# DETAILED ENERGY AUDIT REPORT


## Shankarlal Khandelwal Arts, Science &Commerce College, Akola

**Ganesh Nagar Old City, Akola**

January 2020

## Conducted By

**PPS Energy Solutions Pvt. Ltd.**

Engineering Consultants

Plot No-18, Girish Housing Society

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# PREFACE

Energy Audit is a key parameter of systematic approach for decision-making in the area of energy management. It attempts to determine how and where energy is used and to identify methods for energy savings. There is now a universal recognition of the fact that new technologies and much greater use of some that already exists provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options.

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

Present energy audit is a mare mile marker towards destination of achieving safe, healthy and energy efficient unit. We would like to emphasize that an energy audit is a continuous process. We have compiled a list of possible actions to conserve and efficiently utilize our scarce resources and identified their savings potential. The next step would be to prioritize their implementation. Implementation of recommended measures can help consumes to achieve significant reduction in their energy consumption levels.

# WHY ENERGY AUDIT?

An energy audit determines the amount of energy consumption affiliated with a facility and the potential savings associated with that energy consumption. Additionally, an energy audit is designed to understand the specific conditions that are impacting the performance and comfort in your facility to maximize the overall impact of energy-focused building improvements.

An energy audit is a systematic review of the energy consuming installations in a facility to ensure that energy is being used sensibly and efficiently. An energy audit usually commences with the collection and analysis of all information that may affect the energy consumption of the facility, then follows with reviewing and analyzing the condition and performance of various installations and facility management, with an aim at identifying areas of inefficiency and suggesting means for improvement.

Through implementation of the suggested improvement measures, facility owners can get the immediate benefit for paying less energy bills. On the other hand, lowering of energy consumption in facility will lead to the chain effect that the power supply companies will burn less fossil fuel for electricity generation and relatively less pollutants and greenhouse gases will be introduced into the atmosphere, thus contributing to conserve the environment and to enhance sustainable development.

# ACKNOWLEDGEMENT

We express our sincere gratitude to the authorities of Shankarlal Khandelwal Arts, Science & Commerce College, Akola for entrusting and offering the opportunity. It is our immense pleasure to present the detailed energy audit report.

We acknowledge the positive support from management in undertaking the task of Detailed Energy Audit of all electrical system, thermal systems, utilities and other area and for continuous help and support before and during the Detailed Energy Audit.

We are also thankful to all field staff and agencies working with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system / equipment performance and saving potential. We admire the help of all concerned staff for their active participation in completing official documentations.

We express our sincere gratitude to the authorities of Shankarlal Khandelwal Arts, Science & Commerce College, Akola for entrusting PPS Energy Solutions Pvt. Ltd.

For PPS Energy Solutions Pvt. Ltd.

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# About PPSES

M/s. PPS Energy Solutions Pvt. Ltd (PPSES) is an ambitious company, established by enterprising engineering professionals in the year 2009. The company offers services pertaining to Energy and Engineering to clients across the globe. Our team is based in Pune, a city known for its Software and Engineering talent in India. We are a rapidly growing company with a team of about 100 people which includes highly trained and experienced Techno-Managers, Analysts, and Engineers & Detailers.

We are presently working in India (Maharashtra, Assam, Madhya Pradesh, Gujarat, Andhra Pradesh, Delhi, Orissa, Chhattisgarh, Bihar, Andhra Pradesh, Telangana and Jharkhand) and Abroad (Bahrain, Stanford)

- We serve in majorly four areas,
  - Energy Audit, Management and System Evaluations
  - Power Distribution System Design, Evaluations and Monitoring
  - MEP Design and Project management
  - Research and Training

## PPSES Team Members

| Name | Role | Academics and Expertise |
|---|---|---|
| Dr. Ravi Deshmukh | ECM verification, Report verification and presentation | Accredited Energy Auditor, PhD, M tech, MBA (Power), Graduate E&TC Engineer with over 18 years of experience in Energy Management, Management of Power System, street light projects, Power Exchange Operations, Power Trading and Analysis, Electrical Automation. Has worked as Expert in Iron & Steel sector and Energy |
| Mr .Nilesh Saraf | Co-ordination with officers, project status review. | Expert in Energy sector with 16 years of experience in Energy efficiency assessment, Industrial engineering sector & Renewable Energy. |
| Mr. Vinayak Apte | Energy Audit Expert | Graduate Electrical Engineer with more than 10 years of experience in various sectors. He handled Energy Audits, Energy Conservation and Energy Efficiency projects in Industries, Commercial and Residential Buildings, Pump House |
| Mr. Vedmurthy Swamy | Field study, data tabulation and analysis, report preparation | Graduate Mechanical Engineer with 5 years of experience in project management, energy efficiency assessment |
| Mrs. Utkarsha Bharate | Data tabulation and analysis, report preparation | Graduate in Electrical & Electronics Engineering, Sr. Engineer, 3 years of experience in Energy & Power projects |

# 1. EXECUTIVE SUMMARY

Detailed Energy Audit was undertaken in order to evaluate energy performance and identify potential energy conservation measures. Detailed Energy Audit was undertaken in three steps, i.e. document review of data and information initially provided by facility, site visit and preparation of this report.

Energy Audit team conducted the site visit. The site visit includes interaction with staff, electricians of facility, the collection/review of further data and a field inspection of the facility and equipment.
The salient observations and recommendations are given below.

1. The average cost of energy is around Rs. 332745/- per Annum
2. Average monthly units consumed is 3626 kWh equivalent to Rs. 27729/-
3. Average electricity charges works out to be Rs. 5.4/-

This brief report has therefore sought to provide a high-level overview of the status of energy efficiency at facility, combined with an illustration of areas where further, previously unidentified savings opportunities may exist. Our survey has identified further potential opportunities, ranging from “no & low cost” measures, through to those that will require significant capital expenditure.

Note: Investment figures mentioned in are only indicative, further detailed study is recommended.

### Summary of Recommended Energy Conservation Measures:

| Sr. No. | ECM Details | Investment (Rs. Lacs ) | Savings (kWh/year) | Carbon credit (Tons of Co2) | Saving (Rs. Lacs /Year ) | Payback (Years) |
|---|---|---|---|---|---|---|
| 1 | Replacement of Conventional Lights with More Efficient Lights | 1.71 | 6330.00 | 5.38 | 0.34 | 5.01 |
| 2 | Replacement of Existing Fans with Energy Efficient Fans | 3.95 | 6854.40 | 5.83 | 0.37 | 10.68 |
| 3 | Optimize the temperature setting to 23-25 degree Celsius | 0.00 | 169.81 | 0.15 | 0.01 | 0.00 |
| 4 | Replacement of No star ACs with 5 star ACs. | 1.41 | 872.64 | 0.78 | 0.05 | 29.99 |
| | **Total** | **7.08** | **14226.85** | **12.14** | **0.77** | **9.21** |

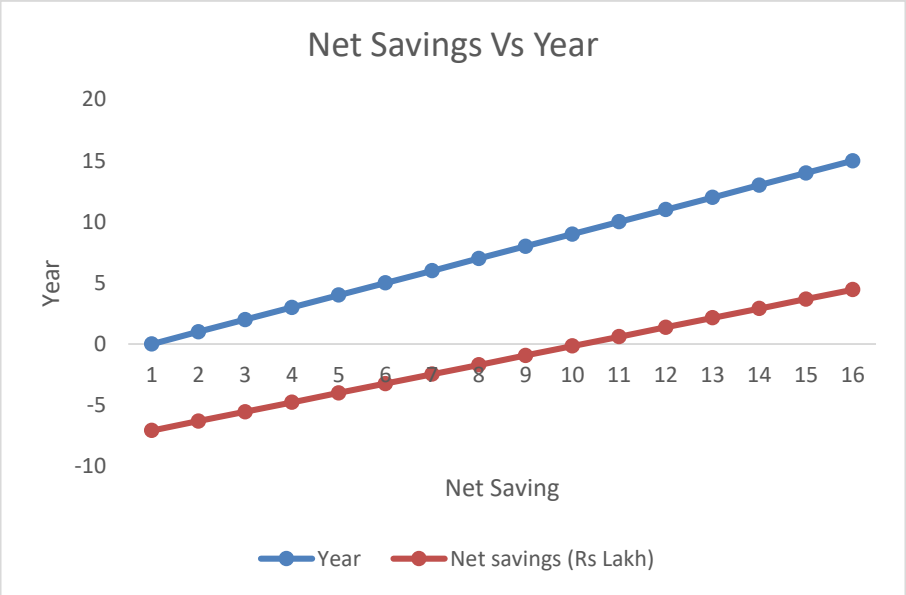
Note: Estimated savings may base on operating conditions

