# ENERGY AUDIT - 2023

## SREE SANKARA COLLEGE

## KALADY, ERNAKULAM

*EXECUTED BY*

**ATHUL ENERGY CONSULTANTS PVT LTD**
4th FLOOR, CAPITAL LEGEND BUILDING,
KORAPPATH LANE, ROUND NORTH, THRISSUR-680020
Ph: +91 7356111990-6 Web: www.athulenergy.com E-Mail: info@athulenergy.com

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## PREFACE

Every institution should be imparting knowledge about the campus environment and its surroundings through activities that follows the principles of sustainability. An energy audit is essential first step to reduce energy cost and greenhouse emissions. Audit is defined as a systematic and implement examination of data statements, records, operations and performance of an enterprise for a purpose. Energy audits is a systematic study or survey to identify how energy being used in its own facility. And identifying the energy savings opportunities in the building Behavioural Change through the student education can provide greatest benefit at least cost. Even small savings in each house holds make dramatic change in the society and for nation. The idea of energy conservation and sustainability will be percolated to society through students will have long standing effect and successful too.

This report is compiled by the BEE certified energy auditor along with the project engineers who are experienced in the field of energy, environment and management.

## ACKNOWLEDGEMENTS

We express our sincere gratitude to Sree Sankara College, Kalady for giving us an opportunity to carry out the project of Energy Audit. We are extremely thankful to all the staffs for their support to carry out the studies and for input data, and measurements related to the project of Energy Audit.

| | | |
|---|---|---|
| 1 | Dr. Preethi Nair | Principal |
| 2 | Dr. Manju T | IQAC Co-ordinator |

Also mentioning our Energy audit team members for successfully completing the assignment in time and making their best efforts to add value.

**ENERGY AUDIT TEAM**

1. **Mr. Santhosh A**
   Registered Energy Auditor of Bureau of Energy Efficiency (BEE – Govt. of India)
   Accredited Energy Auditor No – EA 7597

2. **Mr. Ashok K M P**
   Registered Energy Manager of Bureau of Energy Efficiency (BEE – Govt. of India)
   Accredited Energy Manager No – EA 25612

3. **Mr. Harikrishnan K**
   Project engineer

4. **Ms. Keerthana K**
   Project engineer

5. **Ms. Neema Joy P**
   Project engineer

Yours faithfully

Managing Director
Athul Energy Consultants Pvt Ltd

# EXECUTIVE SUMMARY

## 1. ENERGY SAVING PROPOSALS

**TABLE 1: ENERGY SAVING PROPOSALS**

| Sl. no | Energy conservation measures | Annual Energy Savings | Annual Financial Savings | Investment | Simple payback period |
|---|---|---|---|---|---|
| | | kWh | Rs | Rs | Months |
| 1 | *Power factor Improvement from 0.97 to 0.99* | | *23,025* | *16,000* | *8* |
| 2 | *Contract Demand optimization by improving the PF* | | *16,345* | *Nil* | *Immediate* |
| 3 | *Replacement of Ceiling fans(75W) with BLDC fans 5 star rated(28W) – 250 nos* | *10,575* | *78,255* | *8,75,000* | *134* |
| 4 | *Replacement of Fluorescent lights T12(40W) -49 nos & T8 (36W) - 130 nos with LED (20W)* | *2,203* | *16,304* | *53,700* | *40* |
| 5 | *Replacement of non/low star AC (1.5 Ton) with 5-star AC (1 Ton)* | *1,337* | *9,894* | *38,000* | *46* |
| **Total** | | ***14,115*** | ***1,43,823*** | ***9,82,700*** | ***82*** |
| 6 | *Integration of 50 kW Solar PV system* | | 4,08,000 | 27,50,000 | *7 Years* |

## 2. ENERGY AUDIT SUMMARY & RECOMMENDATIONS

The summary of the report with respect to each section is as follows.

1. **Baseline energy performance:**

   **Electricity consumption analysis**

- **Demand analysis:** The demand analysis was done for the last 12 months. It is found that the recorded maximum demand was 119 kVA which is 99.5% of the contract demand. The percentage of recorded maximum demand in the normal, Peak and off-peak period registered with respect to the contract demand (120 kVA) is 99.5%, 58.8%, and 43.5% respectively.
- **Power factor**: The PF in the last 12 months was found to be 0.97 (average). Installing 16kVar inline capacitor across the incomer (LT side) would help to maintain the power factor above the prescribed limit and improve the power factor to unity

- **Renewable energy integration:** College is benefitted with space in its roof top hence they can go for solar installations in their facility and go for zero billing and claimed as solar powered college or self-sustainable College.
- **Sub metering of panels:** Sub metering of panels suggested to know the separate energy consumption of each building.

**2. Equipment and utility description**

- **Light loads:** By replacing the fluorescent lighting fixtures (T12, T8) with LED light will reduce the overall power consumption. Detailed analysis given in the energy conservation measures section.
- **Ceiling fan loads:** Ceiling fans are installed in majority of the areas by replacing it with Brushless DC fans which consumes in the range of 25 to 30W at full speed, instead of 75W in normal fans, will reduce the power consumption considerably. Also, while purchasing new fans priority should be given for BLDC.

## 3. ENERGY PERFORMANCE INDEX (EPI)

EPI was based on the energy consumption in May 2022 to April 2023. The projected energy consumption after the implementation of energy saving proposals is given in the table below.

**TABLE 2: ENERGY PERFORMANCE INDEX**

| Sl. No: | Energy Performance and climate impact | Unit | Baseline | Projection | % of reduction - annum |
|---|---|---|---|---|---|
| 1 | Annual Electricity Consumption* | kWh | 1,92,610 | 1,78,495 | 7.33 |
| | | TOE | 17 | 15 | |
| 2 | Annual Diesel Consumption | kg | 830 | 830 | 0.00 |
| | | TOE | 0.8 | 0.8 | |
| 3 | Annual LPG Consumption | Kg | 328 | 328 | 0.00 |
| | | TOE | 0.344 | 0.344 | |
| 4 | Total Energy Consumption | TOE | 17.70 | 16.48 | |
| 5 | Energy Performance Index | TOE/Sq.m | 0.00093 | 0.00086 | |
| 6 | Annual Energy Cost | Rs in lakhs | 24.29 | 22.85 | 5.92 |
| 7 | Annual Specific Electricity Consumption | kWh/Students & Staff | 85 | 79 | |
| | | kWh/Sq.m | 10.10 | 9.36 | |
| 8 | Annual Specific Electricity Consumption | TOE/Students & Staff | 0.008 | 0.007 | |
| 9 | Annual Carbon Footprint- Electricity | Ton CO2 | 152 | 141 | 7.33 |
| 10 | Annual Carbon Footprint- Diesel | Ton CO2 | 2.56 | 2.56 | 0.00 |
| 11 | Annual Carbon Footprint- LPG | Ton CO2 | 0.98 | 0.98 | 0.00 |
| 12 | Annual Specific Carbon Footprint | Ton CO2/Student | 0.069 | 0.064 | 7.16 |

** Only sixty percentage of the total electricity consumption is taken into consideration since the electric connection is common for all other institution in the campus premises.*

***Note: Unit conversions:***

| | | |
|---|---|---|
| *TOE* | = | *10 million kCal (BEE energy audit manual)* |
| *MWh of electricity* | = | *0.79 Ton of $CO_2$ (www.cea.gov.in)* |
| *Kg of LPG* | = | *2.99 Ton of $CO_2$ (www.cea.gov.in)* |
| *Kilogram of Diesel* | = | *3.085 Ton of $CO_2$ (www.cea.gov.in)* |
| *Kg of LPG* | = | *10500 kCal (BEE energy audit manual)* |
| *Kilogram of Diesel* | = | *9500 kCal (BEE energy audit manual)* |
| *kWh of electricity* | = | *860 kCal (BEE energy audit manual)* |

## 4. ANNUAL CARBON FOOTPRINT OF APPLIANCES

The present carbon dioxide generation by appliances in the college and the projected value after the implementation of the energy conservation measures is given in the figure below

