

**INVESTMENT GRADE ENERGY AUDIT REPORT**  
OF  
**Office of the Deputy Commissioner**  
**Kamrup, Guwahati,**  
**Assam**

Submitted by

**Energy Management Cell**



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FOR

**Government of Assam**  
**Inspectorate of Electricity**  
**Office of the Chief Electrical Inspector-cum-Adviser, Assam**  
**Mabhairab Building: Pub-Sarania Road: Guwahati**  
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## **BACKGROUND**

Energy is a basic requirement for economic development in almost all major sectors of Indian economy i.e. agriculture, industry, transport, commercial, and residential (domestic). Consequently, consumption of energy in different forms of energy has been steadily rising all over the country, which has maintained a steady growth pattern in the past and the trend is likely to continue in future as well. This has increased the dependence of the state on fossil fuels and electricity.

Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001 in October 2001. The Energy Conservation Act, 2001 became effective from 1st March, 2002. The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency programs in the country and provides a framework for the much-needed coordination between various government entities.

As per the EC Act, Government of India established "**Bureau of Energy Efficiency**" (**BEE**) with the Mission to develop policy and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act (EC Act), 2001 with the primary objective of reducing energy intensity of the Indian economy. Among the key stakeholders are the "**State Designated Agencies**" (**SDAs**) established by State Governments in consultation with BEE with the responsibility to implement the Act within the state through various regulatory and promotional instruments.

**“Office of the Chief Electrical Inspector-cum-Adviser, Government of Assam”** has been declared as the State Designated Agency (SDA) to coordinate, regulate and enforce the Energy Conservation Act-2001 within the state of Assam. The role of Assam State Designated Agency (**ASDA**) is to create general awareness among masses about the importance and benefits of energy conservation measures and also to institutionalize the energy efficiency project implementation in the industry, govt. building & commercial buildings.

Besides these activities, a nationwide programme of **“Investment Grade Energy Audit” (IGEA)** of 500 Government Buildings is proposed by BEE to be completed during the financial year 2008-2009. Out of which 10 Government/Public Sector Buildings is in the state of Assam. Bureau of Energy efficiency is providing financial support for these audits through the SDAs.

It is expected that the owner of these buildings will implement energy efficiency measures recommended by this audit either from their own resources or through **“Energy Saving Companies” (ESCO)** route.

## **ACKNOWLEDGEMENT**

We wish to place on records our thanks to Assam State Designated Agency (ASDA); Office of the Chief Electrical Inspector-cum-Adviser, Guwahati, Assam for offering M/s Blue Star Limited **“Investment Grade Energy Audit of 10 Government / Public Buildings”** in the state of Assam.

We also would like to thank the nodal officer/incharge: The Executive Engineer (E)-PWD, Guwahati and all the individuals who had involved themselves directly and indirectly in the smooth and successful completion of the Investment Grade Energy Audit Study at **“Office of the Deputy Commissioner, Kamrup, Guwahati”**.

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## 1.0 EXECUTIVE SUMMARY

This Investment Grade Energy Audit was conducted for Office of the Deputy Commissioner, Kamrup, Guwahati. This report comes to you after a detailed study of existing system & their performance level study.

*In totality findings of the study are summarised as follows:*

- Annual energy consumption of the facility is around **1,54,434 Units**.
- Annual energy bill of the facility is around **Rs. 10.12 Lacs**.
- Investment grade energy audit reveals various measures for Energy Conservation: Around **34,806 units** of electrical energy per annum can be saved.
- Around **Rs. 1,47,926** of savings per annum with an investment of **Rs. 5,01,000** . Hence overall simple payback of **3.4 years**.
- Adopting many good engineering practices as suggested in Section-9.0 towards energy conservation in building.
- Incorporating Building Management System will allow monitoring and maintaining various operating parameters of equipment on an on-going real time basis. Further, this system allows access to all technical information; thereby enabling trained experts to take corrective measures remotely.
- The proposals identified are based on Investment Grade Energy Audit carried out with an objective of energy conservation and system up-gradation.

All the recommendations and proposals are summarized in table below, giving you a bird's eye view of annual savings expected, investment recommended and simple pay back for each proposal.

**Table 1 : Investment Grade Energy Conservation Measures (ECM)**

Sr.	Ref	Energy Conservation Measures (ECMs)	Annual Energy Consumption for identified ECMs Measures ( kWh)	Annual Energy Savings for identified ECMs (kWh)	% Savings for identified ECMs (kWh)	Annual Energy Cost Saving (Rs.)	Investment Required (Rs.)	Payback Period (Years)
1	7.1	Replacement of 40 Watt FTL to T5 lamps	58,560	25,766	44	1,09,507	3,66,000	3.3
2	7.2	Increase P.F. above 0.95 by incorporating capacitor bank with automatic power factor controller	Rebate of 2% on monthly energy charges by maintaining P.F. above 0.95 and avoiding penalty on monthly energy charges. (9040 Units/Annum can be saved )			38,418	1,35,000	3.5
<b>Total</b>				<b>34,806</b>		<b>1,47,926</b>	<b>5,01,000</b>	<b>3.4</b>

## **2.0 SCOPE OF WORK**

**2.1 Review of present electricity, fuel oil & estimation of energy consumption exploring the Energy Conservation Options (ENCON) in various load centers like lighting, Air Conditioning, Water Pumping etc.**

### **2.2 Electrical Distribution System**

2.2.1 Review of present electrical distribution like single line diagram, transformer loading, cable loading, normal & emergency loads, electricity distribution in various areas/floors etc.

2.2.2 Study of Reactive Power Management and option for power factor improvement.

2.2.3 Study of Power Quality like Harmonics, current unbalance, voltage unbalance etc.

2.2.4 Exploring energy conservation option in electrical distribution system.

### **2.3 Lighting System**

2.3.1 Review of present lighting system, lighting inventories etc.

2.3.2 Estimation of lighting load at various locations like different floors, outside light, pump house and other important locations.

