUMAN CAPITAL

### Problem Statement

EDM employees form a vital resource and must be valued, nurtured, and retained. Employees are the most valuable assets and truly the EDM backbone. They contribute towards the success or failure of EDM, regardless of the latest technology in place.

EDM lacks on a policy that is aimed to maximize the potential of the workforce and provide the structure for linking individual goals to departmental and organizational goals through the objective-setting process.

Additionally, it was identified that rewards based on individual performance indicators are no longer in place. This includes incentives to promote efficiency using a bottom-up strategy.

### 4.8.1 TRAINING DEVELOPMENT

#### Description

While training is a program that helps employees learn specific knowledge or skills to improve performance in their current roles, development is more expansive and focuses on employee growth and future performance, rather than an immediate job role. This training development focuses on developing the members of staff that have an impact in the EDM losses.

This includes the development of methods of work to be standardized by EDM and the training to apply these methods.

Furthermore, see below the approach for the training development:

Principles	Description
<b>Customized, Role-Oriented Training</b>	<ul style="list-style-type: none"> <li>• Curricula will be designed to meet the needs of specific roles based on EDM processes and systems related to revenue and loss reduction. It provides the conceptual framework with function-specific, task-oriented practice.</li> </ul>
<b>Just-in-Time</b>	<ul style="list-style-type: none"> <li>• The philosophy enables the right people to receive the right information and training at the right time.</li> </ul>
<b>Need-to-Know Approach</b>	<ul style="list-style-type: none"> <li>• Employees expect to apply immediately what they have learned to their specific job responsibilities. The philosophy is to match required training to specific job roles, present training in small, manageable components, and focus the training on clearly stated goals and objectives. Loss reduction experts will be utilized on the review of the courseware and to deliver the training to provide the highest quality and enhance knowledge transfer and adoption.</li> </ul>
<b>Incorporation of Adult Learning Principles</b>	<ul style="list-style-type: none"> <li>• Because people generally learn best from actually doing a job, employees will have the opportunity to complete hands-on exercises. There will be adult learning principles in use to help guide the training design and development efforts.</li> </ul>

**Table 18 Training Development Approach**

## Impact

- **Greater Productivity:** A well-trained employee usually shows greater productivity and higher quality of work-output than the untrained employees. Training increases the skills of the employees in the performance of their tasks. An increase in the skills can help EDM to increase both quantity and quality of output.
- **Uniformity of Procedures:** With the help of training, the processes and procedures can be standardized and made available to all employees. Standardization can help EDM to make high-levels of performance rule rather than the exception.
- **Less Supervision:** If the employees are given proper training, the responsibility of supervision is reduced. Training does not eliminate the need for supervision of the EDM operations, but it reduces the need for detailed and constant supervision.
- **Creation of Inventory of Skills:** When totally new skills are required by an organization, it has to face great difficulties in employment. Training can be used in spotting out promising EDM employees and in removing defects in the selection process.
- **Higher Morale:** The morale of employees increases if they are given proper training. This includes greater cooperation and loyalty by molding EDM employees' attitude to achieve support for organizational activities. With the help of training, dissatisfaction, complaints, absenteeism, and turnover can be reduced among the EDM employees.

## Action Plan

To ensure a successful development and implementation of a training development program, EDM must take the following steps:

- Strategic training plan: identify long-term (5 years) business needs and skills in terms of human resources and technologies in order to develop a training strategy accordingly.
- Identify Business Impact: Design and develop the training program to meet the EDM's loss reduction goals. Keeping business goals in focus ensures training and development make a measureable impact.
- Skill Assessment: Identify what are the gaps between EDM employees' current and ideal skills required. This gives the ability to better pinpoint what specific training needs and programs can be available to the employees.
- Layer Training Methods: The most effective training programs use layered, sustainable learning activities to create performance improvement over time. A layered approach ensures that the program targets the most essential employee, customer, and business needs, while training the right people at the right time in the right way. A layered approach is very useful because it blends learning experiences and training methods that maximize the benefits of the training program.
- Evaluate Effectiveness and Sustain Gains: EDM employees need for training and support does not end when they return to the job. In fact, continued support makes that initial training stick. Measureable learning objectives are the foundation to evaluate an initiative's impact.

## Resources

The training development program should be developed by EDM and a specialized team in loss reduction programs. The team should focus on training the operational teams, as well as staff performing administrative roles that impact the commercial losses at EDM.

### 4.8.2 REWARD PROGRAM

#### Description

A reward program is a tool used by employers to effectively attract, retain, and motivate employees. The program offers incentives (rewards or recognition) in exchange for work performance. It must promote or encourage specific actions by a specific audience to produce measurable outcomes through integrated motivational strategies during a defined time period. This reward program should target the Commercial Department to help reducing losses.

#### ***Common Structures of Incentive Programs***

Based on the common bonus structure, the international practices are stated below:

- The payment is made once a year.

