# Improving Guaranteed Minimum Billing Demand for the Reduction of Energy Cost at Rizal Technological University

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## Abstract

*The electrical system design has been installed with greater flexibility to match the connected loads for long period of time. This condition requires greater contracted capacity from electric utility company. The difference between contracted capacity and the actual consumption of power establishes the main source of high electricity bill under distribution cost, and makes the traditional energy conservation techniques ineffective. The high difference between the actual power and the contracted capacity results to a higher cost of Guaranteed Minimum Billing Demand (GMBD), and develop the standby loss in energy bill every month. By using the difference between the actual load and the existing value of GMBD determine the amount of idle power. Distribution charge of monthly electricity bill reduces significantly through recontracted capacity. The improved GMBDs shows an optimum cost of electricity and saves for more than half a million pesos each year in Rizal Technological University.*

*Keywords - GMBD, improving GMBD, effects of GMBD, distribution cost, energy bill, electricity bill, energy conservation, unbundled cost, EPIRA Law, RA 9136, monetary savings, standby loss, potential monetary loss, potential monetary gain, RTU energy bill, MERALCO bill, utility bill.*



## 1. Introduction

Conservation of energy is good but does not mean effective when the electricity bill is concerned. At present, in seven (7) components of unbundled electric bill, the large percentage of energy cost are part of generation, transmission and distribution cost (RA 9136 known as EPIRA Law). Unless, utilization of energy decreases, the customer has nothing to do in reducing monetary obligation every month for generation and transmission cost. However, in the distribution charge, monetary savings will be realized through improved Guaranteed Minimum Billing Demand (GMBD).

Stakeholders of RTU are becoming more aware in efficient use of electric energy. Normally, operating more loads in lightings, small appliances, motors, air-conditioning units and other power equipment increase the supply requirement of electric energy, which results to high electric bills. The administration has developed a program to control and conserve the use of electric energy. Effort has been made to cut and limit the utilization of electricity, which eventually caused a considerable amount of saving. However, despite of the determination by school authority to reduce the amount of electricity bills, still the bill amount each month is relatively the same high. In this study, the analysis for the effects of improving GMBD in the reduction of electricity bill is presented as experience in RTU.

### 1.1. Energy Conservation Background

About 20% of electric energy is intended to lighting purposes for the school setting like RTU. This percentage attracts the school administration to enhance lighting efficiency to reduce the power consumption and thus, energy bills. And so, the approach will be done through replacing types of lights, which consider the location, condition and appropriateness of the lamp.

In the study conducted by Santos, et al [10] had showed of about 45% consumption of electricity in RTU was applied for Air Conditioning Units (ACUs). They suggest that by selecting high efficient ratio with periodic maintenance of equipment would save utility cost and increase the performance of the machine. Further, it was observed that a high efficiency motor reduces the required amount of energy to run. This effective machine has showed significant cost of return that prolongs life and increases the productivity due to maximum tardiness [9]. Also, the significance in the creation of Energy Management is highly recommended for the overall impact in saving electric energy [11].



### 1.2. Problem in Energy Reduction in RTU and Its Solution

Current techniques and methodology mentioned above in reducing the monthly electricity bills were considered part and parcel in the totality of solution. Since, these energy saving practices would only affect directly the generation and transmission cost of the consumed power. However, in the distribution charge, the approach use by RTU is relatively ineffective to earn monetary saving. The actual consumed power decreases due to traditional energy saving techniques. In effect, the difference between the actual connected load and the value of GMBD increases. In such condition, the idle power magnifies monetary losses in the part of distribution charge. Despite of the actual consumption of power is lower than the GMBD, but still the amount of minimum demand at the fixed cost is the basis of charging energy.

The predefined value of GMBD was subjected for the computation of distribution cost. Regardless of the amount saved below the minimum demand (GMBD), the prevailing charge is based on the contracted value of GMBD. The disadvantage was found in the increase of net difference between the actual load and the GMBD due to energy conservation program applied by the institution.

The solution for the holistic approach has presented through improved GMBD. The value of GMBD will calculate to match the actual consumed power based on the 12-month recent electric bills. This computation will optimize the energy conservation methods and realize the monetary savings for electricity bill. The standby monetary loss was eliminated each month. Also, the idle power will utilize by operating the actual connected loads relatively the same or greater than the value of GMBD.

## 2. Review of Related Literature

The increase of electric energy bill is due to different factors. From generation to distribution system, the unbundled cost are collectively added and made significant impact for the monthly energy cost. Details of the parameters are available in the statement of account given by the utility company to their customers. The complex parameters imposed by utility company lead most of the clients from residential to industrial sector to develop a methodology in reducing energy consumption. And so, an optimization in energy usage of RTU renewed continuously to decrease energy demand and derive the potential monetary savings.

### 2.1. Current Practices to Mitigate the Increase of Electric Energy Bill

In general, the unbundled bill has seven (7) parts that shows in statement of the account. These are the generation, transmission, and distribution cost. Also includes system loss, subsidies, government taxes, and universal charges. Based on EPIRA law, the first three (3) of these elements are the dominant factors that affects the percentage cost of energy, which practically taken the total charge of electricity.

Generation charge was referred to the cost of power, which generated and sold to the distribution utility by the National Power Corporation (NPC) as well as the Independent Power Producers (IPPs). The transmission charge was the regulated cost for the use of a transmission system that may include the availment of ancillary service. While the distribution charge was dedicated to regulated cost of building, operating and maintaining the distribution system, which brings power from high-voltage transmission grids, to commercial, industrial establishments, and to residential end-users.

Loads of the RTU are classified in lightings, small appliances, electrical equipment and machineries, which includes air conditioning units and pumps. Currently, the methods of the institution to save the consumption of energy were described into four (4) approaches. These techniques imposed by the administration are (a) retrofitting for lightings with lamp type replacement, (b) acquisition of motors with high efficiency, (c) periodic maintenance, and (d) force conservation for the utilization of electric energy.

Improved lighting efficiency was treated as the simple ways to lower energy bills. The decreased of energy consumption has derived easily by retrofitting and replacing an appropriate types of lamp without sacrificing the illumination level required in the area. Basically for the typical school like RTU, energy consumption for lightings has about 20% maximum. Study conducted by EE faculty group in RTU [10] reported that the estimated 18% of energy in lightings alone would be drastically reduced through retrofitting.

