File Ref.No.137611/IQAC-ASST1/2021/Admn

UNIVERSITY OF CALICUT

Abstract

IQAC - Conduct of Energy Audit in the University- Report of the Committee -Approved for implementation- Orders Issued

IQAC

U.O.No. 5485/2022/Admn Dated, Calicut University.P.O, 25.02.2022

Read:-1. U.O.No. 6955/2021/Admn Dated, 13.07.2021.

2. Orders of the Hon'ble Vice-Chancellor in the file of even No. Dated 11-08-2021.

ORDER

1. As paper paper read (1) above, a Committee has been constituted for conducting the Energy Audit of Calicut University with Dr.Libu K Alexander as its Convener.

2. As directed, the committee has submitted the Energy Audit Report for approval and implementation in the University.

3. Considering the matter in detail, the Hon'ble Vice Chancellor, vide paper read (2) above, has approved the Energy Audit Report for implementation in the University.

Orders are issued accordingly.

Sabu V.V

Assistant Registrar

To

Dr.Libu Alexander - Convenor
Dr.Zuhail (Physics dept)
Dr. Kishore Sridharan (Nano science)

Copy to : PS to VC/PA to PVC/PA to R/SF/DF/FC

Forwarded / By Order

Section Officer

Energy Audit

2021

University of Calicut
Kerala 673635

I. Significance of Energy Audit

One of the critical components of infrastructure for the comprehensive economic growth and development of a nation is electricity. Our country being the 2nd largest populous country is the 3rd largest consumer of electricity and as per the Key World Energy Statistics 2019, India is recognised as the 3rd largest producer of electricity. As of October 2020, the total installed capacity of power stations in India stood at 373.43 Gigawatt (GW) and typically the generation during 2019-20 was 1250.78 Billion Units. Our country's power generation still is primarily based on the non-renewable energy resources derived from fossil fuels such as coal, lignite, natural gas and oil. Excessive burning of fossil fuels has resulted in an increased concentration of atmospheric carbon dioxide (CO_2). As a result, the natural greenhouse is modified and has resulted in climate extremes, such as droughts, floods and extreme temperatures. The air quality index of some of the metro and industrial cities of our country such as Delhi, Kanpur, Lucknow etc. are in the hazardous category (> 400). Further, the bushfires in Australia and the recent heatwave in the Vancouver area of Canada that has killed scores of people are a warning to the world. Therefore, global warming is a serious concern that can lead to crop losses and threaten the livelihoods of agricultural producers and the food security of communities worldwide. However, the electricity demand of our country like most of the countries worldwide has increased rapidly and is expected to rise further. To meet the electricity demand, massive addition to the installed capacity is being considered. Because of the issue of global warming, the Government of India is considering reducing its reliance on fossil fuels for reducing CO_2 emission and is focusing on the sustainable generation of electricity through the Renewable Technology and Integration (RT&I) Division in the Planning Wing of the Central Electricity Authority of India.

On the other hand, for avoiding undisciplined usage of electricity it is vital to administer the consumption and initiate routine checks on the quality of the appliances/equipment installed to weed out and replace those which significantly consume power while delivering poor efficiency. Therefore, systematic planning and action are required for saving the energy and indirectly curb CO_2 emission that triggers global warming. As a role model to the society and students who are our country's future, it is the responsibility of the educational institutions to implement the best practices leading to sustainability. In this regard, we have performed an

energy audit in our university campus to check the overall electricity consumption and figure out the ways to minimise the consumption by maximizing the efficiency of the installed facility. Also, we have explored the possibility of improving the generation of electricity on the campus in conjunction with the Kerala State Electricity Board (KSEB).

