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MANAGEMENT OF POWER LOSS REDUCTION PLAN FOR DISTRIBUTION SYSTEM IN YANGON AREA, MYANMAR

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ABSTRACT

Power loss reduction initiative in distribution systems leads to reduce the cost of energy purchase and increase the distribution infrastructurers' capacities. Therefore it is a vital objective in the sound management of Yangon Electricity Supply Coporation. This paper deals power loss reduction in distribution systems with respective diagnostics and implementation of power losses reduction plan in yangon area in myanmar. The power loss is needed to reduce to acceptable level even though there is no data automation control (DAC) system in distribution system. In this paper, some information is based on experiences of planning and implementation of loss reduction and power improvemet projects that had been planned in Yangon area. This paper has proposed the effective technique and active analytical management approaches for the loss reduction plan and development of action plans to solve the power losses in the Yangon distribution system.

Keywords: Distribution System, Management, Power loss Reduction, System Improvement (SI)

I. INTRODUCTION

Yangon is the largest city in the country with a total area of 10276.71km^2. Its population is estimated to be over 7.3 million or almost 14.3% of the country's total population. The population density is 716 people per square km [1]. The Yangon city is divided into 55 townships, and there are many business and industrial areas scattered around its downtown district. There was the public demonstration with candles at night because of shortage of electricity in May, 2012 [2].In the present day,there is no shortage of electricity since there is an increase of thermal power generation in Yangon area. But reducing technical & non-technical losses is currently an imperative requirement for Yangon Electricity Supply Cooperation (YESC), supplying the electricity to the whole Yangon city, since nearly 20 % of losses can actually endanger the financial status of YESC. The high rate of power losses causes a reduction in revenue resulting in all the ensuing economic consequences, costly, useless investments and poor quality of service offered to customers.They are willing to conduct energy distribution process to reduce technical losses and customer management process to reduce non-technical losses. The reasons which currently cause the distribution losses are poor infrastructure, namely lack of renovation and modernization, overloading, poor maintenance and repair, lack of capital/ investment, low efficiency and

obsolete technology.In this paper, the proposed technique/methodology is for the analysis of problem solving of the loss reduction and for the development of action plans to solve power loss problems through a systemic approach.

II. DISTRIBUTION POWER LOSSES

The transmission and distribution losses are generally as high as 20 to 30 percent of total power generation. Therefore the challenge is more pronounced in case of distribution systems. Basic reason is that the distribution systems are operated at much lower voltages as compared to transmission systems [3]. The distribution losses or total loss in Yangon is classified into two categories, namelyTechnical losses and Non-Technical Loss (commercial loss). Technical losses are generally the sum of load losses in line and, load and no load losses in the transformer. Non-Technical losses often arise from users tampering with electricity meters and inefficient billing system. Fig.1 shows the variation of losses in distribution system in Yangon. It is made the some efforts for reducing loss since 2006, leading to the distribution loss reduced by about 5% from 24.1% in 2006 to 19.3 in 2011. Today, less than 20% of receiving electrical energy of Yangon is lost between sending ends (Thermal Power Plants and Main Substation as the entrance of Yangon region) and receiving (customer) ends.