The retrofit technique described by E. Franconi and F. Rubinstein [6] was related to the effects of room temperature. According to this study, the lightings with the decreased of power rating without losing the luminance level had found less contribution of heat and thereby saved the energy exerted by the ACUs in the area. The combination of lighting and heat energy consumption were converted into monetary savings.

Study in lighting controls [7] revealed the significant potential energy savings in commercial buildings. Like the lighting layout of RTU, when the switches and controls are properly specified, installed, and maintained; lightings will be utilized according to its need. Also, the results of the study [1] implied the possibility of identifying general patterns of user control behavior as a function of indoor and outdoor environmental parameters.

Currently, an LED shows aggressive in the market with a decreased in power rating and free from energy loss consumed by the ballast. An LED described the superiority in terms of electrical ballast, lamp operational, system efficiency, and light output. The technology is used an AC/DC converter to emulate the required input impedance for the ballast output, which convert the high-frequency AC power from the ballast into DC power as an LED input [4]. Further, 30% of energy consumption in the building can save in lighting system by using the LED. Study suggested the replacement of the LEDS or O-LEDs (organic-LED) for the existing old lamps. Substantial savings incurred due to good performance of the new develop in lighting application [12].

Acquisition of motor with high efficiency equates to significant cost of savings over the life span of the machine. The increase of more than 20% due to high efficiency has an impact in the performance of the machine in terms of productivity and reliability. Motors found in industrial and commercial establishments were consumed high energy of about 70% maximum in total electricity bill. In the experimental study conducted by R. Saidur [13] that the highest amount of loss takes place at the rotor and stator parts of a motor. It explained that this area can be treated as potential spot for savings by reducing its loss. Also, the study was found that about 75% of motors are operated below 60% and some are 40% of the load. It was further reported that motors perform better when operated of not less than 75% of the load.

Through electronic converter to create variable-speed, the motor efficiency increase remarkably. Study conducted by B.C. Mecrow and A.G. Jack [3] reported the increase in the efficiency of systems driven by electrical machines with 7% reduced electrical consumption. Based on the analysis, despite the high initial cost in investing variable speed drive (VSD), the payback period found relatively short.

The same results confirmed in a comparative study conducted by Slobodan Mirchevski [14], which the cost of electric energy using the standard motor has doubled as compared to high efficient motor. Study was significantly found that under some reasonable condition of the motor, the production affected with respect to the status of the machine [15].

Machine is highly recommended to develop an optimal preventive maintenance policy due to effects of deteriorating system. The prediction in this study explained in a minimal repair for each failure under the implementation of periodic maintenance [5].

The force conservation for utilization of electric energy by RTU has been contributed in saving of power. Elevators that consumed much power were used in special occasions, and those people who have difficulty in using stairs. These relatively large machines are capable to save more energy, and subsequently converted into monetary gains. The ACU's for selected classrooms and administrative offices were run at definite time and fully shutdown in break time. Further, these approaches had considered useful in the conservation of energy for lightings and small appliance loads.

### 2.2. Problems of the Existing Practices in Dealing with Energy Bill



The methodologies used by RTU are only part and parcel in the holistic approach in the reduction of electrical consumption. The above four (4) approaches described were only affected directly the generation and transmission charges. But these techniques are independent in part of distribution charge.

Despite of effort to conserve electric energy through different forms, still the distribution cost was explicitly increased. Since, the current practice in energy conservation focuses only to decrease the generation and transmission charges. Subsequently, the net difference in power increase between the actual load consumed and the value of Guaranteed Minimum Billing Demand (GMBD).

The GMBD is a predefined amount of power based on the total power of the electrical plan, which submitted by RTU to the utility company (MERALCO). In compliance under Section 36 of RA 9136 (EPIRA Law), MERALCO proposed the minimum billing demand to 70% of the contracted capacity or not less than 40 kW for

General Power (GP) and 5 kW for General Service-B customers. In this provision, the utility company approved by the Energy Regulatory Commission (ERC) to recover the reasonable investment made in distribution assets to provide a contracted capacity to a consumer.

In effect as ordered by Energy Regulatory Commission (ERC) that even if the actual demand falls below the contracted level of GMBD, the distribution charge must be based on the kW of GMBD (ERC Case Nos. 2008-004 RC and 2008-018 RC). This rule made the traditional energy conservation ineffective without the adjustment in GMBD. Ultimately, the net difference between the actual load and GMBD translated in a considerable amount of monetary loss in part of distribution charge. This value reflected to the total bill amount each month with large standby losses each year.

### 2.3. Holistic Approach in Conservation of Energy to Reduce Electricity Bill

The value of GMBD depends on the amount of power treated as contracted capacity. An improved GMBD has optimized the contracted capacity based on the actual utilization of energy that affects the distribution part significantly.

At present, studies about the GMBD have found critically unavailable. However, utility company was cooperated with their clients to improve further the utilization of energy in any methods legally. Almost all of the customers of MERALCO were preferred to common techniques in saving electric power. Most of these common methods for power saving have treated only the generation and transmission charges in the electricity bill.

Significantly, the combination of four (4) approaches discussed above and the improvement of the GMBD were considered holistic approach in reduction of power that converts monetary savings.

Study conducted by Cabugayan [2] in energy management and savings ascertained that the equivalent cost of electric supply was not fully utilized. Further, the actual consumption of power represented as the total cost of energy bill with the inclusion of some empirical calculations. These complex calculations ensure the utility company for the return on their investment. However, this non-related energy cost in distribution part has affected considerably the monthly electricity bill.

Importantly, stationary loss was detected on the effects of the high contracted demand. This perpetual loss that converted monetary loss has seized through revision of the recontracted capacity.

Standby losses were eliminated without any investment, which created by common methodologies in the conservation of energy. The monthly electricity bill was estimated low in part of distribution cost through recontracted capacity and the new value of GMBD.



## 3. Methods and Procedures

In recent energy record, the energy meter for ITC and Old Building has operated significantly below GMBD. Subsequently, the institution’s conservation of energy has increased the difference between the GMBD and the actual consumption of power. In effect, the amount charge of power by RTU each month has remained relatively the same.

### 3.1. Profile of the Location Buildings

Three electric utility service meters are installed in RTU and classified as General Power applied in educational institution. The combined ITC and Old Building has a Service Id Number (SIN) 800878201, for the Administration Building given with SIN

800878001, and two collective buildings of MAB and GSRC, which registered as SIN 986305201.

Loads are composed of lightings, power, motors, and other auxiliary equipment. These are typically operated from 7:30 in the morning to 9:30 in the evening. The school has consumed more electric energy from Monday to Friday as compared to Saturday and Sunday. This behavior is due to the presence of combined loads of the administrative offices and classes related activities.

