INVESTMENT GRADE ENERGY AUDIT REPORT

OF

Bijuli Bhawan
Paltran Bazar, 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

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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 Secretary, Assam State Electricity Board, 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 **"Bijuli Bhawan, Paltan Bazar, Guwahati".**

CONTENTS

1.0 EXECUTIVE SUMMARY

This Investment Grade Energy Audit was conducted for Bijuli Bhawan, Paltanbazar, 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 **3.32 Lacs of Units**.
- Annual energy bill of the facility is around **Rs. 19.58 Lacs.**
- Investment grade energy audit reveals various measures for Energy Conservation: Around **85, 536** units of electrical energy per annum can be saved.
- Around **Rs. 7.25 Lacs** of savings per annum with an investment of **17.85 Lacs**. Hence overall simple payback of **2.5 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 by identified segment (kWh)	Annual Energy Savings (kWh)	% Savings (kWh)	Annual Energy Cost Savings (Rs.)	Investment Required (Rs.)	Payback Period (Years)
1	7.1	Replacement of FTL to T5 lamps	1, 41, 840	62, 410	40	2, 65, 241	9, 85, 500	3.7
2	7.2	Installation of LED based signage in place of FTL based signage	28, 908	23, 126	80	98, 287	3, 00, 000	3.1
3	7.3	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			3, 61, 900	5, 00, 000	1.7
Total				**85, 536**		**7, 25, 428**	**17, 85, 000**	**2.5**

Table 1 B : Without Investment Grade Energy Conservation Measures (ECM)

Sr.	Ref	Energy Saving Opportunities	Reduction in Energy Consumption	Cost reduction	Investment required	Pay Back Period
			kWh	Rs/annum	Rs.	Years
1	7.4	Reduction of no load losses by charging one transformer at main during the month November and March	1, 752	7, 446	Nil	Immediate
Total			**1, 752**	**7, 446**	**Nil**	**Immediate**

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 date.

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

Bijuli Bhawan is a six storey building. The following Tables show the basic information about the building and the utilities.

Table 2: Basic Information about the Building

<table>
<tr><th colspan="3">Basic Building Data</th><th>Unit</th></tr>
<tr><th>No.</th><th colspan="2">Item</th><th>Value</th></tr>
<tr><td>1</td><td colspan="2">Connected Load (kW) or Contract Demand (kVA)</td><td>296 kW</td></tr>
<tr><td>2</td><td colspan="2">Installed capacity: DG/ GG Sets (kVA or kW)</td><td>NA</td></tr>
<tr><td rowspan="3">3</td><td colspan="2">a) Annual Electricity Consumption, purchased from Utilities (kWh)</td><td>332756 kWh</td></tr>
<tr><td colspan="2">b) Annual Electricity Consumption, through Diesel Generating (DG) Set (kWh)</td><td>NA</td></tr>
<tr><td colspan="2">c) Total Annual Electricity Consumption, Utilities + DG Sets (kWh)</td><td>332756 kWh</td></tr>
<tr><td rowspan="3">4</td><td colspan="2">a) Annual Cost of Electricity, purchased from Utilities (Rs.)</td><td>1958216 Rs.</td></tr>
<tr><td colspan="2">b) Annual Cost of Electricity generated through DG/GG Sets (Rs.)</td><td>NA</td></tr>
<tr><td colspan="2">c) Total Annual Electricity Cost, Utilities + DG/GG Sets (Rs.)</td><td>1958216 Rs.</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Area of the building (exclude parking, lawn, roads, etc.)</td><td>Built Up Area (sq. ft. or sq.m.)</td><td>12250 sq.m</td></tr>
<tr><td>o Conditioned Area</td><td>470 sq.m</td></tr>
<tr><td>o Non Conditioned Area</td><td>11640 sq. m</td></tr>
<tr><td>6</td><td colspan="3">No. of Floors inside the Complex
(a) Ground + six storey</td></tr>
<tr><td>7</td><td colspan="2">Working hours (e.g. day working /24 hour working)</td><td>7 hours</td></tr>
<tr><td>8</td><td colspan="2">Working days/week (e.g. 5/6/7 days per week)</td><td>6 Days</td></tr>
<tr><td rowspan="4">9</td><td rowspan="4">Installed capacity of Air Conditioning System</td><td>a) Centralized AC Plant (TR)</td><td>NA</td></tr>
<tr><td>b) Window ACs (TR)</td><td>49.5 TR</td></tr>
<tr><td>c) Split ACs (TR)</td><td>10.5 TR</td></tr>
<tr><td>d) Total AC Load (TR)</td><td>60 TR</td></tr>
<tr><td>10</td><td colspan="2">Installed lighting load (kW)</td><td>75 kW</td></tr>
<tr><td>11</td><td>Water consumption in the building</td><td>Water consumption per month (exclude consumption for garden, lawn, etc.) (kilo liters)</td><td>16500 KL</td></tr>
<tr><td>12</td><td colspan="2">Whether sub-metering of electricity consumption for Air Conditioning, Lighting, Plug Loads, etc. done: Yes/No</td><td>No</td></tr>
</table>

