

# Reduction of Maximum Power Demand using Energy Audit-Case Study

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**ABSTRACT:** Energy management scenario is the foremost issue in various Industries in recent century. To ascertain the maximum power demand, of various loading areas by Energy audit. By means of energy audit process the power consumed by various equipment are analysed. Due to this process maximum power consuming equipment and power consuming areas are studied. This analyzation is prepared by comparing the electricity bill during the subsequent months. This elaborate study reveals efficient remedial act taken by the industries and institutions to reduce the usage of electricity. By introducing special equipment with the existing, the usage of electricity will get reduced. This paper is entirely discussed about various remedies for maximum power demand and installation of art of equipment.

**KEYWORDS:** Energy audit, Maximum power demand, load study, electricity bill, Load shedding, Institution.

## I. INTRODUCTION

At present the world is running short of electricity. The majority of utility equipment depends on electrical energy. As per the need, the power is generated in so many ways. Massive amount of power is generated through various natural resources such as thermal, hydro, nuclear, geothermal, biogas etc. Due to long usage of resources the scarcity arises. To overcome the lack of resources, Renewable energy sources are playing key role. When the natural resources get exhausted the generation of electricity will jump down within this century. To conquer future crisis we have to create awareness between the consumers is vital. Reduction of maximum power demand which will lead to reduce the electricity usage. The electricity usage is calculated by an energy audit process. This paper briefly explains about the various steps involved in energy audit process as well as it gives the solution for reducing maximum power demand.[10]

## II. INTRAMURAL INFLUENCE

Any academic institution is getting supply from the nearest substation to fulfil the need of various electrical utilities. The substation has various feeders which are connected with particular areas. Load demands of all feeders are not similar. The institution has various building blocks such as campus, hostel canteen and auditorium. An energy audit is conducted in various blocks of the institution to reduce the electricity bill effectively.

## III. ENERGY AUDIT

### 1.1 Terminology

It is an inspection, survey and analysis of Load flow, for energy consumption in a building, system to reduce the amount of energy input into the system without negatively affecting the output.[3]

The formal process comprises of

1. Energy consuming device identification.
2. To determine rate of energy consumption.

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### 3. Operating hours in 24-hour period.

The energy manager, while proposing various courses of action and evaluating their consequences, requires a detailed information base to work from energy audit attempts to balance the total energy inputs with its use and serve to identify all the energy streams in the system and quantifies energy usages according to its discrete function

Energy audit is an effective tool in defining and pursuing comprehensive energy management programme. It has positive approach aiming at continuous improvement in energy utilization in contrast to financial audit which stresses to maintain regularity. Energy audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating and 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, instrumentations and technology. It has been established that energy savings of the order of 15 to 30% is possible by optimizing use of energy. Indian industry consumes more energy as compared to its counter parts in the developed countries.

### 1.2 Energy Audit Steps

The energy audit processing steps as follows

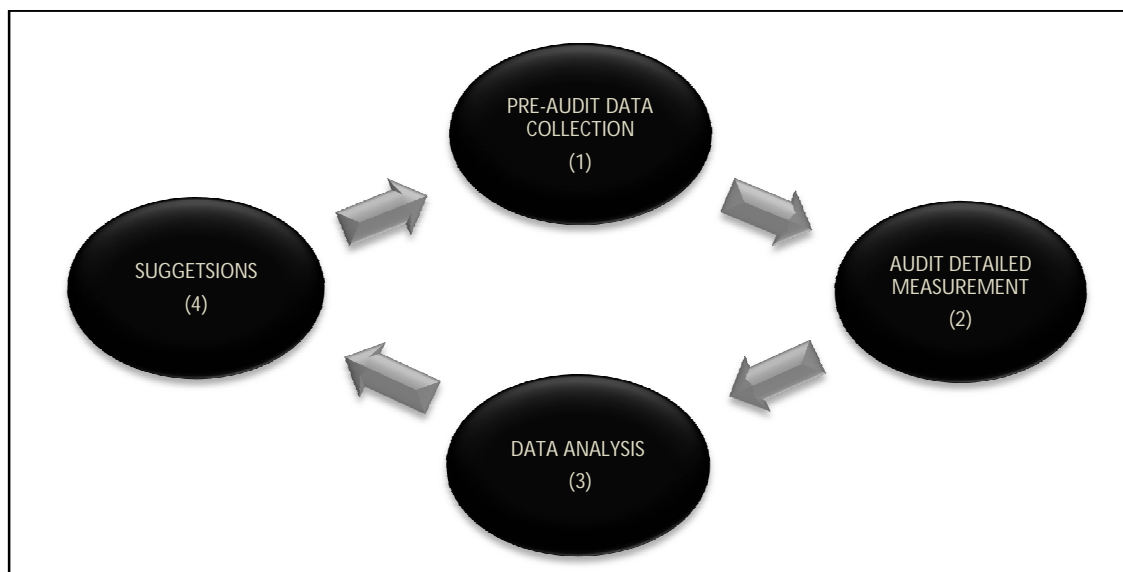


Fig 1: Energy audit process steps

### 1.3 Pre data Collection

The antecedent stage for data compilation is drawing the civil structure of institutions and the latter stage is identifying various electrical utilities.