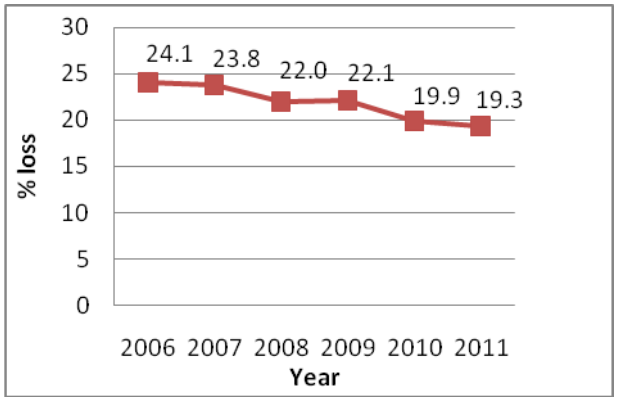

Fig 1.Variation of Losses in Distribution System in Yangon

III. TECHNICAL OPERATION AND NON-TECHNICAL LOSS MANAGEMENT

The problem of power losses is illustrated as shown in Fig.2, explaining the functional process and the losses appeared at each state of the technical and Non-Technical (commercial) management in Yangon. The amount of energy (A) is purchased, which needed for the customers' demand (B) in Yangon region. The objective is to manage this energy and see how to convey to each customer effectively. The financial resources come from the energy billed (C) to each customer (i. e the product actually sold) and effective payment of the bills, the amount of energy (D) indicates in the bills collected. According to this figure process, energy A received by the distribution system is practically higher than energy billed C to customers , and the energy billed C is also higher than energy paid D which is effectively paid. The interest is therefore to reduce distribution system losses. In this paper, the voltage level considering the distribution losses is up to 66kV network voltage level.

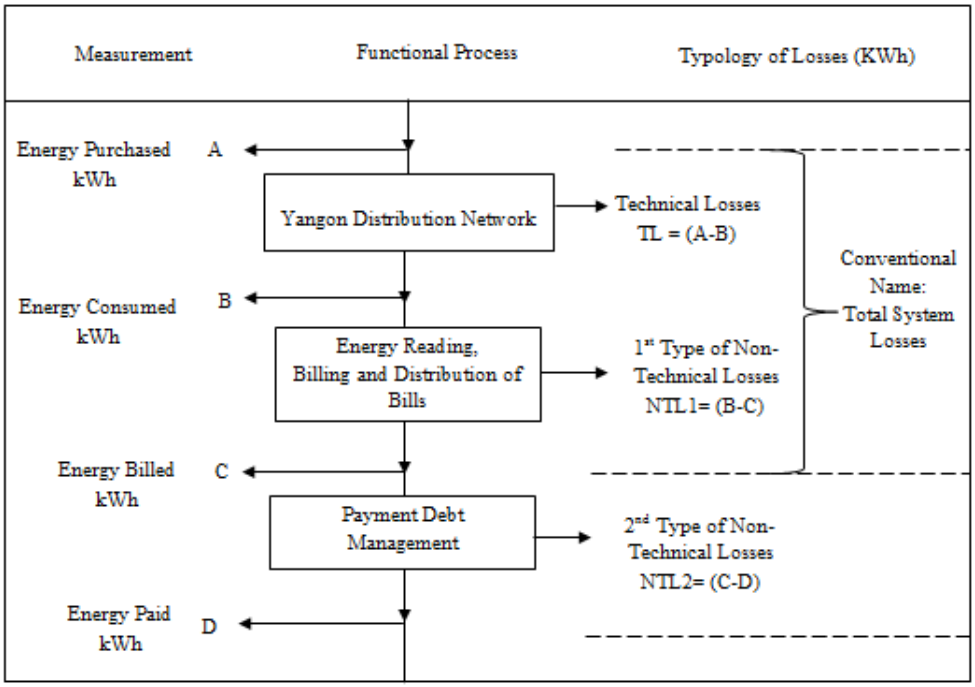

Fig 2.Technical Operation and Non- Technical Loss Management [4]

In figure 2, the non-technical losses or commercial losses (NTL1) result from unbilled energy related to actually consumed energy, but not recorded or inaccurately recorded in the distribution billing system. NTL1 losses depend on the deficiency of the billing system. NTL2 losses are unpaid energy losses as the absence of payment or a delay in the payment of bills issued. Some customers take electricity illegally by direct connection to the distribution lines. It is also counted as commercial losses. These all non-technical losses directly depend on the quality of the customer management chain. In order to reduce the system losses, the following three means of actions are taken:

- Checking the purchased energy amount (A) necessary for demand (B) from Myanma Electric Power Eneterprise (MEPE) and Independent Power Producers. To achieve this, it is needed to manage for designing and operating the power distribution network in a technically optimal way to reduce the losses to a minimum acceptable level with respect to physical phenomena.
- Maximizing billed energy (C) : it must manage for designing and operating a customer management system to assess the energy consumed by customer , to bill it accurately and add up the total amount. A customer forgotten or not billed , leads a financial loss.
- Maximizing paid energy (D) : To achieve this , it must manage to monitor the payment of bills, conduct actions to compel defaulters to pay as quickly as possible so as to reduce unpaid energy to a minimum. For example, in Yangon they are fined Ks. 2000 (equivalent to 57% of cost of basic level of 100 electricity units for per day late till one month), otherwise after one month electricity may be cut off.