### 3.2. Research Design

The study involved applied research to solve the high electricity bill in part of distribution cost and thereby define the potential monetary savings in Rizal Technological University (RTU).

The data derived from utility company for the year 2012 from January to December electric bills. From this information, the existing contracted capacity for the two service meters and their GMBDs determined. The service meter 800878001 has no record for the demand capacity due to update issue in the account for SIN.

The amount of GMBD determined for the comparison on the actual consumption of power used by RTU. Each of the two service meters installed within the premises are evaluated their electric bill. The differences are computed in terms of kilowatts (kW), which refers to demand capacity and actual power consumed. The net values are analysed to estimate the idle power caused by GMBD. This excess power was used in the computation of recontracted capacity after the new GMBD determined. Since the variation of loads depends on utilization of electric energy with respect to time, consumption of load requires under the proposed recontracted capacity. In this case, the calculation develops for the maximum and minimum values of load factor (L.F.). These values were used in the empirical formula for the new GMBD to prevent the overshoot value of recontracted capacity.

The improved GMBD simulates the monthly bills from January to December with demand charge for the year 2012, and thereby derive the estimated monetary savings.

### 3.3. Statistical and Empirical Treatment

The data was tabulated by month from January to December of 2012. The maximum and minimum values are evaluated using the spreadsheet program for energy consumed, actual load, load factor, and the amount of electricity bill. While the technique applied to measure the central tendency is given by the following expression,

$$\overline{X} = \frac{\sum X}{N} \quad \text{...............................(1)}$$

where the $\overline{X}$ is the arithmetic mean (or average), $\sum X$ for the sum of all elements of the variables and $N$ is referred to the total number of cases.

$$New\ GMBD = kW_{max}\left(\frac{LF_{ave}}{LF_{max}}\right) \quad \text{...................(2)}$$

The equation 2 for new GMBD refers to the recomputed Guaranteed Minimum Billing Demand (GMBD), and the $kW_{max}$ is the maximum actual consumed power by RTU. The $LF_{ave}$ and $LF_{max}$ are referred to the load factors in average and maximum, respectively. The ratio between the average and maximum load factor has predicted to capture the swing of actual loads in deviating further in the new GMBD value. While the maximum consumed power ($kW_{max}$) estimate the probability spike of actual loads to avoid overshoot in the value of recontracted capacity.

The recontracted capacity (RC) in equation 3 expressed as the product of GMBD with an increase factor of 1.43. This expression in kW determined the proposed contracted demand required by the utility company. Further, the calculated value compensates the outright rule by the MERALCO in the application of 70% from the contracted capacity.

$$RC = 1.43\ x\left(New\ GMBD\right)....................(3)$$

The load factor (L.F) defined as the ratio of average and the peak load for the specified period of time. This fraction explains that a system with high load factor consumed relatively constant in power. In contrast, the low value in load factor shows an instantaneous high demand of power. To serve such amount under short period of time, capacity is set in idle for long periods. As a result, the system imposed higher cost of electric energy in RTU.

$$L.F = \frac{Average\ Load}{MaxLoad\ \ in\ a\ given\ time\ period}\ ...(4)$$

In Equation 4, the load factor (LF) is significant in the variation of loads from average to a peak value. This change that relative in time of consumption has used in equation 2 to set the boundary of variation of the actual load. The estimated boundary without monetary loss remained in between the value of new GMBD and the recontracted capacity.

The monetary loss existed due to relationship of the existing GMBD to the demand charge per month. These values of GMBD are constants based on the 70% contracted capacity. While the demand charge (DM) per month vary from time-to-time caused by the parameterization of electric bill.

By using equations 5 and 6, the two service meters of RTU developed their monetary loss (ML) and savings (MS). These meters are referred to SIN 800878201 for ITC and Old Building, and SIN 986305201 for MAB and GSRC Building.

$$ML = Existing\ GMBD\ x\ DC\ per\ month\ ......(5)$$

$$MS = New\ GMBD\ x\ DC\ per\ month\ ........(6)$$

The projected monetary savings due to recontracted capacity determined through implementation of the improved GMBD that simulated into 12-month of the year 2012. The total generated savings of RTU derived from the difference between equations (5) and (6).

## 4. Results and Discussion

The financial loss in two (2) of three (3) service meters of RTU each month existed because of idle power. The amount of power loss reflected significantly in part of the distribution charge. Moreover, the amount of electricity bill increased as seen in load profile caused by utilization of electric power below the GMBD value.

### 4.1. Characteristics of Electrical Loads in ITC and OB Building

In 12-month of 2012, the ITC and Old Building found an average consumed energy of about 90,000 kWhr (Table 1). The amount of energy brought about 34% in load factor when the peak power occurs with respect to average power. The changed about 9% in load factor from average to maximum showed considerably high, and thereby increased the idle power of the system. An average of 366 kW of the actual consumed power pronounced a high mean power factor of 91%. These values explained relatively well in terms of balanced loads for the inductive equipment. This condition earned an incentive from utility company for the operation of the system above 85% in power factor. Average monthly electricity bill soared to about 944,000 pesos. The maximum recorded energy cost of about 1.3 million pesos announced noticeably in July for the ITC and Old Building alone. This month belongs to first semester of the academic year of 2012. However, the minimum amount of 120,000 pesos in energy bill occurred in second semester for the half month of January.

Significantly, the actual consumed power in ITC and Old Building observed a considerably lower value than the 515 kW of Guaranteed Minimum Billing Demand (GMBD). Further, the average value of 366 kW and even the maximum of 422 kW of the actual consumed power showed comparatively less than the existing GMBD of 515 kW. Considerably, the 30% difference described relatively large between the GMBD and the actual consumed power. This net value implied for the opportunity in reducing electrical consumption.

### 4.2. Characteristics of Electrical Loads in MAB and GSRC Building

The maximum energy was consumed of about 80,000 kWhr and 288 kW for the actual power (Table 2). The expense for electricity bill reached around 873,000 pesos, which occurred in July. In terms of variation of peak with respect to average value, this service meter found relatively the same as the load factor with 43% in Table 1. The maximum power factor of the system slightly decreased of about 88% but significantly low in its average value with 87%.

Total charged of electricity for MAB and GSRC Building reached to 623,000 pesos in average with less than 30% difference of energy expenditure in ITC and Old building. Minimum energy cost recorded in January because of double reading rule by the utility company.