2.3.3 Detail lux level survey at various locations and comparison with acceptable standards.

2.3.4 Study of present lighting control system and recommended for improvement.

2.3.5 Analysis of lighting performance indices and comparison with norms of high rise buildings.

2.3.6 Exploring Energy Conservation options in lighting system.

### **2.4 Heating, Ventilation & Air-Conditioning (HVAC) System**

2.4.1 Review of present HVAC system like central AC, window AC, split AC, package AC, water coolers and air heaters.



- 2.4.2 Performance assessment of window AC, split AC and packaged AC system.
- 2.4.3 Performance assessment of Chillers, cooling Towers, Air Handling Units and cold insulation system of central AC.
- 2.4.4 Analysis of HVAC performance like estimation of Energy Efficiency Ratio (EER) i.e. kW/TR, Specific Energy Consumption (SEC) of chilled water pumps, condenser water pumps, AHUs etc. and comparison of the operating data with design data.
- 2.4.5 Exploring Energy Conservation Option (ENCON) in HVAC system.

## **2.5 Diesel Generator (DG) Sets**

- 2.5.1 Review of DG set operation.
- 2.5.2 Performance assessment of DG sets in terms of Specific Fuel Consumption (SFC i.e. kWh/Lit).
- 2.5.3 Exploring the Energy Conservation Options (ENCON) in DG Sets.

## **2.6 Water Pumping System**

- 2.6.1 Review of water pumping, storage and distribution systems.
- 2.6.2 Performance assessment of all water pumps i.e. power consumption vs flow delivered, estimation of pump efficiency etc.
- 2.6.3 Exploring the Energy Conservation Option (ENCON) in Water Pumping System.

## **2.7 Thermic Fluid Heaters/Boilers**

- 2.7.1 Performance assessment of hot water generators or Thermic fluid heaters like estimation of efficiency etc.
- 2.7.2 Exploring ENCON option in this system.

## **2.8 Motor Load Survey**

- 2.8.1 Conducting the motor load survey of all drives to estimate the % loading.
- 2.8.2 Exploring ENCON options in electrical drive system.

## **2.9 Energy Monitoring & Accounting System**

2.9.1 Detail review of present energy monitoring & accounting systems in terms of metering, record keeping, data logging, periodic performance analysis etc.

2.9.2 Recommendation for effective energy monitoring & accounting system.

## **2.10 Others**

2.11 Review of present maintenance practice, replacement policies and building safety practices as applicable as applicable to high rise buildings and recommend for improvement.

### **3.0 METHODOLOGY ADOPTED FOR INVESTMENT GRADE ENERGY AUDIT (IGEA)**

#### **Step 1 - Interview with Key Facility Personnel**

During the initial audit, a meeting is scheduled between the auditor and all key operating personnel to kick off the project. The meeting agenda focuses on: audit objectives and scope of work, facility rules and regulations, roles and responsibilities of project team members, and description of scheduled project activities.

In addition to the administrative issues, the discussion during this meeting seeks to establish: operating characteristics of the facility, energy system specifications, operating and maintenance procedures, preliminary areas of investigation, unusual operating constraints, anticipated future plant expansions or changes in product mix, and other concerns related to facility operations.

#### **Step 2 - Facility Tour**

After the initial meeting, a tour of the facility is arranged to observe the various operations first hand, focusing on the major energy consuming systems identified during the interview, including the architectural, lighting and power, mechanical, and process energy systems.

#### **Step 3 - Document Review**

During the initial visit and subsequent kick-off meeting, available facility documentation are reviewed with facility representatives. This documentation should include all facility operation and maintenance procedures and logs, and utility bills for the previous two or three years.

#### **Step 4 - Facility Inspection**

After a thorough review of the construction and operating documentation, the major energy consuming processes in the facility are further

investigated. Where appropriate, field measurements are collected to substantiate operating parameters.

**Step 5 - Utility Analysis**

The utility analysis is a detailed review of energy bills from the previous 12 to 36 months. Billing data reviewed includes energy usage, energy demand and utility rate structure. The utility data is normalized for changes in climate and facility operation and used as a baseline to compute projected energy savings for evaluated ECM's.

**Step 6 - Identify/Evaluate Feasible ECMs**

Typically, an energy audit will uncover both major facility modifications requiring detailed economic analysis and minor operation modifications offering simple and/or quick paybacks. A list of major ECMs is developed for each of the major energy consuming systems (i.e., envelope, HVAC, lighting, power, and process). Based upon a final review of all information and data gathered about the facility, and based on the reactions obtained from the facility personnel at the conclusion of the field survey review, a finalized list of ECMs (energy conservation measures) is developed and reviewed with the facility manager.

**Step 7 - Prepare a Report Summarizing Audit Findings**

The results of our findings and recommendations are summarized in a final report. The report includes a description of the facilities and their operation, a discussion of all major energy consuming systems, a description of all recommended ECMs with their specific energy impact, implementation costs, benefits and payback. The report incorporates a summary of all the activities and effort performed throughout the project with specific conclusions and recommendations. The recommendations that are presented in the report will be discussed with ASDA/Facility Owners in order to help them in making a decision on which ECMs to be implemented.

ECMs – Energy Conservation Measures

## 4.0 BUILDING DESCRIPTION

Deputy Commissioner Office, Kamrup, Guwahati is a three storied building. The following Tables show the basic information about the building and the utilities.

**Table 2: Basic Information about the Building**

Basic Building Data			Unit
No.	Item		Value
1	Connected Load (kW) or Contract Demand (kVA)		180 kW
2	Installed capacity: DG/ GG Sets (kVA or kW)		15 kVA
3	a) Annual Electricity Consumption, purchased from Utilities (kWh)		154434 kWh
	b) Annual Electricity Consumption, through Diesel Generating (DG) Set ( kWh)		3088 kWh
	c) Total Annual Electricity Consumption, Utilities + DG Sets (kWh)		157522 kWh
4	a) Annual Cost of Electricity, purchased from Utilities (Rs.)		1012459 Rs.
	b) Annual Cost of Electricity generated through DG/GG Sets (Rs.)		36026 Rs.
	c) Total Annual Electricity Cost, Utilities + DG/GG Sets (Rs.)		1048486 Rs.
5	Area of the building (exclude parking, lawn, roads, etc.)	Built Up Area (sq. ft. or sq.m.)	2343 sq.m
		o Conditioned Area	400 sq.m
		o Non Conditioned Area	1875 sq. m
6	No. of Floors inside the Complex (a) Ground Floor+ 1 <sup>st</sup> +2 <sup>nd</sup>		
7	Working hours (e.g. day working /24 hour working)		9 hours
8	Working days/week (e.g. 5/6/7 days per week)		6 Days
9	Installed capacity of Air Conditioning System	a) Centralized AC Plant (TR)	NA
		b) Window ACs (TR)	7.5 TR
		c) Split ACs (TR)	32.5 TR
		d) Total AC Load (TR)	40 TR
10	Installed lighting load (kW)		30 kW
11	Water consumption in the building	Water consumption per month (exclude consumption for garden, lawn, etc.) (kilo liters)	1200 KL
12	Whether sub-metering of electricity consumption for Air Conditioning, Lighting, Plug Loads, etc. done: Yes/No		No