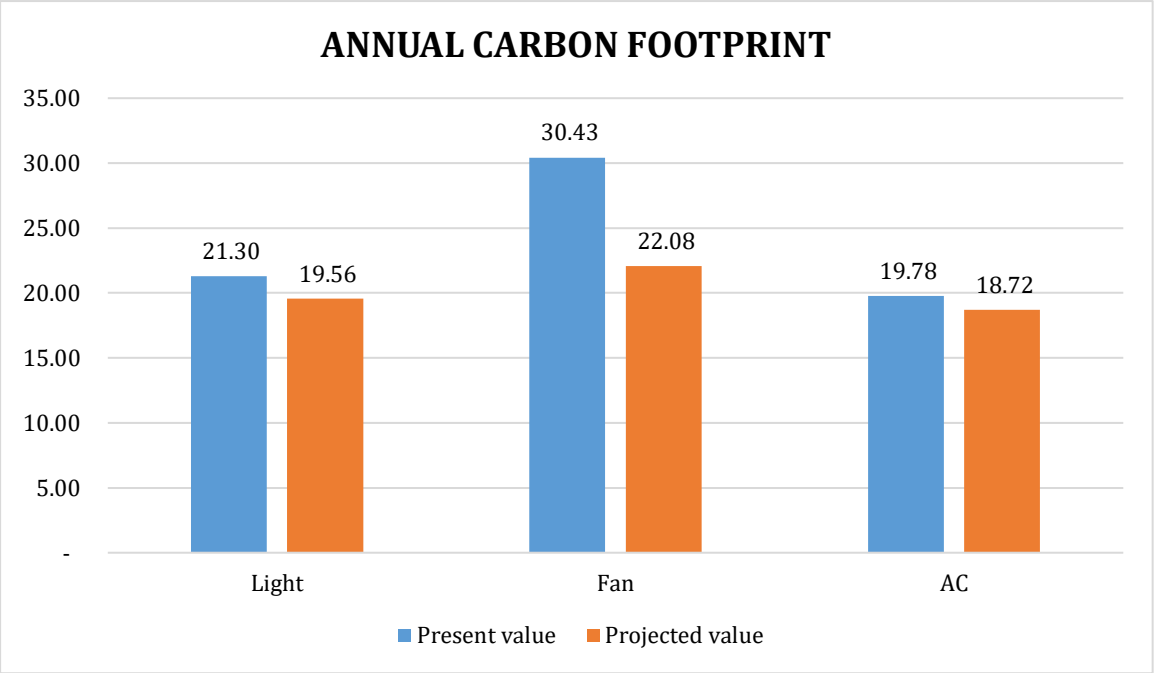



**FIGURE 1: ANNUAL $CO_2$ EMISSION**

## 5. CARBON FOOT PRINT

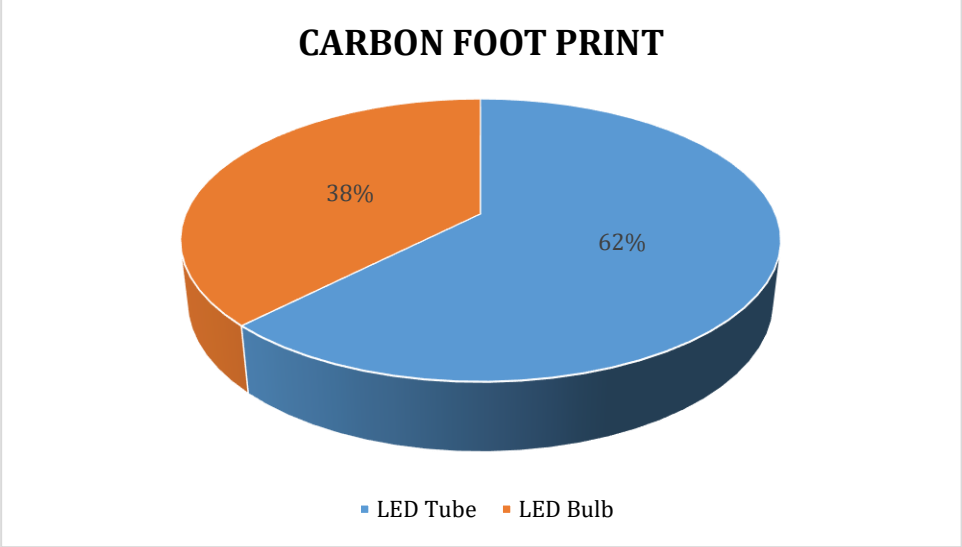
Carbon foot print is often used as short hand for the amount of carbon emission (usually in Tonnes) being emitted by an activity or by organization this is an important component in ecological foot print or the depicting the biological space reduction in the earth. Various environment protection and energy conservation connected with carbon footprint. Institution took its accountability to protect nature and taken few steps for the carbon neutral campus

1. Protecting and conserving trees inside and outside the campus through various students' activities
2. Replacement of old CFLs and tubes with energy efficient LED lights
3. Sustainable construction of buildings for natural ventilation and light in the classrooms and laboratories.

**TABLE 3 CARBON FOOT PRINT**

| Particulars | Energy consumption reduction (kWh) | Carbon Emission reduction (Ton $CO_2$) | % of total |
|---|---|---|---|
| Replacement of 281numbers of T8 Tube (36W) with LED tube light | 3237 | 2.56 | 62 |
| Replacement of 301 numbers of CFL (18 W) with (9W )LED | 1950 | 1.54 | 38 |
| **Total** | **5187.6** | **4.10** | **100** |

**FIGURE 2: CARBON FOOT PRINT**



# INTRODUCTION

## 1. ENERGY AUDIT

An energy audit is a key to assessing the energy performance of an energy consuming facility and for developing an energy management program. The typical steps of an energy audit are:

- Preparation and planning
- Data collection and review
- Plant surveys and system measurements
- Observation and review of operating practices
- Data documentation and analysis
- Reporting of the results and recommendations

### 1.1. Definition of energy auditing

In the Indian Energy Conservation Act of 2001 **(BEE 2008)**, an energy audit is defined as: **"The verification, monitoring and analysis of the use of energy and submission of technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energy consumption."**

### 1.2. Objectives of Energy Auditing

The objectives of an energy audit can vary from one plant to another. However, an energy audit is usually conducted to understand how energy issued within the plant and to find opportunities for improvement and energy saving. Sometimes, energy audits are conducted to evaluate the effectiveness of an energy efficiency project or program. In the College as per the request from the institution, we have assessed the energy consumption and saving opportunities at present scenario.

**Methodology for the study**

The methodology adopted for energy audit starts from historical energy data analysis, power quality analysis, monitoring of operational practices, system evaluation, cost benefit analysis of the energy conservation opportunities, and prepare plan for implementation. The proposals given in the report includes economical energy efficiency measures to reduce facilities unnecessary energy consumption and cost. The energy conservation options, recommendations and cost benefit ratio, indicating payback period are included in this report.

**Scope of Work**

The Scope of Work includes:

1. Historical energy data analysis.
2. Electrical, Mechanical and Thermal energy analysis.
3. Power Quality Analysis.
4. Identification of Energy saving opportunities.
5. Cost Benefit Analysis.

## 2. SREE SANKARA COLLEGE, KALADY

Sree Sankara College, Kalady was founded in the year 1954 by Swami Agamananda, a social reformer and a foresighted scholar of Sri Ramakrishna Advaita Ashram. The institution was established with a view to perpetuating the memory and doctrines of the great saint and philosopher, Adi Sankaracharya and to nurture his birth place as a cultural citadel. The foundation stone was laid on 28 August, 1953 by His Highness the Maharaja of Travancore in the presence of The Maharaja of Cochin and several other distinguished personalities. The Sree Sankara College Association was formed in July 1953.

The vision & mission of the organization was to establish a Centre of Higher Learning with two major objectives —dissemination of knowledge in tune with a university curriculum and fostering community development.

The institution was raised to the status of a First Grade College in 1956. It is affiliated to the Mahatma Gandhi University and is included under sec.2 (f) and 12 (B) of the UGC act, 1956.

In June 1960, the patronage of the college became vested in His Holiness the Jagadguru Sri Sri Sankaracharya Swamigal of Dakshinamnaya. Currently, Sri Sri Bharathi Theertha Mahaswamigal, of Sringeri Mutt, steers the administration through a Board of Directors with Sri. K. Anand as the Managing Director.

The college has done consistently well in Curricular and Cocurricular activities. The National Assessment and Accreditation Council (NAAC), a statutory body of the UGC has accredited the college B Grade with 2.82 CGPA on a four-point scale. The Departments of Economics, Commerce, Sanskrit and Microbiology are approved Research Centres under the Mahatma Gandhi University.

***VISION***

To achieve excellence in higher Education, with a stress on, creativity, skill development, employability, personal values with social

***MISSION***

To mould good citizens with ingenuity, adaptability, social commitment and ethical values who can provide innovative leadership in all walks of life.

## 3. GENERAL DETAILS

The general details of the College are given below in table.

**TABLE 4: GENERAL DETAILS**

| Sl. No: | Particulars | Details |
|---|---|---|
| 1 | Name of the College | Sree Sankara College, Kalady |
| 2 | Address | Sree Sankara College<br>Sankar Nagar, Mattoor, Kalady P.O.,<br>Ernakulam – 683 574 |
| 3 | Contact Person | Dr. Mini K D, Ph: 9605055445 |
| 4 | Contact Number & | 0484-2462341 |
| | E mail | info@ssc.edu.in |
| 5 | Web site | www.ssc.edu.in |
| 6 | Type of Building | Educational Institution |
| 7 | Annual Working Days | 180 |
| 8 | No: of Shifts | Day Shift (One) (9:30AM -3:30PM) |
| 9 | No: of students enrolled | 2100 |
| 10 | No: of teaching staff | 100 |
| 11 | No: of non-teaching staff | 44 |
| 12 | No: of departments | 20 |
| 13 | Total Built Up area | 19078 Sq. m |
| 14 | Total land area | 18 acres |
| 15 | Average power consumption per month. | 26,751 kWh |
| 16 | Average electricity charges per month. | Rs. 2,64,088 /- |

## 4. LOAD BALANCE- ELECTRICAL

The details of the loads installed in the college are given below:

**TABLE 5: CONNECTED LOAD**

| Sl. No: | Particulars | Total Load (kW) | Percentage |
|---|---|---|---|
| 1 | Light & Fan | 76.90 | 34 |
| 2 | Computer and other electronic loads | 55.46 | 25 |
| 3 | Air Conditioner Load | 29.60 | 13 |
| 4 | Other Loads | 62.66 | 28 |
| **Total Power (kW)** | | **224.61** | **100** |

