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ENERGY AUDIT OF CLEAN ROOM FACILITY

Kovid Sharma

(Research scholar in management)
MADHAV UNIVERSITY,PINDWARA(SIROHI),
RAJASTHAN.

ABSTRACT:

Now-a-days the big, hot topic is "energy conservation "all around the world. India is a developing country, so the focus is to save natural resources and also find new alternatives to provide energy for its industrial growth, which is on a fast track. The number of industries, hospitals, establishments, organisations either commercial or non commercial are gradually increasingat a fast pace and so is the demand of energy. It is understood from the available records that industries are the main consumers of energy and it varies from 50% to 65% of the total consumption by every individual unit. To minimise the gap between demand and supply, energy audit is the best solution to avoid wastage and losses and to provide techniques with feasible solutions. Energy audit is a great tool and a systematic approach for decision –making to control and maintain the energy consumption. It not only saves but also suggests how to improve the quality and optimum utilisation of energy.

1 INTRODUCTION

ENERGY AUDIT is the key factor to systematic approach for decision making to minimise energy costs without affecting the quality and production throughout the year, within any organisation, with least environmental effect and also is fundamental to a comprehensive energy management programme [1]. It gives all technical feasible solutions based on the technical submission reports including energy consumption, cost analysis, current trends, procedures and protocols etc. The energy audit team has to checked the performance and analysis how to improve efficiency with cost effective manner and action plan to be taken to make it energy efficient system with available resources [2]. Their energy audit was carried out by selected team members of the establishment along with consultants to find and facts for improving energy efficiency of the system and propose to materialise ideas with latest technology. The time period of energy audit was carried out for two months and completed within the time frame. The above establishment under study had been conducting Research and Development programs. This establishment has a sanctioned load at 11KV, is 748.00 kW. The total plinth area of this establishment is 1540 square meter and comprises of two floor office building for officers and allied working staffs, plant room to accommodate all the services which are required to facilitate the process and the clean room facility for highly advanced programs. A cleanroom is a pressure gradient controlled environment that has a lowest possible level of pollutants which contain airborne particulate, and chemical vapours, for a specified particle size corresponding to an ISO of cleanroom standards. Clean rooms are used in semiconductor products manufacturing units, biotech products, life sciences establishments, pharmaceutical industries, weapons for defence services, operation theatres in hospitals, packaging industries, and other fields that are very essential to environmental control.

A number of installed equipments and machines work round the clock (24 hr x 7 days) to provide the essential parameters to this establishment. All types of equipments/machines consume energy even when the facility is not in operation to maintain required optimal conditions. The energy management techniques were followed for quick response and analysis of the features of all services. These measurements were made into a schedule of energy auditdepicted in table 1{3}.

Table –1

Schedule of Energy Audit

S. no.	**Observations/inspection/ Plan of Action**	**Purpose/Result**
(1)	**Pre Audit Phase** • Plan and organise • Walk – through • Informed interaction.	• Establish an Energy Audit team. • Define Instruments and time frame • Data collections, awareness of process and observation of operation and practices.
(2)	• Introductory Meeting	• To built up cooperation and support. • Consider relevant Issues
(3)	**During Audit Phase** Primary data gathering, Block diagram of the facility and utility diagram.	• Setting up • Baseline Energy Consumption. • Service utilities diagram. • Design, operating data and schedule of operation. • Annual Energy bill consideration energy Consumption pattern.
(4)	Conduct Survey and monitoring.	• Measurements
(5)	Details from previous maintained log books and Tests for Selected major Energy Equipments.	• Power monitoring (MD, PF, KWH etc.) • Load variations • Performance test etc.
(6)	Analysis of Energy use	• Energy and material balance. • Energy loss/ waste analysis
(7)	Identification and Development of Energy Conservation opportunities and techniques.	• Conceive, develop and refine ideas. • Use brainstorming and value analysis techniques. • Contact vendors for new/ efficient technology.
(8)	Cost benefit analysis.	• Assess technical feasibility and economic viability.