## 5.0 PRESENT ENERGY SCENARIO

### 5.1 Review of Present Electricity, Fuel Oil & Estimation of Energy Consumption in various Load Centres

At present the overall energy consumption is catered by the Electricity supply from Assam State Electricity Board. Electricity is received at 11 KV and step-down to 0.433 KV with the help of one no. 11 / 0.433 KV distribution transformer of capacity 250 kVA located outskirts of the building.

#### 5.1.1 Electrical Energy Consumption

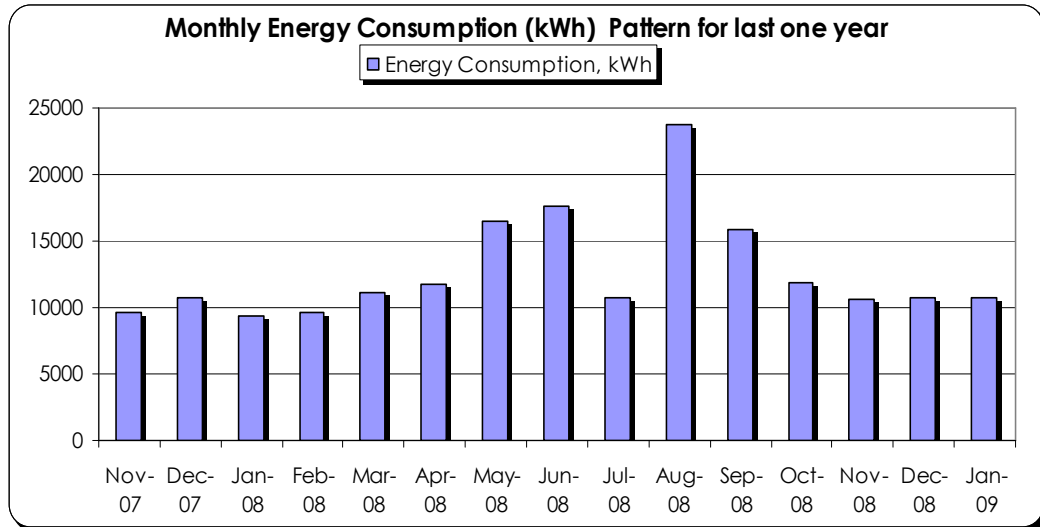
Total sanction load of Office of the Deputy Commissioner, Kamrup from Electricity Board is 180 kW. Energy Bill to the building is monthly. Details of the Energy Bill are shown in Annexure-1. Summary of the Energy Bill from Month of Dec-2007 to Jan -2009 is shown in Table-3.

**Table 3: Summary of Energy Bills:**

S. No	Description	Value	Units
1	Monthly Average Consumption	12,869	kWh/month
2	Monthly Average Energy Cost	84,371	Rs/month
3	Annual Average Energy Consumption	1,54,434	kWh/annum
4	Annual Average Energy Bill EB only	10,12,459	Rs/annum
6	Contract Demand	180	kW
7	Average P.F maintained		0.82

**Note:** The above values are based on average energy consumption from Month of Apr-2008 to Mar-2009 Electricity Bill. The variation in energy consumption is shown in Fig-1.

**Fig 1: Variation in Energy Consumption over a period of one Year**



### 5.1.2 Thermal Energy Consumption

Not Applicable for Office of the Deputy Commissioner, Kamrup.

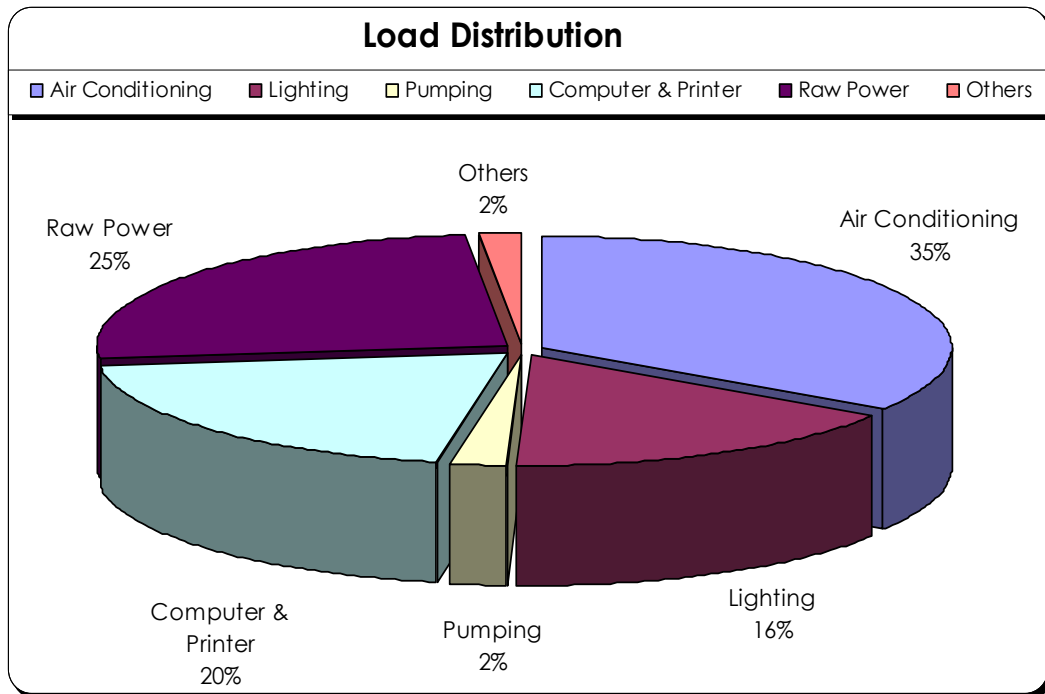
### 5.1.3 Energy Consumption in various Load Centres

The major energy consuming equipments available in the building are

- Air Conditioners- Window and Split Units
- Lighting System- General and Campus Lighting System
- Water pumps
- Ceiling Fans
- Other Electrical Equipments such as Refrigerators, Television, Computers, Printers and photo copying machines etc.

