ENERGY AUDIT REPORT

Shri Ram College

Parikrama Marg

MUZAFFARNAGAR 251001

ENERGY AUDIT

CERTIFICATE

This is to certify that an "Energy Audit" for the Shri Ram College, Parikrama Marg, Muzaffarnagar 251001, has been conducted in Jan-Feb 2018 to assess energy costs, availability and reliability of supply of energy, energy conservation technologies, ways to reduce energy consumption and wheeling of electricity generated through solar panels.

Place: Muzaffarnagar
Date: 7th March 2018

Dr. Navneet Kumar
Asso. Prof., Deptt of EE
Govt. Engineering College
Bijnor
Convener

Er. Rohitash Singh
Head, Deptt of EE
Shri Ram Group of Colleges
Muzaffarnagar
Coordinator

Er. Tushar Sharma
Asst. Prof., Deptt of EE
Shri Ram Group of Colleges
Muzaffarnagar
Auditor

Er. Vivek Ahlawat
Asso. Prof., Deptt of EE
Shri Ram Group of Colleges
Muzaffarnagar
Auditor

Er. Sanchit Kulshreshtha
Shri Ram Technologies,
Parikrama Marg
Muzaffarnagar
Member

Er. Sangeet Grover
Shri Ram Technologies,
Parikrama Marg
Muzaffarnagar
Member

Shri Ram College, Muzaffarnagar

ENERGY AUDITING COMMITTEE

S. No.	Name	Designation	Committee Role
1.	Dr. Navneet Kumar,	Associate Professor, Deptt of Electrical Engineering, Govt. Engineering College Bijnor	Convener
2.	Engr. Rohitash Singh	Head, Dept of Electrical Engineering Shri Ram Group of Colleges Muzaffarnagar	Coordinator
3.	Engr. Tushar Sharma	Assist. Professor Dept of Electrical Engineering Shri Ram Group of Colleges Muzaffarnagar	Auditor
4.	Engr. Vivek Ahlavat	Associate Professor, Dept of Electrical Engineering Shri Ram Group of Colleges Muzaffarnagar	Auditor
5.	Engr. Sanchit Kulshreshtha	Shri Ram Technologies, Parikrama Marg Muzaffarnagar	Member
6.	Engr. Sangeet Grover	Shri Ram Technologies, Parikrama Marg Muzaffarnagar	Member

Contents

Executive Summary

Natural resources on earth are limited and consuming very sharply. It can be saved by employing energy efficiency and it is very necessary to prevent depletion of natural resources. The Electrical audit of any organization shows that the load of electrical equipment's is significant and some necessary step for reducing energy conservation should be taken. Today energy conservation plays a very important role for energy conserving because energy consumption is increasing day by day but the natural resources are not increasing and also generation is not match with consumption People should aware about energy conservation and reduce energy consumption by adopting modern technologies.
Energy Audit attempts to balance the total energy inputs with its use and serves to identity all the energy streams in the systems and quantifies energy usage's according to its discrete functions. Energy Audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating & maintenance practices of the system. It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipment's Instrumentations and technology.

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. it attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions.

The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs availability and reliability of supply of energy, decide on appropriate energy mix, identity energy conservation technologies, retrofit for energy conservation equipment etc. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. The present report shows the energy audit of Shri Ram College campus in terms of pre-audit phase, audit phase and post audit phase.

1. Introduction

In broad sense, Energy Efficiency means economizing on the use of energy without adversely affecting economic growth and development. It includes improving the efficiency of energy extraction, transmission and distribution and increasing the productivity of energy use.

Designated consumers

Central Govt. specify the following criteria for energy Intensive Industries and other establishment. (As per EC Act 2001, Section 14(e), for Industries Electrical connected load 5000 KW and above Designated Consumes to get energy audit by Accredited energy audit firms.

Bureau of Energy Efficiency (BEE)

The Bureau of Energy Efficiency is an agency of the Government of India, under the Ministry of Power created in March 2002 under the provisions of the nation's 2001 Energy Conservations Act. The agency's functions is to develop programs which will increase the conservation and efficient use of the energy in India.

2. Energy Audit

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 efficiently with cost benefit analysis and an action plan to reduce energy consumption".

