Energy Audit Report

Jain Vishva Bharati Institute

(Deemed-to-be University)

Ladnun-341 306, Rajasthan

Certificate by the Team of Independent Auditors

This is to certify that the Energy Audit Report is based on the verification of the facts pertaining to Energy Management of the Institution, during 1st April, 2018 to 31st July, 2019. Further, this is to place on record that the Questionnaire developed for the said Audit has been well responded by the Institution and responses have been authenticated by the Registrar.

We have complied with the ethical requirements of the Audit and have reported the findings/observations/remarks in objectivity, without any favour/bias/prejudice.
Members of the Audit Team, under the leadership of Prof.(Dr.) Nalin K. Shastree, Head, University Teaching Department of Environmental Sciences and Former Dean, Faculty of Science, Magadh University, Bodhgaya-824 234 put their signatures on this Certificate as under:

Prof.(Dr.) Nalin K. Shastree
Head, Univ. Teaching Dept. of Environmental Sciences,
Former Dean, Faculty of Science,
Magadh University, Bodhgaya
Leader of the Audit Team

Members of the Audit Team

Bharat Bhushan	Roshan K. Sinha	Rajeev Ranjan	Pritam K. Yadav
Dept. of Civil Eng.	Dept. of Mech.Eng.	Dept. of Elec.Eng.	Dept. of Elec. Eng.

R.P. Sharma Institute of Engineering & Technology, Patna

Audit Assistance

Rahul K. Sinha	Navneet Kumar
M.Sc. (Env.Sc.) Final Sem. Student	M.Sc. (Env.Sc.) 1st Sem. Student

ENERGY AUDIT REPORT

Introductory Observations

The Energy Audit exercise has identified energy as a crucial and balancing factor in the indices for sustainable development. It has considered that the heavy and unbalanced energy consumption may adversely affect energy price and economic growth and therefore, energy conservation methods need to get priority. Focus of this audit exercise has been to explore ways to optimize energy consumption per unit of product output and/or to lower operating costs.

The Energy Audit, which indeed is an on-going process has been effectuated as a part of a larger procedure to ensure long-term sustainable development and has comprised of the verification, monitoring and analysis of use of energy in the JVBI and this technical report is containing recommendations for improving energy efficiency including the cost benefit analysis and has proposed an action plan to reduce energy consumption. It has aimed at facilitating a systematic approach to the energy management in the university system by way of determining how and where energy is used and has tried to address the regime of the total energy input with its overall usage. It has taken into account all the energy streams in the university system and has quantified the use of energy according to its discrete functions with an aim to identify methods for energy savings. The Energy Auditing for a day has been worked out as the index of the consumption which normalizes the situation of Energy crisis by providing various schemes for conservation of energy. We focused our attention on energy management and optimization of energy efficiency of the systems, sub systems and equipment. The key to such performance evaluation lies in the sound knowledge of performance of equipment and system as a whole.

Opportunities have been viewed in the use of existing renewable energy technologies, with a special focus on solar energy so as to catalyze efforts at gaining energy efficiency and making possible the dissemination of latest technologies. Besides, this audit was undertaken in order to verify how effective these steps were, and also to identify loop holes, if any, in the existing practices, along with outlining measures for enhancing energy utilization. The recommendations of the study will become a basis for future schemes of better energy consumption and preservation throughout the organization.

Objectives of the Energy Audit

- To study the energy consumption pattern of the facilities on campus
- To identify the areas where potential for energy/cost saving exists
- To verify the steps adopted for energy management in the campus
- To spot the inefficient or inadequate practices, if any
- To improve the energy preserving measures and methods
- To identify potential energy saving opportunities
- To formulate feasible steps and measures to be adopted in the campus
- and prepare proposals for energy/cost saving along with investment and payback periods.

Methodology

The objective of Energy Audit is to balance the total energy inputs with its use and to identify the energy conservation opportunities in the stream. It has also focused attention to energy cost and cost involved in achieving higher performance with technical and financial analysis. The best alternative is selected on financial analysis basis. Energy audit has used data from various sources to look extensively at the existing energy consumption patterns and identify the areas for improvement, in addition to set reference points aiming at conservation of energy. An effort has been made to estimate energy savings and cost in order to account for the energy usage by of all major gadgets/equipment.