During the investment grade energy audit, power measurements were carried out building/block/circle wise. Details are shown in Annexure-2. The break-up for Load distribution is shown in Fig-2.

**Fig-2: Load Distribution at Office of the Deputy Commissioner, Kamrup**



**Note:** Raw Power is the total consumption of Refrigerators, Televisions, Ceiling Fan and Photo Copying Machines etc.



## **6.0 PERFORMANCE EVALUATION, OBSERVATION AND ANALYSIS**

### **6.1 ELECTRICAL DISTRIBUTION SYSTEM**

There is one transformer of capacity 250 kVA supplying power to entire campus. Electricity is received at 11 KV and step-down to 0.433 KV with the help of the dedicated 11 / 0.433 KV distribution transformer which is supplying to the main control panel of the DC Office.

#### **6.1.1 Performance Evaluation of Transformer**

Transformers have very high efficiencies (98% and above), as their losses are very low. Higher size transformers have low percentage losses and hence they are more efficient. Study of Transformer Load (Voltage, current, Power & P.F.), has been carried out during the Investment Grade energy Audit with the help of power analyzer.

##### **Observations:**

- Present loading on Transformer is 22.5%.

##### **Comments:**

- This loading pattern varies through out the year.
- Maximum load on the transformer is 55% which is satisfactory.

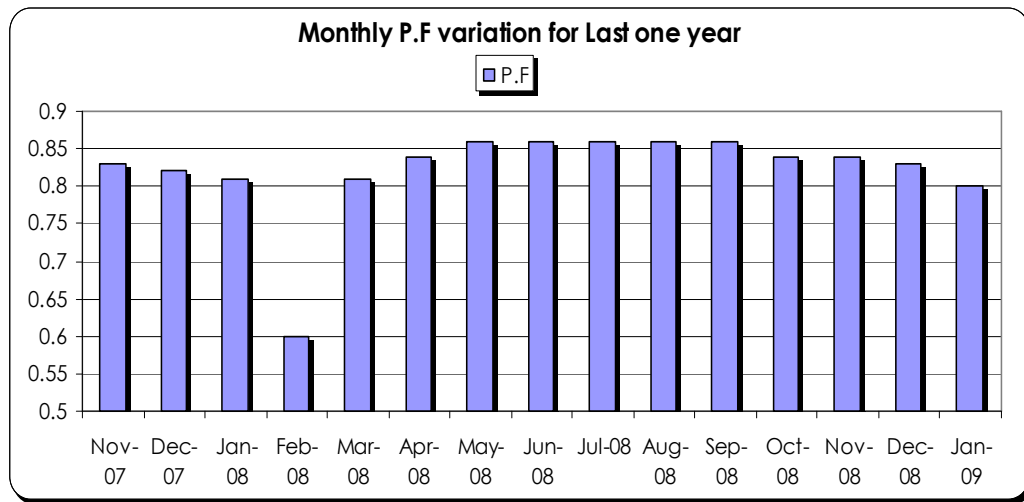
#### **6.1.2 Study of Reactive Power Management**

Power Factor plays an important role in the fixation of Monthly Electricity Bill. Higher Power Factor reduces the system I<sup>2</sup>R losses, KVA demand and increases the voltage level. Additionally maintaining higher power factor tends to rebate on energy charges and vice versa.

**Observations:**

- Monthly average maintained Power Factor is 0.82.
- Almost every month; there is penalty on energy charges due to maintaining P.F. below 0.85.
- The maintained P.F. for last one year is shown in Fig-3.

**Fig-3: Average Monthly for last one Year at DC Office, Kamrup**



**Comments:**

- Present Actual Power Factor can be increased above 0.95 in order to get Maximum Demand Reduction, System Loss and gain in rebate on energy charges.

**6.1.3 Study of Power Quality**

Study of Power Quality Parameters i.e. Instantaneous Total Harmonics Distortion and Voltage unbalance at main incomer (Transformer Secondary) are measured with the help of 3-phase power quality analyzer. The summary of the detailed measurements are shown in Table-4.

**Table-4: Measured Power Quality Parameters**

Sr.	Description	Value	Limit
1	Total Voltage Harmonics Distortion (Vthd)*	1.0%	5%
2	Voltage Unbalancing**	0.05%	<1 %

**\*\* Recommended Limits by IEEE-519-1992**

**Observations:**

- Total Voltage Harmonics Distortion (Vthd) is 1.0%.
- Voltage unbalance was found to be 0.05%.

**Comments:**

- Total Voltage Harmonics Distortion is within the limit.
- Total Voltage unbalance is within the limit.

## 6.2 LIGHTING SYSTEM

### 6.2.1 Review of Present Lighting System

Lighting contributes about 16% of energy consumption of the building. The building is mainly consisting of 36/40W Fluorescent Tube Lights (FTLs) and CFLs to illuminate the workplace. The details of the lighting fixtures are shown in Table-5.

**Table-5: Lighting Fixtures available at DC Office, Sonitpur**

Equipment	No's	Rating	Ballast
Fluorescent lamps	488	40 W	Magnetic
CFL	40	18 W	

### 6.2.2 Estimation of Lighting Load

Lighting contributes about 16% of energy consumption of the building.

### 6.2.3 Lux Level Survey

Location/Floor wise Lux (Lumens/sq. met) level was measured and the details are shown in Annexure-3.

#### Observations:

- Illuminance levels of all the areas are within recommended limit.
- During our audit we observed that there is adequate day lighting, especially in office areas.

#### Comments:

- Switching off lights during the day time may not possible due to the nature of working environment , however to inculcate discipline and sense of participation in the energy conservation movement, any unnecessary lighting during day period should be avoided.

### 6.2.4 Lighting Control System

At present lighting control is manual. According to the requirement, the lighting systems of all floors/cabins/offices/conference hall/multipurpose hall are switching on/off.