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 **A**ssam **S**tate **E**lectricity **B**oard. Electricity is received at 11 KV and step-down to 0.433 KV with the help of two nos. 11 / 0.433 KV distribution transformer of capacity 315 kVA each located outskirts of the building.

5.1.1 Electrical Energy Consumption

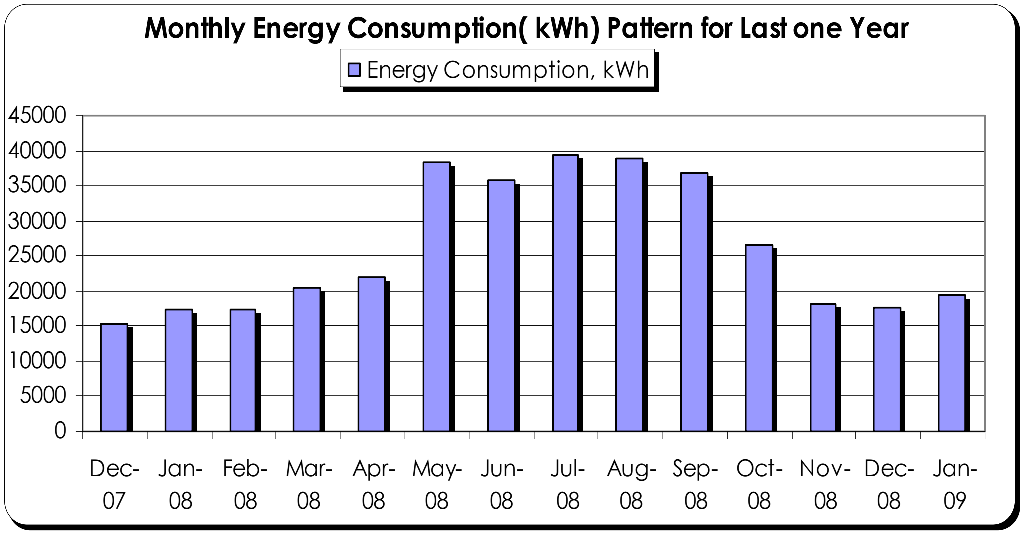
Total sanction load of Bijuli Bhawan from Electricity Board is 296 kW. Energy Bill to the building is monthly. Details of the Energy Bill are shown in Annexure-1. Summary of the Energy Bill from Month of December-2008 to January - 2009 is shown in Table-3.

Table 3: Summary of Energy Bills:

S. No	Description	Value	Units
1	Monthly Average Consumption	27,727	kWh/month
2	Monthly Average Energy Cost	1,63,185	Rs/month
3	Annual Average Energy Consumption	3,32,725	kWh/annum
4	Annual Average Energy Bill EB only	19,58,216	Rs/annum
6	Contract Demand	296	kW
7	Average P.F maintained	0.77	

Note: The above values are based on average energy consumption from Month of December-2008 to January-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



The above figure shows the trend of monthly energy consumption of Bijuli Bhawan starting from December-08 to January-09. There is sharp rise in the energy consumption between April and October. This pattern is observed because the Air Conditioners are switched off during the winter, from November to March.

5.1.2 Thermal Energy Consumption

Not Applicable for Bijuli Bhawan.