IV. POWER OUTAGE RECORD MANAGEMENT

The data on power outage records have to be analyzed to consider which township needs the facilities measures from the perspective of fault. According to [5], the interruption of the outage records indicates that the overhead

distribution lines fault is the most frequent cause of power outage and load shedding was also the major case in June, 2013. This showed that the large number of facilities is 33kV distribution lines and 6.6kV or 11kV distribution lines. Fig.3 shows the frequency of power outage by fault at each voltage level.In figure 3, the fault of overhead lines accounts for the substantial proportion of the causes for fault. The frequent use of bare wires for overhead lines has caused a number of short-circuit and grounding faults due to a contact with trees or other wires.

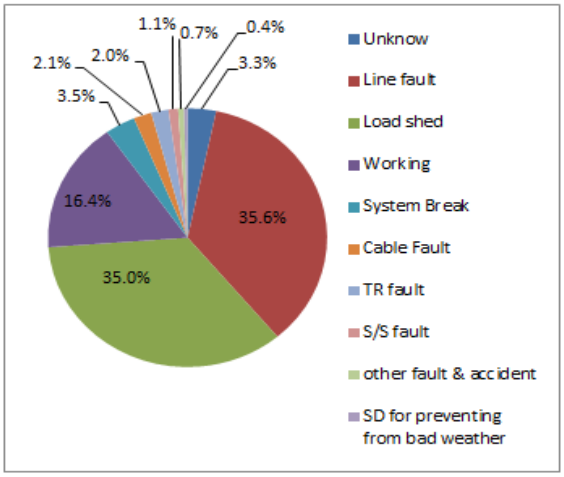

Fig 3.Proportion of Causes of Power Outages (Number of Times)

The number of times of power outage by fault can be reduced by covering lines. The power outage recorded includes power outage by fault, by planned outage and by shut down work. In June 2013, Load shedding was the extremely large fraction of the number of times. This resulted from failure to generate full power due to the smaller precipitation in June than other years, leading to the insufficient amount of water reserved in the dams of hydropower stations. Townships (Seikan and Dagon Seikan) showed the large number of times and longer duration of power outage by fault because of smaller facility capacity. It is due to less number of feeder as well as distribution substations. As this is dependent on the power source capacity, it was expected to improve the power generation facilities that need to cover demands in Yangon. This means Yangon was dependent on hydropower even though where there are four thermal power stations, but hydropower stations are far away from Yangon. The sites with the frequent fault records were picked up in the current distribution networks to develop the priority investment plan. Therefore, as generation side, new GT as well as STG around total 390 MW, were also reinforced in Yangon area in 2014 to generate electric power in order to fulfill the demand of Yangon. Now it can reduce the load shedding in Yangon area.

V. CUSTOMER POWER CONSUMPTION IN DAILY LOAD CURVE

The daily load curve of a system is not the same for all days. It differs from day to day or season to season. It gives the load variation during different hours of the day and the peak load indicated by the load curve gives the maximum demand in the system. The area under the load curve gives the total energy generated in the period under consideration. The total energy generated divided by the total number of hours gives the average load. The ratio of the average load to the maximum demand gives the load factor. In practice, Load curve is not a flat load curve. For a flat load curve, the load factor will be higher. Higher load factor means more uniform load

pattern with less variations in load [6]. It is desirable from the point of view of maximum utilization of associated equipment which is selected on the basis of maximum demand.