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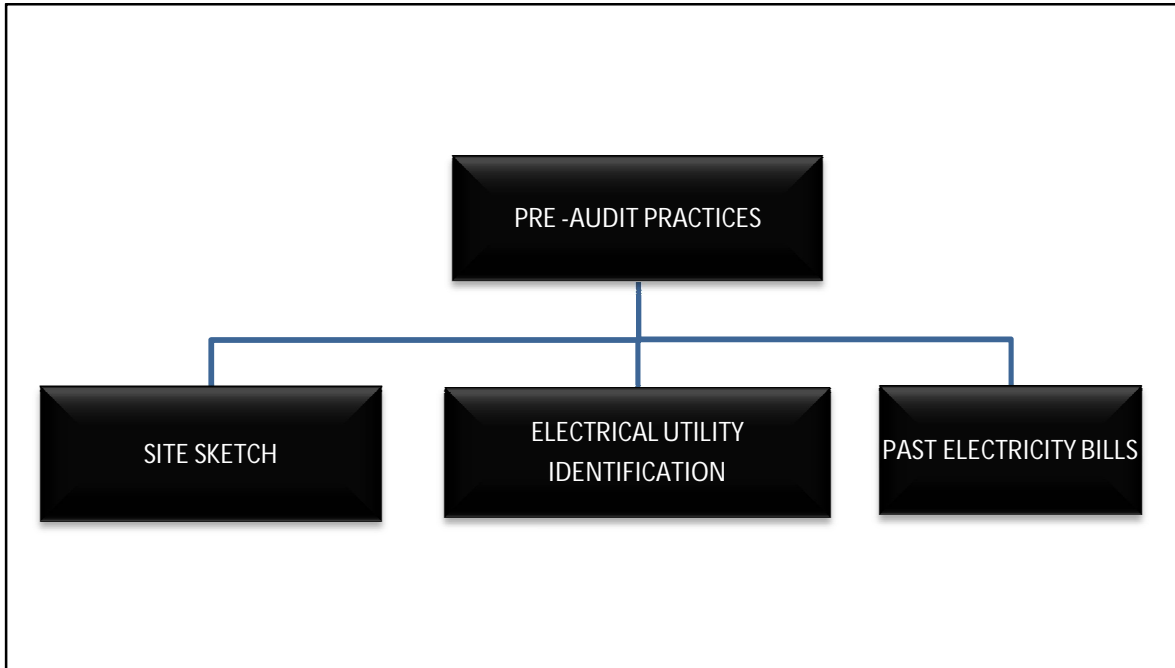


Fig 2: Stages in data collection

### 3.3.1. Civil Structure

Civil structure of all the building were groomed which gave an information about [8]

- The relative location and outline of the building.
- Labelling the rooms by either a name or number

The example for civil structure shown in fig (3)