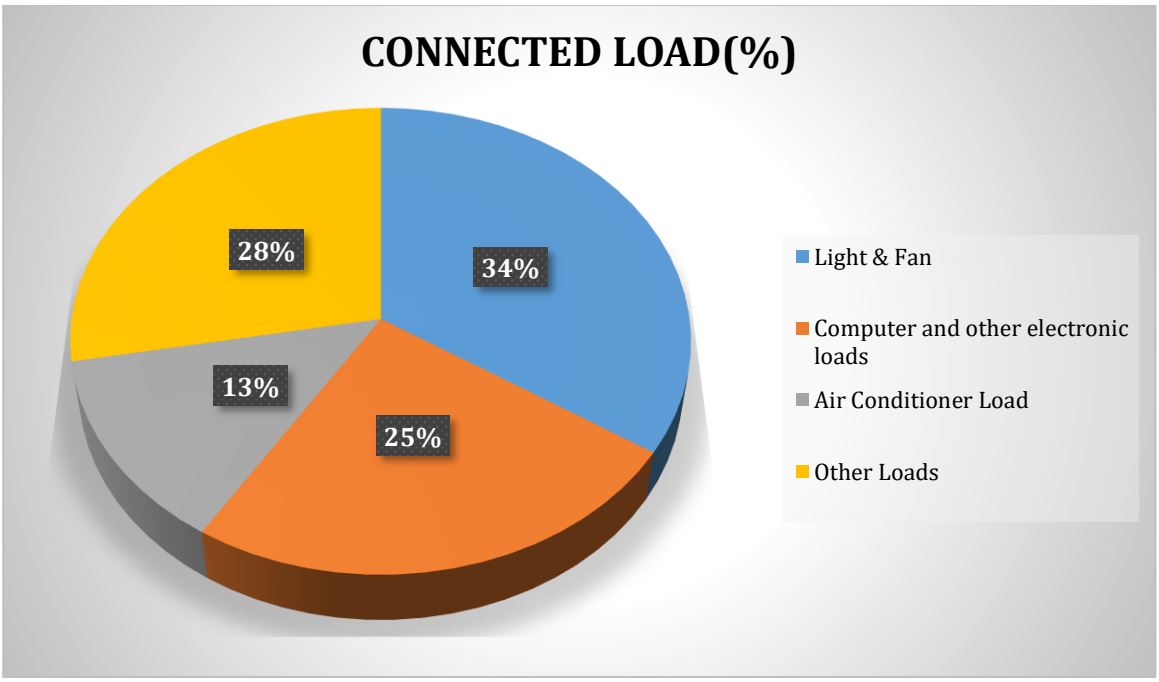



**FIGURE 3: LOAD BALANCE – ELECTRICAL**

## ENERGY & UTILITY DESCRIPTION

In this section the single line diagrams of electricity and water are given which provides an overview of the energy flow in the building.

### 1. SINGLE LINE DIAGRAM – ELECTRICAL

The electrical single line diagram of the college is given below:

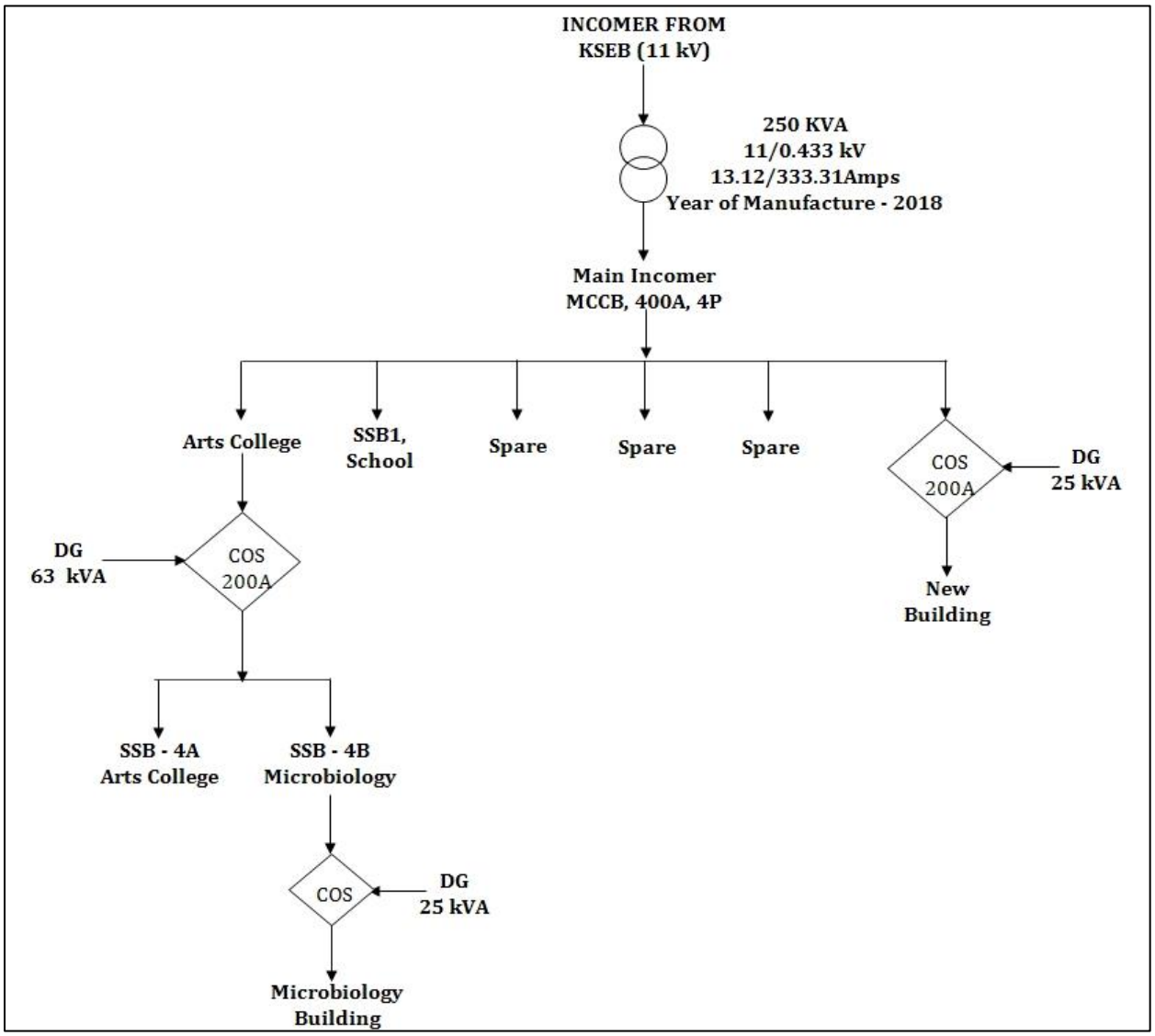



**FIGURE 4: SINGLE LINE DIAGRAM – ELECTRICAL**

## 2. SINGLE LINE DIAGRAM – WATER

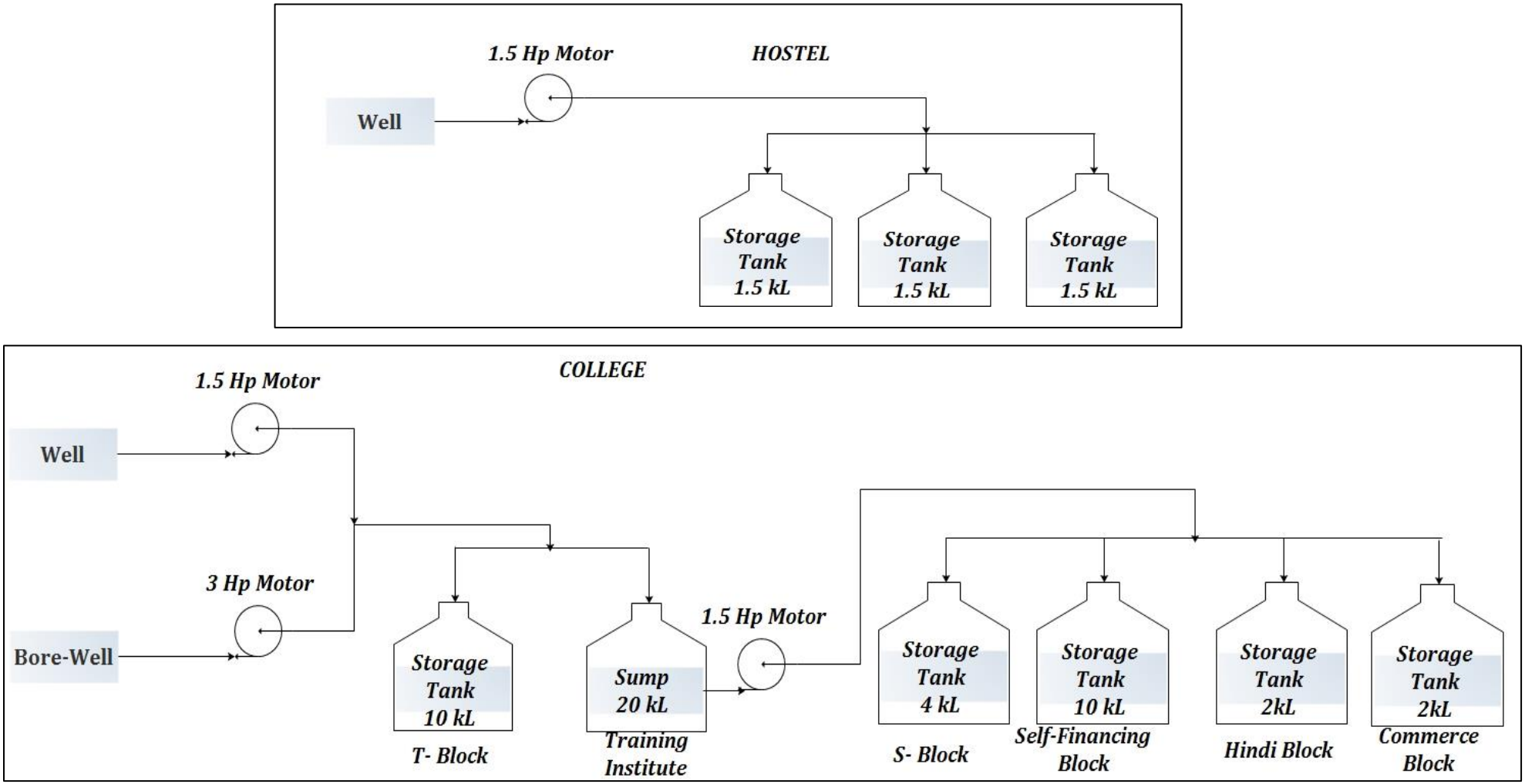



**FIGURE 5: SINGLE LINE DIAGRAM - WATER**

# ENERGY ANALYSIS

The different type's energy usage is given in this section. The major source of energy to the college is electricity. Other forms come in the form of diesel and LPG.

## 1. ELECTRICITY CONSUMPTION ANALYSIS

The major source of electricity to the college and hostel is the electrical connection from the KSEBL. Three diesel generators are provided in the college, but it is only used during the power failures in critical days like examinations or college events.

### I. DESCRIPTION OF ELECTRICITY BILL

Base line data given below is based on the Electricity bill provided by the supplier of electricity to the College. Details obtained from the KSEBL bill for the month of May 2022 to April 2023is as follows in the Table.

**TABLE 6: KSEBL BILL ANALYSIS**

| Particulars | Details | |
|---|---|---|
| Consumer No | LCN: 4/9247 | |
| Contract Demand (kVA) | 120 kVA | |
| Connected Load (kW) | 288.476 kW | |
| Tariff | HT II (B) General | |
| Recorded maximum demand (kVA) | 119.44 | |
| Average monthly electricity consumption (kWh/month) | 26,751 | |
| Average Power factor | 0.97 | |
| Average Demand charges (Rs/month) | 53,289 | |
| Annual power factor penalty & Incentive (Rs/year) | Penalty – Rs. 2,014 /-<br>Incentives – Rs.21,166 /- | |
| Demand charge (Rs / kVA) | 440 | |
| Revised Demand Charge from June 2022 | 500 | |
| Energy charge (Rs/kWh) | Normal | 6.2 |
| | Peak | 9.3 |
| | Off Peak | 4.65 |
| Revised Energy charge (Rs/kWh) from June 2022 | Normal | 6.8 |
| | Peak | 10.2 |
| | Off Peak | 5.1 |
| Average electricity cost (Rs/month) | 2,64,088/- | |

***Inference & Suggestions***

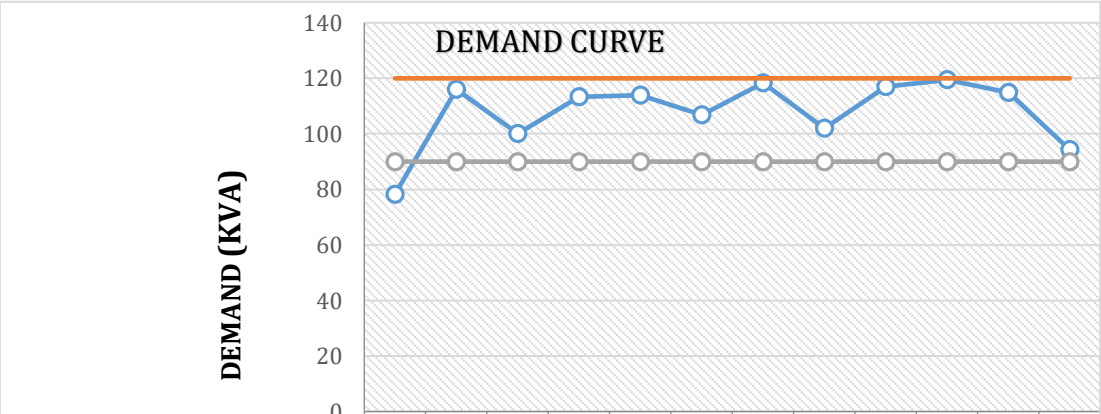
i. *Average Power factor is found to be 0.97. The college received incentives for 10 out of 12 months due to their power factor being above the prescribed limit of 0.95. However, they were levied a penalty for one month during which the power factor was below the prescribed limit.*

ii. *16kVAr inline capacitor can be connected at the transformer secondary side to improve the PF to unity. Detailed explanation provided in the annexure-1*

iii. *Recorded maximum demand (RMD) during past 12 month was 119.44 kVA. It was recorded during the month of February 2023.*

## *II. DEMAND ANALYSIS*

This section analyses the trend for the maximum demand versus the Contract Demand (CD) over a 12-month period (May 2022 to April 2023).




| | May -22 | Jun-22 | Jul-22 | Aug-22 | Sep-22 | Oct-22 | Nov-22 | Dec-22 | Jan-23 | Feb-23 | Mar-23 | Apr-23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RECORDED MAXIMUM DEMAND | 78 | 116 | 100 | 113 | 114 | 107 | 118 | 102 | 117 | 119 | 115 | 94 |
| CONTRACT DEMAND | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| 75% Contract demand | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |

**FIGURE 6: DEMAND IN VARIOUS TIME ZONE**

***Inference***

i. *Annual demand charges came as **Rs. 6,39,467 /-***

ii. *The recorded maximum demand came in the range of 65.2% to 99.5% with respect to the contract demand with an average of 89.9%.*

iii. *The recorded maximum demand was observed to be above the minimum demand that is being charged by the utility which is 90 kVA in every month except for May 2022.*

***Suggestion***

i. *Maintaining the power factor to near unity in lagging mode yields dual benefits, the demand will further reduce and the incentives for the power factor will rise.*

ii. *Installing capacitor will help to maintain the power factor to near unity.*

## *III. ELECTRICITY DEMAND IN VARIOUS TIME ZONES*

The variations of demands in the time zones are given below in figure.

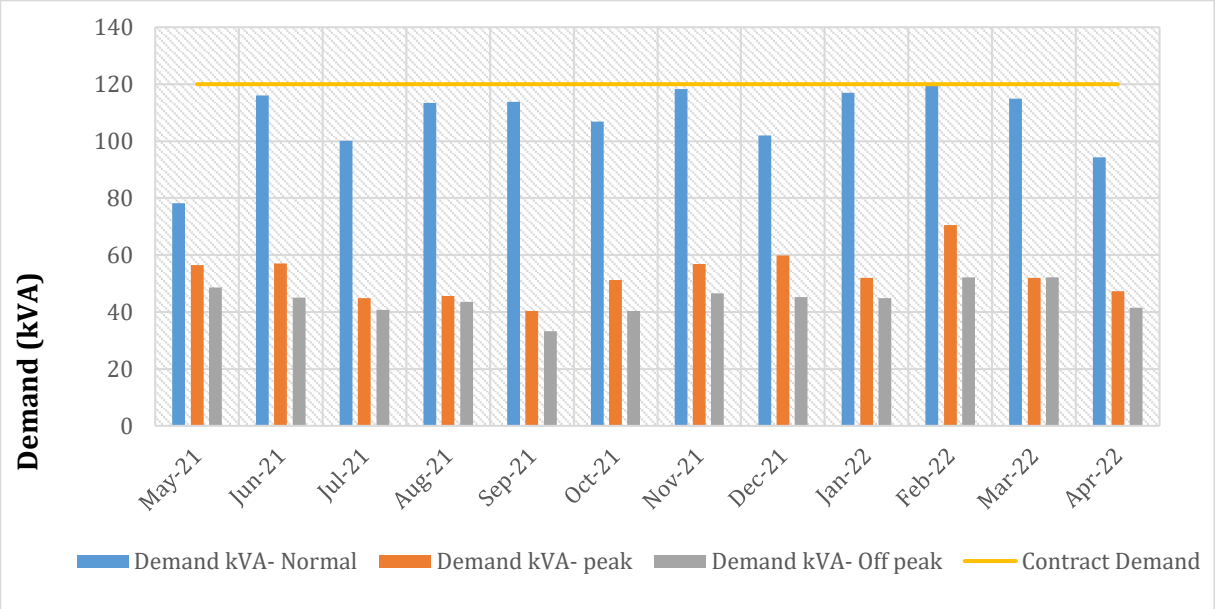



**FIGURE 7: ELECTRICITY DEMAND IN VARIOUS TIME ZONE**

***Inference***

i. *The average demand registered during the normal, Peak and off-peak period at college with respect to the contract demand (120 kVA) were 89.9%, 44% and 37.1% respectively.*

ii. *The percentage of maximum demand during the normal, Peak and off-peak period registered at institution with respect to the Contract demand (120 kVA) were 99.5%, 58.8% and 43.5% respectively.*

## IV. POWER FACTOR ANALYSIS IN KSEBL BILL

The Power factor is the ratio of Active power (kW) and apparent power (kVA).

$$PF = Active\ energy kWh / Apparent energy\ (kVAh)$$

The power factor variations in past one year is given below in figure.