There are three phase of Energy Audit

1. Pre audit phase

2. Audit phase

3. Post audit phase

Above phase include following stages

1. **Data Collection** - In preliminary data collection phase, exhaustive data Collection was performed using different tools such as observation survey communication with responsible persons and measurement.

Following steps were taken for data collection:

- The tam went to each department, center, library, cafe etc.
- Data about the general information was collected by observation and interview.
- The power consumption of appliances was recorded by taking an average value in some cases.

2. **Data Analysis** - Detailed analysis of data collected include: calculation of energy consumption, analysis of latest electricity bill of the campus understanding the tariff plan provided by the Pachimanchal Vidyut Vitran Nigam. Data related to water usages were also analysed using appropriate methodology.

3. **Recommendation** - On the basis of results of data analysis and observation, some steps for reducing power and water consumption were recommended. Proper treatments for waste were also suggested. Use of diesel in generator has to be reduced for the sake of good environment. The above target areas particular to the college was evaluated through a schedule for the collection. The formats of these are given below:-

2.1 Pre audit Phase

2.1.1 Survey Form for data collection

1. List ways that you use fuel in your college. (electric stove, kettle, microwave, LPG, firewood, diesel and others).
2. Electricity bill amount for the last five years.
3. Amount paid for LPG cylinders for last one year.
4. Weight of firewood used per month and amount of money spent? Also mention the amount spent for petrol/diesel/others for generations?
5. Are there any energy saving methods employed in your college? If yes, please specify. If no, suggest some.
6. How much money does your college spend on energy such as electricity, gas, firewood, etc. in a month.
7. How many LED tube lights and lumps has your college installed? Mention use (Hours used/day for how many days in a month).
8. Energy used by each bulb per month? (for example- 60 watt bulb x 4 hours x number of bulbs = kwh).
9. How many LED bulbs are used in your college? Mention the use (Hours used/day for how many days in a month).
10. Energy used by each bulb per month? (kwh).
11. How many fans are installed in your college? Mention use (Hours used/day for how many days in a month).
12. Energy used by each fan per month? (kwh).
13. How many air conditioners are installed in your college? Mention use (Hours used/day, for how many days in a month).
14. Energy used by each air conditioner per month? (kwh).
15. How may electrical equipments are installed your college?
16. Mention the use (Hours used/day for how many days in a month).
17. Energy used by each electrical equipment per month? (kwh).
18. How many computers are there in your college? Mentioned the use (Hours used/day for how many days in a month)
19. Energy used by each computer per month? (kwh)

20. How many photocopiers are installed by your college? Mention use (Hours used/day for how many days in a month).
21. How many inverters your college installed? Mentions use (Hours used/day for how many days in a month)
22. How many cooling apparatuses are in installed in your college? Mention use (Hours used/day for how many days in a month)
23. Energy used by each cooling apparatus per month? (kwh) Mention use (Hours used/day for how many days in a month)
24. Energy used by each photocopier per month? (kwh) Mention the use (Hours used/day for how many days in a month).
25. Energy used by each inverter per month? (kwh)
26. How many electrical equipment are used in different labs of your college? Mention the use (Hours used/day for how many days in a month)
27. Energy used by each equipment per month (kwh)
28. How many heater are used in the canteen of your college? Mention the use (Hours used/day for how many days in a month)
29. Energy used by each heater per month? (kwh)
30. No of street lights in your college?
31. Energy used by each street light per month? (kwh)
32. No of TV in your college and hostels?
33. Energy used by each TV per month? (kwh)
34. Any other item that uses energy (Please write the energy used per month) Mention the use (Hours used/day for how many days in a month)
35. Are any alternative energy sources/nonconventional energy sources in photovoltaic cells in your college? specify
36. Do you run "switch off" drills at college?
37. Are your computers and other equipment put on power-saving mode?
38. Does your machinery (TV, AC, Computer, weighing balance, printers, etc.) run on standby mode most of the time? If yes, how many hours?
39. What are the energy conservation methods adapted by your college?
40. How many boards displayed for saving energy awareness?
41. How much ash is collected after burning fire wood per day in the canteen?
42. Write a note on the methods/practices/adaptations by which you can reduce the energy use in your college campus in future.

