

Energy Auditing in an Educational Institution with Special Focus on Reduction in Maximum Power Demand

Jayesh. R, Jagdish. V, Julian George and Jayanth Premachandran

*Department of Electrical and Electronics Engineering, Amrita University,
Amritanagar, Ettimadai, Coimbatore, India.*

Abstract

Energy management has become one of the pivotal elements in any industry today. This paper focusses on the process of energy audit carried out in an academic institution and how maximum demand of the institution can be reduced. Energy audit was executed in the institution. In the course of the process the electricity bill of the institution was analyzed in detail. It was found from the bill that the maximum demand which occurs at some point of the month was contributing a considerable amount to the monthly electricity bill. This was taken as an area of improvement and research was done on it. The reduction of maximum demand through smart load shedding procedures and installation of state of art equipments is discussed in detail in this paper.

Keywords: Audit; institution; bill; demand; load shedding.

1. Introduction

Nowadays energy is becoming scarce and is one the most sought after commodities. Energy generation cannot be increased quickly but the available energy can be judiciously used. One such method is described in this paper. Unlike other energy audits in which the reduction in consumption and improvement of power factor will be the main focus areas, this paper deals with the idea of reducing the overall electricity bill by reducing the maximum power demand. This paper consists of the complete methodology to reduce the maximum power demand.

2. Background Study

The literature proposes energy audit of various places like academic institutions, industries etc. [1]. The academic institution at which the energy audit was conducted housed two power sub-station. The primary focus of this audit was limited to one the two power sub-stations. The formerly mentioned power sub-station consisted of four buses with twenty four feeders connected to it. The power consumption by these feeders were not monitored as a result of which there was a constant rise in the electricity bill [2]. This problem created a necessity for an energy audit. Singh, H et al conducted an energy audit for academic institution in Malaysian university [3]. The audit of maximum demand thereby reducing electricity bill was suggested in a manual by M.6 [4].

3. Methodology

The methodology adopted focusses on understanding the present energy baseline. It identifies energy saving opportunities and feasibility to implement the potential energy saving measures. In order to identify the energy saving opportunities, the energy use pattern has to be analysed [5]. Also a thorough understanding of the electricity billing system is necessary for the audit.

3.1 Analysis of monthly electricity bill

In a corporate electricity bill three factors contribute significantly to the total amount. They are:

- *Active energy consumption.* The total active or useful energy consumed by all loads connected to the feeders.
- *Power factor consumption.* The total reactive power energy consumed by inductive or capacitive loads.
- *Maximum power demand.* The peak power or the cumulative power rating of all connected loads at a particular point of time.

Though traditionally energy audit targets the active energy consumption and power factor improvement, this project gives special emphasis to reduction of maximum power demand. This is done by smart load shedding procedures after critical load analysis. Also the feasibility of installation of maximum demand meter is analysed.

3.1.1 Analysis of maximum demand in the electricity bill. The twelve months electricity bill is analysed to obtain table 1.

Table 1: Monthly analysis maximum demand and its cost.

Month	Maximum demand(kVA)	Demand Charge /kVA	Demand Charges(Rs)	Permitted MD(kVA)	Penalty due to MD()
Nov-12	815.2	300	244560	825	0
Dec-12	809.6	300	242880	825	0
Jan-13	742.5	300	222750	825	0
Feb-13	796.8	300	239040	825	0

Mar-13	814.4	300	244320	825	0
Apr-13	814.4	300	244320	825	0
May-13	820	300	246000	825	0
Jun-13	742.5	300	222750	825	0
Jul-13	756.8	300	227040	825	0
Aug-13	806.4	300	241920	825	0
Sep-13	891.2	300	267360	825	39720
Oct-13	819.2	300	245760	825	0
Average	802.4166667		240725		3310

From table 1 it may be noted that the maximum power demand which occurs at some point of the month constitutes nearly 2 lakhs of the total amount. If this can be reduced there will certainly be considerable reduction in electricity bill. Also in September 2013 penalty was levied for exceeding the maximum power demand. The annual maximum demand curve is shown in figure 1.