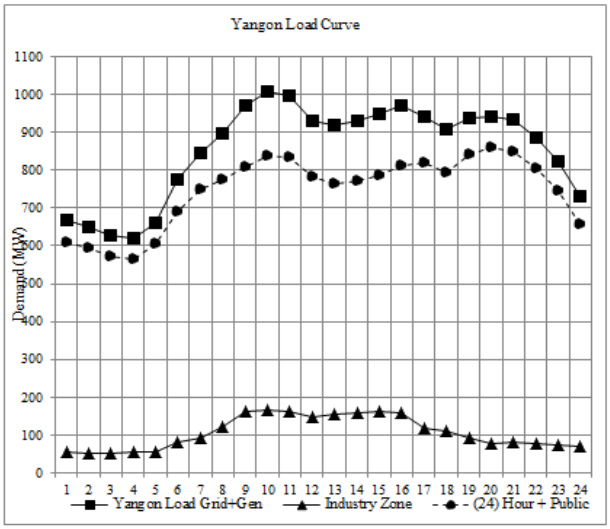

Fig 4.Hourly Different Load in Yangon on April, 2015 (with YESC Permission)

The typical load patterns are normalized by the daily peak power demand in summer season as illustrated in Fig. 4. Normally it is found that the two peak loading for 24 hours and Public customers occurs in the morning (between 9 hour and 11 hour) when people usually cooks their foods and the commercial and industrial business start, as well as at night time period (between 19 hour and 21 hour) whenpeople stay at home with high loading percentage of air conditioners and other home appliances. For industrial customer class, the power loading increases dramatically during the day time business hours because of the continuous manufacturing process. The peak loading of the total Yangon load reaches 1005.7 MW at 10 hour in the morning while the off peak loading is only 621.8 MW at 4hour in the evening. The peak loading of the industrial power consumption is 167.06 at 10 hour in the morning. This typical load can effectively represent the load behavior of total customer population.

After studying the daily load curves, the power load consumption of each district or that of each township can be calculated. After comparing the power consumption with the distribution facilities' capacity, the future project plans are estimated.

VI. DISTRIBUTION SYSTEM IMPROVEMENT (SI) PLAN

The maximum demand of the Yangon distribution network is around 900MW (about 60% of the national demand) as of June 2013 and the power generation capacity nationwide is around 1500MW. During most of the 2000s, the Yangon City showed about 4% annual growth in power demand (GWh). With the prospect of political reform since 2011, a huge wave of development and investment began. Power demand also surged. From 2009 to 2010, the growth rate was 30% strong. Followed by 20% in fiscal year of 2011-2012, and 6% in 2012 -2013. The basic trend is forecasted between 11 % and 16% [5].Therefore,townships as well as head departments must make a yearly plan or 5- year plan or 10 year plan etc. Mostly a yearly SI plan is drawn up for System Improvement and Loss Reduction. In Yangon the reduction measure projects are yearly carried to reduce the technical loss:

- New substation planning and network configuration
- Upgrading and Reinforcement of 66kV Substation
- Upgrading and Reinforcement of 33kV Substation
- Installation of 66kV UG cables and OH lines
- Installation of 33kV UG cables and OH Lines
- Installation of 6.6 kV UG cables and OH lines
- Installation of 11 kV OH lines
- Installation of Capacitor Banks
- Installation of 0.4 kV UG cables and OH lines

Maintaining jobs for emergency cases, replacing jobs for broken poles with concrete poles, changing with Insulated Wire projects, Transformer Maintaining projects, Maintenance projects for Substations and SI projects in townships.

VII. NON-TECHNICAL LOSS REDUCTION

Non-Technical Losses are mainly related to electricity theft and customer management processes in which there exist a number of means of consciously defrauding the electrical utility concerned [7]. In Yangon area, the most portable causes of NTL are:

- Tampering with energy meters to ensure the meter recorded comparatively lower consumption reading
- Tapping of wires on LT lines
- Errors in technical losses computation
- Arranging false readings and ignoring unpaid bills by bribing meter readers
- Errors in accounting and recording meter reading and billing

Metering System Improvement Plan is first priority for non-technical loss reduction measure in Yangon.

7.1 One Phase Two Wire Metering System Improvement Plan

The measures are being conducted to reduce the non-technical loss, namely replacing old electromagnetic energy meters with digital meters (Offsite meter reading system), controlling on theft of electricity by laws, inspection

meters monthly and customer-friendly orientation. This issue is considered as a vital problem to be solved. With the possible cases of unauthorized connection to random bare wires, various countermeasures were being considered by sharing the cases of unauthorized power reception and performing visual inspections by the meter reader or by installation the digital measuring instruments of the offsite meter reading to be mounted to the power poles at the structures. In South Division in Yangon, single phase two wires OMR meters, nearly 25000 meters, were first introduced in place of old analog meters in 2013. There was generally 5 % loss reduction in each township than before. Fig.5 shows Offsite meter reading mounted on a pole.