#### Observations:

- Office lights are on at morning 9 AM and off at evening 6 PM.

#### Comments:

- Installation of occupancy sensors so that the lighting systems are controlled by this occupancy sensor. As and when there is no executive inside the cabin, the occupancy sensor will switch off all the lights inside the cabin thus eliminating human intervention in doing so.

### 6.2.5 Lighting Performance Indices

Lux (Lumens/sq. mt.) and Lighting Power Density (Watt/Sq. Ft) are the performance indicators for assessment of lighting system.

#### Observations:

- Lux level of all areas is within recommended limit.
- Overall Lighting Power Density (Watt/Sq.ft) is within specified limit (<1).

#### Comments:

- Replacement of present installed Fluorescent Tube Lights with T-5 Lamps will reduce the energy consumption inside the building without affecting the present lux level.

## 6.3 STUDY OF HEATING, VENTILATION & AIR CONDITIONING SYSTEM

### 6.3.1 Review of Present HVAC System

Air conditioning requirement at DC Office, Kamrup is catered by 5 nos. of Window Air Conditioner and 19 nos. of Split Air Conditioners of capacity 1.5 TR each. These air conditioners contribute 35% of the total average annual energy consumption.

### 6.3.1 Performance Assessment of Window & Split Air Conditioning System:

Measurements were carried out to determine the present TR delivered and the specific energy consumption (**kW/TR**) of the Air Conditioning Units.

DBT/WBT of discharge air and return air were measured, and so was the suction airflow rate. These measurements were taken at various point of time. Based on these measurements, the actual TR delivered was calculated. The corresponding power consumption by the unit was then

measured to ascertain the specific energy consumption. Performance measurements of Window units are given in Annexure-4.

**Observations:**

- The specific Energy consumption (kW/TR) of the Window and Split AC units is in between 1.1 to 1.43.
- Return air filters are choked in few Window and Split Air Conditioners.

**Comments:**

- The specific Energy Consumption (kW/TR) is quiet acceptable by considering the age and condition of the air conditioning units.
- As a replacement policy, replacing the window/split air conditioning units more than 10 years old with four/five star rated AC units will reduce the present energy consumption for ACs.

## **6.4 DIESEL GENERATOR (DG) SET**

### **6.4.1 Review of DG Set Operation**

There are two nos. of D.G Set of capacity 15 kVA (1 nos. 10 kVA & 1 no. 5 kVA) installed at DC Office Building, Kamrup. D.G Sets are in operation during power failure and supplies to the specific areas. Measurements were carried out in order to find out the present specific power generation ratio (kWh/Lit). The detailed performance analysis is shown in Annexure-5.

**Observations:**

- The maximum operating load on the 10 kVA DG set is about 4 kW while that of 5 kVA DG is 2 kW.
- The specific power generation ratio for the 10 kVA DG Set is 2.22 kWh/Lit.
- The specific power generation ratio for the 5 kVA DG Set is 2.0 kWh/Lit.

**Comments:**

- By considering the age and percentage loading of the DG; performance is quiet ok.

## **6.5 WATER PUMPING SYSTEM**

### **6.5.1 Review of Water Pumping System:**

There is only one pump of capacity 5 HP pumps water and supplies to the Building.

### **6.5.2 Performance Assessment**

Measurements were carried out in order to find out the performance parameter. The pumps are selected based on the actual head and flow requirement. Power consumption of the pump is shown in Table-6.

**Table 6: Power Measurement of the Pump**

<b>Description</b>	<b>Rated HP</b>	<b>Present power Consumption, k W</b>
Pump -1	5	2.9

**Observations:**

- Normally the pump runs for 2 to 3 hours in a day.

**Comments:**

- The operation of the pumps is satisfactory.

## **6.6 THERMIC FLUID HEATERS/BOILERS**

Not applicable.

## 6.7 MOTOR LOAD SURVEY

Load measurement (Volt, Amp, P.F, & kW) for all the LT motors have been carried out with the help of Power Analyzer. The application of rotating devices is used in pumps.

### Observations:

- Pump motor is loaded above 77%.

### Comments:

- Loading on the pump motor is satisfactory.

## 6.8 ENERGY MONITORING & ACCOUNTING SYSTEM

### 6.8.1 Review of Present Energy Monitoring and Accounting System:

#### Observations:

- Electrical maintenance team at DC Office, Kamrup is maintaining a practice to record the total monthly energy consumption from the energy meter installed at LT side for electricity billing purpose.

#### Comments:

- Adoption of Building Management System (BMS) will bring the operation of the entire facility in a single window. Benefits of BMS system is shown in Section -10.
- We recommend the Building maintenance team to install energy meters at following locations and monitor them regularly which are shown in Table-7.

**Table-7: Recommended Energy Meters to be installed**



Sr.	Location	No of Meters to be installed	Parameters to be Monitored	Frequency of Monitoring
1	Lighting Panel (Floor Wise)	3	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11AM and 6 PM
2	LT side	1	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11:00 AM and 6:00 PM
3	Pumping System	1	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11:00 AM and 6:00 PM

## 6.9 Others

### 6.9.1 Review of Present Maintenance Practice, Replacement Policies & Building Safety Practices

#### Observations:

- Maintenance Team is following a standard maintenance practice for the electrical utilities.
- There is no such replacement policy followed.

#### Comments:

- It is advised to follow a regular maintenance practice for all the utilities like window/split air conditioners, pumping system, lighting system, control devices etc on quarterly/half yearly basis. The details of maintenance practices are shown in Section-9.
- Maintenance team should make a standard policy for the replacement/ up gradation of the existing technology for the utilities with energy efficient system.

## 7.0 ENERGY CONSERVATION MEASURES:

### 7.1 Replacement of present 40 Watt Fluorescent Tube Lights with T-5 Lamps.

#### Background:

The internal lighting requirement at DC Office, Kamrup is met by fluorescent light of 40W with magnetic ballast and CFLs. The lighting is contributing about 16% of the total building energy consumption.

#### Recommendations:

At present T5 lamps are available which gives 10 to 15% more lumens/Watt than standard FTL. The energy saving that can be expected by replacing the existing FTL with T5 lamps are given in Table-8.

