www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 4 April, 2014 Page No. 5298-5303

The Case study of Energy Conservation & Audit in Industry Sector

Mehulkumar J Panchal[1], Dr. Ved Vyas Dwivedi[2], Rajendra Aparnathi[3]

[1]Ph.D Scholar, Pacific University,Udaypur, India
ph_mn@yahoo.co.in

[2]Pro Vice Chancellor, C. U. Shah University, Wadhwancity, Gujarat, India
provcushahuniversity@gmail.com

[3]Department of Electrical Engineering, C. U. Shah University, Wadhwancity, Gujarat, India
rajendraaparnathi@live.com

Abstract: ***Energy is very much important input in all sectors of any country's economy. The standard of living of any country can be directly related to per capita energy consumption. The ever increasing population on the world and increased standard of living of human being has no doubt put a tremendous pressure on Earth's Resources. In this research paper, Study of Energy Conservation and Energy Audit in industry. It is carried out and very effectively tried to make systematic approach for the same. It is studied that results of energy conservation and energy audit point out possibilities of energy saving, by simple housekeeping measures as well as improved techniques, better instrumentation and more efficient machinery. A careful day to day monitoring of specific energy consumption can help in saving wastage of energy and raw materials.***

Keywords: Energy Audit; Energy conservation;

1. Introduction of Basic of Energy conservation:

The core concept of the non structural energy conservation approach is about human behavioral change. As defined in the Dictionary of Energy, behavioral change is in the activities of a person or organization that affects the level of energy conservation, either positively (turning off lights when not in use) or negatively (e.g. using an electric dryer to replace a clothesline)". Some examples of energy conservation behavior but not limited to, switching off the unnecessary lighting, thermostat control, turn off the monitor screen whenever not in use, turn the computer in to sleep mode when leaving the computer for a short periods, use stairs instead of lift as possible as could, as well as maximum use of the natural lighting. All of these energy conservation actions can reduce energy usage dramatically[1]-[2]. Human behavior is an essential ingredient in energy conservation efforts. In support of that the best ways to cope with the rising energy demand is not to supply more but is to save. Energy conservation is an inescapable responsibility for humanity. People is the main factor in achieving energy efficiency. The significance of this approach has been reported by many researchers[2].

Approximately 10 % of savings in energy cost can be achieved if the users are more energy conserving and 5-10 % of energy savings can be achieved by improving energy users' behavior. Therefore, cumulative amount of energy cost saving can be reached through energy conservation behavioral changes[2].

1.1. Principle of Energy conservation: Energy conservation means reduction in energy consumption but without making any sacrifice of quantity and quality of production[1],[3].

1.2. Energy conservation : It can be defined as the substitution of energy with capital, labour, material and time. This definition also covers the substitution of scarce type of energy (i.e. coal, oil) with abundant type of energy (i.e. solar, wind) or the substitution of energy with convenience. For example, people will turn lights off when they are not in their premises[2], [4].

1.3. Energy conservation is the act of using energy in a more efficient and effective manner. While any form of energy may be conserved, electricity is the type most commonly referred to in connection with conservation[4].

2. Why Energy Conservation?

- To reduce energy/fuel shortage
- To reduce peak demand shortage
- To save fuel, natural resources and money
- To reduce environmental pollution
- Only 1 % of natural resources available in India, while population is 16% of the world
- Provides Energy security

2.1.Energy Efficiency & Conservation [4].

In a broad sense, energy efficiency means economizing on the use of energy without adversely affecting economic growth and development. It includes improving the efficiency of energy generation, transmission and distribution and efficient end use of energy[4].

The cost effectiveness of energy conservation/efficiency measures is well established as one unit of energy saved at the consumer end avoids nearly 2.5 to 3 times of capacity augmentation due to plant load factor, plant availability, auxiliary power consumption T&D losses etc. Energy savings achieved through energy efficiency &conservation apart from saving the investment required for additional capacity also avoids capital investment in fuel, mining, transport, water and land required for power plant. The potential of energy efficient options, which save costs to the consumer, utility and society as well, has, therefore, to be fully harnessed[5].

2.2. Energy conservation through Energy Efficiency:

- Industrial Sector plays a vital role in economic development
- Industries cannot grow without electricity,
- Electricity is the backbone of economic development
- Setting up new power station for increasing generation capacity is a capacity is a capital intensive project with a long gestation period.
- Energy conservation is an alternative of capacity addition.
- Energy conservation at the cost of comfort and productivity hampers the growth and development of economy

Energy Conservation by enhancing energy efficiency gives impetus to the socio economic development[5].