5.1.3 Energy Consumption in various Load Centres

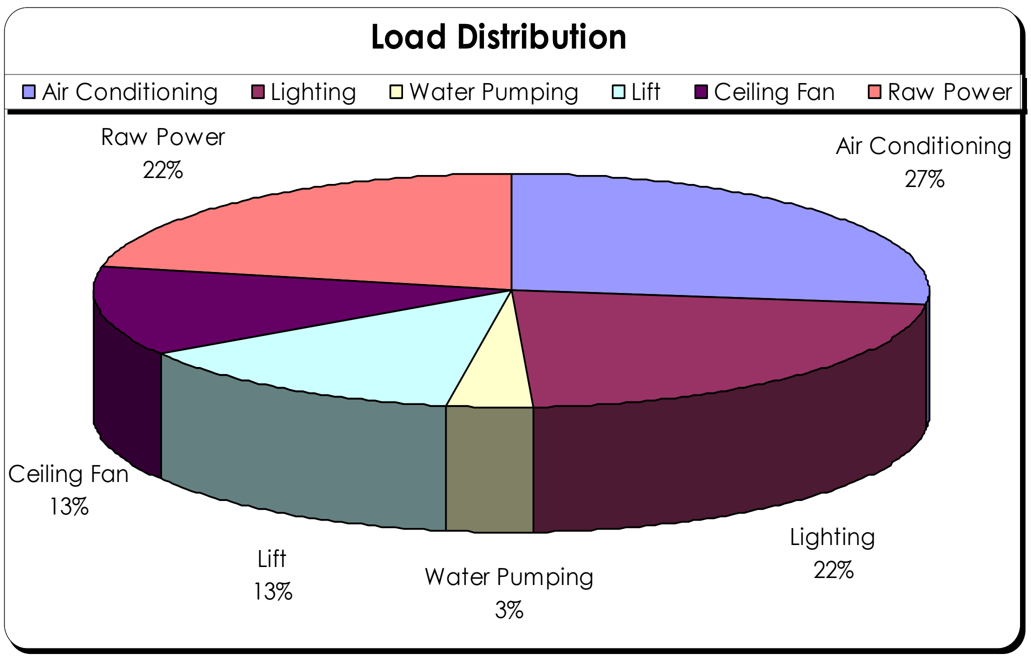
The major energy consuming equipments available in the building are

- Air Conditioners- Window and Split Units
- Lighting System- General and Campus Lighting System
- Water pumps
- Lifts
- Ceiling Fans

- Other Electrical Equipments such as Refrigerators, Television, Computers, Printers, Water coolers 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 Bijuli Bhawan, Guwahati



Note: Raw Power is the total consumption of Refrigerators, Televisions, Computers, Printers, Water coolers and photo copying machines etc.

6.0 PERFORMANCE EVALUATION, OBSERVATION AND ANALYSIS

6.1 ELECTRICAL DISTRIBUTION SYSTEM

There are two transformers of capacity 325 kVA each supplying power to entire campus. Two separate power distribution lines from two transformers: old and new cater the electrical energy requirement at Bijuli Bhawan. Old Transformer supplies to Ground Floor, 1st Floor, 2nd Floor, 3rd Floor, 5th Floor and Pumping System while New Transformer supplies to 4th Floor, 5th Floor and Lift.

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.), of all Transformers inside the Building has been carried out during the Investment Grade energy Audit with the help of power analyzer.

Observations:

- Present loading on New and Old Transformers are 16% and 15% respectively.

Comments:

- Transferring entire load to single transformer and switching off second transformer from main will reduce the no load loss as well as the increase in present operating efficiency.

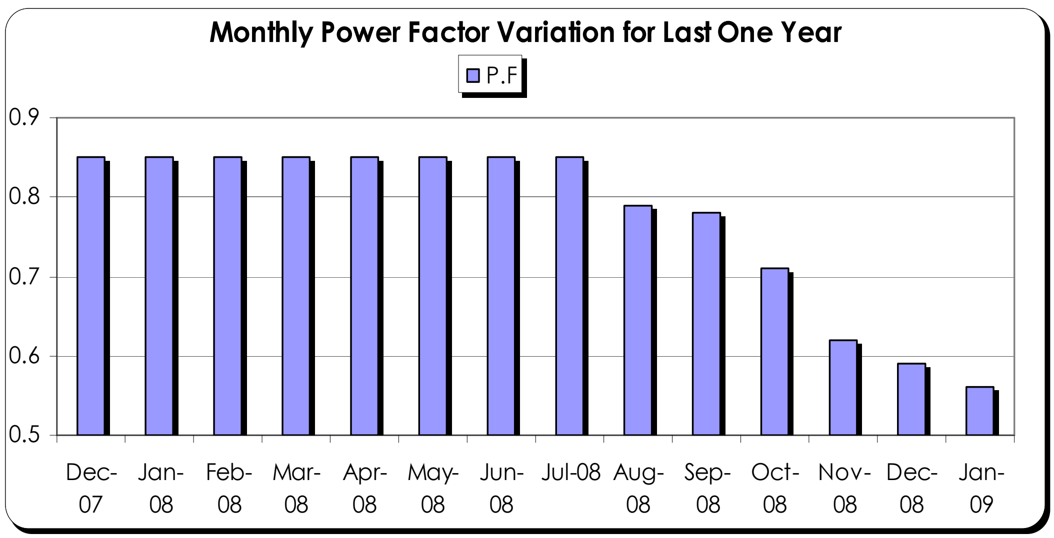
6.1.2 Study of Reactive Power Management