- The value of the bonuses depends on the EDM results and individual performance of the employees. Generally, both evaluations are defined by a set of objectives and targets, where part of them are strategic EDM indicators and applied for all the employees, part of them are department indicators and applied for all employees of the department and part of them are individual indicators of each employee.
- The value of the bonuses is established in number of salaries or percentage of the annual remuneration depending on the individual evaluation of each employee and this range can vary depend on the position of the employee.
- Some utilities use a more simple structure that is a fixed bonus per position in the company for all employees and apply over this value the same percentage of the company target reached out, it means, if the results reached out were 70% of the predefined the employees will receive 70% of the bonuses also predefined.

## **Impact**

- Increased levels of staff productivity: reward programs help employees to motivate themselves to higher achievement levels by attempting to reach pre-established goals such as the losses reduction. This results in an increased EDM performance and operational capability.
- Loyalty: Employees who have the ability to positively impact their earning potential through reward programs are more likely to be loyal to the company they represent. This can contribute to the longevity in the professional relationship between EDM and its employees.
- Reduced Turnover: employees often look for new employment opportunities when they feel they are under-compensated or unappreciated. The reduced turnover results in time and money savings for EDM to recruit new professionals.
- Collaborative Efforts: When employees work together on team reward plans, they establish a sense of camaraderie, pulling together for the common good. It can also enhance regular work relationships between EDM departments and coworkers.

## **Action Plan**

EDM must consider the following elements when developing a reward and recognition program:

- Gain a complete understanding of the current performance environment, and identify the primary causes of performance shortcomings that lead to losses
- Substantiate EDM business priorities and determine where incentives will have the greatest impact within the commercial departments
- Explicitly identify what needs to be accomplished and why that is important (to EDM and its employees)
- Ensure consistency with the EDM's vision and values
- Confirm that results will be measurable and objectively evaluated
- Evaluate EDM capabilities to provide incentives
- Structure a system to monitor the employee performance a link it performance needs, analytics, career management, and incentives management



## Resources

The board should define a percentage of their budget (i.e., 5%) to allocate for bonus and reward incentives to EDM employees based on performance and annual strategic targets (including loss reduction targets).

## 4.9 DEFINE A POLICY FOR COMMUNITY EDUCATION

### Problem Statement

EDM has no education work for the safe and adequate use of energy in low-income communities where it is most difficult for people to pay for energy.

### Description

The utility's presence in low-income communities, where there are often problems with illegal practices to steal energy or difficulties for paying for energy, is very important to be for the utility to be aware of the problems and together with the people of the communities to seek for solutions.

Engaging people from low-income communities in finding solutions to problems has been the most effective mechanism to combat energy losses in these areas, and on the other hand, it helps to strengthen the company's image as a company that is concerned about the situation of these families and has negotiated with the communities a sustainable solution.

As it is a process of building trust, the results usually appear in the medium term; however, they are fundamental to make the business feasible in these areas in the long term.

As this is a negotiation process, EDM needs to define what it can offer to low-income communities, such as, a door-to-door educational work where EDM helps families to take action to reduce their energy consumption and acts proactively to provide support in solving problems of these communities.

The most common actions that are offered to these communities to support educational work are generally as follows:

- Energy efficiency actions with replacement of incandescent lamps by LED and others
- Distribution of educational material with important tips for the families of the communities, such as, how to organize the family budget, health care, education of the children, healthy food, etc., in order to contribute to the quality of life of the people
- Partnership with public sectors and other private companies in order to bring to the communities employment opportunities, vocational training courses, opportunities to participate in sports or cultural events, etc., in order to contribute to the socio-economic development of communities

Contrary to what many people in utilities think, this kind of work is not a typical government assistance work, but rather a business strategy that aims to strengthen the image of the utility in the communities and seek to act proactively to assist socio-economic development of the communities as a way to better the macroeconomic conditions of these areas in order to reduce the probability of theft of energy.

## **Impact**

Some utilities around the world that have structured this type of work and maintained it for several years have managed to reduce energy theft in communities by up to 70 percent, as well as, valued the utility brand and opened up conditions for other opportunities.

## **Action Plan**

Create teams to periodically visit communities, after being adequately trained, with the purpose of visiting the families to understand their habit of energy consumption and their difficulties with EDM and to bring useful information to these families, as well as, to seek solutions for the problems of communities.

These teams may also performing visual inspections to identify inadequate conditions and report the problems to coordination of the action plan to combat losses.

It is not uncommon during the visits in the communities, especially after the trust is built, people tell spontaneously their practices to steal energy, and in this case, these EDM teams can help guide families to avoid such practices.

## **Resources**

The ideal condition is that EDM to prioritize in advance which communities should receive this educational work and structure a sufficient number of teams to make at least two annual visits to these communities, and also, make visits when requested by community leaders when there is a problems.

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