2.2 Audit Phase

In Shri Ram College energy auditing was done with the help of engineers Shri Ram Technologies. The energy audit began with the teams walking through all the different facilities at the college, determining the different types of appliances and utilities (lights, taps, toilets, fridges, etc.) as well as measuring the usage per item (Watts indicated on the appliance) and identifying the relevant consumption patterns (such as how often an appliance is used) and their impacts. The staff and students were

interviewed to get details of usage, frequency or general characteristics of certain appliances.

2.2.1 Data collection

Data collection was done in the sectors such as source of qnergy and energy consumption pattern. College records and documents were verified several times to clarify the data received through survey and discussions. Although whole process was completed within five months from 2019 January to July, 2019 previous energy patterns were also observed.

2.2.2 Site Tour

Site inspection was done along with students and staff Schedules were answered during the site tour and relevant documents were collected.

2.2.3 Review of Documents and Records

Documents such as electrically bills, registers of electricity, fuel consumption were collected and reviewed.

2.2.4 Site inspection

College and its premises were visited and analyzed by the audit-teams several times to gather information. All the buildings inflations infrastructures using electricity ie. canteen, library, office rooms and parking grounds were visited to collect data Number and type of vehicles used by the stakeholders were counted and fuel consumptions for each vehicle was verified with the user. Number of LPG cylinders used in labs, canteen and hostel kitchen mess were also counted. Leakage of a few water taps were noticed during the site inspection.

Table 1: Total Campus Area & College Building Spread Area

Total Area	31704 M^2
Total Cover Area	13657.90 M^2
Road and Open Area	5336.72 M^2
Ground Coverage	3613.25 M^2
Open Area	28090.75 M^2

2.2.5 Energy Sources and Consumption Areas

There are 2 hostels, 5 academic blocks, cafe, stores, generator room and supporting infrastructures like library, labs auditorium and cafeteria. Analysis implies that hostels in general is relatively more power consuming unit of the

campus. Small consumption of cafeteria is due to its small size, less usage and no ACs.

2.2.5 1 Energy Sources

Transformer of capacity 630 KVA (step down), has been installed in campus for distribution of power to different unit.

In case of power cut the supply is made treble power to fulfill demands with help of generators which runs on diesel as fuel.

Generator 1 - 160 KVA

Generator 2 – 82.5 KVA

Power efficiency of generator is 85%

2.2.6 Key Finding and Observations of Energy Usages

The base of energy audit is that its findings are supported by documents and verifiable information. The audit process seeks, on a sampled basis, to track past actions, activities, events, information. The audit process seeks, on a sampled basis, to track past actions events and procedures to ensure that they are carried out according to systems requirements and in the correct manner. Energy audits form a part of a process. Although they are individual events, the real value of energy audits is the fact that they are carried out, at defined intervals, and their results can illustrate improvement or change over time.

Although audits are carried out using policies, procedures, documented system and objectives as a test, there is always an element of subjectivity in an audit. The essence of any energy audit is to find out how well energy management equipment is performing. Each of the three components are crucial in ensuring that the organization's energy performance meet the goals set in its energy policy.

Consolidate Shri Ram College, Muzaffarnagar Details of Unit, & Bill, Amount, 2017			
S.No.	**Month**	**Units**	**Bill Amount**
1	January	11593	126216
2	February	13878.2	144831
3	March	15617.2	159094
4	April	14087.8	127343
5	May	23663.2	253340
6	June	27760.2	278380
7	July	20590.8	211400
8	August	18743	196417
9	September	23363.6	262929
10	October	25489.2	260282
11	November	23177.2	226152
12	December	14613.6	152196
	Total	**232577**	**2398580**

- Electricity Charges Rs. 1,99,881.00 /month
- Number of Generators = 2(163KVA & 83 KVA)
- Cost of generator fuel = Rs 25000/month
- Total cost of energy = Rs 2,24,881.00/month
- Total number of CFL bulbs = 283
- Number of LED Tube = 628
- Number of LED ceiling lights = 174
- Number of fans = 476
- Number of Air conditioners = 45(324 KW)
- Number LED fours lights = 112
- Total Electrical Equipment's in Lab = 126
- Number of Computer and laptops =
- Number of Photocopiers = 3
- Number of Televisions = 8
- Number of Printers = 39
- Energy generation by solar panels 180 kw