Normally, the amount due for electricity bills takes place twice either by December or January. This default system of MERALCO conformed to the audit matters for closing of book at the end of the year. In this condition, the demand charge significantly increased in part of the distribution cost even the total bill amount decreased.

### 4.3. Characteristics of Electrical Loads in Administrative Building

In three service meters of the RTU, only the Administrative building has no record on their minimum demand (GMBD) (Table 3). However, energy profile explicitly showed the good performance of the load with an average of 94% power factor and 96% under maximum value. The value explained that the system in terms of inductive loads revealed considerably small. Even at the condition of minimum value, this Administrative Building received an incentive as a discount for taking the high ratio of true power to apparent power. The maximum energy cost of 668,000 pesos existed in July, which found the same in Table 4.1 and 4.2 as the highest recorded electricity bill. While in January, this account reflected the minimum charge of energy with 40,000 pesos. The average values recorded are 43000 kWhr, 189 kW and 31 percent for energy consumed, actual power and load factor, respectively.

### 4.4. Load Profile with High Potential Monetary Savings

The load profile of ITC and Old Building showed its high possibility for potential monetary savings. With 366 kW average and 422 kW peak power for the actual utilization described significantly far to the 515 kW of

GMBD. The prospective value of about 149 kW as the difference between the actual consumed power and the GMBD indicated the possibility of conversion into monetary savings. However, the discrepancy of average power of 253 kW with 264 kW GMBD of MAB and GSRC Building treated as practically low. This difference of about 11 kW showed comparatively small to the ITC and OB Building for saving electrical consumption. It means that the consumption of power in MAB and GSRC Building utilized nearly the same at the fixed value of its GMBD.

The service meter for ITC and Old Building recorded as the largest idle power. This standby power affected directly the distribution cost. Because of over calculation of electrical design submitted, the utility company (MERALCO) received a considerable amount of contracted capacity. Subsequently, the value of 515 kW GMBD derived in seventy percent (70%) of the contracted capacity. Consequently, the registered demand cost and thereby contributed to high electricity bill. While the electrical system designs of MAB and GSRC building obtained nearly the same on their actual power consumption. Also, the contracted capacity of about 377 kW resulted to 264 kW GMBD, in which the value showed considerably the same on the existed 253 kW average power consumption. The actual consumed power of Administrative Building with an average of 189 kW was excluded for evaluation because of availability of GMBD record.

### 4.5. Percentage of Energy Cost Allocated in the Unbundled Electricity Bill

In seven components of the unbundled electricity bill, the generation, transmission and distribution sectors revealed the majority of percentage shares. The transmission part showed relatively constant in terms of percentage in energy cost, which varied from minimum of about 10% to maximum of 20%. While the average of the transmission cost for ITC and Old Building recorded of about 13%. The generation sector with an average of 54% and closed to the maximum value of about 60% with 32% minimum shared. These fractions reciprocated in distribution charge, which the average of 14% near to 11% minimum value at 33% maximum were resulted twice as the average percentage. This erratic changed of about 33% in maximum showed under distribution part (Figure 1.a).

The amount increased in distribution spiked the energy cost of December and January due to double reading done by the utility company. The energy demand in kW considered substantially low during vacation in December. Despite of the decreased in demand, the distribution charge remained high due to explicitly dependent to the GMBD of 515 kW. The characteristic curves of the breakdown of electric energy charges in Figure 1.b showed relatively the same as depicted in Figure 1.a. The abrupt changed in percentage for the distribution cost observed of about 33%, which also experienced in MAB & GSRC Building. The projected curves of 264 kW GMBD described comparatively identical with 515 kW GMBD in terms of percentage breakdown for electricity charges. Other parts like system loss, subsidies, government taxes and universal charges are practically constants.

### 4.6. Losses in Distribution Charge for Two Service Meters Based on GMBD

The account of ITC and Old Building showed significantly their losses for the year 2012. For the whole year, the idle power loss each month indicated relatively high. These losses in the buildings affected the consumed power, which operated at less than the prescribed GMBD.

The month of November registered the highest monetary loss of nearly 50,000 pesos in Figure 2. This amount worth noticeable in Table 1 for the month of January with lowest actual load of 159 kW, and this supposedly in principle the largest monetary loss in part of distribution cost. However, the demand charge for January for only about 103 pesos described more than twice as compare with 278 pesos in November. This condition explained the month of November emerged as the largest monetary loss than the month of January. Further, about 188 kW difference on their actual consumption of load showed between the months of November and January.

Aside from January, the lowest monetary loss for demand power traced in April of about 25,000 pesos. In this month, the actual load of about 422 kW with net difference of 93 kW developed from 515 kW of GMBD. The discrepancy in power utilization of 93 kW with 263 pesos demand charge showed relatively the same for the month of January. In this month, the 356 kW at 103 pesos demand charge translated in terms of monetary loss under the distribution part.

Collectively, the two service meters of the ITC and OB, and the MAB and GSRC Buildings are subjected to standby monetary losses of about 450,000 pesos. The monetary loss established of not less than a half million pesos each year due to the presence of idle power caused by GMBD.

In MAB and GSRC Building, the monetary losses occurred only in the months of January, February, April, and May with a total of about 29,000 pesos. The month of January showed the highest losses of about 19,000 pesos in part of distribution charge as shown in Figure 3. The remaining seven (7) months are operated above the value of 264 kW GMBD. These months are free from the standby power loss, in which there is no monetary loss incurred. While, the month of November consumed the actual load for about 263 kW. This amount of power considered practically the same as compared to the existing 264 kW of GMBD. These buildings in terms of utilization of electricity consumed in almost the same amount of present GMBD. This advantage revealed in the distribution charge for paying only the actual consumed power of the loads.

The overall monetary losses for the two service meters escalated to half a million pesos for the year 2012. This total loss projected to increase further due to traditional energy conservation approached, which widened the gap between GMBD and actual loads. The demand charge in part of distribution cost increased with a considerable amount every year. Any changes in the increase of this variable affect significantly the monthly electricity bill.