II. Recommendations of the Energy Audit Committee

1. Installation of energy-efficient and environment-friendly appliances/equipment such as LED bulbs/tube-lights, Fans and water pumps with energy-efficient brushless DC motors, Air Conditioners with Inverter having 5-star power rating in a phased manner as and when the life of an existing unit comes to an end for minimizing e-waste.
2. Emphasize standard lux levels as suggested by the Bureau of Energy Efficiency, Govt of India at various areas of the campus such as stairs, corridors, classrooms, library, canteens, and offices.
3. Recurrent maintenance of Air Conditioning and Water pumping units on the campus.
4. Prioritize electrical safety by quarterly/semi-annually monitoring the wiring, sockets and fuses and adopt a policy document regarding this matter.
5. Installation of curtains/sun films in window panes of air-conditioned rooms for ensuring proper sealing and improving the cooling efficiency - that will curtail the excessive usage of electricity.
6. Adopt measures to utilize additional open space available on rooftops for solar power generation in conjunction with Kerala State Electricity Board (KSEB) with consistent monitoring and maintenance.
7. Installation of solar panels can reduce the heat generated on the rooftops during summer and therefore can considerably reduce the load on the air conditioners. The possibility of 100 % coverage with solar panels on the planned building of the university for the academic teaching block should be considered.
8. Utilize the existing biogas plant to its maximum capacity that primarily functions with the food waste collected from canteens, hostels and other parts of the campus. University should consider expansion/introduction of the bio-gas plant for generating energy from the waste collected from the nearby locality.

9. Educate the students and staff in the campus about energy conservation by conducting awareness programme regularly and initiate active their participation with posters/slogan design competition.
10. Initiate plans to regularly update the Single Line Diagram (SLD) which will facilitate better monitoring of the power network.
11. Encourage the plantation of more trees in and around the campus.
12. Encourage Science Faculty to take up research on sustainable energy generation on the topics such as PV technology, solar tapping, electrochemical technologies by providing necessary support including research grants.
13. Accelerate measures for rainwater harvesting and water recharging within the campus – which could cut down energy consumption for water pumping.
14. Time-to time maintenance activities of the solar power plants need to be ensured with in-house expertise and speedy bureaucratic support.
15. Shift the non-essential consumption from the peak hours to off-peak hours as the tariff rate is low during off-peak hours.
16. The measures suggested in this document under the heading 'Energy Conservation Opportunities in Pumping Systems' may be ensured
17. The measures suggested in this document under the heading 'Energy Saving Measures for DG Sets' may be ensured.

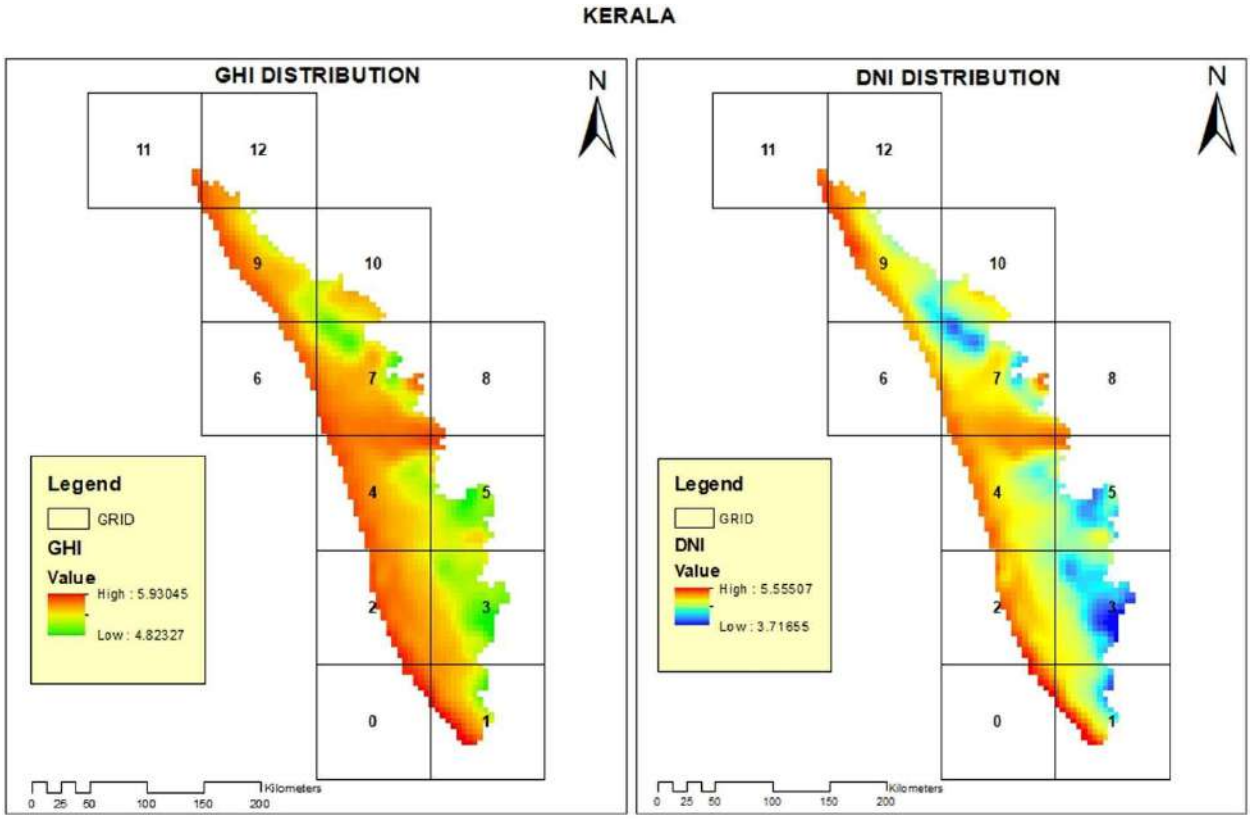
III. Electricity Consumption and Management Analysis

