INVESTMENT GRADE ENERGY AUDIT REPORT

OF

Office of the Deputy Commissioner
Jorhat, 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 Executive Engineer (E)-PWD, Jorhat 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, Jorhat".**

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1.0 EXECUTIVE SUMMARY

This Investment Grade Energy Audit was conducted for Office of the Deputy Commissioner, Jorhat. 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 **1.18 Lacs of Units**.
- Annual energy bill of the facility is around **Rs. 6.03 Lacs.**
- Investment grade energy audit reveals various measures for Energy Conservation: Around **18, 132** units of electrical energy per annum can be saved.
- Around **Rs. 74340** of savings per annum with an investment of **1.79 Lacs**. Hence overall simple payback of **2.42 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	11,372	4,493	39.5	18,420	78,750	4.3
2	7.2	Replacement of 40 Watt GLS Lamps to 20 Watt CFL	2,995	1,498	50	6,140	4,800	0.8
3	7.3	Replacement of 250 Watt HPSV Lamp Street Lighting to CFL (24 Watt x 4 nos.) based street lighting system	19,710	12,141	60	49,780	96,000	1.9
Total			**34,077**	**18,132**	**53**	**74,340**	**1,79550**	**2.42**

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.

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2.6.1 Review of water pumping, storage and distribution systems.

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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, Jorhat is a single 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)		40 kW
2	Installed capacity: DG/ GG Sets (kVA or kW)		25 kVA
3	a) Annual Electricity Consumption, purchased from Utilities (kWh)		115414 kWh
	b) Annual Electricity Consumption, through Diesel Generating (DG) Set (kWh)		3088 kWh
	c) Total Annual Electricity Consumption, Utilities + DG Sets (kWh)		118502 kWh
4	a) Annual Cost of Electricity, purchased from Utilities (Rs.)		567807 Rs.
	b) Annual Cost of Electricity generated through DG/GG Sets (Rs.)		36026 Rs.
	c) Total Annual Electricity Cost, Utilities + DG/GG Sets (Rs.)		603833 Rs.
5	Area of the building (exclude parking, lawn, roads, etc.)	Built Up Area (sq. ft. or sq.m.)	2256 sq.m
		o Conditioned Area	90 sq.m
		o Non Conditioned Area	2100 sq. m
6	No. of Floors inside the Complex (a) Ground Floor		
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)	1.5 TR
		c) Split ACs (TR)	7.5 TR
		d) Total AC Load (TR)	9 TR
10	Installed lighting load (kW)		14 kW
11	Water consumption in the building	Water consumption per month (exclude consumption for garden, lawn, etc.) (kilo liters)	450 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 **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 one no. 11 / 0.433 KV distribution transformer of capacity 100 kVA located outskirts of the building.

5.1.1 Electrical Energy Consumption

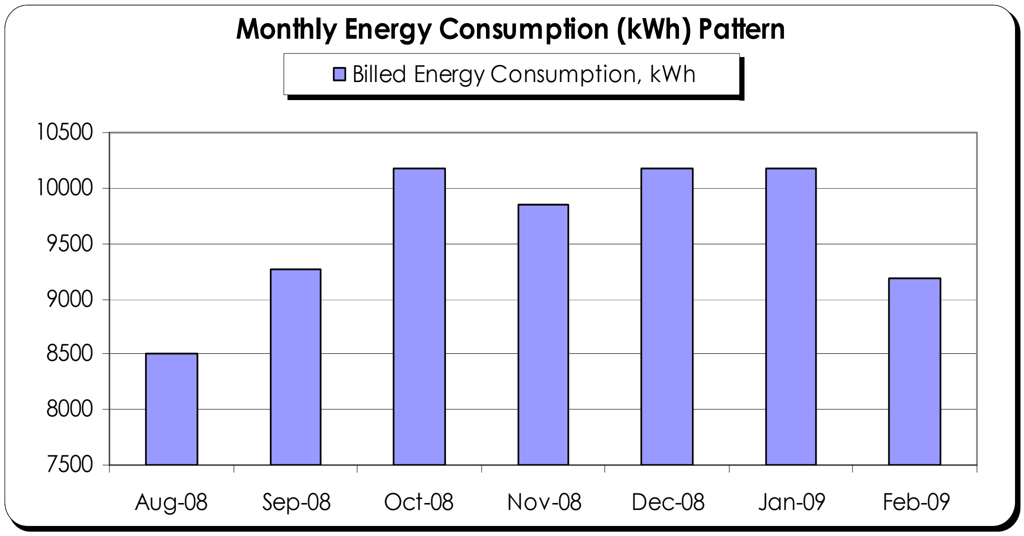
Total sanction load of Office of the Deputy Commissioner, Jorhat from Electricity Board is 40 kW. Energy Bill to the building is monthly. Details of the Energy Bill are shown in Annexure-1. Summary of the Energy Bill from Month of August-2008 to February -2009 is shown in Table-3.