(9)	Reporting and Presentation.	• Documentation, draft report presentation. • Final report preparation on feed back.
(10)	**Post Audit Phase.** Implementation and follow up	• Recommendation • Action plan, and schedule for implementation. • Monitoring and periodic service.

2 MAIN OBJECTIVES

The proposed work was covered in three stages under the prevailing conditions of the establishment. The main purpose of this energy audit was to find how energy was utilised within the facility and to find the best opportunities to evaluate the effectiveness of energy efficiency during the process.

2.1 Pre-Audit Phase

The following observations were completed within one week as per the schedule given in Table 1. The basic equation for net saving and payback period for proposal system in the process are: -

2.11-Net Saving/Year = Annual Saving – Annual operating cost.

2.12-Payback period in month = (Investment/Net Saving/ year) X 12

Energy audit mainly comprised of three key factors which directly affect the input and output of production in term of finance as investment, annual operating costs and saving as showed in table-2. {4}.

Table 2
Energy Efficiencies Measure

S.no	Investment	Annual operating Costs	Annual Saving
I	1.Equipments	1.Cost of capital	1.Thermal Energy
II	2.Civil Works	2.Maintenance	2.Electrical Energy
III	3.Instruments	3. manpower	3. Raw Materials
IV	4.Auxilllaries	4.Energy	4.Waste disposal

2.13- Various instrument are required for measuring the current status of the facility to understand the true scenario as briefed in **Table 3. {5}**

Table-3

List of instruments either online or offline (connection with computer and hand held meters' instruments) for Energy Audit are required to measure below mentioned parameters: -

S. No	Name of Instruments	Purpose
1.	Battery monitoring Ampere hour meter	Health check -up
2.	Insulation Tester	Insulation Testing
3.	Clamp meter	A/C current, frequency
4.	Multi meter	Measure voltage, current and resistance.
5.	ELCB Tester	Earth leakage current
6.	Capacitance meter	Measure of capacitance value
7.	Cosphi meter	Measure of the power factor
8.	Frequency counter	Frequency of the current
9.	Manometer with pitot tube	Pressure in air ducts.
10.	Tachometer/ stroboscope (RPM)	Speed Measurement.
11.	Psychomotor	Temperature and humidity.
12.	Lux meters	All light intensity of visiblespectrum measured.
13.	Smart Energy Meter	Electricity on a real – time basis.

Table 4

Machine Load (connected) details-

S.no	Name of equipment's/machines	qty	Load in kW
1.	100 TR Water chilling machine	3	420.0
2	Cooling tower	3	22.5
3	Chilled water pumps	3	45.0
4	Condenser water pumps	3	30.0
5	Makeup unit	1	15.0
6	RAH	7	135.0
7	AHU	2	15.0
8	Electrical heater in each units	9 set	135.0
9	Lighting load	ls	30.0
10	Fire pumps	3	30.0
11	Equipment's load	ls	125.0
12	125 KVA UPS	2	3.00
13	80 KVA UPS	2	3.00
14	Compressor	2	30.0
15	Water distribution network	1	30.0

16	750 KVA D.G SET	2	
17	Distribution transformer 1000KVA	2	
18	Ventilation system	1	15.0
19	Scrubber system	2	15.0
20	Water treatment plant	1	30.0
21	Gas suppression system	1	10.0
22	UHP System for gases	ls	28.0
21	Building management system	1	12.0

2.15 -Diesel generating set of 2 nox750 KVA are standby provision in case of power failures.

2.16- 2 no x 125 KVA UPS of three phases and 2no x 80 KVA UPS of single phase are for equipment connected for uninterrupted power supply.