**Table-8: Energy Saving Calculation for Recommendation Section 7.1**

Description	Quantity	Unit
Present Wattage of single Fluorescent Tube Light with magnetic ballast	52	W
Proposed T5 Tube Light Wattage with inbuilt electronic ballast	28	W
Present Total Lighting energy consumption by the FTLs	58,560	kWh/annum
Expected savings in Lighting after replacing 488 no FTLs (40W Tube with magnetic) with T5 Tube lights(28W T5 Tubes with inbuilt electronic choke)	25,766	kWh/annum
Expected reduction in energy cost saving after replacing with T5 lights considering overall energy cost Rs. 4.10 per unit, 260 working days per annum and 9 hours operation per day	1,09,507	Rs/annum
Investment required for replacing existing fitting with T5 fitting	3,66,000	Rs.
Simple payback period	3.3	Years

## 7.2 Increase of Power Factor above 0.95 by incorporating Capacitor bank with Automatic Power Factor Controller at LT Panel

### Background:

Power Factor (P.F.) plays an important role in the fixation of Monthly Electricity Bill. Higher Power Factor reduces the system I<sup>2</sup>R losses, KVA demand and increases the voltage level. In addition to the above; maintaining P.F. above 0.85 tends to gain rebate on energy charges and vice versa.

### Recommendation:

It is highly recommended to install capacitor banks with automatic power factor controller at main control panel. This will increase the present power factor level & voltage level and reduce demand & system I<sup>2</sup>R loss. Maintaining P.F above 0.95 will provide rebate of 2% on monthly energy charges and avoid penalty on monthly energy charges. Cost benefit analysis of the proposal is shown in Table-9.

**Table-9: Energy Saving Calculation for Recommendation Section 7.2**

Description	Unit	Quantity
Present maintained P.F.		0.8
Desired P.F.		Above 0.95
Capacitor Required	KVAR	135
Savings on accounts of maintaining P.F above 0.95 per month (Rebate of 2% of the energy consumption of the month)	kWh	215.3
Saving on accounts of recovering P.F. penalty per month	kWh	538
Total Savings per month	kWh	753.3
Total Savings per month	Rs	3201.53
Investment required for capacitor bank and APFC Controller	Rs	135000
Annual Savings	Rs	38418.3
Payback period	Years	3.5

## 8.0 SUMMARY

### 8.1 Outcome of the Study

- Two Proposals have been identified for possible energy savings; out of which all the two proposals required investment.
- Energy saving potential of about **34,806 kWh/** year can be realised by implementing the proposals 7.1 & 7.2 which will save approximately **Rs. 1,47,926** per Annum.
- The implementation would require an one time investment of about **Rs. 5,01,000** to reap the benefits and will get pay back in about **3.4 Years**.

### 8.2 Approach to Energy Conservation

- Each energy conservation proposal should be given a top priority to achieve energy savings.
- All the implemented proposals are to be monitored on a proposal-by-proposal basis for quantifying the actual achievement of savings obtained on a monthly basis.

### 8.3 Specific Action Plan

- Specific target date for implementation for the proposals shall be made at the earliest after the submission of this report.
- The identified proposals shall be prioritized in a phased manner based on investment, payback period and other benefits.
- Low Cost Measures can be implemented immediately followed by other proposals.

**Note:**

While carrying out the Economics of the Energy Conservation Proposals care has been taken to estimate the monetary savings as near realistic as possible. However, the likely investment mentioned in the economic valuation are only indicative in nature as it involves many extraneous factors like quality, price fluctuation, brand name, availability etc.

## **9.0 GOOD ENGINEERING PRACTICES**

### **9.1 GUIDELINES FOR ENERGY MANAGEMENT IN COMMERCIAL BUILDINGS:**

#### **9.1.1 Illumination:**

- Natural light should be used as far as possible. Especially artificial light is not required in staircases during daytime. Use of blinders to block the sunlight should be minimized. This will allow utilization of day light without causing significant glare.
- Whenever design requires, single tube-lights should be used instead of using twin tube fittings everywhere.
- While designing the illumination system, care should be taken so as the lights in each area can be switched off partially when not in use. (e.g. The illumination level required for working on computers is 200 - 300 lux, but when the area is not used for work illumination level of 150 lux is sufficient. (This can be achieved by switching off some of the lights.)
- Also proper naming or numbering of the switches will facilitate the use of them by occupants or security staff.

#### **9.1.2 Use of Efficient Lighting Technology**

- In most of the area 40-watt old tube-lights are used, while replacing them more efficient tube-lights should be used. These tube-lights have efficacy of more than 90 lumens/watt as compared to 65-70 lumens/watt of the existing tube-lights.
- Replacing the existing conventional chokes either by low loss chokes or electronic ballast can reduce the ballast losses from 10-12 watts to 3-7 watts. Before selecting the electronic ballast, following factors should be considered.
- Effect of harmonics, ability of ballast to suppress harmonics or surges.
- Ability of twin tube ballast to work with single tube-lights is essential, so that even in case of failure of single tube ballast should work with single tube.

- Losses of the ballast. Although some manufacturers claim of having ballast losses of 2-3 watts, a testing certificate should be asked to produce before purchasing.

### **9.1.3 Heat Load on Air-Conditioning**

- Reduce the load by minimizing the thermal conduction & air infiltration.
- To reduce the heat load on AC system due to the solar heat gain through windows, double glazed windows should be used for future applications & present windows should be retrofitted with a good quality sun protection film.
- Some additional load reduction strategies can be used like window shedding or tree planting outside the office buildings. For new buildings, under construction use of hollow concrete bricks should be done to maximize the insulation of walls. Special care should be taken for providing insulation for roof. This will reduce the solar heat load considerably.
- Best of the windows have less ability to block solar gain as compared to worst of the walls, so if the designer & interior decorator are not planning to utilize the daylight, then window area can be reduced. This will certainly help in reducing total heat load.
- Any leaks in the building envelope should be sealed. E.g. cracks in windows or weather striping.
- Air ducts should have proper insulation, dead ends should be eliminated.
- Keeping doors and windows closed can reduce A/C power consumption. Use of air curtains or lobbies at the entrances, will also help in reducing A/C power consumption.

### **9.1.4 Electricity Bill Reduction**

- To reduce the peak demand of power supply, scheduling of the non-critical tasks (e.g. running of water pumps) to off peak hours is

advisable. The maximum demand has a direct impact on the billing. The State Electricity Boards charges tariffs, by taking into account the power demand. Thus reducing the peak demand will help in reducing monthly charges.