This step involved actual site measurement and field trials using various portable measurement instruments. It also involves input to output analysis to establish actual operating equipment efficiency and finding out losses in the system.

Identification and evaluation of Energy Conservation Opportunities has been effectuated by involving evaluation of energy conservation opportunities identified during the energy audit. It gives potential of energy saving and investment required to implement the proposed modifications with payback period. All recommendations for reducing losses in the system are backed with its cost benefit analysis.

About the Institution

Jain Vishva Bharati Institute (JVBI), a deemed to be the University is committed to provide highest quality of educational services to the utmost satisfaction of the students and give them an opportunity to cultivate an integrated personality blended with spirituality and moral values. University torch bearers have taken a responsibility for this investment to nurture the Next-Gen leaders with a vision to bridge the existing skill gap by way of providing not only the skilled personnel but also the human resources with values.

Details of the institutional infrastructure are as follows:

• Total Area	75 Acres
• Total plinth area of Academic & Admin Blocks	2.53 lakhs Sq. Ft.
• Total class rooms	56
Smart class rooms	20
Academic block	14
Administrative block	06
Education block	12
Constituent block	24

An assessment of energy usage in the JVBI Campus has been made, which is as follows:

- Electricity from MSEDCL
- High Speed Diesel (HSD)
- Electrical energy is used for various applications, like:
- Computers
- Lighting
- Air-Conditioning
- Fans
- Other Lab Equipment

Data Collection

For the purpose of this audit, audit groups for specific areas were formed. Data was collected through:

- Visual inspection and observation
- Verification/ Identification of energy consumption
- Quantification and segregation of data according to the following criteria:
  A. Energy consumption by end use
  B. Average energy use block-wise
  C. Consumption equipment-wise
  D. Rate of consumption month-wise
  E. Rate of consumption time-wise

The quantified data are presented below as figures and tables for easy reference. Figure-1 shows the energy consumption by end use.