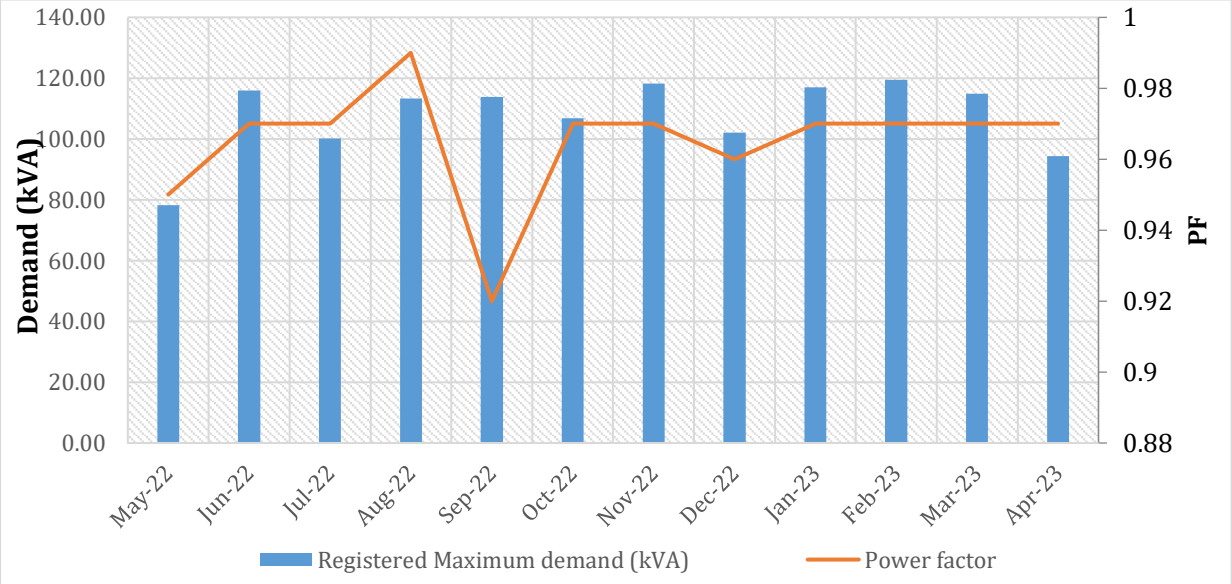



**FIGURE 8: POWER FACTOR ANALYSIS**

***Inference***

i. *Average power factor during the past one year is found to be 0.97*
ii. *Power factor penalty was paid by college for September 2022. If the power factor is maintained close to unity, penalty incurred can be avoided.*
iii. *Capacitors are not installed. A 16 kVAr inline capacitor can be provided at the transformer secondary so as to improve the PF and gain incentives. Detailed explanation is given in the section Energy Conservation Measures ECM 01.*

## V. TARIFF RATES ANALYSIS

The average monthly energy and demand charges for the period May 2022 to April 2023 is represented in Fig.

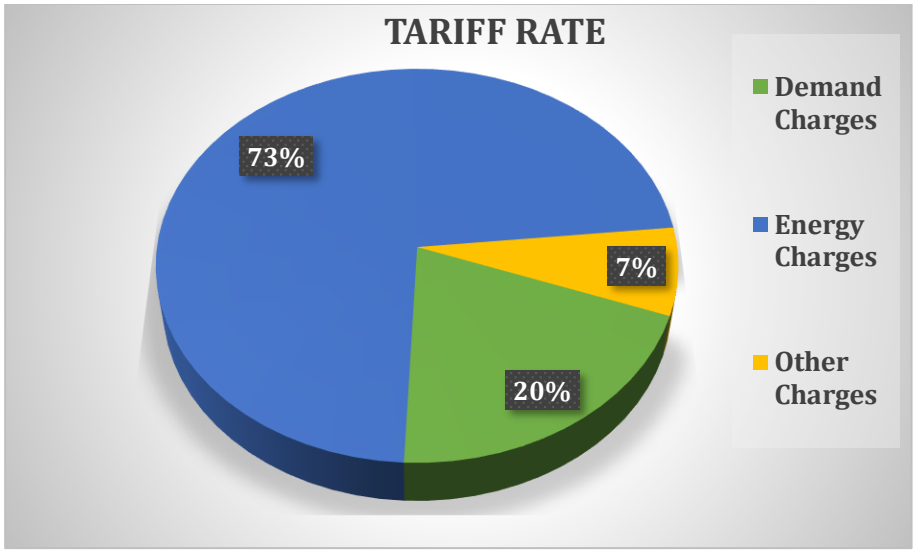



**FIGURE 9: TARIFF RATE ANALYSIS**

***Inference***

i. *Average demand charges for the past one year were* ***Rs 53,289 /-*** *per month and energy charges was* ***Rs 1,91,875 /-*** *per month.*

ii. *The energy charges come about 73% of the total bill.*

## VI. SPECIFIC ELECTRICITY CONSUMPTION (KWH/STUDENTS & STAFF & KWH/BUILDING AREA)

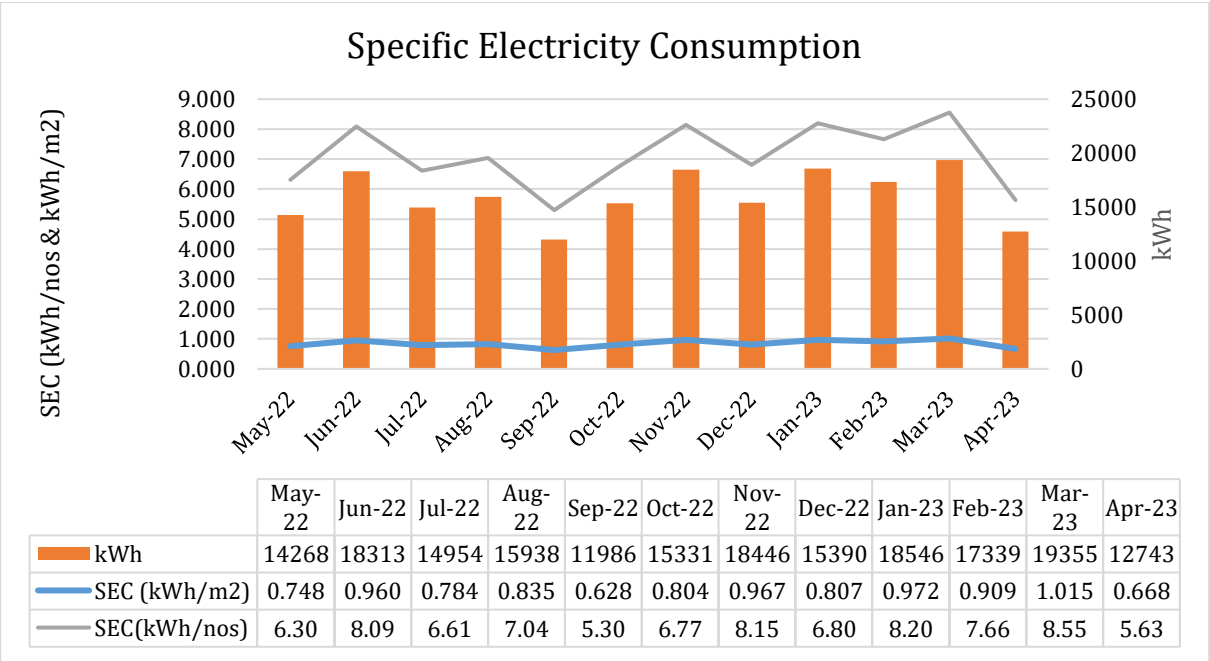
The electricity consumption from the May 2022 to April 2023 has been taken for the benchmarking. Here the comparison is done with electricity consumption and the building area and number of students. The below table shows the specific electricity consumption of the college.