**During the Energy Audit, Total Estimated Investment of Rs.7,08,000/- yields Total Estimated Savings of Rs. 77,000/- which 23 % of the Total Energy Cost of Rs. 3,32,745/- with an overall payback period of 9.21 Months.**

**Other Recommendations:**

A. Regular cleaning and maintenance of equipment's is important to reduce energy losses.
B. Use of star rated equipment's is also strongly recommended specially in case of Fans and Air conditioning.
C. Cleaning of ceiling fan and exhaust fan blades will reduce the drag on the fan and intern will reduce energy loss.
D. Awareness amongst energy users is very essential step to reduce wastage of electricity
E. Energy conservation awareness programs can be conducted once a year. Increasing energy awareness of energy users motivates them to work as a team can lead to reductions in energy consumption and save the money.

| Year | Investment (Rs. In Lacs ) | Saving (Rs.In Lacs /Year ) | Cum Savings(Rs Lakh) | Net savings (Rs Lakh) |
|---|---|---|---|---|
| 0 | -7 | 0 | 0 | -7 |
| 1 | 0 | 1 | 1 | -6 |
| 2 | 0 | 1 | 2 | -6 |
| 3 | 0 | 1 | 2 | -5 |
| 4 | 0 | 1 | 3 | -4 |
| 5 | 0 | 1 | 4 | -3 |
| 6 | 0 | 1 | 5 | -2 |
| 7 | 0 | 1 | 5 | -2 |
| 8 | 0 | 1 | 6 | -1 |
| 9 | 0 | 1 | 7 | 0 |
| 10 | 0 | 1 | 8 | 1 |
| 11 | 0 | 1 | 8 | 1 |
| 12 | 0 | 1 | 9 | 2 |
| 13 | 0 | 1 | 10 | 3 |
| 14 | 0 | 1 | 11 | 4 |
| 15 | 0 | 1 | 12 | 4 |




Net Savings (Rs. Lakh Vs Year)

# 2. GENERAL AUDIT REVIEW

Facility can implement faster payback energy conservation measures (ECMs) which have already been considered and for which the ECMs are fully developed.

Other General Points:

1. Energy conservation awareness programs can be conducted once a year. Increasing energy awareness of staff, students and motivating them to work as a team can lead to reductions in energy consumption and save the money. Savings estimates range in the order of 5 to 10%. When implemented effectively these savings can be realized quickly and cost effectively.
2. Most of the fans are energy inefficient.
3. Most of the places the tube light installed are energy inefficient and fittings are in healthy condition.
4. Natural day light is efficiently used in corridor and few classrooms and labs areas.

It is believed that with the current approach and organization of energy management, energy can be reduced in a systematic, cost effective manner. We hope that this report will help facility to implement these changes and provide direction to the Energy Management Team.

# 3. ABOUT ENERGY AUDIT

## Objective

The overall objective of the assignment is to quantify energy saving in existing system and achieve reduction in energy consumption pattern.

Hence the detail objectives are as under,

1. To calculate the energy consumption
2. To evaluate the performance of the equipment
3. To find out the energy saving opportunities
4. To quantify the total energy savings
5. To find out the ways to achieve energy efficiency

## 3.1. Scope of Work

Following is the scope of work envisaged for this assignment,

**Data Collection**

To collect the details of various electrical and mechanical system and their ratings, the available drawings and details shall be studied. Detail load list shall be prepared and checked.

**A, B, C Analysis**

With the details available from load list, analysis shall be carried out depending on the present usage trends. All the power consuming equipment's shall be classified in three categories depending on their ratings, condition and operating time. The area for larger potentials for savings shall be identified.

**Field Study**

The detail field study on site shall include the following as well as all other measures required for energy audit study,

a. Lay out the system and study of Electrical distribution
b. Study of area wise power distribution and Measurement of power consumption
c. Study of instrumentation provided
d. Measurement of motor currents, voltages, power etc. parameters by energy analyzer and measurement of water flow, pressures etc. parameters of pumps simultaneously and

other measurements as needed to characterize the system and required for calculating efficiency at various combinations

e. Study of air conditioner operations and system requirements

f. Analysis of readings obtained from field with the standard consumption.

## 3.2. Approach and Methodology

1. Understanding the Scope of Work and Resource Planning
2. Identification of Key Personnel for the assignment/ project
3. Structured Organization Matrix
4. Steps in preparing and implementing energy audit assignment
   a) Discussions with key facility personnel
   b) Site visits and conducting "walk-through audit".
   c) Preliminary Data Collection through questionnaire before audit team's site visit
   d) Steps for conducting the detailed audit
      - Plan the activities of site data collection in coordination with the facility in-charge.
      - Study the existing operations involving energy consumption
      - Collect and collate the energy consumption data with respect to electricity consumption
      - Conduct performance tests to assess the efficiency of the system equipment/ electricity distribution, lighting, and identify energy losses.
      - Discuss with facility personnel about identified energy losses.
5. List proposed efficiency measures
   - Develop a set of potential efficiency improvement proposals
   - Baseline parameters
   - Data presentation
   - System mapping
   - List of potential Energy Savings proposals with cost benefit analysis.
   - Review of current operation & maintenance practices
6. Preparation of the Draft Energy Audit Report
7. Preparation and submission of final Energy Audit Report after discussion with concerned persons

# 4. ENERGY DETAILS

Maharashtra State Electricity Distribution Company Limited (MSEDCL) provides the electricity supply for facility. Billing is done with the help of 3 meters. Billing is carried out according to LT- X B I and LT V B I Tariff.

Detailed Energy Audit was conducted for the load connected to the mains supply used.

Mainly energy is used on this facility for the following purposes:

1) Lighting load
2) Ceiling fans
3) Ac

Based on above it is clear that followings areas have highest potential for energy savings

Table 1 Name of Area

| Sr. No. | Name of the Area |
|---|---|
| 1 | II Floor |
| 2 | I Floor |
| 3 | Ground Floor |
| 4 | Girls Hostel |

## 4.1. Electricity Bill Analysis

### 1. Consumer Details of Meter No. 310071394122

**Consumer Details**

Table 2 Consumer Details

| Parameter | Details |
|---|---|
| **Consumer No.** | **310071394122** |
| Consumer Name | SHRI SHANKARLAL KHANDELWAL MAHAVIDHALYA |
| Address | GODBOLE PLOT DABKI ROAD POLE NO GP-3 |
| Pin Code | 444005 |
| Sanction load (KW) | 18 |
| Tariff | LT X B I |

**Consumption Details**

Table 3Billing Data

| Month | kWH | Demand Charges (Rs) | Wheeling Charges (Rs) | Energy Charges (Rs) | FAC (Rs) | Electricity Duty (Rs) | Tax (Rs) | Total Current Bill (Rs) |
|---|---|---|---|---|---|---|---|---|
| Jan-20 | 268 | 351 | 343 | 1319 | 174 | 350 | 51 | 2589 |
| Feb-19 | 136 | 350 | 177 | 563 | 63 | 184 | 26 | 1363 |
| Mar-19 | 199 | 350 | 259 | 837 | 54 | 240 | 38 | 1778 |
| Apr-19 | 444 | 350 | 575 | 2483 | 216 | 580 | 85 | 4288 |
| May-19 | 460 | 351 | 589 | 2644 | 249 | 613 | 88 | 4534 |
| Jun-19 | 33 | 351 | 42 | 140 | 15 | 88 | 6 | 643 |
| Jul-19 | 1309 | 351 | 1676 | 8502 | 751 | 1805 | 249 | 13334 |
| Aug-19 | 454 | 351 | 581 | 2603 | 127 | 586 | 86 | 4335 |
| Sep-19 | 383 | 351 | 490 | 2097 | 0 | 470 | 73 | 3481 |
| Oct-19 | 382 | 351 | 489 | 2106 | 87 | 485 | 73 | 3591 |
| Nov-19 | 406 | 351 | 520 | 2271 | 169 | 530 | 77 | 3918 |
| Dec-19 | 422 | 351 | 540 | 1852 | 254 | 480 | 80 | 46 |
| **Avg** | **408** | **351** | **523** | **2285** | **180** | **534** | **78** | **3658** |
| **Max** | **1309** | **351** | **1676** | **8502** | **751** | **1805** | **249** | **13334** |
| **Min** | **33** | **350** | **42** | **140** | **0** | **88** | **6** | **46** |

