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Energy Audit: A Case Study on Mechanical Engineering Building

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Abstract:- **This energy audit illustrates a monthly data from an institution's energy audit, as well as any steps that can be taken to minimize energy usage and, if necessary, fix or upgrade any equipment. This audit was performed on numerous floors, which included various laboratories, classrooms, staff cabins, and various functional instruments. The audit consisted of some measures which were done before proceeding for the audit, for pre-audit we calculated the consumption related to different floors and where the energy consumption was more and how it can be reduced. The post audit measures were to either check and repair the products using high energy consumption or to replace that products.**

The audit was done from the first floor i.e., the workshop considering different machines like lathe, milling machine, grinders, welding machines, CNCs, VMCs, and other appliances used by the students for practical purposes.

Then the second floor, where classes, cabins are present where the total lights and fans were checked.

Finally, the third floor where along with cabins, computer labs are there and consumption of the lights, fans, and pc was taken into consideration.

The daily energy usage information for each floor is given, as well as various strategies for reducing daily consumption which can help the college for the process of energy audit and reduce the consumption of the college simultaneously resulting in saving of energy and concluding a successful energy audit.

Keywords: *Energy, Audit, Mechanical, Energy audit need.*

I. INTRODUCTION

Bharati Vidyapeeth is a 57-year-old private deemed-university established institution. It was established in 1964 by Dr. Patangrao Kadam, an Indian politician and educator.

This campus, also known as the Dhankawadi Campus, is the main campus of Bharati Vidyapeeth (Deemed to be University) and is spread over 85 acres of land in a very convenient location. There are 24 colleges in total, with the Medical College, Dental College, College of Engineering, being the most prominent. The campus includes a 5-acre football and sports field, as well as the Bharati Hospital and an Ayurvedic and Homeopathic Hospital. There are student hostels, canteens, an ATM hub, a Bharati Bank branch, and a mess facility on campus, which is a well-kept, environmentally friendly green campus.

Bharati Vidyapeeth is divided into several divisions, one of which is the College of Engineering, which houses the mechanical department, for which the energy audit is conducted.

Mechanical Department is housed in a three-story building that includes a workshop, lecture halls/classes for Mechanical Department students, as well as computer laboratories and practical labs for students' better understanding.

The first floor consists of Workshop which is further classified into:

1)Turning shop & 2) Welding shop.

Turning shop has different Lathe machines, CNC machine, VMC machines, Drilling machine, Universal milling machine, Compressor, Tool Grinder.

Welding shop consists of MIG welder, Spot welder, Radial drilling machine etc.

The second floor consists of various classes and lab in the Mechanical Department.

The third floor consists of computer labs for practical explanation of designing, modelling and automation software.

II. NEED OF ENERGY AUDIT

An energy audit is a procedure for conducting an energy inspection, conducting a building survey, and analyzing energy flow in-order-to save energy in a building or industry, or to minimize the amount of energy entering the building without reducing its production. Energy audit also consists of inspection of different electrical appliances whose energy consumption is high and that needs to be either repaired/replaced.

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The building block consist of workshop which consumes maximum energy. It includes high energy consuming appliances like lathe machines, drill machines, milling machines, CNC machines, welding machines etc. In workshop everyday two practical are held by college for various engineering department. Energy consumption of appliances is varying with per day usage.

Mechatronic and other labs possess several appliances such testing machines, sensors, simulating models etc. Daily usage of appliances with their respective power usage and different appliances with their proportional power usage enumerated further.

Ceiling fan and computers also consume big unit of total energy load. The annual energy load of ceiling fan for 109 units is 12208 kWh, computer set energy load is 160 kWh, total energy load by labs is around 10182.2 kWh.

Computers located in labs run for 4 hrs. and the computers in staff cabin run for 8 hrs.

Fig. 1 Actual photo of computer lab

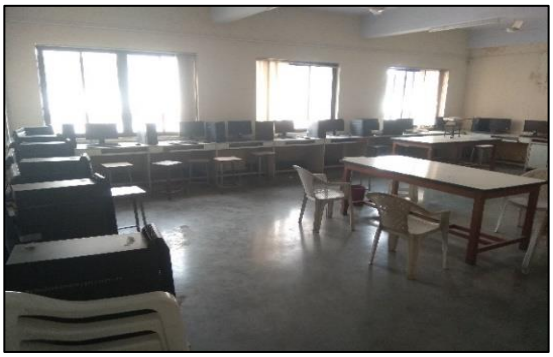

Fig.2 Actual photo of computer lab

Fig. 3 Servo Test Jig

Fig. 4 Photo of metrology(MTC) lab

Fig. 5 Showing Lathe machines in workshop.

Fig. 6 CNC Machine

Fig. 7 Compressor

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Table I: TOTAL ENERGY CONSUMPTION BY THE BUILDING.