**TABLE 7: SPECIFIC ELECTRICITY CONSUMPTION**

| Month | Unit Consumption* | No: of students & Staff | Building area | Specific Electricity Consumption | SEC |
|---|---|---|---|---|---|
| | kWh | Number | $m^2$ | kWh/Students & Staff | $kWh/m^2$ |
| May-22 | 14268 | 2263 | 19,078 | 6.30 | 0.75 |
| Jun-22 | 18313 | 2263 | 19,078 | 8.09 | 0.96 |
| Jul-22 | 14954 | 2263 | 19,078 | 6.61 | 0.78 |
| Aug-22 | 15938 | 2263 | 19,078 | 7.04 | 0.84 |
| Sep-22 | 11986 | 2263 | 19,078 | 5.30 | 0.63 |
| Oct-22 | 15331 | 2263 | 19,078 | 6.77 | 0.80 |
| Nov-22 | 18446 | 2263 | 19,078 | 8.15 | 0.97 |
| Dec-22 | 15390 | 2263 | 19,078 | 6.80 | 0.81 |
| Jan-23 | 18546 | 2263 | 19,078 | 8.20 | 0.97 |
| Feb-23 | 17339 | 2263 | 19,078 | 7.66 | 0.91 |
| Mar-23 | 19355 | 2263 | 19,078 | 8.55 | 1.01 |
| Apr-23 | 12743 | 2263 | 19,078 | 5.63 | 0.67 |
| **Average** | **16051** | **2263** | **19078** | **7.09** | **0.84** |
| **Annual Specific Electricity Consumption** | | | | **85.11** | **10.10** |
| **Annual Energy Consumption*** | | | | | **1,92,610** |

** Only sixty percentage of the total electricity consumption is taken into consideration since the electricity connection is common for all other institution in the campus premises.*

The energy performance index is plotted in the below chart which gives a pictorial representation of the specific electricity consumption and units consumed in various months during the period from May 2022 to April 2023.




| | May-22 | Jun-22 | Jul-22 | Aug-22 | Sep-22 | Oct-22 | Nov-22 | Dec-22 | Jan-23 | Feb-23 | Mar-23 | Apr-23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| kWh | 14268 | 18313 | 14954 | 15938 | 11986 | 15331 | 18446 | 15390 | 18546 | 17339 | 19355 | 12743 |
| SEC (kWh/m2) | 0.748 | 0.960 | 0.784 | 0.835 | 0.628 | 0.804 | 0.967 | 0.807 | 0.972 | 0.909 | 1.015 | 0.668 |
| SEC(kWh/nos) | 6.30 | 8.09 | 6.61 | 7.04 | 5.30 | 6.77 | 8.15 | 6.80 | 8.20 | 7.66 | 8.55 | 5.63 |

**FIGURE 10: SPECIFIC ELECTRICITY CONSUMPTION**

## 2. DIESEL CONSUMPTION ANALYSIS

The Diesel is the fuel which is used for the DGs. The details of the diesel consumption in the last academic year and the generator details are given in the table below.

**TABLE 8: DIESEL CONSUMPTION**

| Particulars | Annual Diesel consumption (kg) | Calorific value (TOE) |
|---|---|---|
| **Generator** | 830 | 0.79 |

*Calorific value of Diesel is 9500 Kcal and 1 TOE means 10000000 Kcal.*

**TABLE 9: GENERATOR DETAILS**

| Particulars | Make | kVA | Fuel |
|---|---|---|---|
| New Building | - | 25 | Diesel |
| Microbiology Block | Kirloskar | 25 | Diesel |
| Main Block | KOEL | 62.5 | Diesel |

## 3. LPG CONSUMPTION ANALYSIS

The details of the LPG consumption in the last academic year are given in the table below.

**TABLE 10: LPG CONSUMPTION**

| Particulars | Annual LPG consumption (Kg) | Calorific value (TOE) |
|---|---|---|
| Microbiology Lab | 193 | 0.20 |
| Biotechnology Lab | 77.2 | 0.08 |
| Biochemistry Lab | 19.3 | 0.02 |
| Zoology Lab | 38.6 | 0.04 |
| **Total** | **328** | **0.34** |

# ANNEXURE – 1

## 1. ENERGY SAVING PROPOSALS - 1

### PF IMPROVEMENT IN ELECTRICAL SYSTEM

**Background**

By referring the last year bills, it is clear that the power factor was below the prescribed limit for several months. As per the KSEBL tariff structure, if the PF is maintained above 0.95(lag), the consumer is entitled to receive incentives.

**Proposal**

- Provide inline capacitor of 16kVAr at the transformer secondary side to improve the PF to unity and gain incentives.

  Calculations for the energy saving proposal is given in the table below.

**Table 11 EC PROPOSAL NO:1**

| Particulars | Units | Values |
|---|---|---|
| Present PF | | 0.97 |
| Proposed PF | | 0.99 |
| Present average energy consumption/month | kWh/month | 26,751 |
| Present average energy charge/month | Rs/month | 1,91,875 |
| Incentives for improving the PF/month | Rs/month | 1,919 |
| Annual incentive | Rs/annum | 23,025 |
| **Annual Savings** | **Rs/annum** | **23,025** |
| **Investment @Rs.1000 per kVAr** | **Rs** | **16,000** |
| **Payback period** | **Months** | **8** |

## 2. ENERGY SAVING PROPOSALS - 2

### CONTRACT DEMAND OPTIMIZATION BY IMPROVING THE PF

#### Background

The contract demand of the College is found to be 120 kVA. By analysing the past 12 months bills, it is found that the maximum demand registered in the college was 119.44 kVA which is about 99.5% of the contract demand. The power factor in the college is found to be low with an average value of 0.97 lagging. Also, the average demand registered during the past 12 months was 68.42 kVA which is 57% of contract demand.

#### Proposal

It is proposed to improve the power factor to unity by providing an inline capacitor of 16 kVAr at the transformer secondary. By implementing EC Proposal 01, the demand on the college will come down considerably and the demand charges also reduces. The average maximum demand will reduce from 108 kVA to 105 kVA thus resulting in a 3% reduction in the demand. Detailed calculation for the proposal is shown in the table below.

#### Calculations

**Table 12 EC PROPOSAL NO:2**

| Particulars | Units | Value |
|---|---|---|
| Present average registered maximum demand | kVA | 108 |
| Present average registered power factor | | 0.97 |
| Proposed Power factor | | 0.99 |
| Expected average maximum demand/month | kVA | 105 |
| Reduction in demand - average/month | kVA | 3 |
| Demand charges | Rs/kVA | 500 |
| Savings in demand charges/month | Rs/Month | 1362 |
| Annual financial savings in demand charges | Rs/Year | 16,345 |
| **Investment cost** | **Rs** | **Nil** |
| **Simple payback period** | **Months** | **Immediate** |

## 3. ENERGY SAVING PROPOSALS – 2

**REPLACEMENT OF CEILING FANS IN THE OFFICE WITH ENERGY EFFICIENT BLDC FANS**

### BACKGROUND

A BLDC fan takes in AC voltage and internally converts it into DC using SMPS. The main difference between BLDC and ordinary DC fans is the commutation method. A commutation is basically the technique of changing the direction of current in the motor for the rotational movement. In a BLDC motor, as there are no brushes, so the commutation is done by the driving algorithm in the Electronics. The main advantage is that over a period, due to mechanical contact in a brushed motor the commutators can undergo wear and tear, this thing is eliminated in BLDC Motor making the motor more rugged for long-term use. To explain, BLDC technology in simpler terms, BLDC uses a combination of Permanent Magnets and Electronics to achieve the kind of efficiency and performance, it delivers. A BLDC fan composes of 3 main components: - 1. Stator 2. Rotor 3. Electronics

### PROPOSAL

Replace the ceiling fans with BLDC in the as per preference of operating hours as office areas. Staff rooms and in class rooms and in hostels the calculation for the savings is given in the table.

**Table 13 EC PROPOSAL NO:3**

| Particulars | Units | BLDC fan |
|---|---|---|
| Present Power Consumption | Watts | 75 |
| Proposed Power Consumption | Watts | 28 |
| Reduction in power | Watts | 47 |
| Operating hours per day | Hr/day | 5 |
| No: of working days per year (Average) | Nos | 180 |
| No: of fans operating | Nos | 250 |
| **Annual energy savings** | **kWh/year** | **10575** |
| Cost per kWh | Rs | 7.40 |
| **Annual Financial Saving** | **Rs/year** | **78255** |
| Cost of BLDC fan | Rs | 3500 |
| **Investment** | **Rs** | **875000** |
| **pay back** | **Month** | **134** |

## 4. ENERGY SAVING PROPOSALS – 4

**REPLACEMENT OF FLUORESCENT TUBES WITH ENERGY EFFICIENT LED LIGHTS**

**BACKGROUND**

The present light fittings are mainly been the LED and fluorescent light of different ratings. Replacement of Fluorescent lights to be done in phase manner with LED lights.

**PROPOSAL**

By replacing the light fitting with LEDs of appropriate ratings the power consumption will reduce considerably by approximate 50% with the present operating hours. The calculation for the savings, approximate investment cost and payback period is given in the table below.

**Table 14 EC PROPOSAL NO:4**

| **Particulars** | **Units** | **T8** | **T12** |
|---|---|---|---|
| Power of Fluorescent lights | Watts | 40 | 36 |
| Power of proposed LED tube | Watts | 20 | 20 |
| Difference in Wattage | Watts | 20 | 16 |
| Operating hours per day | Hrs/day | 4 | 4 |
| No: of working days per year (Average) | Nos | 180 | 180 |
| Number of Lights operating | Nos | 49 | 130 |
| **kWh Saving per Annum** | **kWh/year** | **706** | **1498** |
| Cost per kWh (Average) | Rs | 7.40 | 7.40 |
| **Annual Financial Savings** | **Rs/year** | **5221** | **11082** |
| Cost of LED tube | Rs | 300 | 300 |
| **Investment for LED lights** | **Rs** | **14700** | **39000** |
| **Simple Payback period** | **Months** | **34** | **42** |
| **SUMMARY** | | | |
| **Annual unit savings** | kWh | 2203 | |
| **Total savings** | Rs | 16304 | |
| **Total investment** | Rs | 53700 | |
| **Payback period** | months | 40 | |

## 5. ENERGY SAVING PROPOSAL – 5

**REPLACEMENT OF 3 STAR AC WITH ENERGY EFFICIENT 5 STAR AC**

**BACKGROUND**

The present Air conditioners in the server room are having high power consumption as they having low star AC. This is the sample calculation for replacement of AC at PG block server room (Room No: T38) the operating hours are 24 Hrs. and with low star value.