### 4.7. Monetary Savings with the Improved GMBD in Part of Distribution Cost

The combined amount of monetary losses for about half a million pesos in two service meters acquired due to existing values of GMBD. These collective losses in year 2012 considered as wasted power for about 1942 kW and 201 kW for SIN 800878201 and SIN 986305201, respectively (Table 1 and 2). These values are translated into monetary loss of more than 450,000 pesos, which found in the distribution part. Through the improved 337 kW GMBD for the ITC and Old Building, the losses significantly terminated for about 450,000 pesos. Except the first half of January with 18,000 pesos monetary loss remained (Figure 4.a). The existing value of 515 kW GMBD reduced to an improved 337 kW GMBD, which calculated using an empirical formula. This new GMBD observed their importance for the suppressed losses annually of not less than 450,000 pesos. Aside from this optimized loss in part of distribution cost, a considerable saving of not less than 127,000 pesos realized each year. Essentially, the monetary savings by way of the improved GMBD generated of not less than a half million pesos annually.

However, the MAB and GSRC Building performed better than the ITC and Old Building in terms of GMBD and the actual consumed power. The 264 kW existing GMBD of MAB and GSRC Building relatively realized the actual load in kW. The sum of the net difference between the GMBD and the actual utilization of power reached for about 201 kW in four (4) months of the year 2012. These values converted into 29,000 pesos monetary loss for the months of January, February, April and May.

Consequently, the potential monetary savings as simulated the improved 225 kW GMBD resulted for about 49,000 pesos each year (Figure 4.b). Significantly, the distribution charge drastically reduced by improved values of contracted capacity and GMBD, in which the monetary savings in electricity showed relatively high (Table 4). Based on electrical design submitted, the ITC and OB reached the contracted capacity of about 736 kW. From this value, the 515 kW GMBD derived at seventy (70%) percent contracted capacity. This constant value for the minimum demand developed the idle power, which translated to monetary loss of about half a million under the distribution charge yearly.

While the MAB and GSRC, the contracted capacity resulted to 377 kW with 264 kW GMBD. This value produced a monetary loss of about 29,000 pesos in part of distribution cost. The amount observed that SIN 986305201 performed better than SIN 800878201 in terms of efficient used of electric energy with respect to GMBD value.

For the account of SIN 800878001 dedicated to Administrative Building, the contracted capacity existed under an update of SIN issue. In such case, the actual consumption of power treated as the GMBD value. The quantification of monetary loss experienced the difficulty in distribution charge under this service meter. However, the two remaining service meters collectively earned a projected monetary loss more than half a million pesos each year in part of distribution cost.

Through application of the improved 225 kW GMBD, it revealed significantly the removal of loss about 29,000 pesos. Moreover, this adjustment saved of more than 20,000 pesos each year for SIN 986305201. The total monetary savings incurred comparatively low of about 49,000 pesos. But the greater impact in computation of the new GMBD pronounced in ITC and Old Building. The improved 337 kW for SIN 800878201 eliminated the monetary loss each year of about half a million pesos. Aside from this significant reduction in part of distribution cost, it saved further the additional amount of 127,000 pesos annually. Improvement in the existing GMBD generated a monetary savings of about half a million pesos for the ITC and Old Building alone. The combined savings for two service meters of the RTU asserted the amount greater than a half million pesos each year. This explained the optimization of energy usage that consumed above the GMBD value, and thereby the system removed the idle power that caused monetary losses.

## 5. Conclusions

The method described the difference between the GMBD and the actual energy consumption. The net values had extracted for two service meters in ITC and OB and the MAB and GSRC with 216.78 kW as standby losses. Source of monetary loss discovered from distribution charge due to unused power about half a million pesos annually.

Calculation developed in this study to derive the improved contracted capacity and thereby the new GMBD. More than half a million pesos a year saved without any initial investment through eradication of idled power and from the residues in recontracted values.

The optimization values ascertained in two accounts with 482.51 kW for ITC and OB and 321.66 kW for MAB and GSRC, and collectively have residues gained of 147,000 pesos annually.

The implementation in conservation of energy found within the premises of the school has established their significant impact in generation and transmission charges. However, this strategy has widened the gap between GMBD and the actual load, and subsequently increased the unused power that transmutes high monetary loss in distribution part.

The adverse implication established due to excessive electrical design as referred to contracted capacity. The finding suggests that the tendency of high difference between GMBD and the actual load capacity of the ITC and OB has found significantly under extremely over power design that leads to high kW contract of RTU to utility company. However, the MAB and GSRC electrical design has showed effectively in terms of electricity bill, and the result has revealed that the standby power loss was essentially small.

## 6. Recommendations

To terminate the significant monetary loss in energy bill each month of RTU, the administration should be given the priority in ITC and OB account to reapply the existing contracted capacity to MERALCO. However, this study was conducted in year 2012, and so it is important that the current bills should be validated if the net difference between GMBD and the actual loads has promoted.

In the prospective of holistic approach for energy management [8], the study strongly suggest in the administration to develop the so called, RTU – Energy Group Management (RTU-EGM). The group has recommended as the overall in-charge for evaluation, planning, and implementation for the optimization in energy use (Figure 5).

The customer of MERALCO with energy demand of more than 40 kW should be periodically evaluated their discrepancy between GMBD and the actual consumed power. Most particularly, if the energy conservation has been campaigned, and the consequence has found sufficiently high difference, this research recommends the computation of new contracted capacity, and this should be presented to utility company.



## 7. References

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**Table 1.** Load Profile of Service Id Number 800878201 for the 12-month of the year 2012 in ITC and Old Building.

| MONTHS | Energy Consumed (kWhr) | Actual Load (kW) | Load Factor (%) | P.F. (%) | Total Amount Due (Pesos) |
|---|---|---|---|---|---|
| **Jan** | 5200 | 158.80 | 11.37 | 90.80 | 119984.18 |
| **Jan** | 70400 | 362.80 | 42.55 | 90.25 | 695308.34 |
| **Feb** | 107200 | 393.60 | 36.61 | 90.37 | 1080362.55 |
| **Mar** | 110400 | 405.20 | 39.15 | 91.22 | 1066524.23 |
| **Apr** | 84800 | 422.40 | 26.98 | 91.42 | 930129.15 |
| **May** | 85600 | 358.80 | 33.14 | 92.33 | 906744.67 |
| **Jun** | 76000 | 358.40 | 28.50 | 91.64 | 896440.87 |
| **Jul** | 118000 | 401.60 | 40.81 | 91.16 | 1302690.58 |
| **Aug** | 99200 | 364.00 | 36.63 | 89.87 | 1160362.44 |
| **Sep** | 109200 | 384.80 | 38.14 | 89.77 | 1063628.82 |
| **Oct** | 116000 | 400.80 | 40.20 | 90.42 | 1129132.80 |
| **Nov** | 72800 | 346.80 | 28.21 | 90.61 | 820881.89 |
| **Dec** | 112400 | 394.80 | 39.54 | 90.76 | 1091457.56 |
| **MAX** | **118000** | **422.40** | **42.55** | **92.33** | **1302690.58** |
| **AVE** | **89785** | **365.60** | **33.99** | **90.82** | **943357.54** |
| **MIN** | **5200** | **158.80** | **11.37** | **89.77** | **119984.18** |