Towards the analysis and suggestions for better management of energy-saving options of the university, we have used various reports by BEE, research papers in this direction and the energy audit report of Kerala University as reference materials wherever found necessary.

III.1 Solar Photovoltaic Project and its expansion

The university houses few solar panels that have been placed on the rooftop of some of our buildings. The electricity generated using solar panels is consumed internally. However, the university may consider installing more solar panels - generating electricity that could be used internally as well as routed to the grid.

Solar energy analysis is vital before the installation and commissioning of any photovoltaic system at any geographical location. According to a recent study titled "Satellite-based solar energy potential analysis for southern states of India" published in the "Energy Reports" [D. Kumar, Satellite-based solar energy potential analysis for southern states of India, Energy Reports. 6 (2020) 1487–1500], it can be understood that our University is located in a suitable region with good solar insolation. As observed from Figure 1, the University of Calicut is located at a region where the direct normal irradiance (DNI) with global horizontal irradiance (GHI) are both above 5 kWh/m^2, indicating that it is suitable for the placement of solar panels to generate electricity.



(a) GHI variability (b) DNI variability

Figure 1. Solar insolation data for the state of Kerala. The University of Calicut is located in the grid marked as 7, wherein the GHI and DNI values are above 5 kWh/m^2.

III.2 Installed Solar Infrastructure

Solar Power Plants (SPP) are mainly in two types, Grid-connected Solar Power Plant, Off-Grid Solar Power Plant. The on-grid Solar Power Plant is also known as Grid-Tie or Connected

Solar Power Plant. This is the most cost-effective type for Solar Power Plant compared to the off-grid for electricity saving or reducing the bill. In this Solar Power Plant, a Solar Inverter converts the DC electricity produced by the Solar Panels into AC Electricity, which can then be used directly at home or business.

The University of Calicut has an installed capacity of 255 KWp Solar Power Plants (Grid connected) in the University Campus as detailed below. On average 1 KWp of Solar Power Plant produces 3-4 Units of Electricity in a day.

Sl. No.	DESCRIPTION	CAPACITY
1	Digital Wing	25 KW
2	Men' s Hostel	25 KW
3	Ladies Hostel - 1	25 KW
4	Ladies Hostel - 2	25 KW
5	CHMK LIbrary	25 KW
6	Administrative Block - 1	25 KW
7	Administrative Block - 2	50 KW
8	Guest House-1	25 KW
9	Guest House-2	30 KW

Total Solar Power Plant = 255KWp

The first Project consisting of 4 x 25 KWp SPPs were installed in the year 2013. The Second Project of 2 x 25 KWp SPPs were installed in 2014. The Third project of 1 x 30 KWp and 1 x 50 KWp SPPS were installed in 2016. A 50 KWp Solar Power Plant Project is under construction in the Ladies Hostel. When all SPPs are working properly the complete system produces 255 x 3 units of Electricity per Day. By understanding the relevance of renewable energy sources, the University of Calicut had proposed to install a Ground-Based Solar Power Plant of **1.50 MWp** on the vacant land at the Western side of the New Building for the Department of Life Science, in the University Campus. It is estimated to generate about 18.00 Lakhs Units per Year.