2.2.7 Already Exiting Power Saving Measures

- We already have Solar Geysers Installed in hostels and Mess
- Turn off electrical equipment's when not in use.
- False ceilings in class rooms and offices for maintaining optimum room temperature.
- Resistance regulators Being replaced with electronic regulators.
- Master switches installed outside rooms in hostels.
- CFLs are being replaced by more efficient LEDs.
- Use computers and electronic equipment's in power saving mode

2.2.8 Recommendations for Better Energy Efficiency

Based on the analysis of the power consumption data, certain steps have been recommended for improving energy efficiency of the campus. Complete cost analysis of implementation of recommended measure has been performed wherever necessary. Also, a number of general measures for energy efficiency have been listed. Described below are some important recommendations for better energy efficiency.

2.2.8.1 Low/No investment (Immediate Replacements)

1. **Housekeeping**

   - Curtains - Always keep curtains on windows to prevent direct sunlight inside the room to avoid heating of cooled air. This reduces AC load significantly.

2. **Better Practices for AC**

   The institute has in total 57 window type ACs and 17 split type ACs which make a very large part of total energy consumption of the campus. But, at many places it was found that Ac is not used with best recommended practices. Even simple things, such as insulation, are not taken care of Window panes were found broken at many places. Also, at certain places ACs were found to be used without keeping curtains. These poor practices account for increase in AC load and thus consumption.

   Summarized below are some guidelines for most efficient use of ACs:

   - Proper Insulation – Good quality insulation must be maintained in the air conditioned rooms by keeping all doors and windows closed property so as to prevent cool air go out and hot air come in.
   - Operating – The ACs should be switched on 15 minutes before actual use and should be switched off before leaving the room.

3. Replacing CFLs with LEDs Lamps

Energy Saving Calculation

Cost Analysis of Led light with Conventional tube light.

- Total No. of conventional Tube Lights in Campus =628
- Conventional Tube Light average power = 40W.
- LED Tube Light average power = 20W.
- Difference in power saved per Tube Light = (40-20) W =20W.
- Total Power saving = 628*20W = 12560W = 12.5kW.
- Average Use of Tube Light per year =270*8h=2160h.
- Energy saved per year = 12.5*2160 kWh = 27000kWh.
- Per year saving = 27000*8.5= Rs.229500.
- LED tube light average cost = Rs.450.
- Total Cost of Replacing all Conventional tube lights = 628*450 =Rs.282600.
- Payback time = (282600/229500) =1.23yrs.

Hence, the payback time for replacing all conventional tube lights of the campus with LEDs is around 1.2 year.

2.2.8.2.1 Medium Investment/ Short Term Replacement

Energy Saving Calculation

Cost Analysis of Normal fan and wall fans are replaced by 5-star fans.

- Total No. of Normal fans in Campus =392
- Normal fan average power = 75W.
- 5-star fans average power = 50W.
- Difference in power saved per fan = (75-50) W =25W.
- Total Power saving = 392*25W = 9800W = 9.8kW.
- Average Use of fan per year =240*8h=1920h.
- Energy saved per year = 9.8*1920 kWh = 18816kWh.
- Per year saving = 18816*8.5= Rs. 159936.
- 5-star Fan average cost = Rs. 1500.
- Total Cost of Replacing all Conventional fans = 392*1500 =Rs. 588000.
- Payback time = (588000/159936) =3.6 yrs.

Hence, the payback time for replacing all normal fan of the campus with 5-star fan is around 3.6 year.

2. Use of Master Switch outside each Room:

Installation of a master switch outside a room can make it easy for a person to switch off all the appliances of a room in case someone forgets to switch off while leaving the room. This can help improving energy efficiency. There are total 107 classrooms and labs.

Table 3: Description of Master Switch outside each Room

Appliances	Number	Annual Savings (kwh)	Annual Savings (Rs.)	Capital Investment (Rs.)	Payback Period (Days)
CFL	283	18489.60	73958.40	4280	15
FANS	476	46440.00	185760.00		

3. Use of Motion Sensors in Toilets:

Toilets have large potential of saving energy by use of automation tools. Motion sensors can be used there to automatically switch on the light when there is any movement and switch off the light when there is no movement. This can greatly reduce the total load in toilets. There are 107 toilets in campus, each toilet have 4 tube lights in average. There will be 3 sensors required in a toilet.