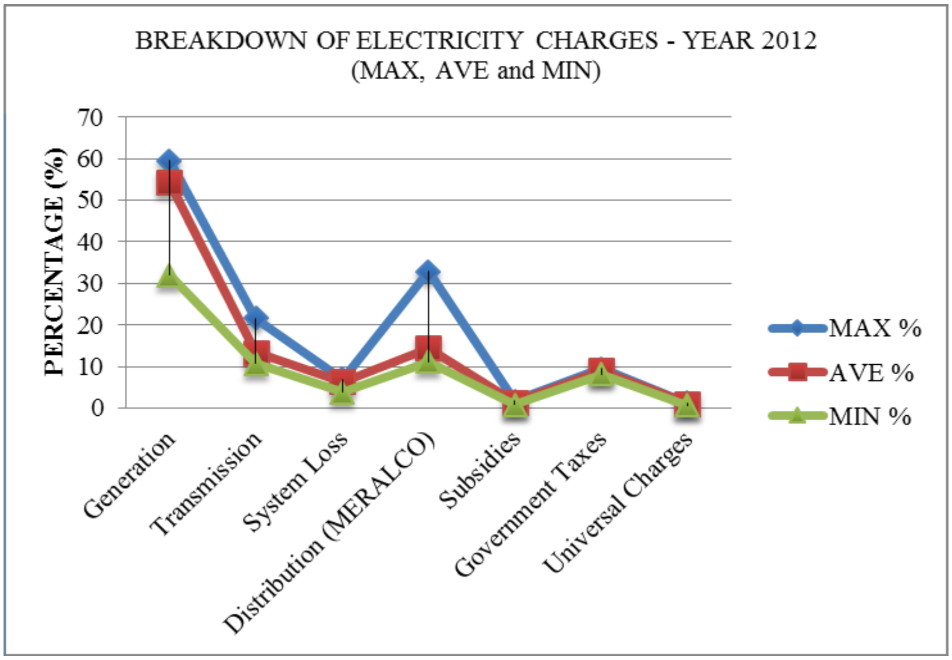
**Table 2.** Load Profile of Service Id Number 986305201 for the 12-month of the year 2012 in MAB and GSRC Building.

| MONTHS | Energy Consumed (kWhr) | Actual Load (kW) | Load Factor (%) | P.F. (%) | Total Amount Due (Pesos) |
|---|---|---|---|---|---|
| **Jan** | 5280 | 135.20 | 13.56 | 86.66 | 92021.30 |
| **Jan** | 44320 | 228.00 | 42.63 | 85.78 | 432573.85 |
| **Feb** | 63680 | 251.36 | 34.05 | 86.20 | 644716.61 |
| **Mar** | 68000 | 266.56 | 36.65 | 87.25 | 656992.50 |
| **Apr** | 58080 | 254.24 | 30.71 | 86.25 | 609336.89 |
| **May** | 63840 | 251.04 | 35.32 | 88.22 | 645410.86 |
| **Jun** | 62240 | 288.48 | 29.00 | 86.95 | 703405.57 |
| **Jul** | 79680 | 281.76 | 39.28 | 88.28 | 872460.01 |

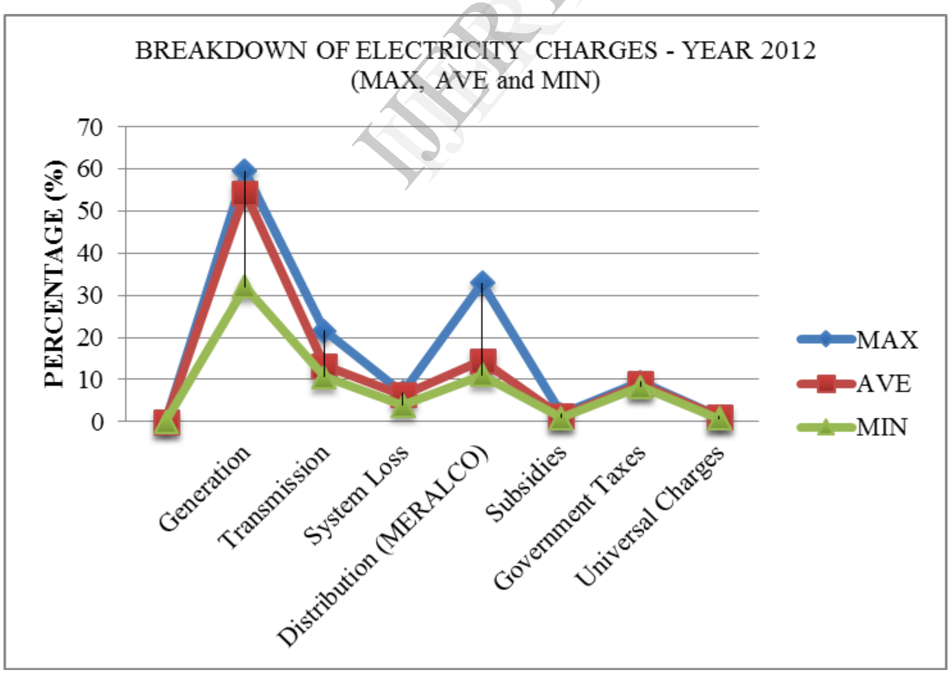
| | | | | | |
|---|---|---|---|---|---|
| **Aug** | 67200 | 268.00 | 33.70 | 85.39 | 778674.68 |
| **Sep** | 70880 | 270.88 | 35.17 | 85.39 | 687199.69 |
| **Oct** | 71200 | 265.28 | 37.28 | 86.09 | 693433.82 |
| **Nov** | 50240 | 262.72 | 25.70 | 84.95 | 557124.67 |
| **Dec** | 76000 | 270.40 | 39.04 | 87.49 | 724768.34 |
| **MAX** | **79680** | **288.48** | **42.63** | **88.28** | **872460.01** |
| **AVE** | **60049** | **253.38** | **33.24** | **86.53** | **622932.21** |
| **MIN** | **5280** | **135.20** | **13.56** | **84.95** | **92021.30** |

**Table 3.** Load Profile of the Unknown GMBD with SIN 800878001 for the 12-month of the year 2012 in Administrative Building.