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

Observations:

- Monthly actual Power factor varies from 0.56to 0.85 of last one year.
- Average Power factor of last one year is 0.77.
- Since August-08; Bijuli Bhawan is paying penalty for maintaining P.F. below 0.85.
- The detail of P.F. for last one year is shown in Fig-3.

Fig-3: Power Factor at Bijuli Bhawan, Guwahati for last one Year



Comments:

- Present Actual Power Factor can be increased to unity in order to get Maximum Demand Reduction, System Loss Reduction and gain 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)*	1.10%	5%
2	Voltage Unbalancing**	0.00%	<1 %

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

**** Recommended Limits by NEMA & BEE Manuals**

Observations:

- Total Voltage Harmonics Distortion (Vthd) is 1.1%.
- No voltage unbalance was found.

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 22% of energy consumption of the building. The building is mainly consisting of 36/40W Fluorescent Tube Lights (FTLs) and CFLs to illuminate the workplace. Campus lighting consists of a few no. of mercury lamps at Bijuli Bhawan. The details of the lighting fixtures are shown in Table-5.

Table-5: Lighting Fixtures available at Bijuli Bhawan

Equipment	No's	Rating	Ballast
Fluorescent lamps	1314	40 W	Magnetic
CFL	148	24 W	
Mercury Lamps	10	150 W	

6.2.2 Estimation of Lighting Load

Lighting contributes about 22% 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 10 AM and off at evening 5 PM.
- All the campus lights are off at evening except some of the critical lights at entrance.

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 lighting energy consumption 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 Bijuli Bhawan, Guwahati is catered by 33 nos. of Window Air Conditioners and 7 nos. of Split Air Conditioners of capacity 1.5 TR each. These air conditioners contribute 27% 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 AC units is in between 1.2 to 1.8 except a couple of Window AC units.
- 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

There is no DG Set at Bijuli Bhawan, Guwahati.

6.5 WATER PUMPING SYSTEM

6.5.1 Review of Water Pumping System:

There are two submersible pumps of capacity 6.38 kW and 4.85 kW which pumps water from the ground to the main over head tank. Only one pump is operation and second one acts as standby.

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 Pumps

Description	Rated kW	Present power Consumption, k W
Submersible pump -1	6.34	5.8
Submersible pump -2	4.85	4.6

Observations:

- Normally the pumps run for 2 to 3 hours in a day.

Comments:

- The operation of the submersible pump is satisfactory.

6.6 THERMIC FLUID HEATERS/BOILERS

Not applicable for Bijuli Bhawan, Guwahati.

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 and Lifts.

Observations:

- Submersible Pump motors are loaded closed to 90%.
- Load on Lift motor is variable.

Comments:

- Loading on the pump motor is satisfactory.
- Since the nature of load for lift is variable, it is very difficult to estimate the actual motor loading.

6.8 ENERGY MONITORING & ACCOUNTING SYSTEM

6.8.1 Review of Present Energy Monitoring and Accounting System:

Observations:

- Electrical maintenance team at Bijuli Bhawan 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)	7	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11AM and 6 PM
2	LT side	2	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11:00 AM and 6:00 PM
3	Pumping System	2	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11:00 AM and 6:00 PM
4	Lift	4	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 at Bijuli Bhawan 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 Sention-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 40 Watt Fluorescent Tube Light with T5 Tube Lights

Background:

The lighting requirement at Bijuli Bhawan is met by fluorescent light of 40W with magnetic ballast and some mercury lamps. The lighting is contributing about 22% of the total building energy consumption.