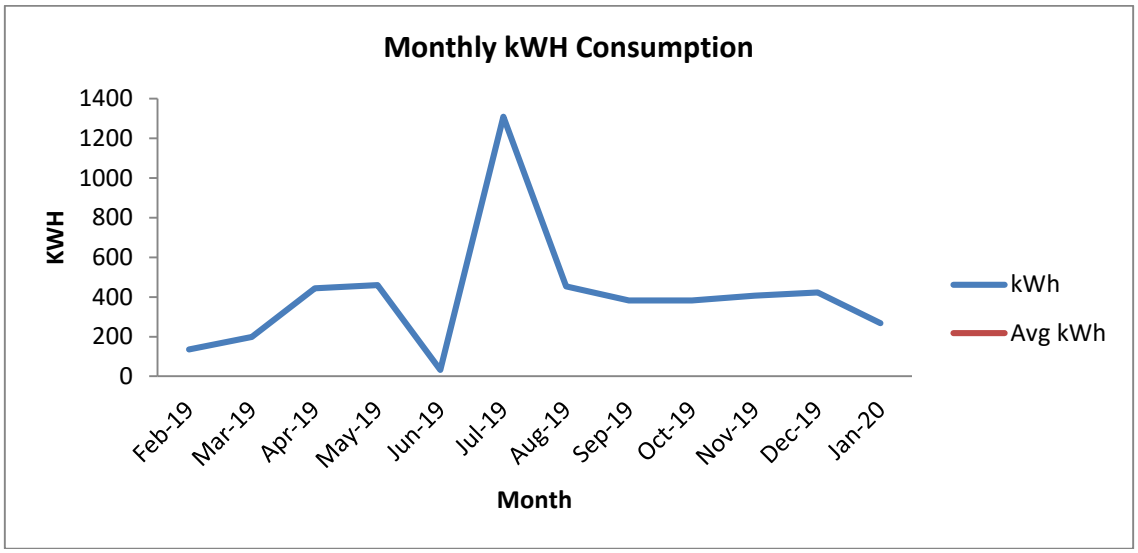



Figure 1 Monthly kWh Consumption

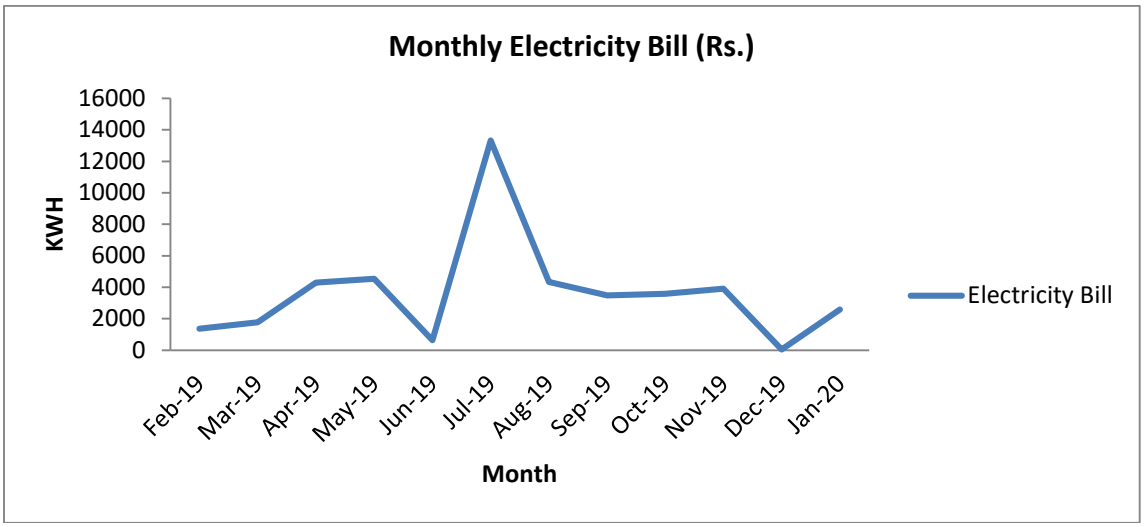



Figure 2 Monthly Electricity Bill

**Comments**:

1. Average monthly units consumed is 408 kWh equivalent to Rs. 3658/-
2. Average electricity charges works out to be Rs. 5.17/-

## 2. Consumer Details of Meter No. 310071444057

**Consumer Details**

Table 4 Consumer Details

| Parameter | Details |
|---|---|
| **Consumer No.** | **310071444057** |
| Consumer Name | M/S PRI SHANKARLAL KHANDEWAL COLLEGE |
| Address | HOUSE NO.17/76 SR NO 07 GA NESH NAGAR OLD CITY AKOLA AKOLA |
| Pin Code | 444001 |
| Sanction load (KW) | 1 |
| Tariff | LT X B I |

**Consumption Details**

Table 5 Billing Data

| Month | kWH | Demand Charges (Rs) | Wheeling Charges (Rs) | Energy Charges (Rs) | FAC (Rs) | Electricity Duty (Rs) | Tax (Rs) | Total Current Bill (Rs) |
|---|---|---|---|---|---|---|---|---|
| Jan-20 | 2218 | 351 | 2839 | 14244 | 1745 | 4028 | 422 | 12393 |
| Feb-19 | 563 | 350 | 732 | 3277 | 327 | 984 | 107 | 5777 |
| Mar-19 | 808 | 350 | 1050 | 4993 | 280 | 1402 | 154 | 8231 |
| Apr-19 | 1344 | 350 | 1738 | 8633 | 720 | 2403 | 256 | 14099 |
| May-19 | 1302 | 351 | 1667 | 8454 | 771 | 2361 | 248 | 13851 |
| Jun-19 | 1048 | 351 | 1341 | 6685 | 634 | 1892 | 200 | 11103 |
| Jul-19 | 623 | 351 | 797 | 3769 | 340 | 1104 | 119 | 6480 |
| Aug-19 | 994 | 351 | 1272 | 6329 | 300 | 1733 | 189 | 10174 |
| Sep-19 | 1087 | 351 | 1391 | 6933 | 0 | 1822 | 207 | 10705 |
| Oct-19 | 1296 | 351 | 1659 | 8412 | 334 | 2259 | 247 | 13263 |
| Nov-19 | 844 | 351 | 1080 | 5135 | 371 | 1457 | 161 | 8555 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dec-19 | 1076 | 351 | 1377 | 6894 | 845 | 1988 | 205 | 11661 |
| **Avg** | **1100** | **351** | **1412** | **6980** | **556** | **1953** | **209** | **10524** |
| **Max** | **2218** | **351** | **2839** | **14244** | **1745** | **4028** | **422** | **14099** |
| **Min** | **563** | **350** | **732** | **3277** | **0** | **984** | **107** | **5777** |