Cost analysis of Installing Motion Sensors in a Typical Toilets:

- Number of tube lights in a Toilets = 206
- Average power of the tube lights = 20 W
- Average number of motion sensors required = 154
- Average reduction in usage per day by motion sensor = 4h
- Total energy saved in Toilets per year =(206 x 20 x 365)/1000= 6015.20 kWh
- Saving in Rs. Per year = 24995.20 x 4 = Rs. 61,355.04
- Cost of installation per motion sensor = Rs. 250.00
- Total cost of installing motion sensors in Toilets =154 x 250 = Rs. 38,500.00
- Capital Cost Recovery Time = 1 Year

Hence, the capital cost recovery time for installing motion sensors in toilets is 1 year. Hence, this is highly recommended step 2 largely reduce the consumption in toilets.

2.2.8.3 High Investment/ Long Term Replacement

1. Energy substitution (Electrical Energy to Solar Energy)

As we know in our campus there is a huge consumption of electrical energy which is not economical so instead of using electrical energy we switch to alternate energy source which is solar energy.

The major energy consumption units are main building and management block, so we have shown the calculation for the no of solar panels for these buildings only.

Cost analysis of solar panel for

- Total Capacity - 160 kWp
- Production Output - 1088 Units/ Day
- Life of Solar Panels - 25 years
- Life of Inverters - 5 years
- Total Cost of Installation - Rs. 85,70,000.00
- Subsidy Amount - Rs. 25,70,000.00
- Net Cost - Rs. 60,00,000.00
- Cost per Watt - Rs. 37.50
- Total Generation per month - Rs. 32,640.00
- Generation Value - Rs. 3,32,928.00
- Annual Saving - Rs. 39,95,136.00
- Pay back Period - 5 Years

2.2.9 Consolidation of Audit Findings

- The communication process for awareness in relation to energy conservation is found adequate.
- Average power factor of 0.95 is maintained
- Assessment of electrical load calculation has been done by the college.
- Monthly use of electricity in the college is not very high.
- Objectives for reducing energy, water and fuel consumption are sufficient.
- Energy efficient equipments are being used by replacing the old non-energy efficient fans.
- Regular monitoring of equipment's and immediate rectification of any problems in being done.