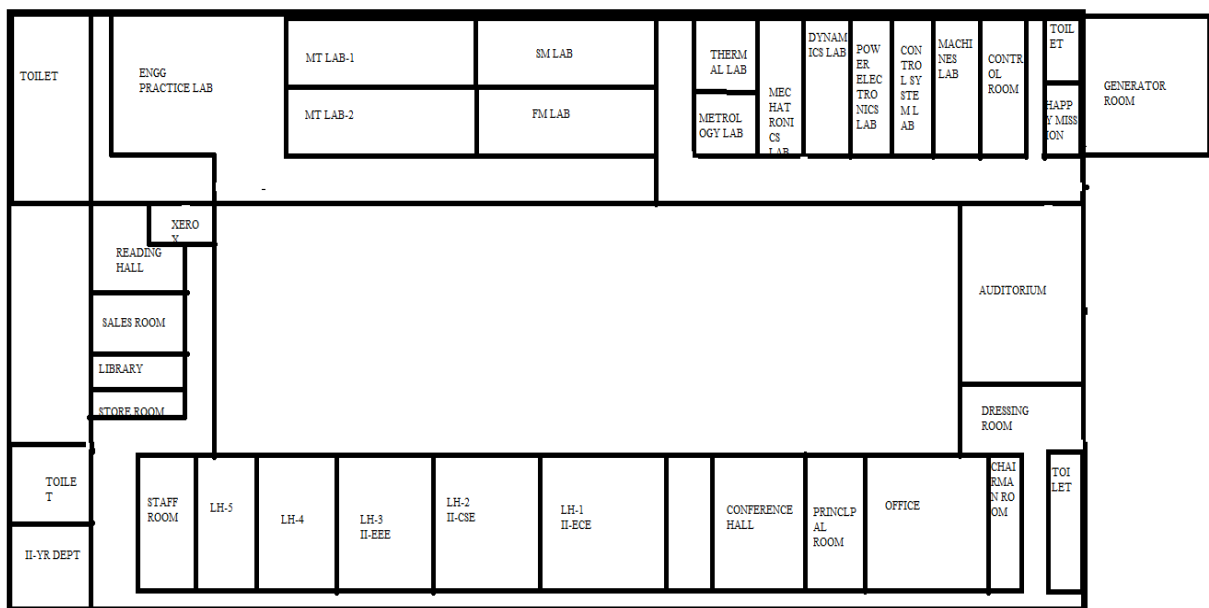


Fig 3: Civil structure

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### 3.3.2 Establishment of Electrical Utilities:

Keeping the civil structure as a reference, the count of each and every electrical equipment such as light, fan, computer systems, motors etc were taken based on the rooms .In addition to determining the quantity, their individual power rating was noted down. This data was gathered in order to calculate the maximum connected load present in the institution.

### 3.3.3 Acquisition of past electricity bill

The electricity usage was acquired from the electric bill register for the time period of six month from July to December [2]. The electricity used details for the year 2008 to 2016 was taken. It is shown in table (1)

Table 1: Energy consumption July to December

MONTH/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016
JULY	6330	7530	8431	10569	11659	13789	15124	17489	19950
AUGUST	6210	7466	9684	11489	12636	13912	14348	15933	16800
SEPTEMBER	6280	7124	8167	9487	10569	12698	14569	16578	17640
OCTOBER	5790	6319	9814	12943	14698	15187	16913	17441	18068
NOVEMBER	8640	8912	9913	12671	14362	15913	16523	17013	18068
DECEMBER	7290	9156	12934	14802	15371	18961	20197	21763	22110

### 1.4 Audit Detailed Measurement

Based on the result of pre-audit, this type of energy audit consists of energy use survey in order to provide a comprehensive analysis of the studied installation, a more detailed analysis of the facility and a breakdown of the energy use to correct the defect or improve the existing installation. This level of analysis involves on-site measurements.

It is a temporary process with load study as the aboriginal step, measuring the actual consumed current and voltage drop across the equipment to equate the power consumed being the secondary step and unit calculation being the ultimate and triennial steps [3]

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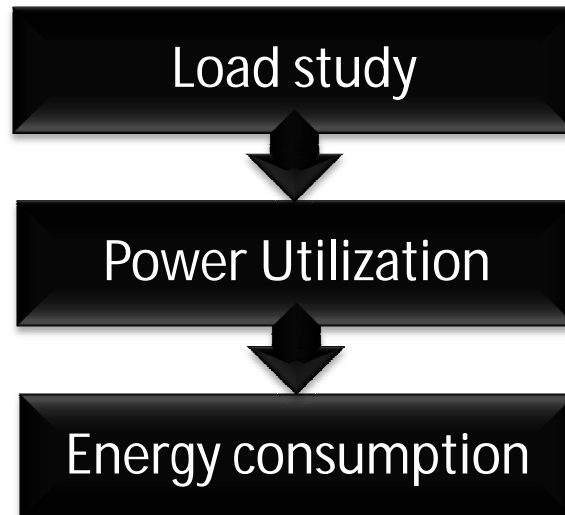


Fig 4: Audit detailed measurement phases

### 1.4.1 Load study

As per the power rating gathered from each equipments, the total connected load was calculated which was the product of the ratings and quantity of equipments. The load calculation was taken for all connected load .and part of that is shown in the below table (2)

Table 2: Maximum connected load in each area

AREA	MAXIMUM LOAD(W)
Computer lab	27100
Library	2300
Reading room	880
Auditorium	24012
Conference Hall	855
Administrative office	5875

### 3.4.2 Power Utilization and Energy Consumption

The power factor of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit and it is a dimensionless number in the closed interval of -1 to 1 .A power factor of less than one means that the voltage and current waveforms are not in phase, reducing the instantaneous product of the two waveforms (V x I). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be

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grater then the real power. A negative power factor occurs when the device generates power, which then flows back towards the source, which is normally considered as the generator.