Recommendation:

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 Section 7.1

Description	Quantity	Unit
Present Wattage of single Fluorescent Tube Light with magnetic ballast	50	W
Proposed T5 Tube Light Wattage with Electronic ballast	28	W
Present Total Lighting energy consumption is 22% of total energy consumption of building	141,840	kWh/annum
Expected savings in Lighting after replacing 1182 no FTLs (40W Tube with magnetic ballast) with T5 Tube lights(28W T5 Tubes with inbuilt electronic choke)	62,410	kWh/annum
Expected reduction in cost after replacing with T5 lights considering 300 working days per annum	265,241	Rs/annum
Investment required for replacing existing fitting with T5 fitting	985,500	Rs.
Simple payback period	3.7	Years

7.2 Installation of LED Based Signage in place of FTL based Signage

Background:

Bijulee Bhawan is utilising Fluorescent Tube Lights for their signage. These are lighting up from 6:00 PM to 6: 00 AM. Bijuli Bhawan has three numbers of signage: one in English, second one is in Assamee and third one is in Hindi displaying 50 Years at the service of the state -ASEB during Night hours.

Recommendation:

Light Emitting Diodes (LEDs) are new type of lighting technology which is far more efficient than FTL lighting especially for signage purpose. The energy saving that can be expected is between 80 and 90% of energy consumed by FTLs. Cost benefit analysis of this proposal is shown in Table-9.

Table-9: Energy saving calculation for Section-7.2

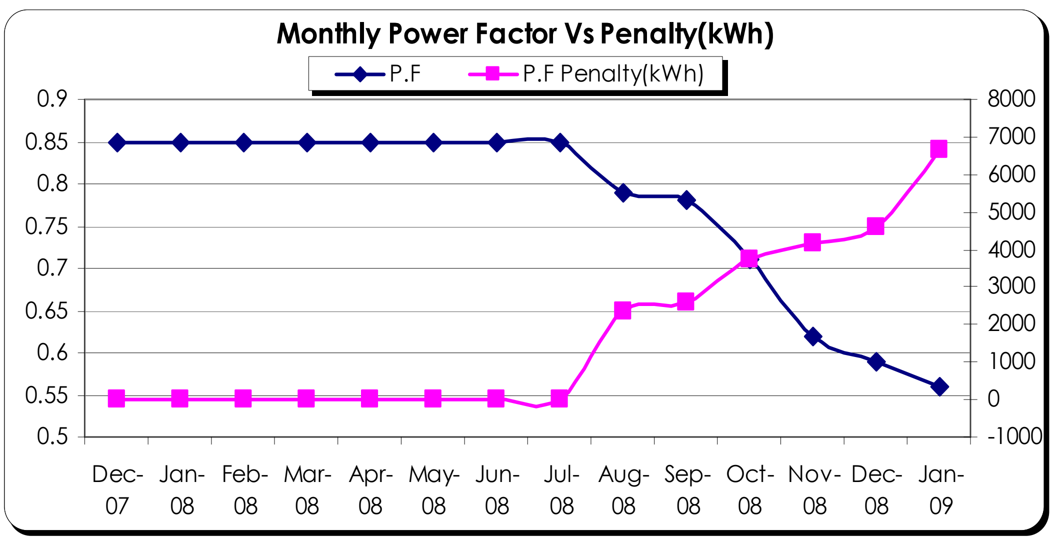
Description	Value	Unit
Present Power consumption of FTL Lamps for three signage board	6.6	kW
Expected power savings by installing LED Lamps	80%	%
Expected power savings	5.28	kW
Hours of operation per day 6 PM to 6 AM	12	Hours
Days of operation	365	Days
Expected energy savings	23,126	kWh/annum
Expected cost reduction per annum	98,287	Rs/annum
Investment required	300,000	Rs.
Simple payback period	3.1	Years

7.3 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^2R 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.

Since last six months; Bijuli Bhawan is paying a huge penalty on monthly energy consumption. The details of the P.F. and penalty are shown in Fig-4.



Recommendation:

It is highly recommended to install capacitor banks with automatic power factor controller at old and new LT control panel. This will increase the present power factor level & voltage level and reduce demand & system I^2R 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-10.