Fig 5 Installation of 1 Phase 2 Wire Offsite Meters Mounted on a Pole (with YESC Permission)

In Yangon, one of the pilot Projects in Hlaing Township had been tried in 2012 for Automatic Meter Reading (AMR) System that is provided with a transmitter/receiver module and it had to change LV bare conductor with Arial Bundled Cable (ABC) Conductor. In this pilot project, 447 digital electronic meters were replaced in the place of old analogue meters under feeding of 6.6/0.4kV, (315) kVA. Meters can be read via GSM (Global Service for Mobile Communications) by using internet. But the facing difficulty is that internet services have not yet developed in Yangon. Replacing the whole LV distribution system with ABC wire and AMR smart meters leads to investment is high even though the losses reduced from 26 % to 3.6 %. Total material cost was estimated $ 55649.95 for this project. Therefore it has to do an optimal cost analysis to develop AMR System.

7.2 Three Phase Four Wire Metering System Improvement Plan

New customer- metering investments can enhance the performance of distribution systems. The traditional meters have been used strictly for billing purposes. In the traditional paradigm, meter readers visit customer premises and manually read electromechanical energy meters (kWh meters) that measure electric energy consumption. These meters are no longer economically available in the Yangon Division, having been replaced by digital electronic meters, but many electromechanical meters are still in use today. Digital electronic meters can more easily store and communicate energy consumption as a function of time. Offsite Meter Reading (OMR) System has enabled distinct new approaches to data capture and management with respect to customers' consumption. In OMR System a meter reader go the site and then read meters far away 300 m with Hand Held Unit (HHU) in which short-range radio –frequency signals is used. In Yangon 433MHz is used for Radio OMR Meters. This means that non-technical losses is tried to mitigate by education workers on how to detect signs of meter tampering and installing offsite meter reading (OMR) devices that read energy consumption information remotely from electricity meters. By installationOMR meters, the wrong wire connection,no load condition and tempering status can be checked. This system is used where the power consumption is very high such as commercial industries and cold industries. But these efforts have been met with limited success.

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VIII. INVESTMENT PLAN FORMULATION AND IMPLEMENTATION

The load requirement of an area depends on its physical land features, its population and living standards, its present development plans, future development plans, cost of power, budget allocation etc. [8]. In Yangon, the new loan projects are needed to essentially be selected by following the flowchart process after all conditions of facilities (e.g., current facility operation rates, fault records, demand forecast, distribution network plan, environmental and social consideration etc.) are surveyed. The individual projects in the 5-year distribution network development and loss reduction plan, and latest investment plan can be developed to deal with overload, demand increase, voltage drop, and supply to important distribution facilities according to the statics of survey on current facilities conditions. The new projects depend on the demand record in the previous and the alternative demand forecast. Fig.6 presents the formulation and Implementation of an investment project plan for Yangon distribution system.