Location	Type of appliances	No. of appliances	Power consumption per appliance (kWh)	Hrs/day	Annual power consumption
WORKSHOP	Center Lathe Machine (Dilip make)	15	1.86	4	22320
	Center Lathe Machine (Kirloskar make)	6	2.23	4	10704
	Center Lathe Machine (G.D. Willer make)	1	1.1	4	880
	CNC Milling (Turning Center)	1	7.45	2	2980
	Vertical Milling Machine	1	7.5	2	3000
	Drilling Machine	1	0.745	2	298
	Universal Milling Machine	1	1.5	2	600
	Lathe (NH-26)	1	8.94	1	1788
	Compressor	1	2.23	1	446
	Tool Grinder	1	2.2	1	440
	MIG Welder	1	7.45	2	2980
	Spot Welder	1	11.5	0.5	1150
	Radial Welding Machine	1	9.6	2	3840
LABS (Computer and Practical)	Governor	1	0.745	0.75	111.75
	Projector	2	0.6	4	960
	Servo testing jig	1	7.5	2	3000
	Optical encoder	1	0.007	4	5.6
	Inductive Proximity Sensor	1	0.03	4	24
	Rotary encoder	1	0.018	4	14.4
	Switches & relays	1	0.018	4	14.4
	Mcleod gauge	1	0.23	4	184
	Resistive temperature detector	1	0.24	4	192
	Data acquisition system	1	0.48	4	384
	Bellows/ bourdon/ diaphragm pressure transducer	1	0.48	4	384
	S-type load cell	1	0.12	4	96
	Pick & place robot	1	0.48	4	384
Other appliances	Lift	1	7.5	1	1500
	Cooler	3	0.45	3	810
	Fluorescent Lamp Tube	148	0.043	8	10182.4
	Ceiling Fan	109	0.08	7	12208
	Personal computer	76	0.2	4	12160
	LED Bulbs	6	0.009	8	86.4
TOTAL ENERGY CONSUMPTION					**94126.95**

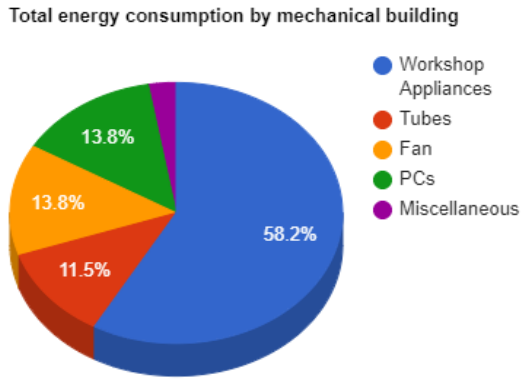

Fig. 8 Energy consumption by Mechanical Engineering building

III. ENERGY AUDIT CALCULATIONS

A) FAN:

The fans used in the college have short length blades which tend to reduce the efficiency and have a low area for air conditioning. Instead of using the short-blade fans we can use long length blade which would increase the area of cooling, it can also be helpful to reduce the number of fans and hence reducing daily power consumption.

If we use 40W fans long blade instead of 80W fan the total energy consumption would be:

There are 109 number of 80W fan working for 7hrs a day i.e., 61.04kWhr/day, if they are replaced with 40W fans

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the consumption will decrease and the no of fans needed will also decrease if long bladed fans are used.

Assuming 40% decrease in number of fans the total consumption will be:

66*0.04*7=18.48kWhr/day.
Total energy saved per day is: (61.04-18.48) kWh/day = 42.56 kWh/day

So, annually we can save 42.56*200 = 8512 kWh.

B) TUBELIGHT:

The tube lights used in the college are of 43 W and can be replaced by a 20W LED tube lights.

There are a total 148 fluorescent tubes in the mechanical engineering building, which are running for an 854pprox..8hrs & the total consumption by fluorescent tubes is considered,

Total consumption by 148 Fluorescent tube = 50.912kWh/day.

Instead of it, if we use 20W tube lights, the total consumption of 148 tubes will be:

148*20*8=23.68kWh/day
Total power saved per day is: 50.912-23.68=27.232kWhr/day
So, annually we can save 27.232*200=5446.4kWh annually.

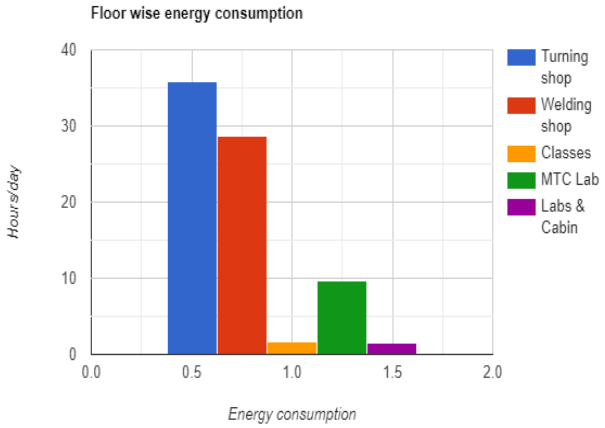

Fig. 9 Graph representing floor-wise energy consumption.