At the current Tariff Rate of Rs. 7/Unit, this shows that an amount of **Rs. 1,26,00,000** per year can be saved on Energy Charges with a Return on Investment of **12.60 % (At Current Tariff Rates).**

III.4 Tariff and Electricity Charges

The Calicut University campus electric supply is charged under the latest tariff order no. 1007/FRT/KSERC/2016 dated 17-04-2017 HT II(A) general of the Kerala state electricity regulatory commission. The HT II(A) general tariff structure is given in the table below.

As per the Time-Of-Day (TOD) tariff, electricity consumption for 6.00 hours to 18.00 hours ie normal period is charged at full rates 100%, 18.00 hours to 22.00 hours ie peak period is charged at 150% of the above rate and 22.00 hours to 6.00 hours ie off-peak period is charged at 75% of the above rates.

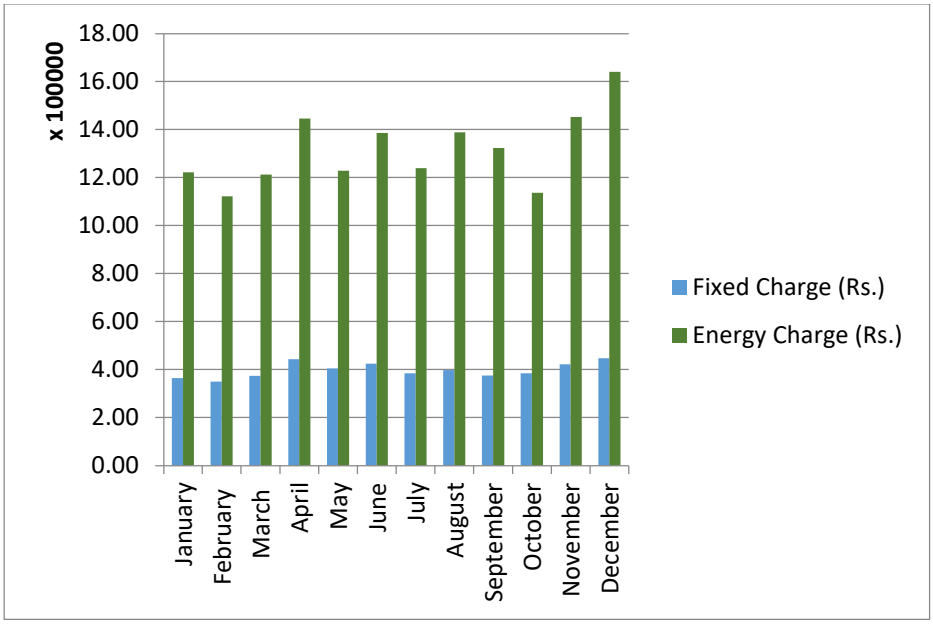
Table 1-Tariff structure-HT II (A) General

HIGH TENSION – II – GENERAL (A)	
(A) Demand Charges(Rs./kVA of billing demand/month	350
(B) Energy Charge (Paise/kWh)	540