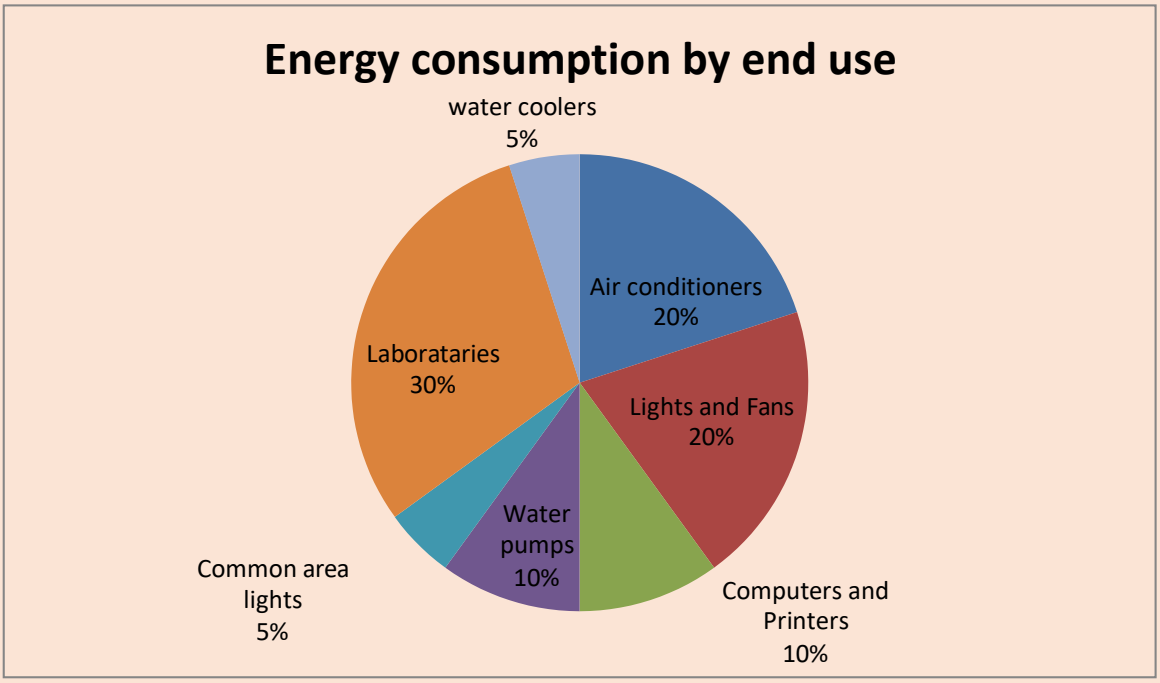

Figure-1: Energy Consumption by End Use

The consumption of energy block-wise is shown in Table-1:

Table-1: Average Use of Energy Block-wise

Blocks	Average day-time use on working Days (kwh)	Average use on Holidays (kwh)	Average night- time Use (kwh)
VC office	4.81	1.17	1.5
Academic Block	29.86	27.33	11.5
Ladies Hostel	3.45	4.5	2.5
Kalu Kanya Mahavidyalay	51.81	55.67	29
Administrative Offices	52.68	48.83	31.5
Library	72.90	61.5	34.05
Canteen	10.55	3.17	2.5
Boys Hostel	45.05	5.17	4
Guest House	16.36	14.17	2
Residential Complex 1	32.18	21.5	16
Residential complex 2	34.18	13.83	18.5

Figure-2: Shows the month-wise consumption rate of energy for the year 2018:

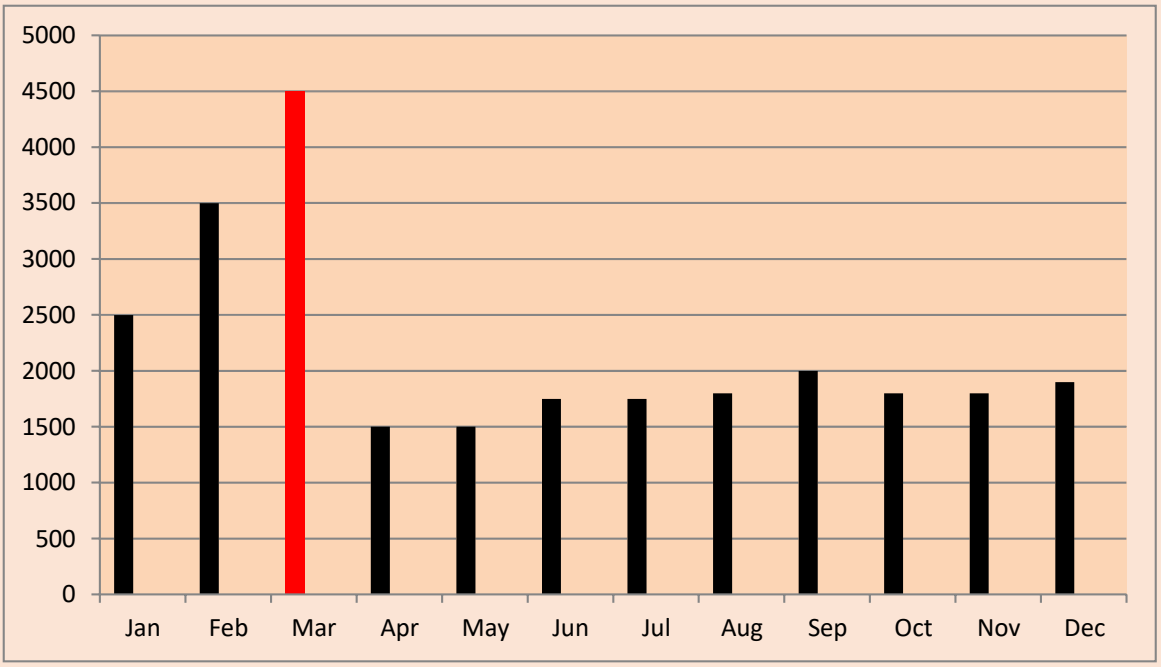

Figure-3: Energy Consumption for the Year 2018:

Figure-3: Shows the Time-wise Split-up of Energy Consumption on a Normal Working Day