2.3 Post audit phase

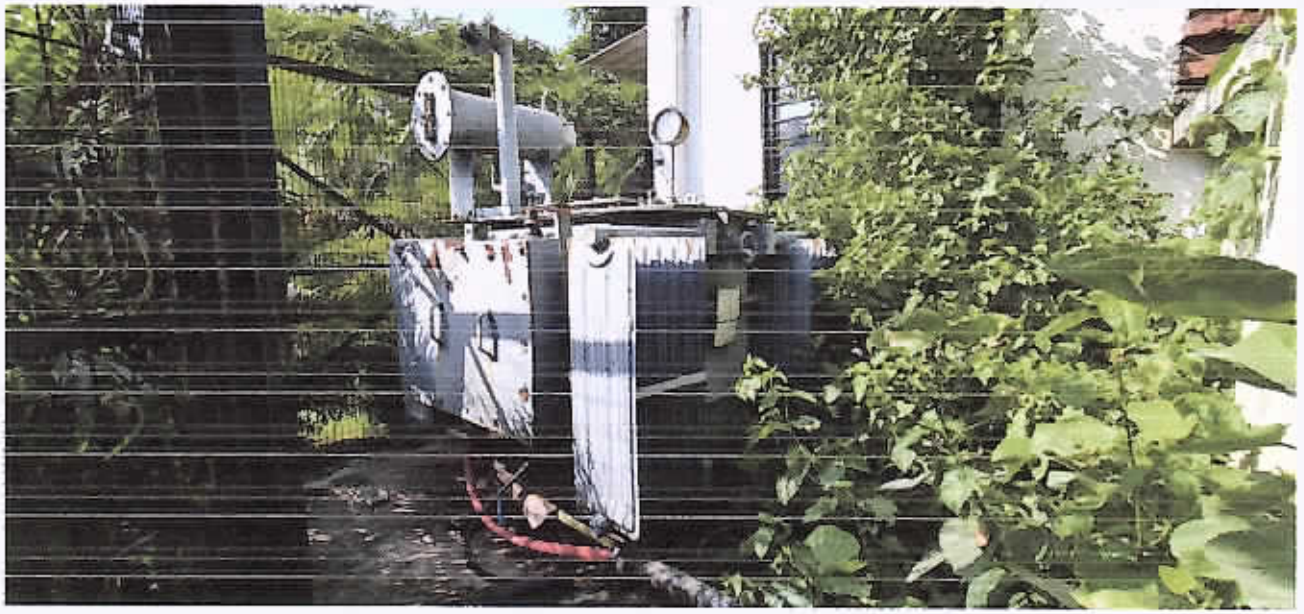
Follow Up and Action Plans

Energy audits form a part of an on-going process. Innovative energy saving initiatives has to be designed and implemented every year to make the college environmentally sustainable. Follow up programs of energy auditing recommendations should be done meticulously before the next audit.

Already the college has started replacing the CFL lamps with LED lamps. 5 star rating fans are purchased for newly constructed buildings. Biogas plant already working in the campus. All the rooms are provided with curtains to reduce temperatures. Solar Energy of 160 KW is being finalised with the vendor. Street light sensor already provided. Water level controller are installed on all the pumps. It clearly shows that Shri Ram College authorities and management is committed to save energy and to generate green energy not only for campus consumptions but to wheel it to main grid of electricity board.