2.3. Effectiveness & Necessity for Legal Provisions related to Energy Conservation[6]:

- For Socio-economic growth and development of the nation, energy conservation is must through enhancing energy efficiency.
- Government initiative is very much required for energy conservation through enhanced energy efficiency.
- Mandatory statues regarding energy conservation plays an important role for enhancing energy efficiency

2.4. Energy conservation measures in different area:Energy Conservation in Electric Motors and Drives[6].

Electricity used in the industries for motive power; i.e. electric motors, for heating and melting, for illumination and for electrolysis. About 70 to 80% of the electricity in industries is consumed by electric motors. Choosing a motor, most suitable for particular application is based on many factors, including the requirement of the driven equipments, service conditions, motor efficiency and motor power factor. Good energy management is the application of the motor and its components that results in the least consumption of energy[6].

2.5. Illumination

In Industries, electricity consumption for illumination rarely exceeds 5% of total consumption. Proper design selection and maintenance can however lead to some savings. The following points must be considered [7].

- Required lighting levels for different work areas.
- Selection of light sources.
- Maintenance and Effective Control.

The actual value of lighting levels for different work areas is a controversial subject. In India, maximum advantage should be taken of the excellent natural lighting available throughout the year. Maintenance and control of lighting must be done very carefully.

2.6. Electro-heat and other uses

Modern Arc furnaces have inherently low p.f. of the order of 0.7 to 0.75. The current also fluctuates widely resulting into voltage fluctuations. Power also varies with voltage. On load tap changers for furnace transformers wear out quickly due to sever duty. Electric utilities now in system p.f. are improved to nearly unity. Thyristor switched capacitors can consistently monitor furnace load and keep p.f. nearly unity and also improve the voltage level increasing production[8].

Electrolytic process-require D.C. power. Static convertors can improve efficiencies. A large amount of waste heat is generated in these processes. More fundamental studies of cell design, electrode processes and configuration etccan lead to significant improvement in efficiencies [8].

2.7. Power Factor Correction system

Use p.f. power factor correcting capacitors are increasingly very rapidly as utilities insist on higher power factor being maintained by consumers. Suitable incentives in tariff are also being offered [9].

2.8. Load Management

Load management is a set of technologies for control of power supply and demand to increase the system load factor. Managing electric utility loads in manners which improves the effective utilization of generating capacity and encourage judicious use of electricity by all-consuming sectors. Customers can benefit both from personal decision to defer energy consumption until off peak hours if incentives are provided moderating requirements for increased rates[9].

Distributing companies can benefit from load shifts which allow more balanced plant utilization, minimizing the need for construction of new generating capacity. Country as a whole can benefit from actions which reduce the need for peaking power, which is typically provided using gas and oil fired peak load generators[9].

2.9. Electricity Storage

Like fossil fuel Oil and Coal, It is not possible to store Electricity for one week by afactory at factory premises or at the power station. Storage of Electricity can play a very vital role in electricity conservation and management. The peak demand on a system can be met by stored electricity in place of new generating capacity. This is because on all practical power systems, the demand curve has peaks and valleys. Electricity storage system basically aims at storing electricity generated during off peak period and supplying this electricity during the periods of peak demand [10].

An Electricity storage system consists of three components. 1) Convertor which converts electrical energy into energy from which can be easily stored. 2) Sufficient structure for the energy storage. 3) Invertors which converts the stored energy into electrical energy. The following technologies are generally used for storage systems like Chemical Energy Storage, Battery storage, Pumped Hydro, compressed air storage, Thermal storage, super conducting magnets etc[10].

2.10. Co- Generation

Co-generation can be defined as the coincident

generation of steam and electricity by an industry – with or without involvement of a utility or by a utility itself. In Co-generation systems from its inherent thermodynamic characteristics, Fossil-fuel- fuel fired control stations convert one-thirds to escape in the form of thermal discharge. By using the reject heat, cogeneration plants can achieve a thermal efficiency as high as 80%. Co-generation makes use of this waste heat in two basic thermal cycles – topping cycles and bottoming cycles. In a bottoming cycle, burned fuel produces process is then converted to electrical or mechanical power. In topping cycle, fuel is burned to produce electrical or mechanical power; the waste heat from the power – production system then serves as process heat [4], [5], [11].