Table 3: Summary of Energy Bills:

S. No	Description	Value	Units
1	Monthly Average Consumption	9,617	kWh/month
2	Monthly Average Energy Cost	47,317	Rs/month
3	Annual Average Energy Consumption	1,15,414	kWh/annum
4	Annual Average Energy Bill EB only	5,67,807	Rs/annum
6	Contract Demand	40	kW
7	Average P.F maintained	0.9	

Note: The above values are based on average energy consumption from Month of August-2008 to February-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, Jorhat.

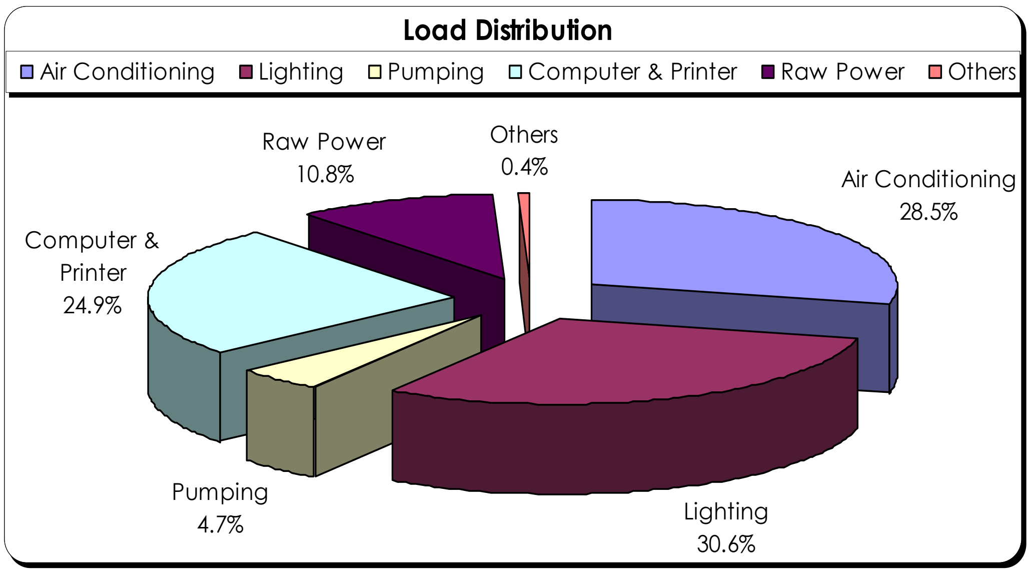
5.1.3 Energy Consumption in various Load Centres

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, Jorhat



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 100 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 and connected to the main distribution panel.

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 10.5%.

Comments:

- This loading pattern is not same through out the year. As per connected load; loading on transformer at peak load is 45%.

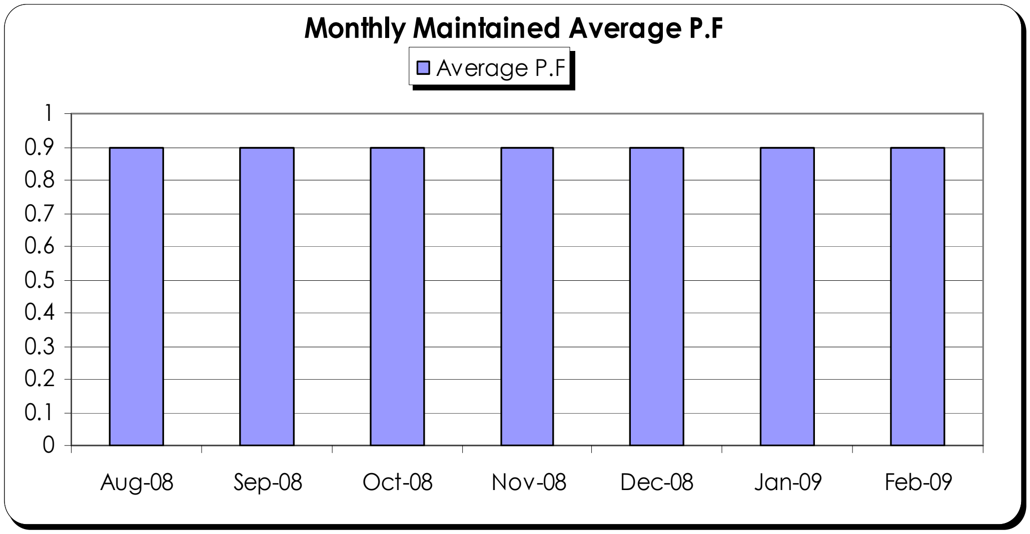
6.1.2 Study of Reactive Power Management

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 average maintained Power Factor is 0.9.