Solar Panels on Roofs

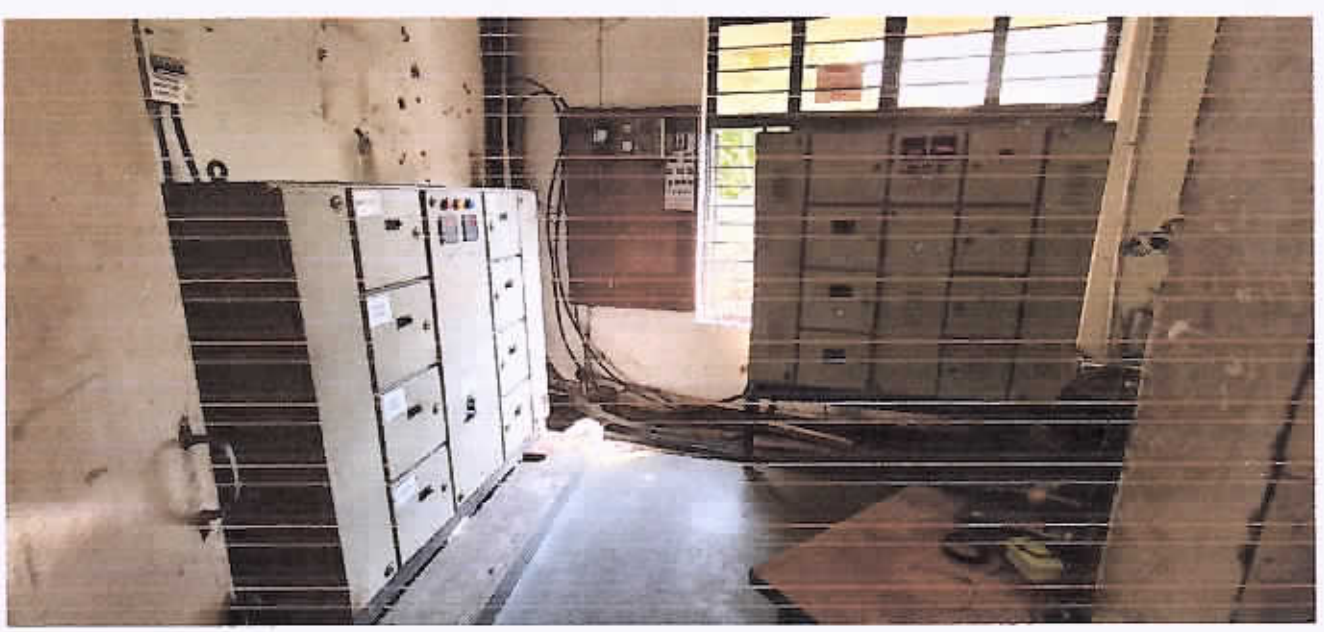
Solar Inverter



Transformer at Sub-Station

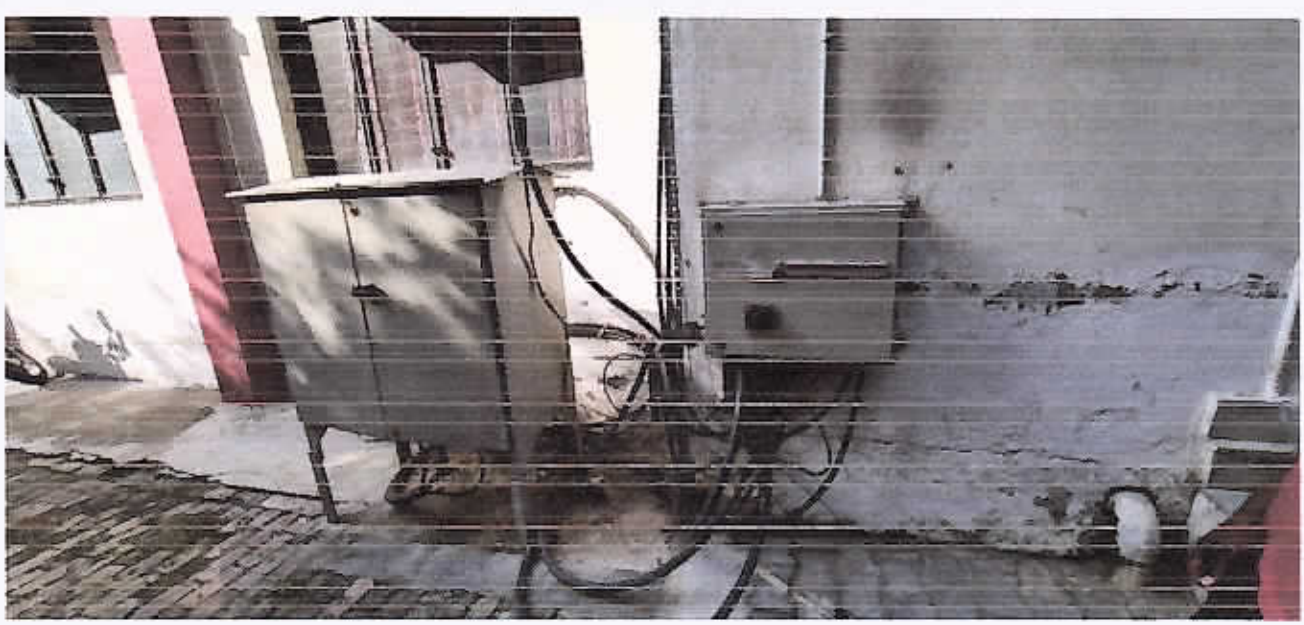
HT Breaker in Sub-Station

Generator Room



Electric Sub-Station in Block-2

Electric Sub-Station in Block-3



Electric Sub-Station in Block-4

Electric Sub-Station

LPG Pipe Line