3. Means of Energy Efficiency:Agriculture DSM

In-efficient use of electrical pump sets will increase wastage of Energy in a very high range. As a result, the Energy Audit Study becomes an effective tool in defining and pursuing comprehensive Energy Management Programme (EMP)[11].

In the background of skewed tariff and un-willingness on the part of the utilities to promote energy efficiency among the high paying consumers viz. industries and commercial, following DSM activities are likely to receive energy in the agriculture sector can be the corner stone of utility driven DSM strategy. This will require not only replacement of pump sets and the entire pumping systems with an efficient one but will also require encouraging Energy Service Companies (ESCOs) to take up the same in an agreement which will involve Utility as well as farmers for a sustainable results. Reasonable tariff on agriculture will further give boost to agriculture DSM [11].

3.1. Municipal water pumping

Municipal water pumping is high energy in-efficient in India. The potential for saving is estimated to be over 30 to 40%. The investment in replacement of pumping system and plugging leakages could save energy over 40% with low pay back period. Thus this could be implemented in all the major municipalities through performance guarantee contract mechanisms by ESCOs.[1],[3],[5]

3.2. Power factor correction

Notification for penalty for low power factor or incentives for near-unity power factor for al l the HT consumers and LT commercial/individual consumers will give significant gains in terms of energy savings to the utilities. Such notification will help in developing market to make investment on performance contracting mechanisms [11].

3.3. Time-Of-Use Tariff (TOU)

Introduction of Time-Of-Use Tariff will incentivize energy intensive HT customers to shift activities/part activities to off-peak period to take advantage of low tariff. This can give a very major gain to utilities to reduce peak demand. However, to introduce TOU tariff requires trivector meters and a complete computer software and hardware to manage the same [6].

3.3.1.Water pumping in high rise buildings

Water pumping in major buildings is very energy in-efficient. The utilities could promote energy efficient pumping systems through notification and promote implementation through market mechanisms[7].

3.3.2. Domestic Lighting

Lighting loads generally coincide with the peak demand of the utility. Hence targeting lighting efficiency improvements would be in the interest of utility to reduce peak demand and strategic conservation i.e. reducing overall average consumption of the utility. The latest lighting technologies utilizing compact fluorescent lamps, fluorescent tube lights with electronic chokes would need to be encouraged for domestic sectors[8].

3.3.3. Barriers to Energy Efficiency

Considerable untapped potential exists for curbing wasteful use of energy estimated to be of the order nearly 30 per cent of the total consumption of commercial energy. The size of energy efficiency markets growing @ 10% annually in India is estimated to be in the range of Rs. 200 to Rs. 300 billion.[8]

In spite of many efforts and benefits of energy efficiency several technical financial market and policy barriers have constrained the implementation of energy efficiency projects[8].

(a) Lack of Awareness: The main barrier to energy conservation is the lack of awareness by industry managers of the potential gains from improved efficiency. Industrials well as Government of customers, are yet to take into consideration factors such as tax credits, depreciation benefits, electricity price escalation, life cycle savings of the investment and the time release of money.

(b) Lack of Widespread Education and Training: Shortage of widespread educational opportunities in energy management and conservation and appropriate facilities; lack of trainers and auditors.

(c) Economic and Market Distortions: Irrational response to conservation measures because of inappropriate pricing and other market distortions, or socio-economic factors.

(d) Lack of Standardization and Labeling of Equipment / devices. Slow rate of progress in achieving higher standards of energy consumption in equipment and appliances.

(e) Lack of financing:-The lack of credit and the inability to obtain financing for projects are strong deterrents to investments in energy efficiency in India.

(f) Lack of Effective Co-ordination:- In India, the lack of effective national-level co -ordination and promotion of energy conservation activities have been a major constraint to achieving energy efficiency.

H- Factor: The Human Factor: Sustaining energy efficiency through energy effectiveness : The Human Factor is identified as one of the critical factors first of all to achieve energy efficiency and then to migrate from energy efficiency to energy effectiveness [9].

Energy efficiency means using less energy to perform the same function. This may be achieved by substituting higher efficiency products, services, and/or practices. It is most effective ways of meeting the demands of sustainable development. The benefits of energy efficiency up on the environment are self evident. Energy Effectiveness means ensuring sustainability of energy efficiency practices by embracing specific technologies. The importance of Energy/Effectiveness is to ensure that energy efficiency is practiced on a consistent basis and that people do not return to their previous in efficient behavior[9].