Table 10: Energy Saving Calculation for Section 7.3

Description	Unit	Quantity
Present maintained P.F.		0.56
Desired P.F.		Above 0.95
Capacitor Required by considering the peak load	KVAR	500
Savings on accounts of maintaining P.F above 0.95 per month(Rebate of 2% of the energy consumption of the month	kWh	390.08
Savings on accounts of recovering present P.F Penalty per month	kWh	6706
Total Savings per month	kWh	7096.08
Total Savings per month	Rs	30158.34
Investment required for capacitor bank and APFC Controller	Rs	500000.0
Annual Savings	Rs	361900.1
Payback period	Years	1.4

7.4 Reduction in no load loss by charging one Transformer at Main

Background:

At present two transformers of 325 kVA are operated in parallel. The two transformers supply power to New and Old LT Panel. The present loading in each of the transformer is only 15%. This loading pattern follows during the months November and March. Rest of the year; the load on the transformers increase due to switching of Air Conditioning Systems and Ceiling Fans.

Recommendations:

We recommend Bijuli Bhawan to transfer entire load to single transformer during November to March and load one out of two transformers in alternate week/fortnight/month will save no load losses of one transformer as well as increase in efficiency of transformer. The energy saving calculation is shown in Table-11.

Table-11: Energy saving calculation for Section-7.4

Description	Value	Unit
Present no load loss for each Transformer of capacity 325 kVA	400	Watt
Annual Energy loss(no load) per Transformer considering 24 hours a day and 365 day in a year of charging of the Transformer	3,504	kWh
Annual Energy cost saving by charging one Transformer at mains out of two at every week/fortnight/month between the month November to March	7,446	Rs
Expected investment for shifting the load to one Transformer	Minor	
Payback period	Immediate	

8.0 SUMMARY

8.1 Outcome of the Study

- Four Proposals have been identified for possible energy savings; out of which three proposals required investment and last proposal is without investment.
- Energy saving potential of about **94,384 kWh**/ year can be realised by implementing the proposals 7.1, 7.2 7.3 & 7.4 which will save approximately **Rs. 7, 32, 874**per Annum.
- The implementation would require an one time investment of about **Rs. 17, 85,500** to reap the benefits and will get pay back in about 2.5 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-08 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	7.12.07	5.1.08	15316	0.85	0	15316	110175
2	5.1.08	5.2.08	17364	0.85	0	17364	117572
3	5.2.08	5.3.08	17302	0.85	0	17302	117302
4	5.3.08	7.4.08	20554	0.85	0	20554	131448
5	7.4.08	1.5.08	21874	0.85	0	21874	137190
6	1.5.08	6.6.08	38414	0.85	0	38414	209139
7	6.6.08	5.7.08	35736	0.85	0	35736	197490
8	5.7.08	6.8.08	39383	0.85	0	39383	213355
9	6.8.08	8.9.08	38990	0.79	2339	41329	225347
10	8.9.08	11.10.08	36925	0.78	2585	39510	217435
11	11.10.08	11.11.08	26623	0.71	3727	30350	174827
12	11.11.08	8.12.08	18107	0.62	4165	22272	134165
13	8.12.08	7.1.09	17769	0.59	4796	22565	139560
14	7.1.09	9.2.09	19504	0.56	6706	26210	159580

Annexure 2: Power Measurement

Sr.	Description	Phase	V	I	PF	kW	Total kW
1	Old Transformer	R	428	66.9	0.76	37.7	37.8
		Y	428	68	0.76	38.3	
		B	428	66.3	0.76	37.4	
2	New Transformer	R	426	80.2	0.87	51.5	44.7
		Y	426	70.6	0.87	45.3	
		B	426	56.1	0.9	37.3	
3	4th & 6th Floor	R	246	10.1	0.8	2.0	10.7
		Y	243	22.9	0.76	4.2	
		B	246	20.4	0.89	4.5	
4	Ground Floor	R	243	9.12	0.96	2.1	2.1
		Y	0	0	0	0.0	
		B	0	0	0	0.0	
5	Lift	R	243	32.8	0.58	4.6	15.8
		Y	247	37.4	0.63	5.8	

Sr.	Description	Phase	V	I	PF	kW	Total kW
		B	246	40.9	0.53	5.3	
6	1st & 2nd Floor	R	245	12.5	0.95	2.9	7.6
		Y	248	10.7	0.84	2.2	
		B	246	11.2	0.89	2.5	
7	3rd & 5th Floor	R	245	55.2	0.88	11.9	32.4
		Y	248	37.4	0.85	7.9	
		B	245	59.8	0.86	12.6	
8	Submersible Pump-1	R	416	10.6	0.74	5.7	5.8
		Y	417	10.3	0.77	5.7	
		B	418	10.6	0.77	5.9	
9	Submersible Pump-2	R	417	8.43	0.87	5.3	4.6
		Y	419	6.68	0.81	3.9	
		B	416	8.27	0.77	4.6	