Table 5

Visual field Inspection Report

S. no	Deficiency observed during the site visit
1	Energy consumption 65% through HVAC System due to recirculation handling unit are of 75% of the total consumption.
2	Maximum energy usage at the time of operation in day time only.
3	Demand is higher than required
4	Controlling mechanism for capacitance in stepping up and down not functional.
5	Maximum energy of individual machine .
6	Electrical power factor varies from .85 to .92.
7	Standard operating procedure not drawn.
8	Schedule of certification missed
9	E/M Equipments are of old model .
10	Unbalancing of distribution network caused extra loss.
11	Building management system not fully functional .
12	Distribution network for essential and non-essential load which is mandatory, was not found

Table 6

Documents for Pre-Audit Phase

S.no	Documents /information
1	Layout plan and systematic scheme with design details.
2	Essential requirements for facility

3	Selection details of installed items and equipments
4	Cost of assets at the final stage of the project
5	Target focus for the project in term of productions etc
6	Standard operating procedure
7	Adoption Procedure and protocol
8	Available Logbooks and printed details
9	Team members
10	Contractual/legal documents
11	Details of energy consumption onmonthly basis.
12	Certification procedures and Test reports

2.17- **As** there are many plant rooms to feed various research units, hence energy consumption for specific unit was considered. The total energy consumed on monthly basis for the year 2015-2016 is considered and tabulated in table -7. [6]

2.18-Contract demand is 900 KVA and billing should be max 85% of the contract value that is 765 KVA. The load factor is the ratio of energy consumed in a given period of times of hours to peak load which has occurred during that specific period. The purpose of L.F(load factor) is how efficiently use of energy. {7}

Table-7

Summary of Annual Electricity consumed in day and night for year 2015-2016.

Month	M.D Actual (KVA)Day	M.D Actual (KVA) Night	Power Factor	M.D Billing (KVA)	Days
Mar	585	356	.95	765	31
April	561	348	.85	765	30
May	592	346	.93	765	31
June	542	362	.90	765	30
July	532	349	.90	765	31
Aug	514	346	.95	765	31
Sept	538	362	.90	765	30
Oct	434	347	.95	765	31

Nov	596	352	.95	765	30
Dec	485	358	.98	765	31
Jan	576	361	.98	765	31
Feb	578	346	.90	765	29

2.2 During energy Audit

During the energy audit phase, observations were made with the support of available records and field tests either online or offline in which every feasible data and reports wereconsidered for obtaining the max output so that true picture could be analysed to improve the energy efficiency.

2.21-The summary of Actual energy consumed for 12 months since March 2015 to Feb 2016 is shown in table-7 except for energy consumed unit month wise for billing amount. The electricity bill for the year were transferred to another establishment on the basis of contract agreement. Therefore, the calculation of this table was worked out on the available documents details.

2.22-The performance of different machines and appliance has been checked and found that almost all machines were not being operated to their maximum capacity. It was felt that the motors used in these machines are of higher rating [3]. Some of the equipments / machines operated at average power factor of 0.74 lag and drew higher current. But when observed during the night, there is less variations in all factors. Due to variations of this factor consumer paid extra cost which can be reduced.

2.23– Details of energy related to facility: -
The total connected load = 1187.5 KW
The contractual demand of energy= 900 KVA
The maximum energy consumed in day time =592 KVA
The maximum energy consumed in night time = 392 KVA

2.24–Capacitor bankfor power factor improvement -

According to the electrical data obtained from records, it is observed that a capacitor bank was not to maintain the power factor as required due to relay setting. It is well known that less value may be considered as penalty factor by electricity department. In such case, the energy consumption shall be high and become part of expenditure.

2.25-The energy demand can be higher than actual, therefore re-examined the details to reduce the energy and maintence cost also.

2.3- Suggestion basedon obtained details from records and field results during the energy Audit.

(i) All over sized motors should be replaced by energy efficient motors to maintain power high factor and possibly add variable frequency drives.

(ii) Building management must be incorporated to maintain the power factor with the capacitor panel continuously.

(iii) The operation period of the facility must be increased for optimal output.

(iv) Re-examine the energy details as per current scenario and add capacitor bank.

(v) An energy management team be constituted to examine and continuously monitor the establishment.

(vi) Though this facility is only operated in day time but all the support services run continuously round the clock. Therefore, a small rating of solar plant of 50% capacity of the maximum demand load as consumed during the survey at night time based on data table -7 be installed to save energy and natural resources.

2.4 Suggestions: -

(i) All the feasible proposals were submitted to the higher authorities by team members and follow up suggested at earliest.