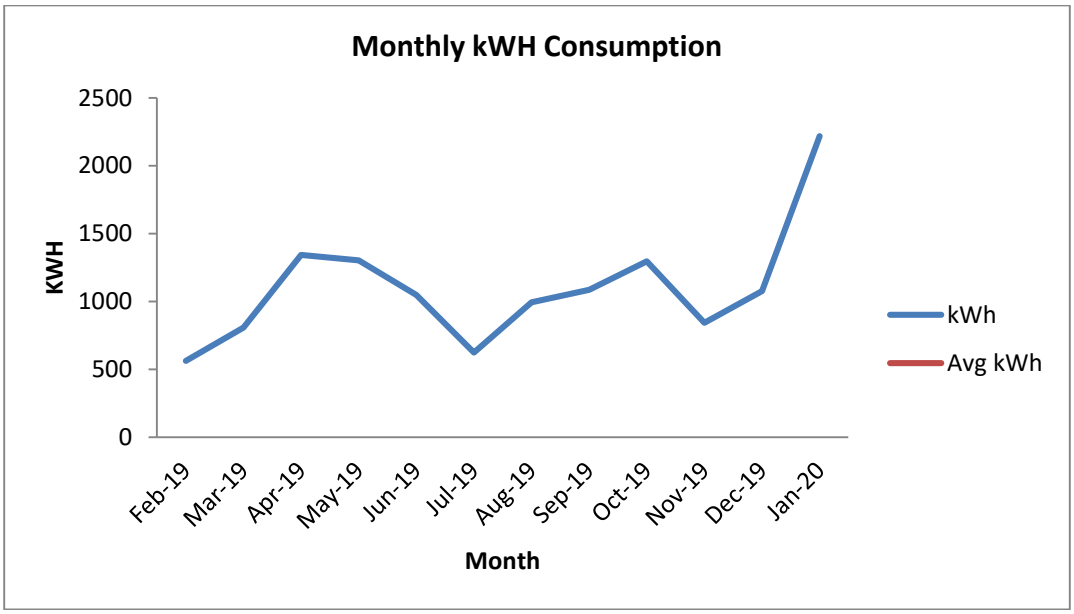



Figure 3 Monthly kWh Consumption

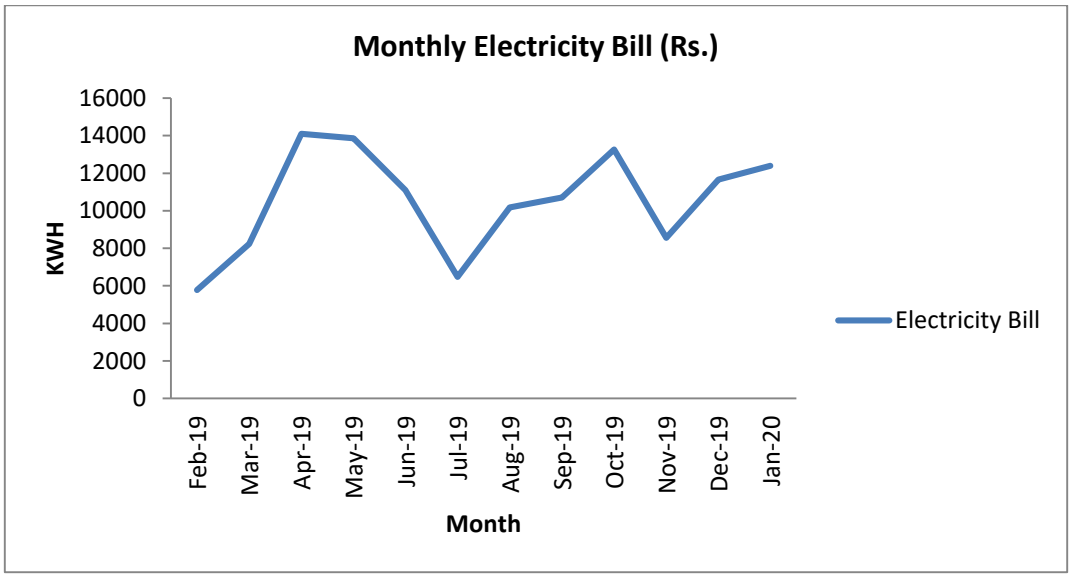



Figure 4 Monthly Electricity Bill

**Comments**:

1. Average monthly units consumed is 1100 kWh equivalent to Rs. 10524/-
2. Average electricity charges works out to be Rs. 6.29/-

## 3. Consumer Details of Meter No. 310070397551

**Consumer Details**

Table 6 Consumer Details

| Parameter | Details |
|---|---|
| **Consumer No.** | **310070397551** |
| Consumer Name | SHRI SHANKARLAL KHANDELWAL MAHAVIDHALYA |
| Address | GODBOLE PLOTS AKOLA |
| Pin Code | 444002 |
| Sanction load (KW) | 8 |
| Tariff | LT V B I |

**Consumption Details**

Table 7 Billing Data

| Month | kWH | KVAH | RKVAH (Lag) | RKVAH (Lead) | Recorded MD | Billed MD | Demand Rate (Rs/KVA) | Commercial Units | Demand Charges (Rs) | Wheeling Charges (Rs) | Energy Charges (Rs) | FAC (Rs) | Electricity Duty (Rs) | Tax (Rs) | Total Current Bill (Rs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dec-19 | 1686 | 0 | 0 | 0 | 10 | 0 | 441 | 1686 | 441 | 2158 | 8110 | 1028 | 1092 | 321 | 11379 |
| Nov-19 | 1526 | 0 | 0 | 0 | 7 | 0 | 441 | 1526 | 441 | 1953 | 7340 | 931 | 992 | 291 | 10345 |
| Oct-19 | 1346 | 0 | 0 | 0 | 17 | 0 | 441 | 1346 | 441 | 1723 | 6474 | 485 | 848 | 256 | 8814 |
| Sep-19 | 3500 | 0 | 0 | 0 | 16 | 0 | 441 | 3500 | 441 | 4480 | 16835 | 700 | 2088 | 666 | 21536 |
| Aug-19 | 2040 | 0 | 0 | 0 | 15 | 0 | 441 | 2040 | 441 | 2611 | 9812 | 14 | 1198 | 388 | 12323 |
| Jul-19 | 2047 | 0 | 0 | 0 | 24 | 0 | 441 | 2047 | 441 | 2620 | 9846 | 491 | 1246 | 390 | 12885 |
| Jun-19 | 2298 | 0 | 0 | 0 | 16 | 0 | 441 | 2298 | 441 | 2941 | 11053 | 988 | 1434 | 438 | 14883 |
| May-19 | 2351 | 0 | 0 | 0 | 12 | 0 | 441 | 2351 | 441 | 3009 | 11308 | 1081 | 1473 | 448 | 15292 |
| Apr-19 | 2549 | 0 | 0 | 0 | 15 | 0 | 441 | 2549 | 441 | 3263 | 12261 | 1122 | 1589 | 485 | 16484 |
| Mar-19 | 2296 | 0 | 0 | 0 | 18 | 0 | 441 | 2296 | 356 | 2982 | 10937 | 918 | 1413 | 437 | 14633 |
| Feb-19 | 2107 | 0 | 0 | 0 | 14 | 0 | 350 | 2107 | 350 | 2739 | 10029 | 569 | 1273 | 401 | 13149 |
| Jan-19 | 1667 | 0 | 0 | 0 | 8 | 0 | 350 | 1667 | 350 | 2167 | 7935 | 767 | 1043 | 317 | 10829 |
| **Avg** | **2118** | **0** | **0** | **0** | **14** | **0** | **426** | **2118** | **419** | **2721** | **10162** | **758** | **1307** | **403** | **13546** |
| **Max** | **3500** | **0** | **0** | **0** | **24** | **0** | **441** | **3500** | **441** | **4480** | **16835** | **1122** | **2088** | **666** | **21536** |
| **Min** | **1346** | **0** | **0** | **0** | **7** | **0** | **350** | **1346** | **350** | **1723** | **6474** | **14** | **848** | **256** | **8814** |

| Month | "A" Zone Units | "A" Zone Demand | "B" Zone Units | "B" Zone Demand | "C" Zone Units | "C" Zone Demand | "D" Zone Units | "D" Zone Demand |
|---|---|---|---|---|---|---|---|---|
| Dec-19 | 0 | 0 | 786 | 10 | 400 | 0 | 189 | 0 |
| Nov-19 | 0 | 2 | 734 | 7 | 282 | 6 | 136 | 5 |
| Oct-19 | 0 | 2 | 714 | 17 | 312 | 12 | 163 | 8 |
| Sep-19 | 0 | 2 | 1820 | 16 | 842 | 15 | 285 | 6 |
| Aug-19 | 0 | 2 | 1067 | 15 | 450 | 14 | 189 | 5 |
| Jul-19 | 0 | 3 | 1065 | 24 | 469 | 16 | 182 | 3 |
| Jun-19 | 0 | 3 | 1066 | 16 | 613 | 15 | 221 | 11 |
| May-19 | 0 | 3 | 1180 | 11 | 540 | 12 | 268 | 6 |
| Apr-19 | 0 | 3 | 1239 | 15 | 610 | 15 | 262 | 4 |
| Mar-19 | 0 | 2 | 1163 | 16 | 524 | 17 | 225 | 3 |
| Feb-19 | 0 | 2 | 1100 | 13 | 374 | 13 | 235 | 9 |
| Jan-19 | 0 | 2 | 778 | 7 | 304 | 7 | 212 | 3 |
| **Avg** | **0** | **2** | **1059** | **14** | **477** | **12** | **214** | **5** |
| **Max** | **0** | **3** | **1820** | **24** | **842** | **17** | **285** | **11** |
| **Min** | **0** | **0** | **714** | **7** | **282** | **0** | **136** | **0** |