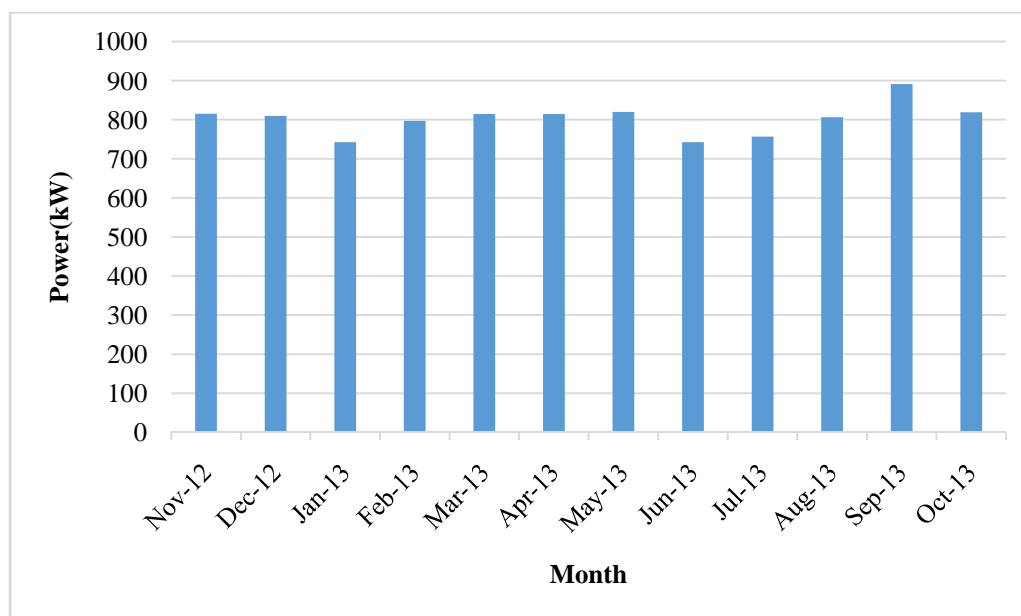


Fig. 1: Annual maximum demand curve of the institution.

3.2 Analysis of energy usage patterns

A detail survey of the load pattern on working days and holidays is carried out. A working day’s energy meter reading is recorded on an hourly basis and the load pattern is deduced with the recorded reading. As a result a distinct idea of the load pattern can be inferred. This data is used as a base for critical load analysis which served as the main criteria for load shedding to reduce the maximum demand. The load pattern observed on 22.04.2013 is shown in table 2.

Table 2: Maximum demand in each feeder at given time in a day.

Feeder/Time of Day	22.04.2013				23.04.2013
	09:00	12:00	16:00	20:00	09:00
Feeder 1	10.5	13	19.9	43.1	4.987
Feeder 2	10.7	10.9	12	2.665	15.2
Feeder 3	15.8	4.7	4.9	4.788	17.3
Feeder 4	0	4.1	0.86	0	4.5
Feeder 5	38.5	50.3	50.9	31.8	43.8
Feeder 6	15.1	22.9	19.1	5.124	16.1
Feeder 7	33.4	39.9	26.7	27.4	40.7
Feeder 8	35.6	23.1	27.2	36.2	19.8
Feeder 9	13.7	9.7	17.2	38.3	6.122
Feeder 10	7.8	43.3	44.4	5.736	33.3
Feeder 11	0	0	0	0	0
Feeder 12	9	0.53	0.582	0	85.4
Feeder 13	6.1	4.8	5.7	22.5	7.872
Feeder 14	33.9	23.2	25.5	16.9	30.1
Feeder 15	8	2.8	0.277	0	5.74
Feeder 16	1.3	0.823	11.5	2.346	10.1
Feeder 17	1.4	8.7	7.1	3.088	1.64
Feeder 18	4.8	19	9	4.785	6.995
Feeder 19	27.5	36	37.2	48.5	33.3
Feeder 20	35.1	19.9	26.5	5.52	5.538
Feeder 21	3.1	3.1	4.4	9.65	4.05
Feeder 22	5.6	18.1	14.8	4.487	9.785
Feeder 23	12.3	18.8	11.3	16.7	29.7
Feeder 24	1.704	0.694	0.881	2.343	0.596
Total	330.904	378.347	377.9	331.932	432.625

The feeders are connected to different loads inside the institution such as hostels, academic buildings, convention centers, labs, etc.

4. Maximum Demand Control

4.1 Critical load analysis

Based on the data obtained from table 2, a study for determining the most critical load at any point of the day was done. Based on this report, during occasions when the maximum demand exceeds the preset value the the non-critical loads at that point of time can be switched off thereby reducing the maximum demand. Fig. 2 to Fig. 5 indicate the demand at certain points of a day.