Annexure-3 Lux Level Measurement

Sr.	Description	Average Lux Level (Lumens/m2)
A	**Ground Floor**	
1	B-01	153
2	B-02	195
3	B-03	139
4	Security	112
5	Pension section AEGCL	189
6	GM Accounts Section	280
7	Telephone Exchange	153
8	G-01	172
9	G-06	218
10	MD AEGCL	183
B	**4th Floor**	
11	4B9	114
12	4B6	110
13	4B7	145
14	4B8	120
15	4B10	151
16	4B4	132
17	4B5	117

Sr.	Description	Average Lux Level (Lumens/m2)
18	4B3	161
19	4B2	123
20	4B1	116
21	Lobby near to Lift	159
22	4C1	141
23	4C2	130
24	4C4	151
25	4C6	131
26	4C5	118
27	4C7	165
28	4C8	169
29	4C9	111
30	4D8	109
31	4D7	158
32	4D4	108
33	4D3	128
34	4D6	114
35	4D5	117
36	4D2	137
37	4A6	155
38	4A2	201
39	4A1	220
40	4A3	112
41	4A4	134
42	Conference Room	309
43	Store Room	136
C	**3rd Floor**	
44	3C2	142
45	3C1	133
46	3C3	122
47	3C4	153
48	3C5	116
49	3C6	144
50	3D7	120
51	3D5	138
52	3D8	147
53	3D6	156
54	3D4	151

Sr.	Description	Average Lux Level (Lumens/m2)
55	3D3	167
56	3D1	159
57	3D2	148
58	3A1	157
59	Administrative office	163
60	3A7	140
61	3A4	147
62	3A3	165
63	3A5	166
64	3A8	172
65	3A6	108
66	3A9	116
67	3A10	146
68	3B8	118
69	3B11	130
70	3B10	144
71	3B7	179
72	3B6	153
73	3B4	160
74	3B3	134
75	3B2	112
76	3B9	116
77	3B1	121
D	**2nd Floor**	
78	2A1	173
79	2A2	130
80	2A3	146
81	2A4	135
82	2A5	131
83	2A6	122
84	2B6	138
85	2B5	128
86	2B2	128
87	2B4	161
88	2B1	126
89	2C1	112
90	2C2	151
91	2C3	168

Sr.	Description	Average Lux Level (Lumens/m2)
92	2C4	149
93	2C5	139
94	2C9	147
95	2C5	139
96	2C8	111
97	2D5	118
98	2D6	133
99	2D3	111
100	2D4	142
101	2D1	107
102	2D2	144
E	**1st Floor**	
103	1D1	146
104	1D2	135
105	1D3	114
106	1D4	118
107	1C6	151
108	1C5	117
109	1C4	118
110	1C3	156
111	1C1	136
112	1C2	140
113	1B3	135
114	1B1	161
115	1B2	167
116	1B8	114
117	1B5	162
118	1B7	118
119	1B9	107
120	1A3	101
121	1A7	111
122	1A6	131
123	1A5	114
124	1A4	132
125	1A2	152
126	1A3	124
127	1A9	146
128	1A1	115

Sr.	Description	Average Lux Level (Lumens/m2)
F	**5th Floor**	
129	5B1	169
130	5B2	195
131	5B3	197
132	5B6	187
133	5B7	147
134	5B8	144
135	5A12	119
136	5A2	140
137	5A4	171
138	5A3	136
139	5A9	133
140	5A6	132
141	5A7	188
142	5A8	171
143	MD Room	201
144	5D1	118
145	5D2	131
146	5D7	167
147	5D3	105
148	5D8	107
149	5D4	161
150	5D5	118
151	5D9	123
152	5D10	149
153	5C4	112
154	5C3	153
155	5C2	185
156	5C1	177
G	**6th Floor**	
157	6C4	147
158	6C3	155
159	6C2	112
160	6C1	153
161	6C6	110
162	6C7	117
163	6C8	142
164	6D11	111