Fig-3: Monthly Maintained Power Factor at DC Office, Jorhat



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. 0%	5%
2	Voltage Unbalancing**	0.01%	<1 %

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

Observations:

- Total Voltage Harmonics Distortion (Vthd) is 1.0%.
- Voltage unbalance was found to be 0.01%.

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 30% of energy consumption of the building. The building is mainly consisting of 36/40W Fluorescent Tube Lights (FTLs), GLS Lamps and CFLs to illuminate the workplace. Campus lighting consists of HPSV Lamps . The details of the lighting fixtures are shown in Table-5.

Table-5: Lighting Fixtures available at DC Office, Jorhat

Equipment	No's	Rating	Ballast
Fluorescent lamps	105	40 W	Magnetic
	45	40 W	Electronic
CFL	99	18 W	
GLS Lamps	32	40 W	
HPSV	24	250 W	

6.2.2 Estimation of Lighting Load

Lighting contributes about 30% 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.
- All the campus lights for court field are on at evening throughout the year.

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 and GLS with CFL will reduce the energy consumption inside the building without affecting the present lux level.
- Replacement of present HPSV Lamps for court yard lighting with CFL based courtyard lighting fixtures will reduce the campus lighting energy consumption.

6.3 STUDY OF HEATING, VENTILATION & AIR CONDITIONING SYSTEM

6.3.1 Review of Present HVAC System

Air conditioning requirement at DC Office, Jorhat is catered by a single Window Air Conditioner and 5 nos. of Split Air Conditioners of capacity 1.5 TR each. These air conditioners contribute 28.5% 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 1.2 to 1.3.
- 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 is one D.G Set of capacity 25 kVA installed at DC Office Building, Jorhat. D.G Set is in operation during power failure. 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 load in the DG set is about 15 kW.
- The percentage loading of DG set is 70 % only.
- The specific power generation is 2.25 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 are two pumps of capacity 2 HP and 1 HP which pumps water from the under ground tank and supplies to New and Old Court 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 Pumps

Description	Rated HP	Present power Consumption, k W
Pump -1	2	1.2
Pump -2	1	0.7

Observations:

- Normally the pumps run 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 motors are loaded 60 to 70 %. Pump-1 is loaded 60% and Pump-2 is loaded 70%.

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, Jorhat 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	1	kWh,kVA,kW, p.f, Voltage and Current	Every day at 11AM and 6 PM

Sr.	Location	No of Meters to be installed	Parameters to be Monitored	Frequency of Monitoring
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	2	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 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:

A. LIGHTING SYSTEM

Background:

The internal lighting requirement at DC Office, Jorhat is met by fluorescent light of 40W with magnetic and electronic ballast, CFLs and some GLS lamps. The outer lighting i.e. courtyard lighting is through 250 Watt HPSV Lamps. The lighting is contributing about 30% of the total building energy consumption.

Recommendations:

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

7.2 Replacement of present 40 Watt GLS Lamps with 20 watt CFLs.

7.3 Replacement of present 250 watt HPSV lamps for courtyard lighting with CFL based courtyard lighting fixtures (24 x 4 nos. CFL in one fixture).

The cost benefit analysis for the above recommendations is shown in the following Tables.

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
Present Wattage of single Fluorescent Tube Light with electronic ballast	42	W
Proposed T5 Tube Light Wattage with inbuilt electronic ballast	28	W
Present Total Lighting energy consumption by the FTLs	11,372	kWh/annum

Description	Quantity	Unit
Expected savings in Lighting after replacing 105 no FTLs (40W Tube with magnetic & electronic ballast) with T5 Tube lights(28W T5 Tubes with inbuilt electronic choke)	4,493	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	18,420	Rs/annum
Investment required for replacing existing fitting with T5 fitting	78,750	Rs.
Simple payback period	4.3	Years