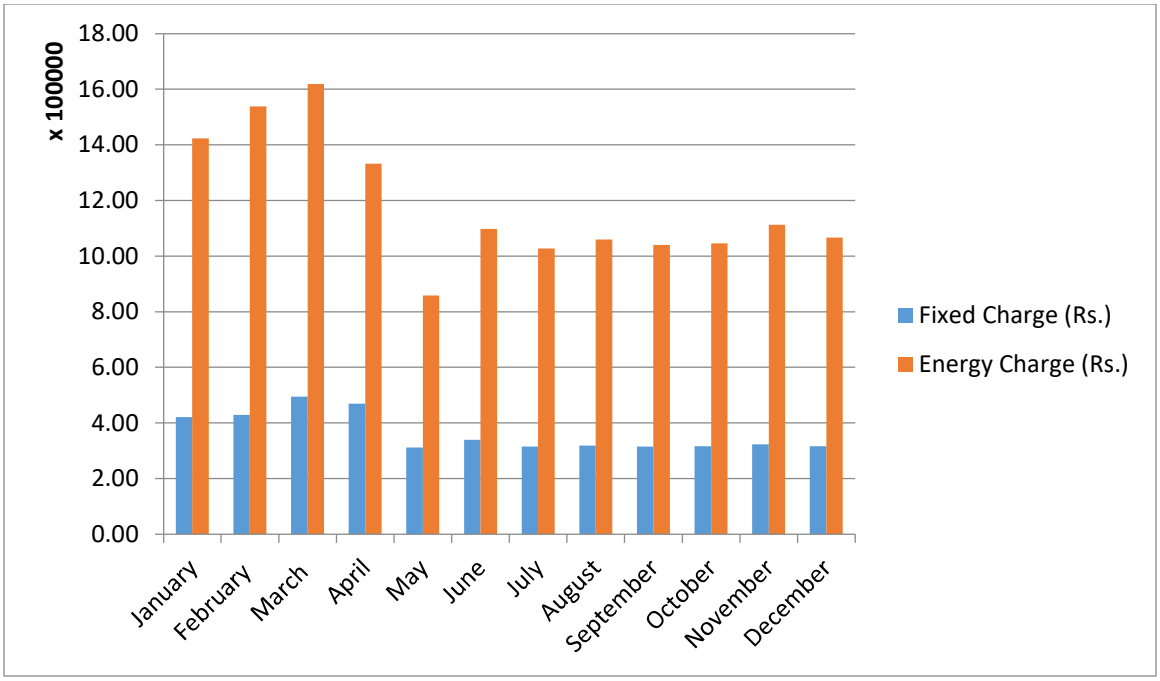
The suggestion of the committee is to shift the non-essential consumption from the peak and normal hours to off-peak hours as the tariff rate is low during off-peak hours.

The monthly energy consumption in kWh for 2019 and 2020 are shown in the Tables below. Note that the table is prepared based on the provided tariff bills – therefore the consumption should be associated with the previous month of the billing month.

Sl No.	Month	Consumption (kWh)	Energy Charges (Rs.)	Fixed Charge (Rs.)	Total (Rs.)
1	January 2019	229400	1222470.63	3,64,274.90	1586746.00
2	February	208070	1121745.24	3,49,732.76	1471478.00
3	March	227950	1212950.57	3,73,295.43	1586246.00
4	April	272240	1445583.24	4,42,484.76	1888068.00
5	May	231730	1228311.00	4,03,848.00	1632159.00
6	June	262720	1385878.48	4,24,232.52	1810111.00
7	July	232750	1238787.00	3,84,129.00	1622916.00
8	August	249590	1388719.14	3,98,048.86	1786768.00
9	September	230400	1323461.58	3,75,075.42	1698537.00
10	October	199830	1136912.00	3,84,717.00	1521629.00
11	November	254920	1453158.00	4,21,789.00	1874947.00
12	December 2019	288140	1640240.00	4,46,508.00	2086748.00
Total		**28,87,740**	**157,98,216.88**	**47,68,135.65**	**2,05,66,353.00**



Sl No.	Month	Consumption (kWh)	Energy Charges (Rs.)	Fixed Charge (Rs.)	Total (Rs.)
1	January 2020	247820	1423714.18	4,20,956.82	1844671.00
2	February	270420	1538530.00	4,29,234.00	1967764.00
3	March	286030	1618652.07	4,94,445.93	2113098.00
4	April	236640	1332613.45	4,69,023.55	1801637.00
5	May	148420	858299.40	3,11,009.60	1169309.00
6	June	189920	1097432.28	3,39,641.72	1437074.00
7	July	179000	1027765.90	3,14,544.10	1342310.00
8	August	184150	1059976.82	3,17,862.18	1377839.00
9	September	179560	1039816.75	3,15,244.25	1355061.00
10	October	180540	1045983.89	3,15,876.11	1361860.00
11	November	192730	1112785.10	3,22,761.90	1435547.00
12	December 2020	181130	1066478.49	3,15,879.51	1382358.00
Total		**24,76,360**	**142,22,048.33**	**43,66,479.57**	**185,88,528.00**



The excess units beyond the allowed units (750 units) are charged 150%. It has been observed the excess demand in the following months in the studied period.