4. H – Factor –Behavioural change [9]:

To self-demonstrate this concept, throughthe means of simple behavioural changes and energy efficient technologies, reduced my household consumption by 73% since 2011[26]. I have gone the extra mile by appointing my family members as Energy Conservators and providing them with certain "Happy points"tomaintain and achieve higher savings. By making energy efficiency a shared goal in my home, I was able to unite my entire family to help lower our energy consumption. I have since shared this initiative that demonstrated financial savings with others so that they too could embark on a similar journey.

Energy efficiency puts the power in the hands of home owners and by using electricity efficiently and effectively, it will not only lower the monthly bill, but also have a positive and significant impact on the overall health and the environment.

5. Energy Conservation

5.1. Measures

The basic important points should be taken into considered when Energy Conservation measures are to be implemented which are discussed as below[10].

1) Energy conservation should be given the pride of place in official policy

2) Energy conservation program should be carried out by distribution companies for industries in co-operation with various industrial associations and other related agencies

3) Electricity should be realistically priced. Peak load and time off day pricing must be made mandatory for large industrial users.

4) Staggering of holidays must be made permanent for industrial consumers.

5) Maintenance of existing power stations should receive more importance than reckless expansion of capacity.

6) Suitable tax incentives should be provided for installing new energy efficient equipments.

7) Co-generation of heat and power should be encouraged in industries.

8) Norms of consumption should be drawn up for all important industries.

5.2. Benefits of Energy Conservation[10]:

1) Individual consumer/ industry: Saving in energy cost

2) Grid: Capacity increase without capital investment

3) Society: Deceleration in depleting natural resources for the betterment of next generation.

4) Environment: Reduced emission of greenhouse gases helps protecting the environment for controlling the global warming.

5) Nation: Gives Energy security

5.3. Energy Conservation Potential [5],[11]

As shown below, Table-1 gives a fairly conservative potential for energy conservation in various sectors. Nearly 25000 MW equivalent of capacity creation (Negawatt– NW) through energy efficiency in the electricity sector alone, has been estimated in India.

Table - 1: Energy conservation potential in various sectors of economy[10]

Sector	Potential (%)
Economy as a **whole**	Up to 23
Agricultural	Up to 30
Industrial	Up to 25
Transport	Up to 20
Domestic and	Up to 20

5.4. Case Study in Industry

We are taking this opportunity to express our heartily gratitude to **Management**of **M/s Zydus Infrastructure Pvt. Ltd.** for giving opportunity & encouraging us in the new concept of **ENERGY AUDIT** made mandatory by Hon. Govt. of Gujarat.

We once again put up our appreciation for full co-operation & valuable guidance for perfect auditing of the plant to technical as well as commercial persons for providing all the required information & data as well as for providing co-operation with all the departments & extend his best help in our work. We have tried our level best for the work of Energy Audit up to their satisfaction.

The audit team has conducted Energy Audit at **M/s Zydus Infrastructure Pvt. Ltd.** located at "PHARMEZ" Pharmaceutical SEZ, Sarkhej-Bavla National Highway No. 8 A, Near Village- Matoda, Taluko- Sanand, District – Ahmedabad- 382 213from 16th to 17th September- 2013.

The major activities carried out by Ambica Associates team during the audit are as follow:

- Collection of Manufacturers data from company's records regarding Electricity Power Bills, Power Distribution Diagram, Specifications of major power handling equipment – such as transformers, switch gear s & other utilities.
- Taking on-line spot measurement of various parameters of equipment (with our instruments) such as Voltage, Current, KW, P.F., Airflow, Water Flow, Temperature& Pressures.
- Calculations of effective output of the machines & comparing with original specifications.
- Analysis of above calculations, isolating the areas vulnerable to energy consumption not related to production.
- Recommendation of various methods of rectification.
- Making case study of projected saving by following our recommendations; and estimating potential investment &pay back period.

6. Senior Manager- EHS & SEZ Operation Energy Audit Team M/s Zydus Infrastructure Pvt. Ltd.

When you submit your paper print it in two-column format, including figures and tables. In addition, designate one author as the "corresponding author". This is the author to whom proofs of the paper will be sent. Proofs are sent to the corresponding author only.