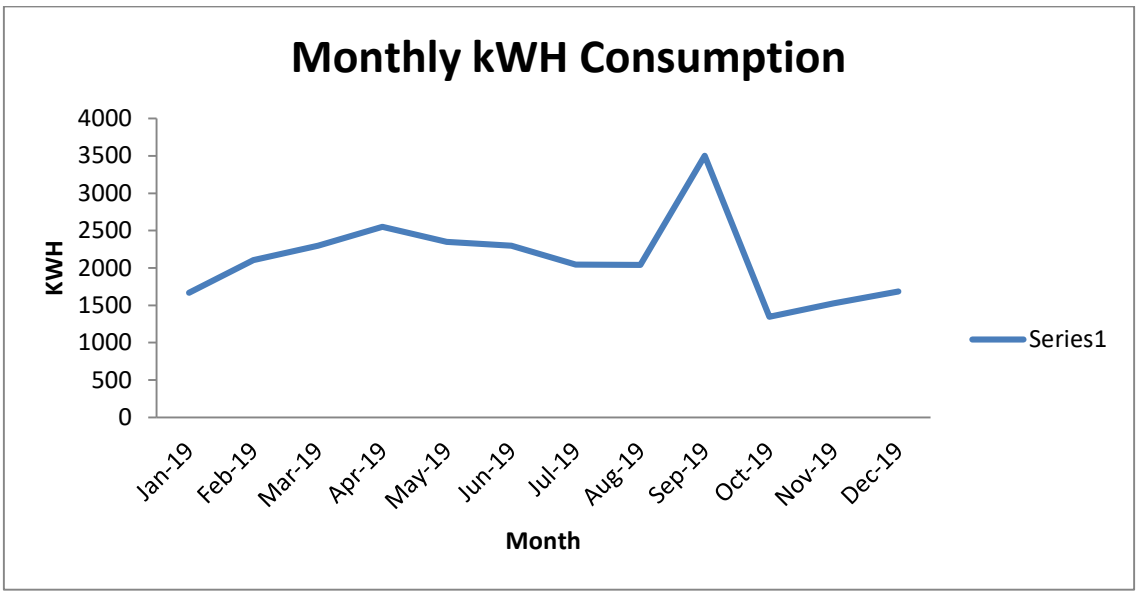



Figure 5 Monthly kWh Consumption

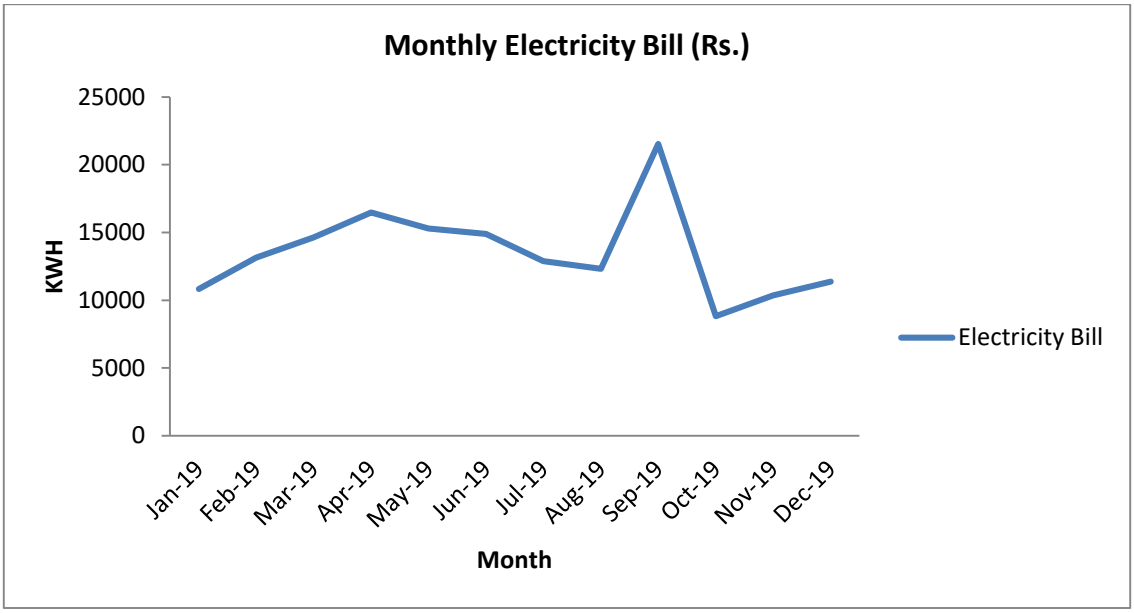



Figure 6 Monthly Electricity Bill

**Comments**:

1. Average monthly units consumed is 2118 kWh equivalent to Rs. 13546/-
2. Average electricity charges works out to be Rs. 4.8/-

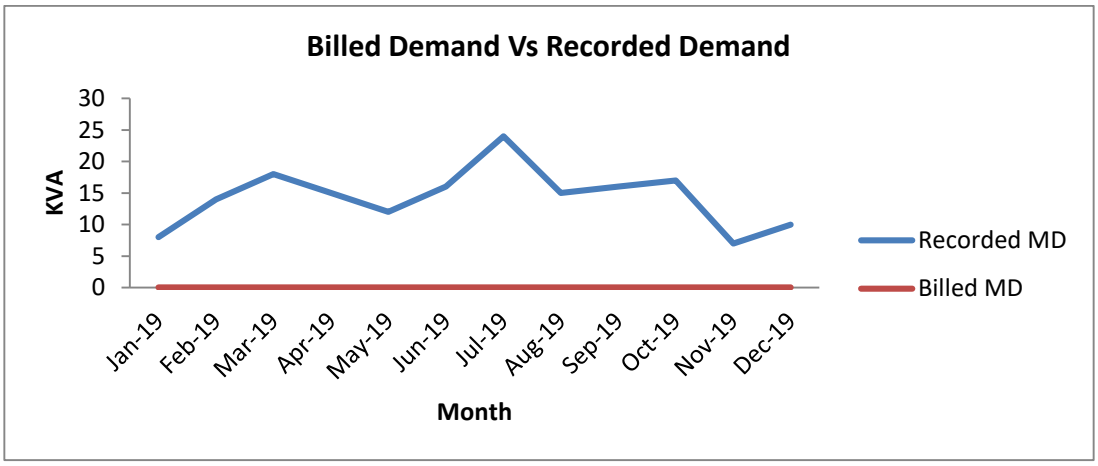



Figure 7 Billed Demand vs Recorded Demand

## 4.2. Connected Load Quantity of Buildings

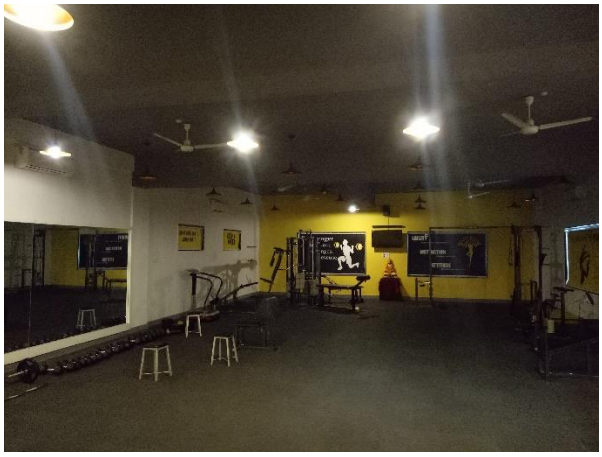
Table 4 Connected Load of Facility

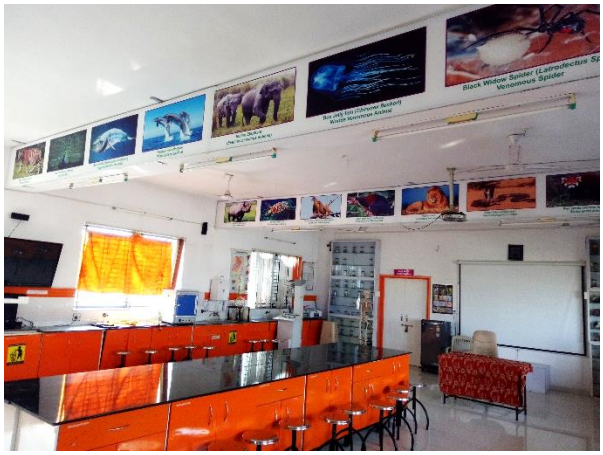
| Fixtures | Wattage | II Floor | I Floor | Ground Floor | Girls Hostel | Total Quantity | Total KW |
|---|---|---|---|---|---|---|---|
| Ceiling Fan | 75 | 46 | 62 | 52 | 44 | 204 | 15.30 |
| Exhaust Fan | 40 | | | 2 | | 2 | 0.08 |
| Exhaust Fan | 55 | | 2 | | | 2 | 0.11 |
| Wall Fan | 55 | | 2 | 7 | | 9 | 0.50 |
| LED Tube Light | 20 | 22 | | 11 | | 33 | 0.66 |
| Tube Light | 28 | | 8 | | | 8 | 0.22 |
| Tube Light | 36 | 32 | | 40 | 44 | 116 | 4.18 |
| Tube Light | 40 | | | 1 | | 1 | 0.04 |
| LED Light | 9 | | 8 | | | 8 | 0.07 |
| LED Light | 5 | | 20 | 40 | 30 | 90 | 0.45 |
| LED Focus Light | 15 | | | 7 | | 7 | 0.11 |
| LED Spot Light | 2 | | | 5 | | 5 | 0.01 |
| CFL | 11 | | | 25 | | 25 | 0.28 |
| CFL | 18 | | 86 | 6 | | 92 | 1.66 |
| PL | 36 | | 66 | | | 66 | 2.38 |
| Water Cooler | 700 | | | 1 | | 1 | 0.70 |
| TV LCD | 60 | 1 | 1 | 2 | | 4 | 0.24 |
| Computer | 150 | 27 | 61 | 12 | | 100 | 15.00 |
| Printer/scanner | 150 | 9 | 18 | 4 | | 31 | 4.65 |
| Xerox M/C | 700 | 2 | 2 | | | 4 | 2.80 |
| Fridge | 700 | 2 | 1 | | | 3 | 2.10 |
| Projector | 350 | 3 | 3 | 3 | | 9 | 3.15 |
| Oven | 2000 | 3 | | 3 | | 6 | 12.00 |
| Deepfreezer | 1500 | 1 | | | | 1 | 1.50 |
| AC Spilt (2*) | 2200 | | 6 | | | 6 | 13.20 |
| AC Spilt (0*) | 2500 | | | 3 | | 3 | 7.50 |
| AC Spilt (3*) | 1600 | | | 5 | | 5 | 8.00 |
| **Total** | | | | | | **841** | **96.87** |