- Due to addition of new loads, the PF (Power factor) may drop. Precautionary steps should be taken to maintain power factor above 0.95 in order to reduce the maximum demand.
- Where the power supply quality is not good & there are too many power cuts, then possibility of having a DG set for power supply can be evaluated. Also due to the government promotional efforts solar energy may also turn out to be a feasible alternative.

#### **9.1.5 Preventive Maintenance**

- Inspect & monitor equipment operations. Maintain regular operation & maintenance log for major equipment.
- Fix minor problems before they result in major repairs. For this regular inspection of all equipment by trained staff is necessary.
- If necessary maintenance shutdown should be taken at least once in 6 months. During this wiring, contacts & other components should be thoroughly inspected for voltage imbalance, loose connections or self-heating.
- If major repairs are required, evaluate the economic benefit of replacing the old equipment with more efficient and compact equipment before doing the repairs. Such study should be done well in advance, so that in case of breakdown a decision can be taken quickly.
- Adjust schedules to keep all equipment on only when necessary.
- Adjust temperature & humidity set points for AC within comfort zones seasonally.
- Use night setback temperature during unoccupied hours.
- Thermostats should be calibrated after regular interval & replace inaccurate gauges & thermometers.

- Ducting arrangement for A/C should be checked periodically for leakage & it should be cleaned. Filters, condenser tubes, cooling towers should be regularly cleaned, so that the system can work at the designed efficiency.
- A bimonthly cleaning schedule for lighting fittings (lamps & reflectors) should be prepared, so that the lumen loss due to dirt accumulation & environmental impact can be avoided. In addition, this information should be provided to the illumination designer, to enable him to consider a higher maintenance factor while designing the lighting system.
- As a thumb rule for fluorescent lamps, group replacement of lamps can be used to keep the system operating near peak o/p & efficiency. It is proved that the economic replacement can be done at 70% - 80% of the lamps rated life. The replacement interval in years can be calculated by dividing useful operating life in hours by annual operating hours.

#### **9.1.6 Training & Awareness**

- Maintenance & operating staff should be trained / informed about the energy management issues & procedures.
- To implement an effective preventive maintenance program, the operational staff must be given comprehensive training on each type of equipment, regarding system fundamentals, use of reference material & manuals, maintenance procedures, service guidelines & warranty information.
- Proper maintenance schedules could be supplied to them for different equipment.

#### **9.1.7 Other Savings**

- New computers available in the market offer built in power saving modes. These monitors are called as Energy Star compliant monitors. However, it was found that most of the users are not aware of this



facility. Therefore, steps should be taken to inform every one of this & any such future options.

- This example emphasizes the fact that proper employee training or awareness is necessary for success of any energy management initiative.
- Switches for computers should be made more accessible, so that employee can turn off their terminals when not in use.
- If found economical, then meters should be installed to monitor energy use. This will help in preventive maintenance, in identifying energy management opportunities. Proper metering also helps to allocate energy costs to various cost centers.

## 10.0 BUILDING MANAGEMENT SYSTEM

Automation is the buzzword in today's technically advanced and progressive which will bring the operation of entire facility through single window. It allows you to monitor and maintain various operating parameters of your equipment on an on-going real time basis. Further, this system allows access to all technical information; thereby enabling trained experts to take corrective measures remotely. This facility prevents expensive and unforeseen breakdown and enhance the performance, helping you get the best from your air conditioning system. This facility will also pave the way for energy savings.

### **Benefits:**

- Centralized control of equipment located anywhere.
- Operation by trained personnel.
- Data analysis and condition monitoring
- Performance enhancements resulting in energy savings.
- Required report generation.
- Looks after the air conditioning system on 24x7 basis.
- Predictive maintenance.
- Reduction of down time and lower life cycle costs.

**Annexure 1A – Energy Bill (Dec-07 to Jan-09)**

Sr.	Month		Energy Consumption	P.F	P.F Penalty	Total Billed Energy Consumption	Total Bill
	From	To	kWh		kWh	kWh	Rs.
1	7.11.07	4.12.07	9685	0.83	194	9879	69489
2	4.12.07	5.1.08	10790	0.82	324	11114	79861
3	5.1.08	6.2.08	9405	0.81	376	9781	74262
4	6.2.08	5.3.08	9585	0.6	396	9981	79334
5	5.3.08	7.4.08	11145	0.81	446	11591	82877
6	7.4.08	3.5.08	11735	0.84	117	11852	76720
7	3.5.08	5.6.08	16485	0.86	-165	16320	102739
8	5.6.08	30.6.08	17680	0.86	-127	17553	78628
9	30.6.08	31.7.08	10785	0.86	-108	10677	76966
10	31.7.08	31.8.08	23740	0.86	-237	23503	130835
11	31.8.08	30.9.08	15885	0.86	-159	15726	97136
12	30.9.08	31.10.08	11850	0.84	119	11969	82392
13	31.10.08	30.11.08	10660	0.84	107	10767	76308
14	30.11.08	31.12.08	10810	0.83	216	11026	78432
15	31.12.08	31.1.09	10765	0.8	538	11303	79595

**Annexure 2: Power Measurement**

Description	Phase	V	I	PF	kW	Total kW
Main Transformer	R	400	75.9	0.9	47.3	45.0
	Y	398	63.4	0.89	38.9	
	B	398	77.1	0.92	48.9	
Submersible Pump	R	230	6.2	0.85	1.2	2.9
	Y	229	6.6	0.87	1.3	
	B	230	1.8	0.8	0.3	

**Annexure-3 Lux Level Measurement**

Sr.	Description	Average Lux Level (Lumens/sq. met)
<b>A</b>	<b>Ground Floor</b>	
1	Nazir Branch	153
2	Counter no-2	130
3	Bakijai Branch	157
4	Magistrat Branch	163
5	Room No-6	173
6	Room No-7	160
7	Room No-8	133
8	Room No-9	129
9	PFC Room	117
10	Tagari Staff Room	178
11	Corridor	110
12	Room No-14	112
13	Registrar Room	151
14	Computer Section	178
15	Marriage Officer	138
16	Election Godown	119
17	Exex Branch	117
<b>B</b>	<b>1st Floor</b>	
1	Room No-3	156
2	PA to DC	152
3	DC Office-1	245
4	DC Office-2	169