| MONTHS | Energy Consumed (kWhr) | Actual Load (kW) | Load Factor (%) | P.F. (%) | Total Amount Due (Pesos) |
|---|---|---|---|---|---|
| **Jan** | 2800 | 72.80 | 13.35 | 96.15 | 39483.58 |
| **Jan** | 21600 | 122.40 | 38.70 | 92.61 | 209217.90 |
| **Feb** | 31200 | 128.40 | 32.66 | 92.93 | 312056.01 |
| **Mar** | 49200 | 210.00 | 33.66 | 94.63 | 482522.14 |
| **Apr** | 43600 | 196.00 | 29.90 | 94.15 | 448813.46 |
| **May** | 47600 | 210.80 | 31.36 | 95.03 | 489728.11 |
| **Jun** | 42000 | 203.20 | 27.78 | 94.59 | 477355.57 |
| **Jul** | 60400 | 229.60 | 36.54 | 94.55 | 667546.02 |
| **Aug** | 50800 | 214.40 | 31.85 | 93.30 | 591771.15 |
| **Sep** | 54400 | 220.40 | 33.18 | 93.17 | 530111.87 |
| **Oct** | 56400 | 214.80 | 36.47 | 93.16 | 547613.36 |
| **Nov** | 40800 | 203.20 | 27.00 | 93.10 | 440903.48 |
| **Dec** | 58400 | 234.40 | 34.60 | 93.79 | 568406.51 |
| **MAX** | **60400** | **234.40** | **38.70** | **96.15** | **667546.02** |
| **AVE** | **43015** | **189.26** | **31.31** | **93.94** | **446579.17** |
| **MIN** | **2800** | **72.80** | **13.35** | **92.61** | **39483.58** |




**(a)**




**(b)**

**Figure 1.** The seven components of the unbundled electricity bill and breakdown the allotted charges into percentage for (**a**) 515 kW and (**b**) 263.62 kW GMBD.