# 5. ENERGY CONSERVATION MEASURES

## *ECM1: Replacement of Tube Lights with More Efficient Lights*

| ECM No. | Energy efficiency improvement measures | Investment Rs. In Lakh | Estimated saving | | Estimated Savings Rs. In Lacs | Estimated Payback Years |
|---|---|---|---|---|---|---|
| | | | Electricity kWh | Carbon credit (Tons of $CO_2$) | | |
| 1 | Replacement of Conventional Lights with More Efficient Lights | 1.71 | 6330.00 | 5.38 | 0.34 | 5.01 |




**Observations:**

Facility has installed Type of Tube light of 28, 36 W and CFL 11 ,18 W in their premises

**Recommendations:**

During energy audit, it is observed that facility has installed Tube light of 28, 36W and CFL 11 ,18 W at some of the places in the facility. The operating hours for these lightings are around 5 hours. Tube light of 28, 36 W and CFL 11 ,18 W lights with equivalent LED fixture thereby achieving significant reduction in energy consumption. The LEDs could be replaced in such a manner that it has same fixture so there will not be retrofitting cost attached to the replacement. The replacement could be done in a phased manner. LED lights have better efficacy as well as better lifetime than conventional lights.

**Energy Saving Calculations:**

| Particular | Unit | Value |
|---|---|---|
| **Energy Saving Calculation** | | |
| Power consumption of TL,CFL and Halogen lamps | KW | 8.71 |
| Power consumption of suitable LED | KW | 4.49 |
| Average power saving after replacement with LED lights | KW | 4.22 |
| Replacement of conventional lights with suitable LEDs | Nos | 307 |
| Average working hour per day | hrs | 5 |
| No. of working days in a year | Days | 300 |
| **Cost Benefit Calculation** | | |
| Annual Energy Saving potential | kWh | 6330 |
| Electricity tariff | Rs/unit | 5.4 |
| Annual Cost Saving | Rs. Lakh | 0.34 |
| Total investment cost | Rs. Lakh | 1.71 |
| Annual Saving | Rs. Lakh | 0.34 |
| Simple Payback Period | Years | 5.0 |

| Type of Fitting | Wattage | Qty | Proposed LED W | Price - Rs/ Unit | Dismantling cost | Price with GST | Existing KW | Proposed KW | Saved kW | Investment Rs Lakh |
|---|---|---|---|---|---|---|---|---|---|---|
| Tube Light | 28 | 8 | 20 | 878 | 13 | 998 | 0.22 | 0.16 | 0.06 | 0.08 |
| Tube Light | 36 | 116 | 20 | 878 | 13 | 998 | 4.18 | 2.32 | 1.86 | 1.16 |
| CFL | 11 | 25 | 7 | 134 | 13 | 165 | 0.28 | 0.18 | 0.10 | 0.04 |
| CFL | 18 | 92 | 7 | 134 | 13 | 165 | 1.66 | 0.64 | 1.01 | 0.15 |
| PL | 36 | 66 | 18 | 369 | 13 | 428 | 2.38 | 1.19 | 1.19 | 0.28 |
| **TOTAL** | **129.00** | **307.00** | **72.00** | **2393.00** | **65.00** | **2752.96** | **8.71** | **4.49** | **4.22** | **1.71** |

### *ECM 2: Replacement of Old Fan with Energy Efficient Super Fan*

| ECM No. | Energy efficiency improvement measures | Investment Rs. In Lakh | Estimated saving Electricity kWh | Estimated saving Carbon credit (Tons of $CO_2$) | Estimated Savings Rs. In Lacs | Estimated Payback Years |
|---|---|---|---|---|---|---|
| 2 | Replacement of Existing Fans with Energy Efficient Fans | 3.95 | 6854.40 | 5.83 | 0.37 | 10.68 |




**Observations:**

During energy audit, it is observed that facility has old 75 watts' fan and its energy consumption is on higher side.

**Recommendations:**

During energy audit it is observed that facility has installed non star rated fan of 75 watts so we recommend to replace energy consuming fan with energy efficient super fan

**Energy Saving Calculations:**

| Particular | Unit | Value |
|---|---|---|
| Existing energy consumption of Fan | kWh/year | 18360 |
| Fan Wattage | Watt | 35 |
| Energy consumption after replacing with Energy Efficient Super Fan | kWh/year | 8568 |
| Operating hrs/year | Hrs/year | 1200 |
| Diversity factor | % | 70% |
| Annual Saving | kWh/year | 6854 |
| Unit rate | Rs/kWh | 5.4 |
| Annual Saving | Rs. In Lacs | 0.37 |

| Category | Nos | Estimated Running kW |
|---|---|---|
| Ceiling Fan 75 W | 204 | 15.30 |

### *ECM 3: Replacement of No star rated AC with 5-starrated AC*

| ECM No. | Energy efficiency improvement measures | Investment Rs. In Lakh | Estimated saving Electricity kWh | Carbon credit (Tons of CO2) | Estimated Savings Rs. In Lacs | Estimated Payback Years |
|---|---|---|---|---|---|---|
| 3 | Replacement of No star AC with 5 Star AC | 1.41 | 872.64 | 0.78 | 0.05 | 29.99 |

**Observations:** During Energy Audit, it is observed that facility has old No star ACs and its energy consumption is on higher side.

**Recommendations:** We recommend to replace No star ACs with 5 Star ACs

**Energy Saving Calculations:**

| Particular | Unit | Value |
|---|---|---|
| Quantity of 1.5 Ton AC with no star | Nos | 3 |
| Wattage of 1 Ton AC with no star | Watt | 2500 |
| Total load of 1.5 Ton AC with no star | kW | 7.5 |
| Total load of all no star installed AC | kW | 7.5 |
| Wattage of 1.5 Ton 5 star AC | Watt | 1490 |
| Total load of 1.5 Ton 5 Star AC | kW | 4.470 |
| Total load of all 5 star AC | kW | 4.470 |
| Load reduction after replacement | kW | 3.030 |
| Diversity Factor | % | 60% |
| Operating Hrs per day | hrs./day | 4 |
| Operating days per year | Days/year | 120 |
| Estimated energy Saving | kWh/year | 872.64 |
| Unit Rate | Rs/kWh | 5.4 |
| Annual Saving | Rs Lakh/year | 0.0471 |

**Investment Details:**

| Particular | Value | Unit |
|---|---|---|
| Rate of 1.5 Ton 5 star Split AC | 47107 | Rs. |
| Total Investment for 1.5 Ton Split AC | 141321 | Rs. |

### *ECM 4: Optimize The AC Temperature Setting to 23-25 Degree Celsius*

| ECM No. | Energy efficiency improvement measures | Investment Rs. In Lakh | Estimated saving Electricity kWh | Carbon credit (Tons of CO2) | Estimated Savings Rs. In Lacs | Estimated Payback Years |
|---|---|---|---|---|---|---|
| 4 | Optimize The AC Temperature Setting To 23-25 Degree Celsius | 0.00 | 169.81 | 0.15 | 0.01 | 0.00 |

**Observations:**

During Energy Audit, it is observed that ACs installed in facility run with lower temperature than the recommended temperatures.

**Recommendations:**

We recommend to keep the set temperature of AC between 23 to 25$^0$C to get the energy saving.

Standard:
It is known that a 1°C raise in AC temperature can help to save almost 3 % on power consumption (this can also be verified in BEE guideline: Chapter 4. HVAC and Refrigeration System).