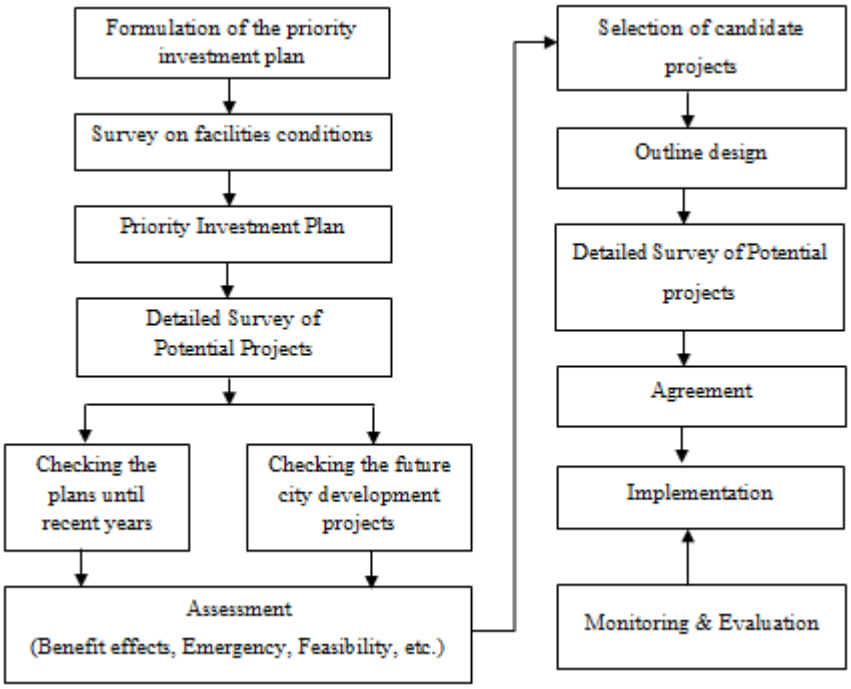

Fig6.Formulation and Implementation of an Investment Project Plan [5]

The following basic concepts can be concerned for improving the distribution networks facilities while conducting the formulation and Implementation of an investment project plan:

- Measures against overload of facilities
  (Strengthening sub-transmission and substation system, thereby the supply load will not exceed installed capacity)
- Reduction of Power losses
  (Improving distribution facilities, thereby the supply load will not exceed installed capacity)
- Measure against troubles
  (Improving distribution facilities, thereby they will not cause troubles)
- Capacity building (Improving Capacity building of engineers, they can judge which is profit or loss)

The investment project plan has been also implemented on a priority basis for Yangon distribution System:

- Medium and long term substation expansion plans
- Distribution System expansion plans
- Replacing and upgrading the distribution facilities in order to reduce loss and failures in distribution lines

IX. TRAINING FOR ENGINEERS

In some developing countries, employees' performance capability is needed to enhance capacity building improvement and most of distribution engineers have to know how to run business in a better manner and how to reduce losses. With regard to system upgrading and configuration, technical loss reduction, control on theft of electricity, consumer - friendly orientation, establishing commercial viability of the distribution business, information technology to replace human interface to the extent possible, the engineers should have the know-how to formulate power distribution network and substation reinforcement plans with respect to the efficient operations of substations and distribution lines and to minimize the effects of faults and power distribution loss. Furthermore engineers should also know how to manage the non-technical loss reduction measures and the latest news about distribution infrastructures. Therefore, the education and training need to support by cooperation with the projects or by on-job training at vocational training center. The following are the institutional profits for distribution engineers by cooperation with the investment projects:

- Enhancing the know-how of administration work necessary as an administrator of substationmaintenance works or construction works by learning through practical trainings
- Enhancing the engineer's skills, such as planning, designing, administrating construction works, and inspections, necessary when implementing distribution related projects
- Strengthening the engineer's capability of planning works so that one cope with the large amount of the distribution line works
- Strengthening the engineer's ability to educate workers through on-the- job training taking advantage of construction works
- Acquiring abilities to grasp the entire description of work of the projects and create systematic constructionplans for reducing the frequency and areas of service interruption resulting from substation and distribution line work
- Acquiring in-machine control and learn how to use and store the data of equipment (e.g., transformers, low-voltage lines, meters, customers, etc.) of substations. Distribution lines and distribution facilities when the construction is completed by following the renewal of facilities.

X. LOSS REDUCTION PROJECT AS TOWNSHIP WIDE

During the loss reduction projects plan, the main items to be conducted [9] are:

- Measuring and evaluating the losses with respect to technical, economic and accounting nature.
- Diagnosis allowing to determine the level and the origin of the losses
- Recommendations for proposing the actions to be undertaken to reduce losses to a tolerable level

- Implementation of tried methodologies, resulting in the drawing up of a schedule of actions to be carried out and mark out the project
- Determination of the economic profitablility criteria for the choice of the proposed actions
- Constitution a precise management system such as finicial and institutional terms
- Implementation of a maintenance program to maintain the results obtained

In Yangon, the Losses Reduction and improving the energy efficiency project has to be carried out as a feasibility study in two townships, namely Insein and Shwe Pyi Thar. A compressive approach for distribution loss reduction built on three aspects such as people, technical and management. In order to reduce losses reduction, people should have willing to do these tasks, namely problem solving methodology, Root cause Analysis as measurement, idea generation and work plan for priority and Implementation (Action and report). In every reduction losses business process, every engineer working for any distribution company should have knowledge of management as Key Performance Indicator. Therefore, the training system has to be set up for developing awareness and desire to reduce losses.