Table-9: Energy Saving Calculation for Recommendation Section 7.2

Description	Value	Unit
Present Power consumption of single GLS Lamp	40	W
No of GLS Lamps	32	nos.
Hours of operation	9	Hours
Days of operation	260	Days
Energy Consumption by GLS Lamps	2,995	kWh/annum
Energy saving by replacing present installed GLS with CFL	1,498	kWh/annum
Energy cost saving by replacing present installed GLS with CFL	6,140	Rs/annum
Investment required for replacing the existing GLS Lamps	4,800	Rs.
Simple payback period	0.8	Years

Table-10: Energy Saving Calculation for Recommendation Section 7.3

Description	Value	Unit
Present Power consumption of single HPMV Lamp	250	W
No of HPMV Lamps	24	nos.
Hours of operation	9	Hours
Days of operation	365	Days
Energy Consumption by HPMV Lamps	19,710	kWh/annum
Energy saving by replacing present installed HPMV with CFL based street Lighting	12,141	kWh/annum
Energy cost saving by replacing present installed HVMV based strreet lighting with CFL based street lighting	49,780	Rs/annum
Investment required	96,000	Rs.
Simple payback period	1.9	Years

8.0 SUMMARY

8.1 Outcome of the Study

- Three Proposals have been identified for possible energy savings; out of which all the three proposals required investment.
- Energy saving potential of about **18,132 kWh**/ year can be realised by implementing the proposals 7.1, 7.2 & 7.3 which will save approximately **Rs. 74,340** per Annum.
- The implementation would require an one time investment of about **Rs. 1, 79,550** 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 (Aug-08 to Feb-09)

Month	Billed Energy Consumption, kWh	Average P.F	Total Bill, Rs
Aug-08	8503	0.9	41802
Sep-08	9265	0.9	45941
Oct-08	10176	0.9	49988
Nov-08	9846	0.9	48381
Dec-08	10173	0.9	49988
Jan-09	10173	0.9	49988
Feb-09	9189	0.9	45133

Annexure 2: Power Measurement

Sr.	Description	Phase	V	I	PF	kW	Total kW
1	Transformer Main Incomer	R	241	9.99	0.9	2.2	9.5
		Y	243	27	0.94	6.2	
		B	241	5.43	0.92	1.2	
2	Pump-1	R	228	4.46	0.85	0.86	0.9
3	Pump-2	R	231	2.48	0.9	0.52	0.5

Annexure-3 Lux Level Measurement

Sr.	Description	Average Lux Level (Lumens/sq. met)
1	Public Facilitation Center	118
2	System Administrator	112
3	Computer Room	156
4	Nazarat	120
5	Revenue Branch	142
6	Room No-9	147
7	ADC Room	120
8	Revenue Record Room	131
9	Room No-13	134
10	Room No-14	156
11	Court Office	155

Sr.	Description	Average Lux Level (Lumens/sq. met)
12	Administration Branch	159
13	Sub Division Officer	110
14	Revenue Office	155
15	Majestic Branch	151
16	Room No-19	109
17	Personnel Branch	140
18	Room No-26	168
19	Room No-25	120
20	Room No-21	109
21	Ballot Paper room	111
22	Room No-22	102
23	Room No-23	156
24	Security Room	117
25	Personnel Cell	111
26	Medical Hall	106
27	Exixor Branch	124
28	ADC Room	123
29	Room No-30	113
30	Video Conference Room	228
31	DC Room	190

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	System administrator Room Split AC	350.00	594.65	10.9	67.1	23.9	56.8	1.5	1.7	1.44	1.18
2	Computer Room split AC	367.00	623.53	7.6	87.2	22.8	53.6	1.5	1.53	1.43	1.07
3	Video Conference Room Split AC	334.00	567.47	8	87	23.6	54	1.5	1.72	1.37	1.26
4	DC Room Split AC-1	367.00	623.53	9.2	86.1	24.1	54.1	1.5	1.66	1.45	1.15
5	DC Room Split AC-2	400.00	679.60	11.6	75	22.3	61	1.5	1.72	1.32	1.30

Annexure 5: DG Set Performance Evaluation

Description	Quantity	Unit
DG No-1		
Initial Tank level	15	Lit
Final Tank Level	10	Lit
Initial kWh Reading	0	kWh
Final kWh Reading	18	kWh
Start time	12:00	PM
End time	01:15	PM
Total hours of operation	01:15	Hr
Total kWh generated	18	kWh
Total Diesel Consumption	8	Lit
Specific Energy Generation Ratio	2.25	kWh/L

Annexure 6: List of Suppliers

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

Supplier	Address	Contact Person	Contact Details
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

Supplier	**Address**	**Contact Person**	**Contact Details**
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