Figure-3: Energy Consumption Per-Hour on a Working Day

Table-2: Study of Month-wise Maximum Demand Variation

Sr. No	Month	Maximum Demand (kVA/Month)
1	Aug-18	39
2	Sep-18	39
3	Oct-18	39
4	Nov-18	39
5	Dec-18	39
6	Jan-19	39
7	Feb-19	39
8	Mar-19	39
9	Apr-19	39
10	May-19	39
11	June-19	39
12	July-19	39
	Average	**39**

Table-3: Study of Month-wise Load Factor Variation:

Sr. No	Month	Load Factor
1	Aug-18	0.421
2	Sep-18	0.421
3	Oct-18	0.139
4	Nov-18	0.295
5	Dec-18	0.377
6	Jan-19	0.261
7	Feb-19	0.334
8	Mar-19	0.263
9	Apr-19	0.293
10	May-19	0.368
11	June-19	0.407
12	July-19	0.268
	Average	**0.3205**

Electrical Load factor has been measured as the utilization rate, or efficiency of electrical energy usage. It is the ratio of total energy (KWh) used in the billing period divided by the possible total energy used within the period, if used at the peak demand (KW) during the entire period. Thus,

Load Factor = KWh/ (KW/hours in the period/ number of days in the billing cycle),

If the load factor ratio is above 0.75 your electrical usage is reasonably efficient. If the load factor is below 0.5, you have periods of very high usage (demand) and a low utilization rate. Low load factor customers would benefit from a peak demand control system or from a Battery Energy Storage System to distribute electrical usage out over longer intervals of time and smooth the peaks.

Low load factors, such as, below 0.4 shall contribute significantly to the overall monthly electric bill in the form of demand charges. These demand charges are listed on the bill as coincident demand, facilities demand, and summer time related demand.

Study of Air Conditioners

In the facility for air conditioning there is no centralized system with AHU (air handling unit), but mostly split air conditioners are installed.

Load of ACs was as follow:

Item	Rated Power (kW)	Qty	Voltage	Current Amp	Actual Power
ACs	7	33	406	8.4	6.1

Observations and suggestions

1. Normal air conditioning temperature should be kept as high as possible. By thumb rule, increase in 3 degrees in indoor air temperatures can save 1% of electricity.
2. The ventilation in area can be provided with installation of natural ventilation. Natural ventilation will also minimize the requirement of exhaust fans.

Carbon-di-oxide Emission

It has been computed by taking into account of consumption of 1 Unit (1 kWh) of Electricity as equivalent to the CO_2 emission of 0.8 Kg or 0.8 Kg/kWh. In the following Table we present the total units consumed and CO_2 emitted as under:

Table 4: CO_2 Emission:

Month	kWh	CO_2 emitted in MT
Aug 18	11815	9.45
Sep-18	11815	9.45
Oct-18	3904	3.12
Nov-18	8284	6.63
Dec-18	10576	8.46
Jan-19	7332	5.87
Feb-19	9386	7.51
Feb-19	7374	5.90
Mar-19	8224	6.58
Apr-19	10324	8.26
May-19	11437	9.15
June-19	7512	6.01
July - 19	10335	8.36

Major Findings:

I. The laboratories record the highest consumption based on end use

II. The areas having high level of academic activities record the highest rate of consumption

III. Gadgets/Laboratory equipment show the highest rate of consumption equipment-wise

IV. Summer months shows the peak in consumption

V. The time slots in the Afternoon record the highest consumption on a normal working day.

VI. Identify the easiest areas of attention

Based on the physical observation and the analysis of data collected, certain areas have been identified as areas of attention:

- Old wiring cables in many parts of the campus leading to loss of energy
- Old water pipelines in several parts of the campus leading to waste of energy
- Use of incandescent bulbs in certain rooms
- Electric supply still depending on State Electricity Board, instead of solar panels
- Use of old equipment such as refrigerators in laboratories
- Uneven lighting facility – certain classrooms are under-illuminated, certain classes have more lights than required
- Estimate the Scope for Saving

The study could identify a large scope for saving energy in the campus, including:

- updating of technologies in laboratory equipment
- replacing old electrical cables and pipelines
- replacing incandescent bulbs with LEDs
- ensuring even lighting facilities in rooms
- use of Solar panels as a main source of lighting, especially common areas and grounds
- replacing old gadgets in laboratories

Immediate Areas of Improvement:

- ❖ Replacing incandescent bulbs with LEDs
- ❖ Repairing and updating laboratory equipment
- ❖ Encouraging students and staff to switch off electrical gadgets and turn off the water taps when not in use

Energy Conservation Proposals:

Providing Energy Saver Circuit to the Air Conditioners:

The energy saver circuits for the air conditioners, intelligently reduces the operating hours of the compressors either by timing or temperature difference logic without affecting the human comfort. This can save around 15% to 30% of the electricity depending on the weather conditions and temperature settings.

There are total 33 air conditioners. It is Recommended that the old air conditioners are being replaced with new energy efficient BEE STAR labeled (3 Star and above) air conditioners in a phased manner.

Considering the average compressor ON time = 5 h/day Power consumption by 2 TR compressor = 6.1 kW

Average daily consumption = 6.1 x 5 = 30.5 kWh/day/ air conditioner Yearly operating days = 100 days/year/ air conditioner

Yearly electricity consumption = 3050 kWh/year/ air conditioner

Considering a saving of 15%, total annual savings = 15% x 3050 = 457.5 kWh/year/ air conditioner
Cost of electricity = Rs. 8 / kWh

Yearly savings = 8 x 457.5 = Rs. 3660/ year/ air conditioner Total number of Air Conditioners = 33
Total yearly Saving = 33 x 3660/year = 1,20,780/year

Total Cost of each energy saver circuit = Rs. 4500 x 33 = Rs. 1,48,500

Replacing Fluorescent Tube Lights (FTL) with LED Tube Lights

The 36 W FTLs can be replaced with the LED tube lights 16 W. These changes can be made at the places where the life is higher. Usually minimum of 3 years warranty is given and approximate burning hours is 40 000. (15 years considering 8 hours per day running) Following calculations are done for the 8 hours working:

Power consumption by 36 W FTL with conventional choke = 40 W/ Tube Light Equivalent LED tube light = 16 W/ Tube Light
Savings in power = 24 W/ Tube Light

Yearly operating hours = 8 h/day x 300 = 2400 h/year/ Tube Light Yearly savings = 2400 x 24 W = 57.6 kWh/ year/Tube Light Average Cost of electricity = Rs. 8/ kWh
Saving= 57.6 kWh x 8 = Rs. 460.8 / year/ tube light

Approximate investment on single LED Tube lights = Rs. 2000 Number of Tube Lights to be replaced = 506

Total Yearly Saving = 506 x 460.8 = Rs. 2,32,760/year Total Investment = 506 x Rs. 2000 = Rs. 10,12,000

Providing Solar PV System for Part Load Operations during Day Time

There are mainly Lighting and Computer loads. Since, there is no separate lighting feeder; it becomes necessary to separate out the lighting feeder for those lights where they are used 6 to 8 hours in a day.

A 5 kW Solar PV is proposed for the Lighting load application with minimum Storage batteries. The power saved considering the 85% loading = 5 kW
Average Daily available hours = 6 h/day Electricity Saved = 6 x 5 = 30 kWh/day Yearly availability = 250 days/year

Yearly savings in electricity = 250 x 30 = 7500 kWh/year Monitory Savings = 7500 x 10 = Rs. 75000 / year Approximate cost of the solar system = Rs. 10.0 lac Subsidy from central government = Rs. 3.0 lac
Net cost = Rs. 7.0 lac

Proposal for enforcing Energy Efficiency Improvement measures: Table 5

Sr. No.	Recommendations	Annual Saving Potential (Rs.)	Estimated Investment (Rs)	Pay Back period (Months)	Remarks
1	Providing Energy Saver Circuit to the Air Conditioners	120780	148500	5 Months	Mid Term
2	Replacing Tube Lights (FTL) with LED Tube Lights	232760	1012000	54 Months	Long Term
3	Providing Solar PV system for part load operations during day time	75000	1000000	112 Months	Long Term
	TOTAL	**4,28,540**	**21,60,500**		