April 2019 – 46 units

May 2019 – 17 units

June 2019 – 22 units

March 2020 – 58 units

April 2020 – 19 units

Also comparing the tables of 2019 and 2020, the committee notices an increased consumption (Here January, February and March can only be considered for comparison purposes as April – Dec 2020, the campus was partially closed because of the pandemic). This escalation in consumption needs a detailed investigation by the electrical section of the university and corrective measures if possible may be taken.

III.5 Energy Conservation Opportunities in Pumping Systems

1. The availability and working of basic accessories with the water pumps like pressure gauges, flow meters etc should be ensured.

2. The pumps need to be ensured to be working near the best efficiency point. Pump operators are working across all the shifts to avoid the wastage of water.
3. Balance the system to minimize flows which can, in turn, reduce power requirements for the pumping. Electrician and pumping overseer will make frequent visits to ensure the same.
4. Modify pumping system and pumps losses to minimize throttling.
5. Running multiple pumps may not be an efficient manner. Therefore consider adding an auto-start for an online spare or a booster pump in the problem areas.
6. Small pumping loads requiring higher pressures should be complemented with booster pumps.
7. Repair packing and seals which can minimize water loss by dripping.
8. Pumping head with a free-fall return needs to be avoided by using the siphoning effect.
9. The water consumption can be minimised by conducting the water balance.
10. While combining the operation of pumps, the measure to avoid throttling should be ensured.
11. Booster pumps need to be provided for areas of higher head
12. Replacement of less efficient old pumps with energy-efficient pumps should be carried out in a phased manner.
13. In the case of an over-designed pump, provide downsize/replace impeller or variable speed drive.
14. Time to time pressure drop assessment and pipe size optimization should be carried out to reduce system resistance.
15. Rainwater harvesting should be encouraged. Proposed tanks (total 4.5 lakh litres capacity) and pond at Chettiarmad, near to University campus will ensure the same and therefore actions to enable them should be carried out.
16. Utilize untreated water for the garden plants.
17. Recharging of the surrounding wells should be ensured.

III.6 Diesel Generator system.

In the events of power cuts from KSEB the 2 X 750 kVA Diesel Generators set is used as a backup supply. DG 1 is installed near Pareeksha Bhavan and DG 2 is near the science department block. Each DG has been used for an average of 10 hours/month (according to handbook data in 2020). Both the Diesel generators are purchased from Powerica Ltd. One engine uses approximately 40 litres of diesel for an hour. DG sets are installed in sheet roofed rooms. The hot working environment can reduce engine efficiency considerably. Therefore the hot air should be driven outside of the generator room through the roof. An extension of about 6 feet using an exhaust pipe is given– see images below. This will further help to reduce the hot atmosphere around the DG. The Exhaust pipes and exhaust silencer of engines are to be insulated against feeding heat towards turbo intercooler. It may be insulated using Rock wool/Glass wool. The exhaust silencer also needs to be insulated for better efficiency.

III.7 Energy Saving Measures for DG Sets

1. Ensure dust-free (Improve air filtration) and cold air at intake.
2. Ensure steady load conditions on the diesel generator set by avoiding harmonic loads, fluctuations, and imbalance in phases.
3. The manufacturer guidelines should be strictly followed in fuel oil storage and handling.
4. Fuel oil additives can improve DG fuel oil properties.
5. Full compliance with the maintenance checklist should be ensured.
6. Carry out regular field trials to monitor the performance of diesel generator set.

Extension for the exhaust pipe

Based on the analysis presented in section III, the recommendations of the energy audit committee is presented in section II of this document.