As technical aspects, the following project process was carried out;

- Availability of Distribution Asset Data Base (including meters data base)
- Smaller transformer capacity for low density area and more LV feeder for each transformer
- Mechanical connectors for better wire connection
- Balancing transformer loading
- Attention to voltage level at end-points

The loss reduction project steps are briefly described in the following:

Step 1. Field survey for fact finding

In Yangon it is needed to find out the needs and problems of electricity related to improving energy efficiency and reduce losses, Fact Finding activities includes;

- Understanding the business process of YESC relating to power delivery
- Understanding the root of the problem/ root-cause of losses

Step 2. Diagnosis Phase

In the diagnosis phase, data collection operations are involved regarding a loss reduction project. The technique of data collection covers following activities as a Root Cause Analysis and Solution (RCAS);

- Face to Face interview and discussion with head of office, engineers, staff officers (Finance & Admin) about the process of township office.
- Visiting Field condition directly and sharing data within project areas

According to the results of these activities, several opportunities for improvement of distribution delivery system can be taken. These opportunities are;

- To develop business process for billing system
- To develop customer handling system
- To improve meter reading system
- To improve service voltage to customers
- To improve LV distribution network connection

- To improve the balance of load transformer
- To improve the clearance of the network from the trees

Step 3. Idea Generation or Brainstorming

Based on the several opportunities, the management teams have to discuss to generate a variety of new approaches or solutions for the facing loss issue in distribution system by suggesting many different options and suggesting an existing concept.

Step 4. Prioritization

In this phase, each team work has to decide/ determine what activities should be carried out regarding to ease of implementation and economic aspects to provide optimal results of loss reduction. By choosing activities intelligently from "wish lists ", it can make the very most of time and opportunities , considering background information, subsequent events, the responsible parties, costs and impact emerging and ease of implementation.

Step 5. Implementation of Work Plan

To manage the implementation of the ideas that has been defined, a work plan can be created. The work Plan includes two parts: work development (e.g., administrative work) and work deployment (e.g., changing meters, replacing connectors and pruning tree, and load balancing of distribution transformers.

Step 6. Monitoring and Evaluation

It focuses on what we have done according to work plan, on what we have achieved and how we accomplished that work plans. Through monitoring and evaluation, the progress of the work plan can be reviewed, problems can be identified and adjustments or correction of activities (if there is any problem or difficulty) can be made. In this stage,management teams are always on the track. This monitoring and evaluation model makes sure the achievement of the target at the top level.

Step 7. Implementation Results

The management team work carry out the following tasks;

- Connection Repairing

  (To improve the quality of service voltage at end user by replacing/ fastening connector)
- Load Balancing

(To reduce significant neutral current)

- Meter Checking

(To check '0' unit energy consumption, too small energy consumption, unstable usage style etc.)

The result of above implementation of losses reduction project in Yangon was that average losses decrease 3.28% from average 23.64 % to 20.36% [9].

XI. CONCLUSION

The reduction of losses for distribution system in Yangon is a major priority for YESC as well as for their community. In order to participate financially in the development of the power sector, it is needed to reach an acceptable loss level. Therefore the management can organize the reduction of losses as an actual investment project to be conducted over a period of several years. Management of loss reduction project has to conduct the diagnosis of the existing situation of distribution system, identification of losses and the main causes of losses,

establishment of an action plan so as to reduce the detected losses, implementation of the action plan and follow-up of the results obtained even though distribution andautomation control system has not yet developed. YESC has to not only findto reduce the losses, but also try to continuously achieve reducing losses. This paper recommends the management of loss reduction plan based on the approaches of effective technical and economical view reflected in an action plan for Yangon distribution system. If Implementation work is done according to theproposed plans, it is targeted that the losses of Yangon are to reduce around 5% than the current situation losses.

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BIOGRAPHIES

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