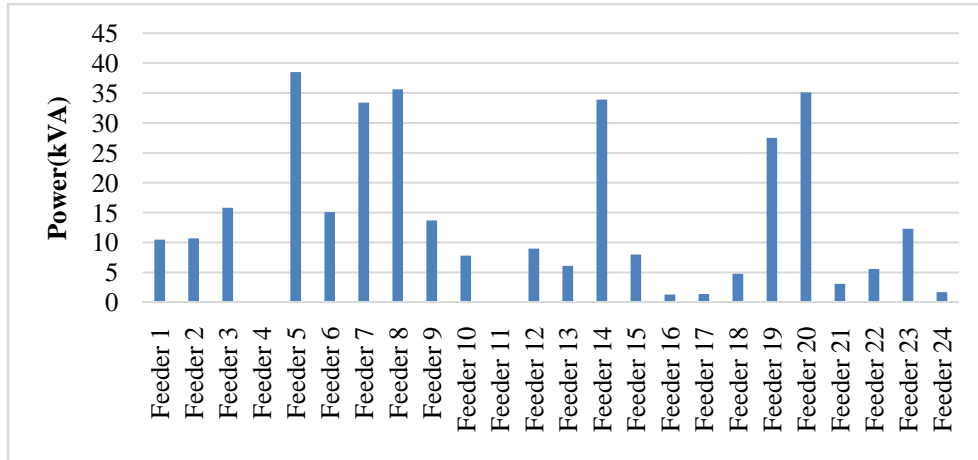


Fig. 2: Power demand in each feeder at 09:00.

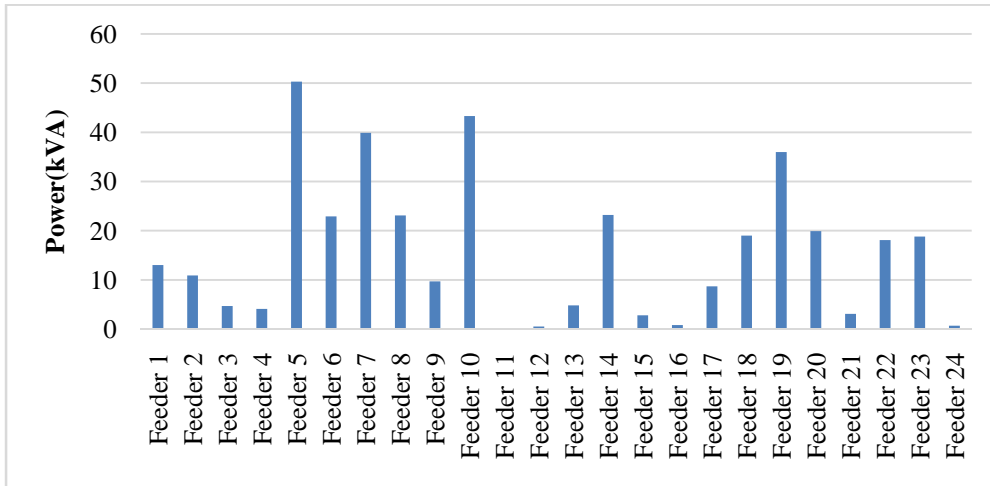


Fig. 3: Power demand in each feeder at 12:00.

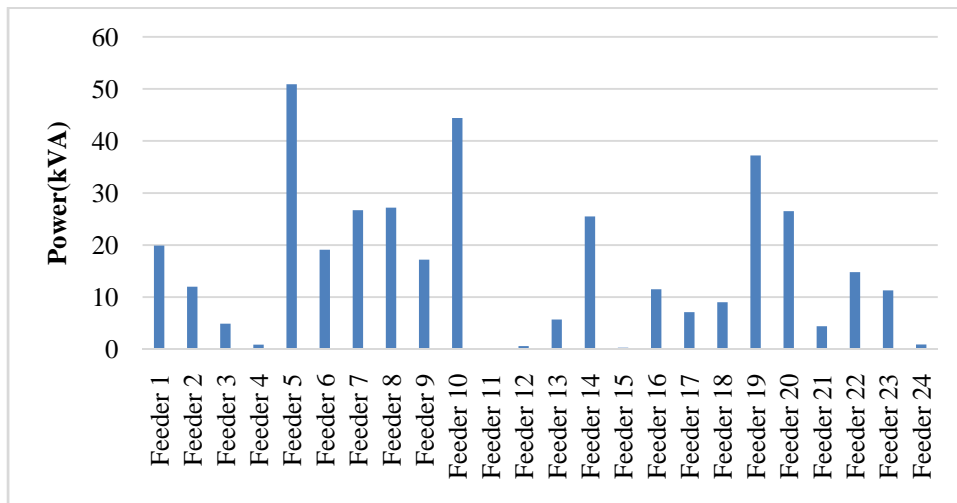


Fig. 4: Power demand in each feeder at 16:00.