LPG Station in Hostel

Indraprastha Gas Limited

Bio Gas Plant

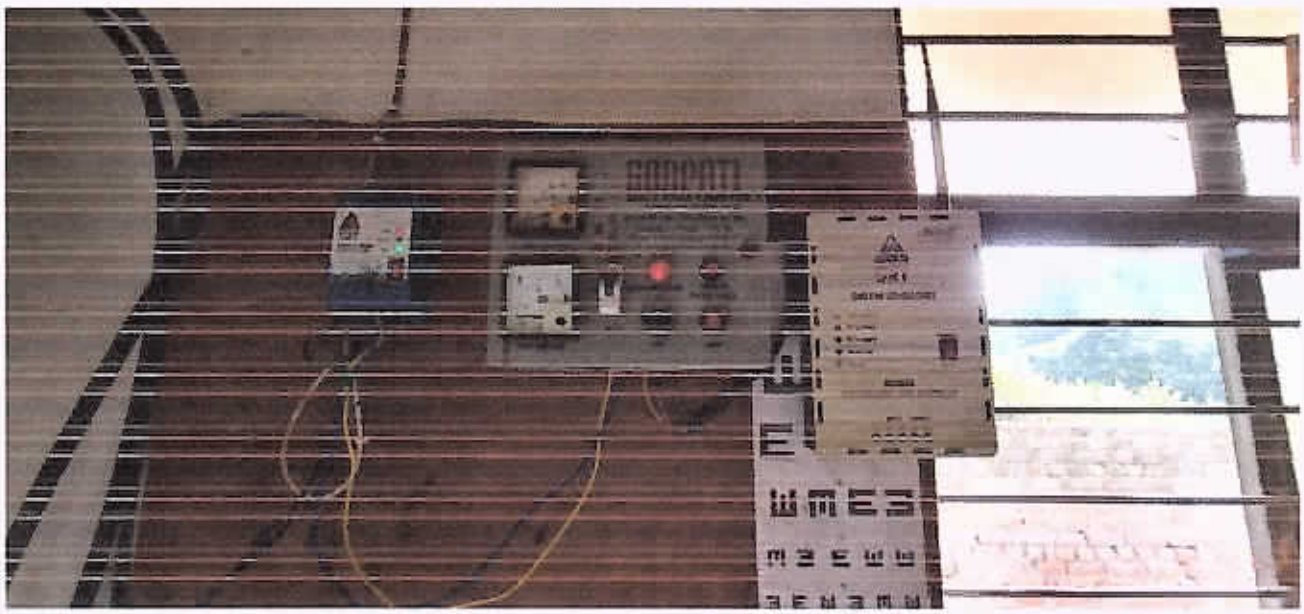
Bio Gas Plant

LED Ceiling Lights in Lobby

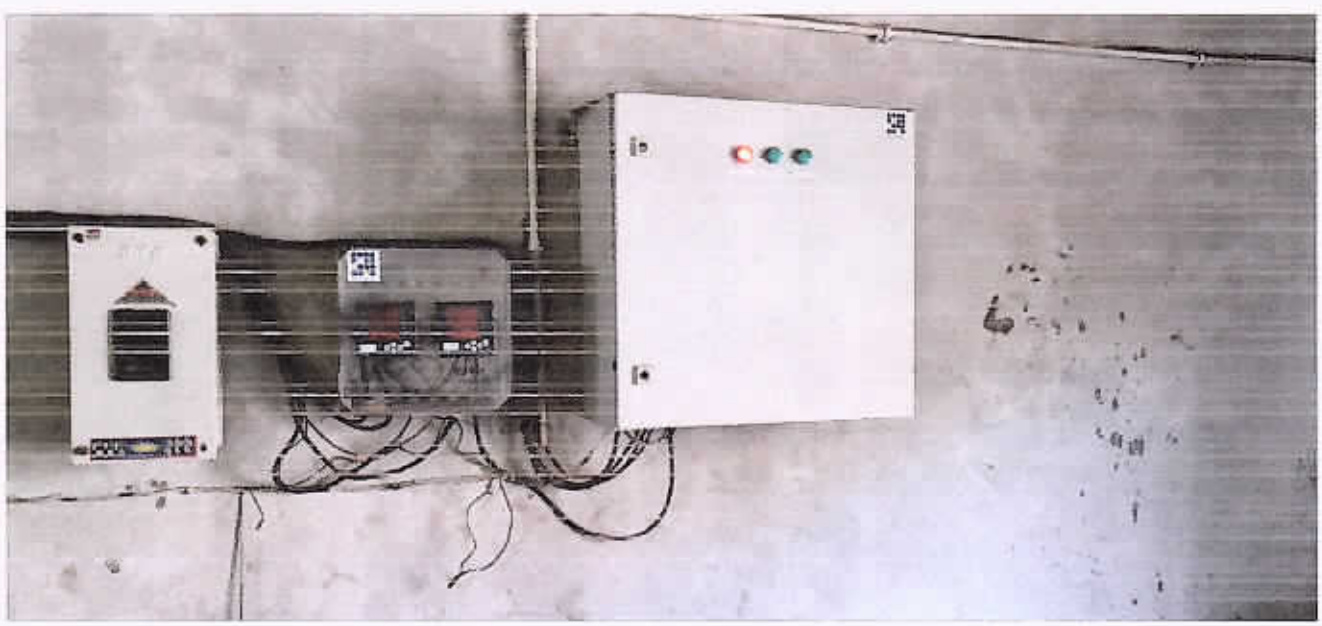
LED Light on Road Crossing

LED Ceiling Lights in Office

LED Ceiling Lights in Conference Hall



Water Level Controller



Street Light Sensor