(ii) Automatic arrangement must be done for essential and non-essential distribution of energy considering top most priority factors to run the facility on maximum demand of load even when it is non –operational.

(iii) Add on variable frequency device on high rating appliances.

(iv) Capacitor bank has also been considered after re -examine the energy details.

(v) Provide adequate operating procedures and training programmes.

(vi) Improved preventive maintenance required to sort out issues like poor-setting, equipment design limitations, operator adjustments, and appropriate intrusive preventive process control issues.

3 CONCLUSIONS

(1) Energy audit is one of the best technique and most reliable comprehensive tool to give uttermost result within a short duration, it can be applied in all types ofindustry, establishments, commercial and residential areas also in achieving energy saving which is essential to save natural sources.

(2) Energy audit is a team work of field experts. By their opinions excess and wasteful consumption of energy can be minimised and it also reduces the annual maintenance.

(3) A solar power plant should be provided to save energy and natural resources. The cost of solar plant would bepaid back within ten years.

(4) The suggestions given in this paper are solely dependent on the decision of the management.

(5) Due to some site restriction, severalsuggestions may not be implemented asimplementation is in hands of management.

(6) Energy saving strategies and also individual solutions for reducing energy consumption are challenging managements, public and scholars. State of art solutions with automated control with high quality sensors (which could be expensive) shall be the challenges in future.

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REFERENCES

1. Mehulkumar J Panchal, VedvyasDwivedi and RajendraAparnathi "The Case study of Energy Conservation and Audit in Industry Sector" Science, Vol.3, Issue, pp 5298-5303, April, 2014.

2. A reference book "Energy Management"published by S.K.kataria and sons.

3. Mukesh K. Saini "Energy adult of an Industry, Volume – 3, Issue 12, Dec 2014.

4. Energy managers/Auditors Guide books published by Bureau of Energy Efficiency.

5. ShashankShrivastava, Sandip Kumar and Jeetendra Mohan Khare "Improving Industrial Efficiency by Energy Audit" International Journal of Scientific Engineering and technology, Vol.2, Issue 4, pp 291-294, April, 2013.

6. Manivannan. R and Dharmendra J Davda "Performance studies on an IT Facility by Using Energy Audti as a Tool" Proceedings of International Conference on circuits, Power and Computing Technologies[ICCPCT-2013], nagercoil, India, pp 653-660, March, 2013.

7. Energy Management Hand book, john wiley and sons – wayne C. Turner.

8. Guide to Energy Management, capeffart, Turner and Kennedy.

9. http://www.eeca. Govt. nz.

10. National Action plan on climate change prepared by PMs council on climate change.

11.Chee Khiang Pang, Cao Vinh Le, Opn Peen Gan, Xiang Min Chee, Dan Hong Zhang, Ming Luo, HianLeng Chan, and frank L. Lewis. "Intelligent Energy Audit and Machine Management for Energy-Efficient Manufacturing" Proceeding of 5th International Conference on Cybernetics and Intelligent Systems (CIS), Qungdao, pp 142-147, Septemberr, 2011.

12. Inamdar H. P, Hasabe R.P '' IT Based Energy management through Demand Side in the Industrial Sector" proceedings of International Conference on Controk, automation, Communication and Energy conservation, Perundurai, pp 1-7, June, 2009.

13 R. Hari Baskar, Hitu Mittal, Mahesh S Narkhede and Dr. S. Chatterji "Energy audit-A case study" International Journal of Emerging Technology and Advanced Engineering, Vol.4, Special Issue 1, India, pp 73-78, February, 2014.

14. Noor.M. Maricar "Industrial Energy Audit Web Application using Data Mining Model" Proceedings of GCC Conference (GCC), Manama, pp 1-6, March, 2006.

15. Energy Audit Reports of National Productivity Council.

16. S.L Uppal, A reference book "Electrical wiring and estimating costing"by Khanna publishers, Delhi-6.

17. B.R Gupta, A reference book "Generation of electrical Energy" by Eurasia Publishing House (Pvt.).