Table-6: Summarized Account of the Findings and Recommendations of the Audit

Findings	Recommendations
Most of the power consumption is used for lighting, electric fans, computers and water pumping	N. A.
The architectural design of buildings, with most of the rooms blessed with natural light and ventilation helps in reducing the number of lighting and ventilating equipment and gadgets.	New buildings, when constructed should follow the hanged patterns and assure more of natural light and flow of air passage to reduce loss of energy
The electrical wiring of many buildings was found to be old and inefficient	Replacement of old electrical cables with new ones
Poor plumbing lines leads to loss of water and subsequent loss of power resulting from over pumping	Replacement of old pipelines with new ones, and latest motors for pumping water.
There are a number of unused sockets and redundant power points causing power wastage.	The number of sockets should be assessed in objectivity and redesigning of placing electrical sockets with proper earthing connections should be ensured
There seem to be a lack of judicious use of power among students and staff. During the study, it was found that lights, fans and computers were kept on working mode in many rooms, without a single person present.	Students and staff should be motivated continuously to use energy judiciously. Posters and pamphlets should be distributed and notices about saving energy should be posted at major points of use.
Uneven distribution of lighting facilities. Certain classrooms were under-illuminated, while certain classrooms had more than sufficient lights.	Even lighting distribution system should be ensured.
Many Departments still use incandescent bulbs causing heavy power loss	Incandescent bulbs should be replaced with LEDs
Except for solar units entire power requirement is met from the RESB line.	More solar panels should be installed in key areas of the campus, and loads for common areas and grounds should be met from these.
AC, refrigerators and freezers used in many departments use obsolete technology and hence cause power loss.	Gadgets and equipment should be repaired and/or replaced with latest ones to save energy.
Power consumption is high in many locked buildings at night. This is probably due to locking the rooms without switching off gadgets.	Proper switching off of the gadgets and equipment should be ensured strictly.

Table 7 – A Bird's Eye-view of Cost and Returns of Recommended Actions

Action	Power units saved	Cost of implementation	Annual return	Period of return
Conversion of 200FTLinto LED	3000	1,00,000	18,000	5.5 years
Conversion of 600FTL chocks to electronic ballast	6000	1,20,000	36,000	3.3 years
Conversion of resistive regulator of 500fans into electronic regulator	5000	1,25,000	30,000	4 years
Providing solar water heater 500litres	4000	50,000	24,000	2 years
Replacing A/c and fridges by 5 star rating equipments	8000	2,00,000	48,000	4 years
Installation of Bio-gas plant 30Kg capacity	Equivalent to 90LPG cylinder 14.2Kg	60,000	72,000	10months
Energy saving settings for Computers	2500		15,000	
Replacing old 100desktop computers by Laptop	5000	3,00,000	30,000	
Providing 2KWSolar Panel with power units	3600	50,000	21,600	2.3 years

Conclusion

- A well-conceived electrical wiring plan for the campus is required, which would help to identify unused points of power and also in re-wiring the buildings
- Electric fans should be serviced and bearings replaced wherever necessary
- The scope for non-conventional energy should be increased.
- Installation of roof top solar panels should be made on certain locations like the top of library building, Kalu Kanya Mahavidyalay, Academic Block, which would cut the power bill substantially and may become a source of revenue generation over the period of time.
- Installation of a suitable Bio-gas plant to save energy used for heating water in Science laboratories.

- Rigorous training for both students and staff to inculcate awareness for the need of energy conservation. If everyone ensures switching off lights, fans and electrical gadgets that are not in use, roughly 10% to15% of energy saving is possible
- A master switch located at a prominent place which can be directly supervised by the HoD/supervising staff would help avoid power wastage in closed rooms.
- A healthy competition may be encouraged between departments by honoring those departments that produce higher savings by good practices. An element of weight-based on the above lines may be considered for allocation of funds.
- It is suggested that a permanent body under the chairmanship of a senior teacher may be established in the College for periodical review of energy usage and concurrent energy audit. Representatives of students, staff and PTA may be included in the body.