**PROPOSAL**

Replace the 1.5 TR 3-star with new 1 ton 5 star rated one will provide sufficient energy savings. The calculation for savings is given in the tables below.

**Table 15 EC PROPOSAL NO:5**

| Particulars | Units | Value |
|---|---|---|
| Present power consumption of AC | Watts | 1334 |
| Power of proposed 5 Star AC | Watts | 715 |
| Difference in Wattage | Watts | 619 |
| Avg No: of working hours/day | Hrs/day | 12 |
| No: of working days per year (Average) | Nos/year | 180 |
| No: of working hours per annum | Hrs/year | 2160 |
| Number of AC operating | Nos | 1 |
| **kWh Saving per Annum** | **kWh/year** | **1337** |
| Cost per kWh (Average) | Rs | 7.4 |
| **Annual Financial Savings** | **Rs/year** | **9894** |
| Cost of 5 Star AC | Rs | 38000 |
| **Investment for AC** | **Rs** | 38000 |
| **Simple Payback period** | **Months** | **46** |

## RENEWABLE ENERGY INTEGRATION

The Sun is an inexhaustible, reliable and non-polluting source of power. Since the inception of life on earth, the only energy that was available came from the sun. The time is now approaching when humankind will again depend upon the sun as dominant energy source. We are aware that fossil fuels are not going to last forever. Of the numerous renewable sources of energy known to mankind, Solar Photo Voltaic or SPV is one that has the potential to supply power for our future needs. The advantages of solar power are:

1) The solar energy is more evenly distributed in the world than wind or biomass.
2) It is well proven and demonstrated technology.
3) It promises to be most cost-effective renewable power at high volumes.

### 1. GENERAL REQUIREMENT FOR ROOF TOP SOLAR PV PLANT INSTALLATION

***SPACE REQUIREMENT FOR PANEL MOUNTING:***

A minimum shadow free space of 10 $m^2$ is required for the solar panel mounting for the capacity of 1KW. The panel must be mounted facing south with appropriate inclination for maximum output from installation. Suitable structure according to wind speed and roof structure must be used without shading the panel surface.

***SOLAR PV MODULES AND INVERTER:***

Solar PV panels of 300W or above must be selected for the rooftop installation above 10KW. The efficiency of individual panel must not be less than 16%.

String inverter with MPPT charge controllers is more suitable for the solar power plant installation in roof top. Equipment and installation must be complied with CEA grid regulations-2013.

***LOCATION:***

Open terrace on roof top is available in the indoor stadium 1323 $m^2$ approximately.

## 2. CALCULATION

The area available for solar installation is 1323 $m^2$ in the Roof top area at indoor stadium. On grid system of 50 kW can be installed in this location without any shades.

**Table 16 RENEWABLE ENERGY INTEGRATION**

| Particular | Units | Value |
|---|---|---|
| Proposed system | kW | 50 |
| Approximate available units for utilization | kWh/day | 200 |
| Approximate annual unit generation | kWh /year | 60,000 |
| Present annual unit consumption* | kWh /year | 1,93,568 |
| Average utility electricity cost* | Rs | 6.8 |
| **Annual Financial Savings** | **Rs/Annum** | **4,08,000** |
| **Investment (subsidized & in grid tied mode)** | **Rs** | **27,50,000** |
| **Simple payback period** | **Years** | **7** |

** Power consumption (kWh) and average utility cost (Rs. /kWh) is considered for normal period only*

# ANNEXURE-2

## 1. CONNECTED ELECTRICAL LOADS

### i. *LIGHT & FAN LOADS*

**Table 17 LIGHT AND FAN LOADS**

| Particular | T12 | T8 | LED Tube Light | LED | CFL | LED Spot Light | Sodium Vapour lamp | Mercury Vapour Lamp | Ceiling Fan | Pedestal Fan | Wall Fan | Exhaust Fan | Exhaust Fan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Block/Watts** | **40** | **36** | **20** | **9** | **18** | **40** | **50** | **60** | **75** | **60** | **60** | **80** | **120** |
| Commerce Block | 14 | 22 | 39 | 2 | | | | | 56 | 1 | | | |
| Computer Block | 3 | 3 | 15 | | | | | | 5 | | | | |
| Microbiology Block | 45 | 7 | 28 | 1 | 6 | | | | 34 | | | 6 | |
| Ladies Hostel | | 12 | 25 | 31 | | | 1 | | 34 | | | 1 | |
| Canteen | | | 55 | 4 | | | | | 42 | | | 3 | |
| New Block | | 219 | 15 | 58 | | | | | 130 | 3 | | | |
| S - Block | 12 | 16 | 16 | 22 | | | | | 53 | | | | |
| Common Toilet (Girls Toilet) | 5 | 3 | 6 | 7 | | | | | | | | 1 | |
| Stadium | | 23 | | | | | | | | | 16 | | |
| Auditorium | | 8 | | 72 | | | | | 25 | | | | |
| Main Block | 103 | 124 | 82 | 104 | 7 | 1 | 1 | 1 | 181 | 1 | 7 | 4 | 2 |
| **Total Number** | **182** | **437** | **281** | **301** | **13** | **1** | **2** | **1** | **560** | **5** | **23** | **15** | **2** |
| **Total Watts** | **7280** | **15732** | **5620** | **2709** | **234** | **40** | **100** | **60** | **42000** | **300** | **1380** | **1200** | **240** |
| **Net Total Watts** | **7690** | | | | | | | | | | | | |

### ii. OTHER LOADS

**Table 18 OTHER LOADS**

| Particular | PC | Printer | Projector | Amplifier | Water Filter | Water Dispenser | Xerox | Printer 3 in 1 | Scanner | Kettle | Coffee Maker | Incinerator | Vending M/C | TV | Induction Cooker | Motor | Motor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Block/Watts** | **200** | **120** | **150** | **250** | **120** | **920** | **750** | **400** | **80** | **1500** | **750** | **250** | **40** | **120** | **2000** | **1119** | **2237** |
| Commerce Block | 4 | 32 | 2 | | | 1 | | | | | | 1 | | | | | |
| Computer Block | 16 | | 1 | | | | | 1 | | | | | | | | | |
| Microbiology Block | 16 | 1 | 2 | | | | | | | | | | | | | | |
| Ladies Hostel | | | | | 1 | | | | | | | | | 1 | 1 | | |
| Canteen | 1 | | 1 | | 1 | | | | | | 1 | | | | | | |
| New Block | 4 | 2 | 7 | | | 4 | 1 | 1 | | 2 | | | | | | | |
| S - Block | 3 | 2 | 2 | | | 1 | | 1 | | 1 | | 1 | | | | | |
| Common Toilet (Girls Toilet) | | | | | | | | | | | | 1 | 1 | | | | |
| Stadium | | | | | | | | | | | | | | | | | |
| Auditorium | | | | | | | | | | | | | | | | | |
| Main Block | 42 | 11 | 8 | 1 | 2 | 1 | 7 | | 2 | 2 | | | | | | | |
| Others | | | | | | | | | | | | | | | | 1 | 1 |
| **Total Number** | **86** | **48** | **23** | **1** | **4** | **7** | **8** | **3** | **2** | **5** | **1** | **3** | **1** | **1** | **1** | **1** | **1** |
| **Total Watts** | **17200** | **5760** | **3450** | **250** | **480** | **6440** | **6000** | **1200** | **160** | **7500** | **750** | **750** | **40** | **120** | **2000** | **1119** | **2237** |
| **Total Watts** | **55456** | | | | | | | | | | | | | | | | |

### iii. LAB EQUIPMENT

**Table 19 LAB EQUIPMENTS**

| Particular | Block/Watts | Microbiology Block | Canteen | New Block | Main Block |
|---|---|---|---|---|---|
| Centrifuge | 350 | 2 | | | |
| Water bath | 200 | 3 | | | |
| Water Bath | 500 | 2 | | 1 | |
| Water Bath | 2000 | | | 1 | |
| Water Bath | 1200 | | | 1 | |
| Distillation Unit | 350 | 1 | | 2 | |
| Distillation Unit | 2500 | | | 1 | |
| Hot Air Oven | 2000 | 1 | | | |
| Hot Air Oven | 1000 | 1 | | 3 | 2 |
| Hot Air Oven | 1500 | | | 2 | |
| Freezer | 800 | 2 | 3 | | |
| Incubator | 2000 | 1 | | | |
| Hot Plate | 200 | | | 1 | |
| Incubator | 1500 | 1 | | 2 | |
| Fridge | 160 | 10 | | 6 | 4 |
| Colorimeter | 20 | 2 | | 6 | |
| Weighing M/C | 20 | 2 | | | |
| Incubator | 500 | 2 | | 2 | |
| Incubator | 800 | 3 | | | |
| Incubator | 1200 | | | 1 | |
| Centrifuge | 1650 | 1 | | | |
| Laminar Air Flow | 400 | 4 | | 3 | |
| Microwave oven | 1100 | 2 | | 1 | |
| Ice M/C | 750 | 1 | | | |
| Centrifuge | 500 | 1 | | 1 | |
| Shaker | 110 | 1 | | 1 | |
| Auto Clave | 2000 | 3 | | | |
| Auto Clave | 3000 | | | 2 | |
| Auto Clave | 500 | | | 1 | |
| Vaccum Oven | 187 | | | | 1 |
| **Total Watts** | | **28640** | **2400** | **28790** | **2827** |
| **Net Total (W)** | | **62657** | | | |