In an electric power system, a load with a low power factor draws more current than a load with high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the cost of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor. A high power factor is generally desirable in a transmission system to reduce transmission losses and improve voltage regulation at the load.

Different loads have varying power factor. If the power, voltage and current ratings were known, power factor was calculated. [10]

Then the power factor calculation is [7]

➤ Single phase circuit

$$\text{Power factor} = |\cos \phi| = 1000 \times P_{(KW)} / (V_{(v)} \times I_{(A)})$$

➤ Three phase circuit

i. Calculation with line to line voltage

$$\text{Power factor} = |\cos \phi| = 1000 \times P_{(KW)} / (\sqrt{3} \times V_{L-L(v)} \times I_{(A)})$$

ii. Calculation with line to neutral voltage

$$\text{Power factor} = |\cos \phi| = 1000 \times P_{(KW)} / (3 \times V_{L-N(v)} \times I_{(A)})$$

Power consumed calculation

➤ DC equipment

$$P_{(KW)} = V_{(v)} \times I_{(A)}$$

Where

P – Power (W)

V – Voltage (V)

I – Current (I)

➤ Single phase AC equipments

$$P_{(W)} = \text{Power factor} \times V_{(v)} \times I_{(A)}$$

➤ Three phase AC circuits

i. Line to Line Voltage

$$P_{(W)} = \sqrt{3} \times \text{Power factor} \times V_{L-L(v)} \times I_{(A)}$$

ii. Line to Neutral Voltage

$$P_{(W)} = 3 \times \text{Power factor} \times V_{L-N(v)} \times I_{(A)}$$

The part of the load calculation sheet is shown below in table (3) for some equipment.

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Table 3: Power Consumption of Equipments

S.NO	EQUIPMENT NAME	QUANTITY	MEASURED CURRENT(A)	ACTUAL VOLATG E (V)	POWER FACTOR	TOTAL (W)	No.OF UNITS (Based on Working Hours) (kWh)
1	Fluorescent Lamp	6	0.1	230	0.58	73.08	14.616
2	Fan	9	0.2	230	0.65	245.7	49.14
3	Pedestal fan	2	0.1	230	0.543	23	2.3
4	Purifier	1	1.6	230	0.598	200.928	40.1856
5	Iron Box	1	4	230	0.966	811.44	10.143
6	Electric stove	1	5.6	230	0.915	1076.04	26.901
<b>TOTAL</b>						<b>2430.2</b>	<b>143.2856</b>

### 3.4.3 Energy Conservation Measures

#### 3.4.3.1 Lighting Savings

Lighting loads constitutes a huge percentage of the loads, T12, T8 and T5 are conventionally named for tube lights where “12” is the thickest and “5” is the slimmest tube light. T12 were quite popular in the past. They were replaced with slimmer T8 version, which are the most popular and easily available product today. But T5 is the most efficient energy saving option that is available in the present market. T5 tube lights have a life of 4-5 years and come with 1-2 years replacement guarantee. They are 40% more efficient. The power ratings of different types of FTLs shown in table (4)

Table 4: Power ratings of different FTLs

FTL	POWER RATINGS (WATTS)
T -12	40
T - 8	36
T - 5	25

#### 3.4.3.2 Efficient Super Fans

Amount of units contributed by fan is a lot considering various areas in institutions where it is running continuously whole day. The rating of ceiling fan used is 60W as opposed to super fan whose rating is just 35W

#### 3.4.3.3 Energy savings in computer.

Starts – ups and shutdown do not use any extra energy. Shutting computers down actually reduces system wear and saves energy. Flat screen monitor, setting computers, monitors and copiers to sleep mode when not in use helps cut energy cost by approximately 40%[9].

#### 3.4.3.4 Automated light control

Smart lighting is a lighting technology designed for energy efficiency. This may include high efficiency fixtures and automated controls that make adjustment based on conditions such as occupancy availability. This is recommended to be employed in areas with high lighting demand.

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## IV. CONCLUSION

This paper briefly explains about the various steps involved in energy audit process and also it is a detailed study about the reason for maximum load demand. Due to energy audit load calculation is done. Through the load study various power consuming area are identified. To rectify this maximum power demand various energy conservation measures are suggested. From the detailed energy audit as well as the energy saving measures the load demand and the energy consumption can be reduced close to 40%.

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