Office of the Deputy Commissioner, Kamrup, Guwahati

Sr.	Description	Average Lux Level (Lumens/sq. met)
5	Room No-5	148
6	Room No-6	143
7	Room No-8	145
8	Room No-9	204
9	Room No-10	151
10	Room No-12	168
11	Room No-13	146
12	Room No-46	140
13	Room No-46A	151
14	Room No-45	129
15	Room No-43	168
16	Room No-44B	148
17	Asst. Commissioner Room	111
18	Nazarat Branch	156
19	Room No-41B	134
20	Settlement Branch	107
21	Room No-39	129
22	Room No-38A	135
23	PA to DC	143
24	DC Room	222
25	Conference Room	241
26	Corridor	100
<b>C</b>	<b>2nd Floor</b>	
1	Election Branch	146
2	Computer Room	165
3	Room No-48	189
4	Administration Branch	127
5	Room No-49	134
6	Room No-50	128
7	Room No-51	120
8	Room No-54	133
9	Room No-55	146
10	Relief Branch	159
11	Revenue Branch	156
12	Land Settlement Branch	163

**Office of the Deputy Commissioner, Kamrup, Guwahati**

<b>Sr.</b>	<b>Description</b>	<b>Average Lux Level (Lumens/sq. met)</b>
13	Election Branch	149
14	Personnel Branch	154
15	Room No-59	116
16	ITDP	139
17	Development Branch	142
18	Personnel Office	111
19	Room No-70	148
20	Room NO-69	102
21	Exax Branch	137
22	Room No-80	142
23	Room No-79	165
24	Room No-78	133
25	Room No-77	122
26	Wing-2	100
27	Room No-71	149
28	Room No-73	116
29	Chairman ITDC	113
30	Room No-75	106
31	Room No-74	114
32	Corridor	100

**Annexure 4: Performance of Window/Split Air- Conditioning Units**

Sr.	Description	Flow		Supply		Return		Rated Capacity	Power Consumption	Actual Cooling	Sp. Energy Consumption
		CFM	m3/hr	DBT(oC)	RH(%)	DBT(oC)	RH(%)	TR	kW	TR	kW/TR
1	Conference Room Split AC-1	539.19	916.08	13.5	69	25.7	49	2	2.06	1.79	1.15
2	Room No-48 Split AC-1	517.29	878.88	8.9	75.6	24.2	46.8	2	2.08	1.98	1.05
3	Room No-48 Split AC-2	437.00	742.46	10.1	68.4	25.1	52.5	2	2.0	1.95	1.03
4	Dy. Commissioner Room Split AC-1	241.47	410.26	8.4	73.5	25.7	53.4	1.5	1.8	1.24	1.43
5	Dy. Commissioner Room Split AC-2	271.66	461.55	8.1	77.9	25.5	53.1	1.5	1.7	1.36	1.27
6	PFC Room Split AC	485.70	825.20	7.5	79	22.5	50.7	2	2.0	1.86	1.10

**Annexure 5: DG Set Performance Evaluation**

<b>Description</b>	<b>Quantity</b>	<b>Unit</b>
DG No-1(10 kVA)		
Initial Tank level	7	Lit
Final Tank Level	5.2	Lit
Initial kWh Reading	5	kWh
Final kWh Reading	9	kWh
Start time	02:35	PM
End time	03:35	PM
Total hours of operation	60	Min
Total kWh generated	4	kWh
Total Diesel Consumption	1.8	Lit
Specific Energy Generation Ratio	2.22	kWh/L

<b>Description</b>	<b>Quantity</b>	<b>Unit</b>
DG No-1(5 kVA)		
Initial Tank level	7	Lit
Final Tank Level	6	Lit
Initial kWh Reading	3	kWh
Final kWh Reading	5	kWh
Start time	03:35	PM
End time	04:35	PM
Total hours of operation	60	Min
Total kWh generated	2	kWh
Total Diesel Consumption	1	Lit
Specific Energy Generation Ratio	2.00	kWh/L

**Annexure 6: List of Suppliers**

**(A) List of the CFL & T-5 Lamp Manufacturers/Traders**

<b>Supplier</b>	<b>Address</b>	<b>Contact Person</b>	<b>Contact Details</b>
M/s Osram India Pvt Ltd	Signature Towers ,11 th Floor , Tower -B,South City - 1,Gurgaon -122001	Mr Chandan Bhattacharjee Divisional Manager (Display Optics,OEM&UR-IR)	Phone No :0124-4081581 Fax :0124-4081577 <a href="mailto:c.bhattacharjee@osram.co.in">c.bhattacharjee@osram.co.in</a>
M/s Asian Electronics Ltd	Surya Plaza ,First Floor , K-185/1,Sarai Jullena, (Near New Friends Colony ) New Delhi - 110025	Mr DS Bedi General Manager	Mobile No : 9312628768 <a href="mailto:aeldel@spectranet.com">aeldel@spectranet.com</a>
M/s Havells India Ltd	E-1 ,Sector 59 ,Noida - 201307 UP India	Mr Sunil Sikka Sr VicePresident	Phone No : 0120-2477777 Fax : 0120-2477666 <a href="mailto:sunilsikka@havells.com">sunilsikka@havells.com</a>
M/s Surya Roshini Ltd	Padma Tower-1 ,2 nd Floor , Rajender Place ,New Delhi -110008	Mr B.B Pradhan President	Phone No :011-25759051 Fax :01125789560 export @sroshini.com
M/s Phillips Electronics India Ltd	Motorola Excellence Centre, 5 th floor ,415/2,MehauriGurgaon Road, Sector -14,Gurgaon - 122001	Mr R.Nandakishore Sr .GM sales and marketing Lalit Srivastava - Area Manager – TPF	Phone No :0124-4091900 Fax : 0124-4091993 <a href="mailto:r.nandakishore@phillips.com">r.nandakishore@phillips.com</a>
M/s Wipro Consumer Care &Lighting	Doddakanelli ,Sarjapur Road Banglore - 5600035 , India	Shri Sanjay Gupta Vice President Sales	Landline :080-28440011 Fax :08028440054