## iv. AIR CONDITIONER LOADS

**Table 20 AIR CONDITIONER LOADS**

| Block | Floor | Location | Make | Type | Capacity | EER | Star rating | Working condition | Rated power |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tr | | | | Watts |
| Commerce Block | First Floor | FF11 | Voltas | Split | 1.5 | 2.95 | 3 | Good | 1695 |
| | Second Floor | SF19 | Voltas | Split | 1 | 3.15 | 3 | Good | 1015 |
| | | | Voltas | Split | 1 | 3.15 | 3 | Good | 1015 |
| | | SF15 | Lloyd | Split | 1.5 | 3.59 | 3 | Good | 1875 |
| PG Block | First Floor | T37 | Voltas | Split | 1 | 3.16 | 3 | Good | 1013 |
| | | T38 Server Room | Godrej | Split | 1.5 | 3.7 | 3 | Good | 1334 |
| Microbiology Block | Ground Floor | M2 | Voltas | Split | 1.5 | 3.16 | 3 | Good | 1656 |
| | First Floor | Research Lab Micro Biology | LG | Split | 1.5 | 3.19 | 3 | Good | 1900 |
| | | M9 | Godrej | Split | 1 | 3.11 | 3 | Good | 1061 |
| Main Block | First Floor | Seminar Hall | Voltas | Split | 2 | | 3 | Good | 2071 |
| | | | Voltas | Split | 2 | | 3 | Good | 2071 |
| | | | Voltas | Split | 2 | | 3 | Good | 2071 |
| | | | Voltas | Split | 2 | | 3 | Good | 2071 |
| | | | Voltas | Split | 2 | | 3 | Good | 2071 |
| | | T3, Research Lab | Haier | Split | 1 | 3.11 | 3 | Good | 1076 |
| Office Block | Ground Floor | Front Office | Godrej | Split | 1.5 | | 3 | Good | 1334 |
| | | | Godrej | Split | 1.5 | | 3 | Good | 1334 |
| | | G1, Manager Office | Voltas | Split | 1.5 | | | Good | 1695 |
| | | Principal Office | Bluestar | Split | | | | Good | 1250 |
| **Total (W)** | | | | | | | | | **29604.63** |

# ANNEXURE-3

## 1. LIST OF INSTRUMENTS

| SL.NO | EQUIPMENT DESCRIPTION | MAKE & MODEL |
|---|---|---|
| 1 | POWER ENERGY & HARMONIC ANALYZER | KRYKARD ALM 31 |

## 2. ABBREVIATIONS

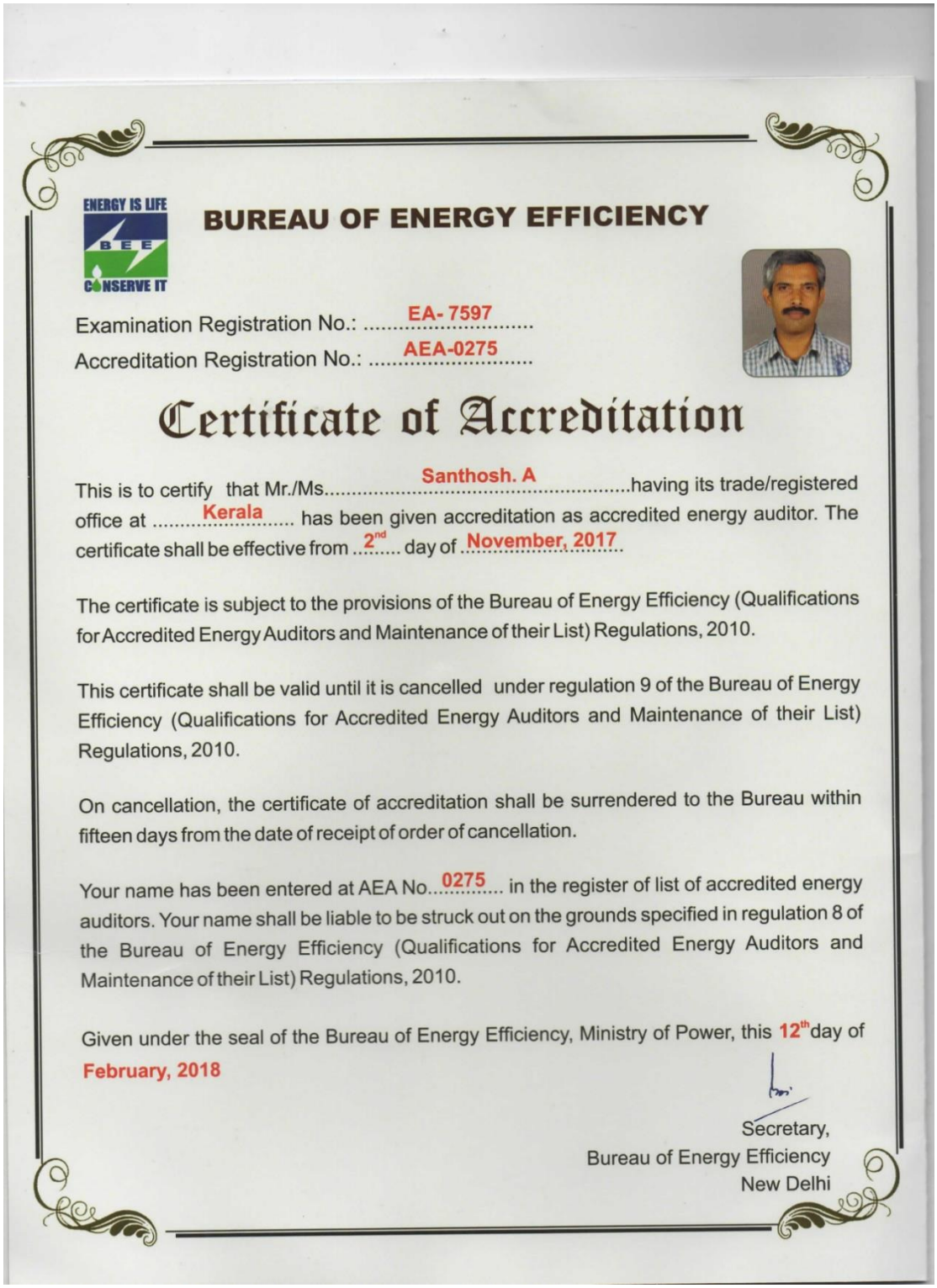
| | | |
|---|---|---|
| AVG | : | Average |
| BEE | : | Bureau of energy efficiency |
| $CO_2$ | : | Carbon dioxide |
| KSEB | : | Kerala State Electricity Board. |
| DB | : | Distribution Board |
| EC | : | Energy Conservation |
| IEEE | : | The Institute of electrical and electronics engineers |
| IS | : | Indian Standard |
| kL | : | kilo Litre |
| KVA | : | kilo Volt Ampere |
| kVAh | : | kilo volt Ampere Hour |
| kVAr | : | kilo volt ampere |
| kW | : | kilo Watts |
| kWh | : | kilo watt hour |
| LT | : | Low tension |
| MAX | : | Maximum |
| NSS | : | National Service Scheme |
| SLD | : | Single Line Diagram |

## 3. REFERENCES:


- Handbook on energy audit and environment management by TERI.
- Bureau of Energy Efficiency (BEE) books for certification of Energy Auditors & Managers.

## 4. CERTIFICATES

### I. BEE Accreditation Certificate



ENERGY IS LIFE
BEE
CONSERVE IT

**BUREAU OF ENERGY EFFICIENCY**

Examination Registration No.: EA- 7597

Accreditation Registration No.: AEA-0275

# Certificate of Accreditation

This is to certify that Mr./Ms. Santhosh. A having its trade/registered office at Kerala has been given accreditation as accredited energy auditor. The certificate shall be effective from 2nd day of November, 2017.

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0275 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 12th day of February, 2018

Secretary,
Bureau of Energy Efficiency
New Delhi

## II. EMC Empanelment certificate

Energy Management Centre - Kerala
(Department of Power, Govt of Kerala)

**CERTIFICATE OF EMPANELMENT**

*This is to certify that* ***M/s.Athul Energy Consultants Pvt Ltd****(4/2, Capital Legend Building, Korapath Lane, Rouund North, Thrissur)is empanelled as Energy Audit firm in Energy Management Centre Kerala to conduct mandatory energy audit as per Government of Kerala G.O (Rt) No.2/2011/PD dated 01.01.2011.*

**Empanelment No:**
**EMCEEA-0811F-3**

| Scope/Area | Building | Industry -Electrical | Industry Thermal |
|---|---|---|---|
| | Yes | Yes | Yes |

*This empanelment is valid up to 01/02/2024*
*Issuing Date: 02/02/2021*
*Place: Thiruvananthapuram*

Director,
Energy Management Centre - Kerala