The energy saving done by replacing tubes and fans can be shown by below table:

Table II: Energy saving by replacement of Lights & Fans.

Sr No.	Appliance type	Fluorescent tube light	Ceiling fan
1	Unit	kWh	kWh
2	No. of appliances	148	109
3	Type of appliance required for replacement	LED tube light	Long blade fan
4	No. of appliance required	148	66
5	Energy load of replaced appliance	0.02	0.04
6	No. of working days	200	200
7	No. of working hours	8	7
8	Total annual energy saving (kWh)	5446	8512

IV. GENERAL RECOMMENDATIONS TO SAVE ENERGY

1. **FAN:**
- Dusting fan blades once in a week with a rag/duster can increase efficiency of the fan by decreasing the drag on the blades.
- The size of fan blades should be increased and no of fans should be decreased to save more electricity.
- Switch off the fans when not in use.

2. **PC:**
- Turn off monitors instead of screensavers.
- Devices like printer and scanner consume more power should be only used when required instead of keeping them always connected.
- We can keep the screen brightness as low as possible to save more energy.
- When you are not working on PC, shut down the PC.
- Do not keep PC idle as desktop consumes more electricity.
- Operate the PC at less brightness. These small things will lead to energy conservation.

3. **Lights**
- Lights when not in use should be turned off.
- After leaving the classroom or any practical lab, please have a look at all lights and bulbs to keep it off.
- If students gather at one place, and other space is empty, then only the required lights should be turned on.

4. **Lathe machine:**
- After every operation performed on lathe, turn it off immediately.
- Removal of metal chips on the machine after its use.
- Proper adjustment of parts.
- Regular maintenance.
- Proper use of tools and keys.
- Use of coolant in processes whenever required.

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- Changes in spindle speed while lathe is on, is not permittable.

5. Milling machine:
- Be at the place of milling machine when it is in use.
- Proper space is required to keep the machine and all its parts.
- After every usage of parts, lubricant such as oil must be applied.
- Do not use rapid feeding otherwise machine equipment can be get damaged.

6. Drilling machine:
- Choose the correct drill bit.
- Operate the drill at the minimum speed.
- Switch it off after use.

7. Compressor:
- Always cool the intake air.
- Compressor should be used whenever it is necessary as the compressed air in the tank may affect its efficiency.

8. Tool grinder:
- Switch off the fuse when not in use.
- Unplug while changing any component.
- Tight grip is necessary over the machine.

9. Projector:
- After the presentation is shown to students, and then projector is not in use, turn off the main button as it leads to more and more energy loss.

10. Lift:
- Switch off the light and fan in the lift while exiting.
- The lift can be machined with sensor doors which will automatically turn off light and fan in the lift or while not in use.
- Use of lift should be decreased for going to the first floor.

Below is a table showing the energy of pre and post replacement of the tube lights and fans:

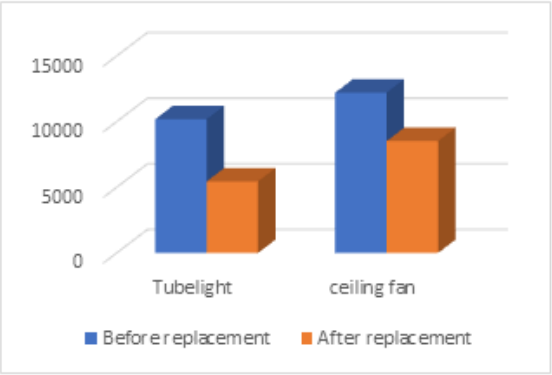

Fig. 2 Graph showing Pre and Post replacement detail.

IV. CONCLUSION

The energy audit done on this Mechanical Engineering building shows that how the energy can be saved considering various appliances and how we can conserve more energy with help of a simple energy audit.

This Audit serves a main purpose of Energy conservation as we all know that the Renewable energy sources are depleting & there is a huge need to conserve more and more energy for future generations.

From energy load pattern before implementation of recommendation, Energy load of tube light in building is about 10182.4 kWh annually for 148 units of fluorescent tube lights. Implementing remedial action tube lights are replaced by highly efficient and low wattage LED tube. It causes reduction of electrical energy load by 46.51% saving of 5646 kWh which helps of reduce electrical bill. Ceiling fan before usage consumes 12.97 % of total annual electrical load of building. After implementing remedial action saving of 30.27% electrical load by ceiling fan annual energy consumption. The reduction of energy by replacing highly efficient appliances will saves 13958 kWh energy annually.

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