Sr.	Description	Average Lux Level (Lumens/m2)
165	6D12	137
166	6D10	110
167	6D9	155
168	6D8	126
169	6A7	123
170	6A6	100
171	6D5	138
172	6D4	107
173	6D2	144
174	6D3	146
175	6D1	127
176	6A1	155
177	6A2	177
178	6A3	116
179	6A4	147
180	6A5	119
181	6A6	117
182	6A10	123
183	6A7	118
184	6A9	127
185	6A8	139
186	6B10	192
187	6B9	163
188	6B7	177
189	6B8	147
190	6B6	141
191	6B1	136
192	6B4	168

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

Sr. No	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 Window AC-1	229.00	389.07	8.6	76.1	21.8	59.8	1.5	1.8	0.9	1.97
2	Conference Room Window AC-2	291.43	495.14	8	70	22	57	1.5	1.7	1.21	1.44
3	Chairman Room Window AC-1	306.00	519.89	7	77.5	21.6	55.6	1.5	1.8	1.23	1.43
4	Chairman Room Window AC-2	293.00	497.81	5.9	84.5	22.3	53.6	1.5	1.7	1.26	1.37
5	Member Technical Room Window AC	248.00	421.35	8.2	71.2	23.6	54.5	1.5	1.8	1.12	1.62

Sr. No	Description	Flow		Supply		Return		Rated Capacity	Power Consumption	Actual Cooling	Sp. Energy Consumption
6	Secretary Room Window AC	485.70	825.20	9.2	81.4	18.4	66.6	1.5	1.9	1.3	1.44
7	Room 3D1 Window AC	353.00	599.75	11.7	73.8	22.5	50.9	1.5	1.7	0.95	1.77
8	Room 3A1 Window AC	312.00	530.09	11.2	73.9	23.6	62.2	1.5	1.5	1.27	1.18
9	Room 2A1 Window AC	721.00	1224.98	11.5	79.7	16.3	64.4	1.5	1.7	0.78	2.16
10	Room 2A2 Window AC	620.00	1053.38	12.1	81.1	21.4	53.9	1.5	1.7	1.29	1.35
11	Room 2D1 Window AC	396.90	674.33	9.4	62.1	17.2	55.1	1.5	1.7	0.86	1.98
12	Room 1D2 Window AC	250.00	424.75	7.9	64	19.1	74	1.5	1.6	1.06	1.53
13	Room 1B3 Window AC	393.00	667.71	6.1	71.4	17.1	65	1.5	1.5	1.36	1.13
14	Room 1A1 Window AC	420.00	713.58	7.2	81.1	17.1	65.2	1.5	1.7	1.16	1.48

Sr. No	Description	Flow		Supply		Return		Rated Capacity	Power Consumption	Actual Cooling	Sp. Energy Consumption
15	Room 5B1 Split AC	429.00	728.87	5.7	67	15.3	62	1.5	1.5	1.19	1.29
16	Room 5D1 AC	588.00	999.01	8.9	58	15	48	1.5	1.5	0.88	1.74
17	MD Room Split AC-1	587.00	997.31	11.8	62	19.1	52	1.5	1.7	1.13	1.51
18	MD Room Split AC-2	529.00	898.77	10.1	58	16.9	44	1.5	1.7	0.77	2.23
19	6D1 Room Window AC	443.00	752.66	9.6	69.2	19.9	55	1.5	1.7	1.25	1.38
20	6A1 Room Split AC	495.00	841.01	9.9	72	18.2	68	1.5	1.7	1.36	1.27

Annexure 5: List of Suppliers

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

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 c.bhattacharjee@osram.co.in
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 aeldel@spectranet.com
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 sunilsikka@havells.com
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 r.nandakishore@phillips.com
M/s Wipro Consumer Care &Lighting	Doddakanelli ,Sarjapur Road Banglore - 5600035 , India	Shri Sanjay Gupta Vice President Sales	Landline :080-28440011 Fax :08028440054

(B) List of LED Signage Supplier

Marc Signage	20A, Lake View Road Kolkata - 700029	Tel. 033-24659543
Philips Electronics India Limited	Temple Towers,5th Floor, Old No. 476, New No. 672 Annasalai, Nandanam Chennai – 600035	Phone: +91-44-66501000 +91-44-66501155
OSRAM	Contact Type Distributor Name Avnet Asia 2nd Floor, The Estate 121 Dickenson Road Bangalore Bangalore 560 042 Country India	Phone +91 80 5550228 Fax +91 80 5588146