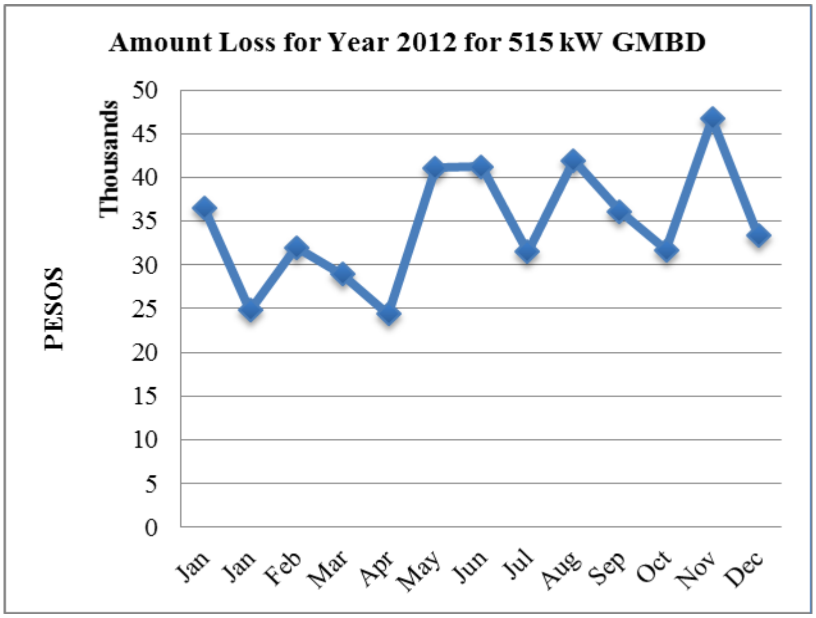



**Figure 2.** Losses of ITC & Old Building in distribution charge due to 515 kW GMBD.



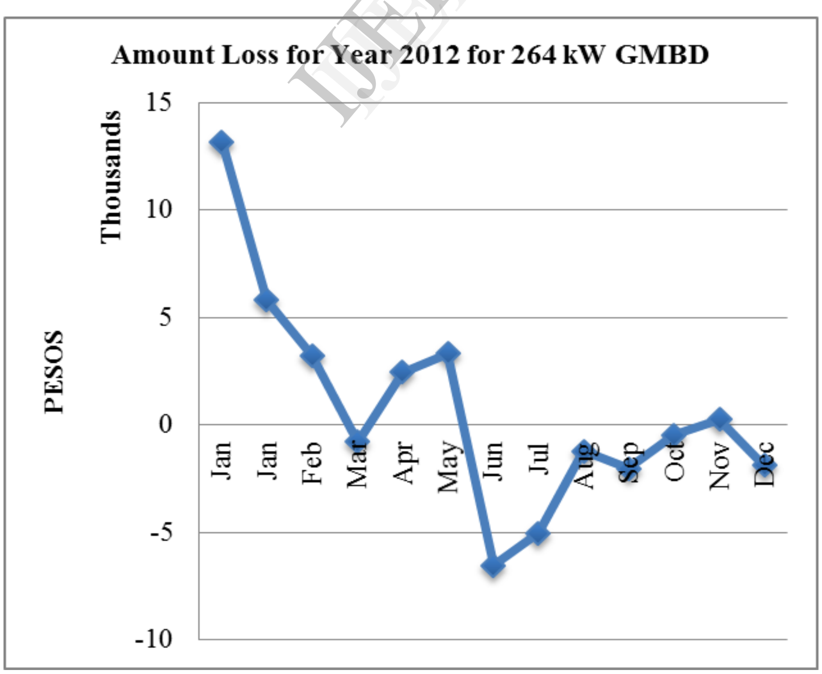
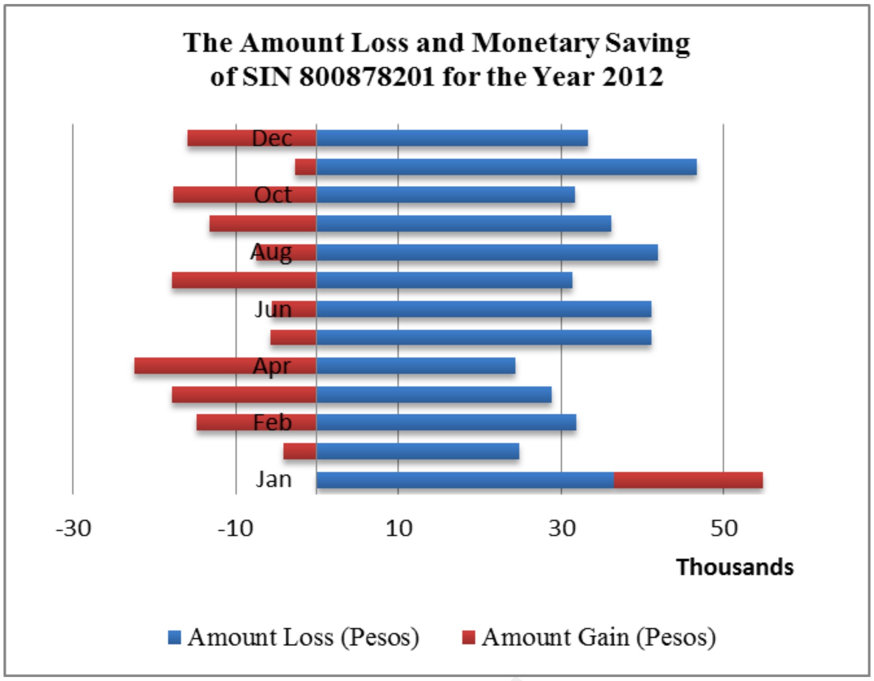
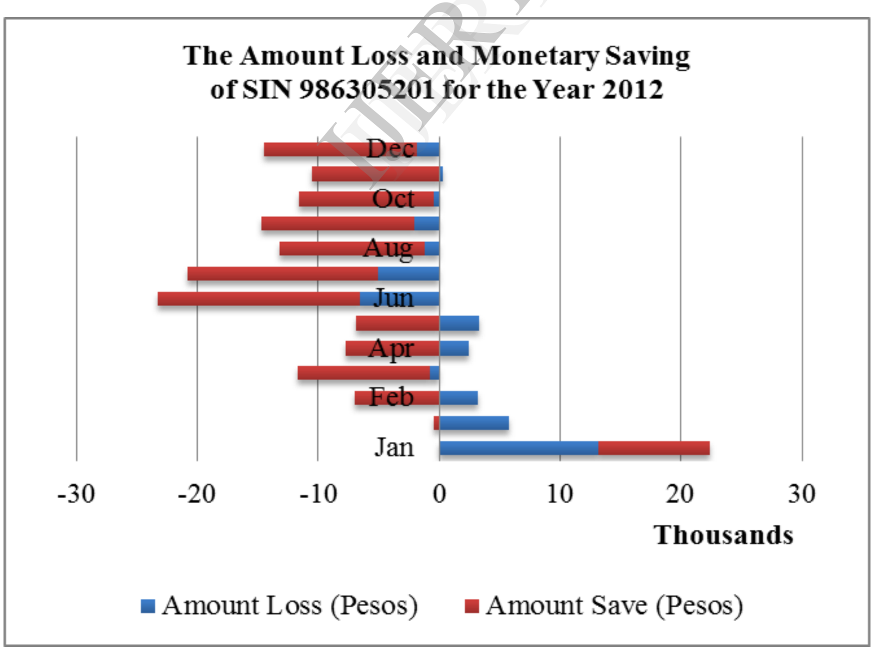



**Figure 3.** Losses of MAB & GSRC Building in distribution charge due to 264 kW GMBD.




(a)




(b)

**Figure 4.** The amount loss and monetary saving for the two service meters under the Guaranteed Minimum Billing Demand (GMBD) of (**a**) 515 kW and (**b**) 263.62 kW.

**Table 4.** The Contracted Capacity and GMBD from existing to improved values with an impact for the Distribution Charge annually.

| VALUES | EXISTING CONTRACTED VALUES | | | IMPROVED CONTRACTED VALUES | | |
|---|---|---|---|---|---|---|
| | 800878201 (ITC & OB) | 986305201 (MAB & GSRC) | 800878001 | 800878201 (ITC & OB) | 986305201 (MAB & GSRC) | 800878001 |
| Contracted Capacity (kW) | 736.45 | 376.60 | unknown | 482.51 | 321.66 | unknown |
| GMBD (kW) | 515.52 | 263.62 | actual load | 337.42 | 224.94 | actual load |
| Distribution Charge (Pesos) | (–) 450,000 | (–) 29,000 | N/A | (+) 127,000 | (+) 20,000 | N/A |

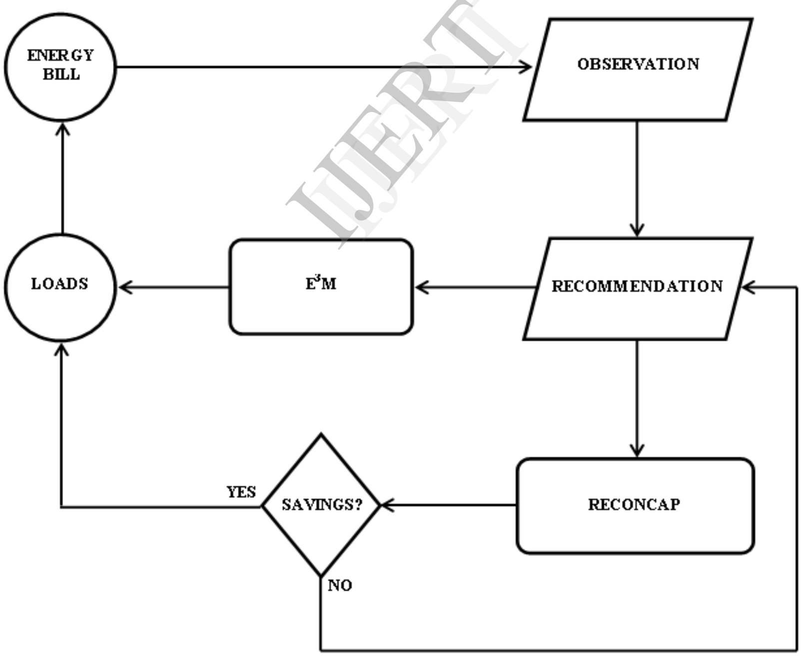





**Figure 5.** The life cycle of RTU – Energy Group Management (RTU-EGM).

*The life cycle of RTU-EGM begins with the observation in energy bill. From this observed data, the group will generate the recommendation on how to improve or maintain the optimum energy utilization. The recommendation divides into two, the Efficient Electrical Equipment and Maintenance ($E^3M$) and recontracted capacity (RECONCAP). These two approaches will be applied to the loads to control the generation, transmission and distribution charges, and thereby induce the effective monetary savings of the institution.*