The TR capacity of the same AC systems will also increase with the increase in evaporator temperature (AC set points), as given in Table below:

| Effect of variation in Evaporator Temperature on Compressor Power Consumption | | | |
|---|---|---|---|
| Evaporator temperature($^0$C) | Refrigeration Capacity* (tons) | Specific Power Consumption | Increase in kW/ton (%) |
| 5 | 67.58 | 0.81 | - |
| 0 | 56.07 | 0.94 | 16 |
| -5 | 45.98 | 1.08 | 33 |
| -10 | 37.2 | 1.25 | 54 |
| -20 | 23.12 | 1.67 | 106 |

* Condenser temperature 40°C

**Present Energy Consumption Details:**

| Sr No | Type | Ton | Qty | Annual Consumption |
|---|---|---|---|---|
| 1 | Air Conditioner (Split) (1.5 Ton) (2*) | 1.5 | 6 | 3157 |
| 2 | Air Conditioner (Split) (1.5 Ton) (3*) | 1.5 | 5 | 2503 |
| **Total** | | | **11** | **5660** |

**Energy Saving Calculations:**

| Particular | Unit | Value |
|---|---|---|
| Estimated consumption of ACs | kWh/hr | 5660 |
| Estimated Saving | % | 3% |
| Operating Hrs per day | hrs./day | 4 |
| Operating days per year | Days/year | 120 |
| Estimated Saving | kWh/year | 170 |
| Unit Rate | Rs/kWh | 5.4 |
| Annual Saving | Rs Lakh/year | 0.01 |

# 6. List of Instruments

## POWER ANALYSER


Picture 1 ALM 20 Power Analyzer

ALM 20 Power Analyzer is designed for Measuring power network parameters

### TECHNICAL SPECIFICATIONS

| | |
|---|---|
| Number of channels | 3U/3I |
| Voltage (TRMS AC + DC) | 100V to 2000V ph-ph /50V to 1000V ph-N |
| Voltage ratio | Up to 650 kV |
| Current (TRMS AC + DC) | 5mA to 10,000 Aac / 50 mA to 5,000 Adc (depending on Clamp) |
| Current ratio | Up to 25 kA |
| Frequency | 42.5 - 69 Hz, 340 - 460Hz |
| Power values | W, VA, VAr, VAD, PF, DPF, cos ø, tanø |
| Energy values | Wh, VAh, VArh |
| Harmonics, THD | on V, U, I & In up to 50th order |
| Electrical safety | IEC 61010, 1000V CAT III / 600V CAT IV |
| Protection | IP54 |

## DIGITAL CLAMP METER


Picture 2 MECO 3150 DIGITAL CLAMP METER

Power Clamp meter is a Portable Digital multi-functional measuring instrument. Designed for Measuring selected power network parameters, AC/DC Voltage, AC/DC current, Resistance, Continuity, Diode and Frequency.

### TECHNICAL SPECIFICATIONS

| | |
|---|---|
| **DC VOLTAGE (Auto Ranging)** | |
| Ranges | 4V, 40V, 400V, 1000V |
| Overload Protection | 1200V DC/800V AC |
| **AC VOLTAGE (Auto Ranging) 40-500Hz** | |
| Range | 4V, 40V, 400V, 750V |
| Overload Protection | 1200V DC/800V AC |
| **RESISTANCE (Auto Ranging)** | |
| Range | 400Ω, 4KΩ, 40KΩ, 400KΩ, 4MΩ, 40MΩ |
| Test Current | 0.7mA on 400Ω, 0.1mA on 4KΩ |
| **Diode Test** | |
| Measurement Current | 1.0 ± 0.6 mA Approx |
| Open Circuit Voltage | 0.4V Approx |
| Overload Protection | 500V DC / AC |
| **Frequency (Auto Ranging)** | |
| Range | 10.00Hz, 50.00Hz, 500.0Hz, 5.000kHz, |
| | 50.00kHz, 500.0kHz |
| Sensitivity | 3V |
| Overvoltage Protection | 200V DC or AC peak |

## DIGITAL CLAMP METER

Picture 3 RISH POWER CLAMP 1000 A/400 A AC-DC

Power Clamp meter is a Portable Digital multi-functional measuring instrument. Designed for Measuring selected power network parameters, AC/DC Voltage, AC/DC current, Resistance, Continuity, Diode and Frequency.

### TECHNICAL SPECIFICATIONS

| Measuring function | Measuring range |
|---|---|
| kWh | 9.999 kWh |
| | 99.99 kWh |
| | 999.9 kWh |
| | 9999 kWh |
| Ahr | 999.9 Ahr |
| Phase angle | $0.0^{o}$….$360.0^{o}$ |
| Power Factor | -1…0…1 |
| Harmonics (RMS & %) | 1…13 |
| | 14…49 |
| THD | 0…99.9% |
| Crest Factor | 1.0…2.9 |
| | 3.0…5.0 |
| Power Clamp 1000A peak | 1400 A/ 1400 V |
| Power Clamp 400A peak | 100 A |
| | 560 A/ 1000 V |
| Power Clamp 1000A INRUSH | 999.9 A |
| Power Clamp 400A INRUSH | 99.99 A |
| | 400 A |
| Resistance | 9999 Ohm |
| Continuity | Below 40 Ohm |

## THERMAL IMAGER


Picture 4 FLIR TG 167 Thermal imager

FLIR TG 167Thermal imager is designed to easily find unseen hot and cold spots in electrical cabinets or switch boxes, giving you quality image detail on even small connectors and wires.

### TECHNICAL SPECIFICATIONS

| | |
|---|---|
| Accuracy | ±1.5% or 1.5°C (2.7°F) |
| Detector Type | Focal plane array (FPA), uncooled micro bolometer |
| IR Resolution | 80 × 60 pixels |
| Laser | Dual diverging lasers indicate the temperature measurement area, activated by pulling the trigger |
| Memory Type | Micro SD card |
| Object Temperature Range | -25°C to 380°C (-13°F to 716°F) |
| Thermal Sensitivity/NETD | <150 mK |
| Display | 2.0 in TFT LCD |

## INFRARED THERMOMETER


Picture 5 HTC IRX 64 Infrared thermometer

HTC IRX 64 infrared thermometer is useful instrument to measure the surface temperature. Infrared thermometers are ideal for taking temperatures need to be tested from a distance. They provide accurate temperatures without ever having to touch the object you're measuring (and even if your subject is in motion).

### TECHNICAL SPECIFICATIONS

| Specification | Range |
|---|---|
| IR | -50℃~1050 ℃ |
| Contact | -50℃~1370 ℃ |
| IR Temp. Resolution | 0.1℃ |
| Basic Accuracy | +/- 1.5% of reading |
| Emissivity | Adjustable 0.10 ~ 1.0 |
| Optical resolution | 30 : 1 |

## LUX METER


Picture 6 Nishant NE 1010 Lux meter

Nishant NE 1010 Lux meter is used to measure the lux levels.

### TECHNICAL SPECIFICATIONS

| | |
|---|---|
| Measuring range | 0 Lux ~200, 000 Lux/0 Fc~185, 806 Fc |
| Accuracy | ± 3% rdg ± 0.5% f.s.( <10,000 Lux) |
| | ± 4% rdg ± 10% f.s.( >10,000 Lux) |
| Digital Updates | 2 times/s |
| Photometric sensor | Silicon diode |
| Battery life | 18 hours (continuous operation) |
| Operating temperature and humidity | 0°C ~ 40°C, 10% RH ~ 90% RH |
| Storage temperature and humidity | -20°C ~ 50°C, 10% RH ~ 90% RH |
| Power | 9V battery |
| Unit Size | 52.5 x 52.5 x 166 mm |
| Auto power off | After 5 minutes |

# 8. ANNEXURE (SOLAR)

## 1) Introduction

The solar energy has a great potential as future source of energy. With its availability in large quantity almost in every corner of the country, solar power has the distinctive advantage of generating power at local and decentralized levels and being one of the prime factors for empowering people at grassroots level. The solar mission, which is part of the National Action Plan on Climate change has been set up to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil-based energy options. The solar photovoltaic device systems for power generation had been deployed in the various parts in the country for electrification where the grid connectivity is either not feasible or not cost effective as also some times in conjunction with diesel based generating stations in isolated places, communication transmitters at remote locations. With the downward trend in the cost of solar energy and appreciation for the need for development of solar power, solar power projects have recently been implemented. A significant part of the large potential of solar energy in the country could be developed by promoting solar photovoltaic power systems of varying sizes as per the need and affordability coupled with ensuring adequate return on investment.

## 2) Benefits of Solar Energy

a. Power from the sun is clean, silent, limitless and free.

b. Photovoltaic process releases no CO2, SO2, or NO2 gases which are normally associated with burning finite fossil fuel reserves and don't contribute to global warming.

c. Photovoltaic are now a proven technology which is inherently safe as opposed to other fossil fuel based electricity generating technologies.

d. Solar power shall augment the needs of peak power needs.

e. provides a potential revenue source in a diverse energy portfolio

f. Assists in meeting renewable portfolio standards goals.