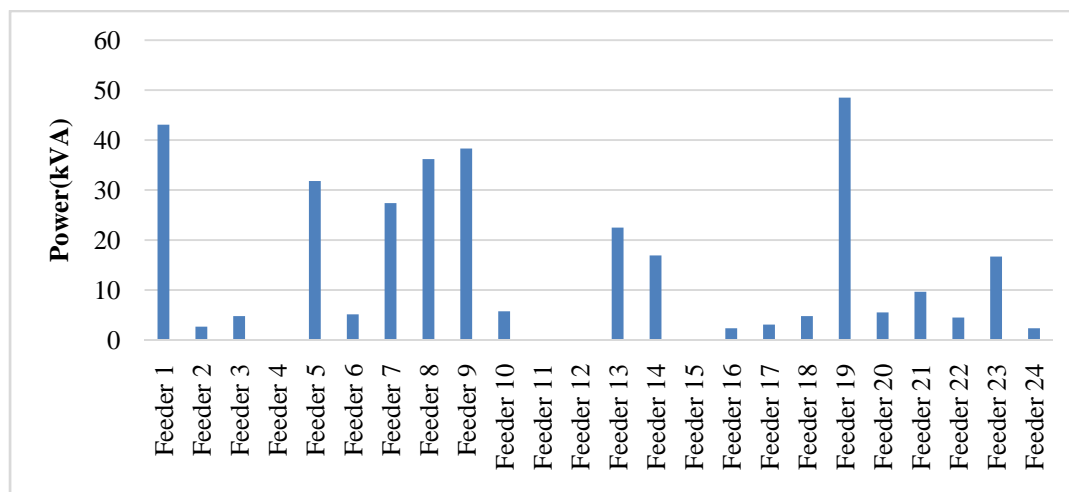


Fig. 5: Power demand in each feeder at 20:00

4.2 Smart load shedding plan

Based on this load shedding plan the loads which are not so critical can be switched off and this can be used a standard operating procedure. Table 3 gives the load shedding plan at various times in a day.

Table 3: Table indicating the critical loads in decreasing order.

Criticality of feeder/ Time of Day	09:00	12:00	16:00	20:00
Least Important Feeder	4(AC)	11(Street light)	15(Mess)	11(Street light)
2nd Least Important Feeder	11(Street light)	12(Convention center 1)	11(Street light)	12(Convention center 1)
3rd Least Important Feeder	16(Academic block light)	24(Canteen)	12(Convention center 1)	24(Canteen)
4th Least Important Feeder	17	16(Academic block light)	24(Canteen)	16(Academic block light)
5th Least Important Feeder	24(Canteen)	21	4(Hostel)	15(Mess)

The numbers in table 3 represents the feeder number in which these loads are connected.

4.3 Feasibility of maximum demand control meter

Maximum demand control meter is a preventive control method of maximum demand where the loads get automatically disconnected when the demand exceeds a preset limit. Various maximum demand control meters are available in the market. The cost benefit analysis for a sample maximum demand control meter is shown below. The

maximum demand meter considered here is “SMART DEMAND CONTROLLER-EM3460”.

Cost of the maximum demand control meter	=	70,000	
Average maximum demand	=	802 kVA	
Maximum demand limit set to the MD meter	=	750 kVA	
Saving in Maximum demand per month	=	$(802-750)*300$	= 15600
IRR value	=	$70000/15600$	= 4.87 months

Also the penalties due to excess maximum demand can be saved here. Hence apart from the load shedding procedures it is advisable to install a maximum demand meter.

5. Conclusions

Hence the monthly electricity cost of the institution can be reduced by reducing the maximum demand and the saving per month will be nearly 20000. In addition to the load shedding scheme detailed above it is advisable to install a maximum demand control meter which enables unmanned control of the system. This methodology saves nearly 3% amount of the monthly electricity bill without even reducing the consumption. To improve energy efficiency further, maximum demand meters can be installed in all individual feeders and a continuous monitoring SCADA system can be implemented.

References

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