This proposal is prepared for design, engineering, procurement / manufacture and installation of solar power generating system. The grid-tie solar photovoltaic power generation system is mainly composed of PV array, String Inverter, and PV mounting structure.

It also consists of supporting devices like AC / DC switchgears, Lighting Arrestor, Earth Electrodes, AC / DC cables. As there is no any battery, it’s maintenance cost is negligible and initial investment per KW is very low.

## 3) Objective

- Provide reliable, clean, regulated, un-interrupted power on demand to the pre-identified critical loads
- System to provide low life cycle cost and maximize savings to the beneficiaries.

- To save diesel in institutions and other commercial establishments including industry facing huge power cuts especially during daytime.

**4) Design Assumptions**

General

a. The Solar Radiation Data's are based on standard books & simulation software as NASA and Metronome. The Mean Hourly Radiation Data is considered.

b. The module rating considered is tentative. The exact module sizing and rating will depend on the availability of cell grade and site suitability.

c. Solar Panels are roof/ground mounted in one location. Environmentally protected, closed, ventilated, inverter room at minimum distance from PV modules.

d. Application: Self consumption, captive grid or NET metering.

e. Emergency Backup: Generator or any other source in absence of Grid.

**5) System Description:**

Solar Power Plant comprises of the main equipment and components listed below:

1. Solar PV Modules
2. String Inverter with MPPT
3. Module mounting system
4. Monitoring system
5. Cables & connectors

Each of the sub systems has been described for the functionality and operation modes. The physical construction of the system follows a modular approach, which is field-tested and is regularly used for delivery of power systems.

## 5.1 Solar PV Module (Electrical Features)

The PV modules convert the light reaching them into DC power. The amount of power they produce is roughly proportional to the intensity and the angle of the light reaching them. They are therefore required to be positioned to take maximum advantage of available sunlight within sitting constraints.

## 5.2 Solar PV Module (Mechanical Features)

Solar Module design will conform to following Mechanical requirements:

- Toughened,
- low iron content,
- High transmissivity from glass.
- Anodized Aluminum Frame.
- Ethyl Vinyl Acetate (EVA) encapsulating.

- Tedlar/Polyester trilaminate back surface.
- ABS plastic terminal box for the module output termination with gasket to prevent water & moisture.
- Resistant to water, abrasion hail impact, humidity & other environment of actors for the worst situation at site.

### 5.3 Module Mounting Structure

The structure shall be designed to allow easy replacement of any module and shall be in line with site requirement. Structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site. The array structure shall have tilt arrangement to adjust the plane of the solar array for optimum tilt.

### 5.4 Junction Box

The junction boxes shall be dust, vermin and waterproof and made of FRP/ABS Plastic with IP65 protection. The terminals shall be connected to copper bus bar arrangement of proper sizes. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable marking shall be provided on the bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification

### 5.5 String Inverter

The STRING INVERTER is A combination of Solar Charger (MPPT), Inverter and synchronization unit for two different AC supplies, all housed in a single unit. Maximum power point tracker (MPPT) shall be integrated into it to maximize energy drawn from the solar array. The Inverter converts the DC available from the array into an AC output. The output of the inverter is filtered to reduce the harmonics to an acceptable level (less than 5%). MPPT shall be microprocessor/micro controller based to minimize power losses and maximize energy utilization. The efficiency of MPPT shall not be less than 90% and shall be designed to meet the solar PV Array capacity.

### 5.6 AC /DC Cables

We use DC & AC cables of Lap, Apar, Polycab, Havels, Finolex or equivalent make to ensure minimum losses in transmission.

In order to complete the energy study that leads to the construction of a photovoltaic installation, hourly series of global horizontal irradiation values for a complete year are used, which resume the irradiation and other meteorological parameters behavior over a long term. We use PV. SYST. Software to workout optimum power production at site with minimum loses.

## 5.7 Grounding and Lighting Protection

- A protective earth (PE) connection ensures that all exposed conductive surfaces are at the same electrical potential as the surface of the Earth, to avoid the risk of electrical shock. It ensures that in the case of an insulation fault (a "short circuit"), a very high current flows, which will trigger an over current protection device as fuses and circuit breakers that disconnects the power supply.
- A functional earth connection serves a purpose other than providing protection against electrical shock. In contrast to a protective earth connection, a functional earth connection may carry a current during the normal operation of a device.
- Lightning protection is a very specialized form of grounding used in an attempt to divert the huge currents from lightning strikes. A ground conductor on a lightning arrester system is used to dissipate the strike into the earth.
- Lightning ground conductors must carry heavy currents for a short period of time. To limit inductance and the resulting voltage due to the fast pulse nature of lightning currents, lightning ground conductors may be wide flat strips of metal, usually run as directly as possible to electrodes in contact with the earth.
- In proposal, the entire system is fully provided with the required lighting and grounding protection.

## 6) Solar PV Locations

**Area Considered for Solar Power Installation**

**Details of Facility:**

Average Unit Consumption / year of facility is 125.36 Units (Ref. 12 months Electricity Bills)

| Sr. No. | Area | Length (ft.) | Width (ft.) | Area (Sq. ft.) | Plant Installed (kW) |
|---|---|---|---|---|---|
| 1 | Main Building Area 1 | 88 | 40 | **3520.00** | **44.00** |
| 2 | Main Building Area 2 | 40 | 32 | **1280.00** | **16.00** |
| 3 | Main Building Area 3 | 78.5 | 41 | **3218.50** | **40.23** |
| 4 | Girls Hostel Area 1 | 54 | 12 | **648.00** | **8.10** |
| 5 | Girls Hostel Area 2 | 16 | 13 | **208.00** | **2.60** |
| 6 | Girls Hostel Area 3 | 40.5 | 28.5 | **1154.25** | **14.43** |
| **Total** | | | | | **125.36** |

Total Available Area = **10028.75 Sq. Ft.**& As per available shadow free Area maximum **125.36 KW** Plant can be installed at facility as per details mentioned in above table.

## 9. Capacity Evaluation

**Calculation for Required Solar Capacity plant to fulfill In-house Requirement**

| Calculation to Fulfill Building Total Load Requirement | | | |
|---|---|---|---|
| **Sr. No.** | **Details** | **Value** | **Unit** |
| 1 | Average electrical consumption per year | 43512 | KWh |
| 2 | Units generated per day per KWp | 4.5 | KWh/KWp/day |
| 3 | Units generated per Year per KWp (330 days / Year) | 1485 | KWh/KWp/Year |
| 4 | Solar KW capacity For 43512 KWh consumption / year | 29 | KWp |

As per electrical consumption (Building Load), capacity of Solar Power Plant required is 29 KWp. As per shadow free space available on college building maximum 120-125 KWp plant can be installed which is more than the actual requirement of full Electrical Load.

**It is suggested to install Solar Plant of Capacity 29 KWp, which can be installed on New building itself & it covers all required load**.

The SPV power plant with proposed capacity of 29 KWp would be connected to the main electrical distribution panel. The system would meet full load requirement of the connected load during the day. Advance control mechanism in the Power Conditioning Unit will ensure

that the maximum power generated by PV modules will be utilized first and the balance requirement of power will be met by either grid or DG set

The 29 KWp SPV Power Plant is estimated to afford annual energy feed of 29 KWh/year (After considering all losses) considering efficiency of the solar module as 15.16%, Power Conditioning Unit (PCU) efficiency as 98.3% and losses in the DC and AC system as 3%.

## 10. Budgetary Estimation of the Project

| Details | Value | Unit |
|---|---|---|
| Shadow free space required for approx. 1 KWp Solar Plant | 80 | Sq.Ft |
| Shadow free space available at Facility | 10028.75 | Sq.Ft. |
| Solar Plant capacity to be Installed at Facility | 125.35 | KWp |
| Solar Plant Requirement as per actual consumption | 29 | KWp |
| Installation Cost Per KW for 1 KWp Solar Plant | 0.57 | Rs. In Lakh |
| Gross Estimated System cost (For 29 KWp Grid Connected Solar Plant) | 16.7 | Rs. In Lakh |
| Unit generated per day per kWp | 4.5 | KWh |
| Electricity generation per day for 29 KWp Grid Connected Solar Plant | 131.9 | KWh/day |
| Electricity generation per year for 29 KWp Grid Connected Solar Plant (330 days/year) | 43512 | KWh/year |
| Average Electricity Unit Cost | 5.5 | Rs./KWh |
| Electricity cost saved per year | 2.39 | Rs. In Lakh |
| Simple payback period | **6.98** | **Years** |