BRIEF PROFILE OF M/s Zydus Infrastructure Pvt. Ltd.:-
ZIPL was set up in 2008 to, as the name suggests, provide infrastructural services, right from acquisition of land, to the proposed pharmaceutical SEZ.
The services include

- raw water supply through network of piping to all the SEZ units
- treating effluents from the SEZ units delivered to it in tankers
- power supply to street lights of SEZ
- providing temporary office space to new units etc.

7. Comparison

Case Study -1 M/s Zydus Infrastructure Pvt. Ltd, Ahmedabad. The Result of the Energy audit carried out in the industry is compared with before the energy audit and after the energy audit conditions and the same is discussed.

Sr. No.	Before Audit	After Audit
1	During the recent past 12 months studied, -only for one month (as far as back in December-2012) the actual demand (245 KVA) is lower than the minimum billing demand (255 KVA) i.e. only for 1 out of 12 recent past months, the contract demand is under-utilized.	therefore suggest to control the actual MD to within the existing contract demand of 300 KVA as done in the latest month of September-2013 (actual MD = 272 KVA) to avoid excessive demand charges
2	Out of a total of 270 KVAR of capacitors, only one 20KVAR capacitor (sr.no.5 above) in APFC panel is partially derated	so it requires to be repaired / replaced, if need be, so as to maintain the PF near to unity.
3	The unit has no. of old rewound motors which draws higher current and more power having lesser efficiency.	It is advisable to replace rewound motors in plants & pumps with energy efficient motors. In these motors losses are less & motor output is more due to less slip, which increase's the mass flow. Some of motors are found energy efficient in plant.
4	We have taken thermograph readings of some important switch gear with an Infrared gun, to detect over heating of live electrical switch gear elements, such as contacts and terminal sockets, to indicate any undue over heating	This heating indicates loose joints, corroded contacts which result into waste of electrical energy by radiation and eventual failure/short circuit. Temperatures of 40*C and above are not desirable and these points must be corrected during maintenance

8. Conclusion

Energy audit is of two type that add completeness to the energy conservation proposal description.The Energy audit and Energy conservation measures described in the research paper does not only provide a very different perspective to the wastage and energy crisis and energy security but also an implementation platform that addresses all aspects of managing several energy sources. This approach differs from the approach taken in many publications that divide the research into Energy conservation strategy and address sub-problems without demonstrating how they fit into a larger picture. The review on previous and ongoing work by other researchers in this field provided a comprehensive description and aspects of the research topic. Following this, key issues pertaining to the implementation of Energy Conservation proposal and methodology have been discussed in detail. Findings based on the exhaustive literature survey were presented to state the various methods of addressing energy conservation and energy audit in keeping mind the present Energy scenario and future condition.

References

[1] HarishkumarAgarwal, Smart Grid Initiative in India and Supreme's Experience in the Electrical India, Vol 53, No.9 September 2013, page 78.

[2] Bibhu Prasad Rath and Prof. JavaidAkhter, Understanding Carbon Credit Prospects for Electricity Generation in India, Electrical India, Vol 52, No.5, May 2012 page76.

[3] B S Srikanthan&Srinivas S, Minimization of Distribution losses for domestic appliance – A Case Study, Electrical India, Vol. 53, No. 9, September, 2013, page no. 68.

[4] PranjalDutta, "Behavioural Science and Energy Efficiency An interdisciplinary Perspective". Electrical India, Vol. 52, No. 10, October, 2012, page no. 96

[5] .Ashok S, Energy Conservation Why Elevated now to the Top of Pyramid? – Ashok S, Electrical India, Vol. 53, No. 11, November, 2013, page no. 54 to 60.

[6] R P Deshpande, Solar Energy Future in India, Electrical India, Vol 53, No.11, November 2013, page 108.

[7] PrakashNayak, Feeding Growth: Renewable Energy to the rescue- Electrical India, November, 2013, Vol 53, No 11, page no.96.

[8] AmolKotwal, Fuel Resource Crunch and its impact on India's Power Sector and overall Economy, Electrical India, Vol 53, No.11, November, 2013, Page no. 178 to 180

[9] JayantSinha, Energy Conservation & Demand Side Management in Power Sector Reforms –Electrical India,Vol 52, No.10, October 2012, page No. 122.

[10] .Mr.Siddharth Bhatt, The inter relationship Between Energy Efficiency Energy Consumption in the Electrical Sector, Electrical India, December 2012, Vol 52, No.12 page no. 192 to 202.

[11] Dr. NareshJotwani, Renewable Energy: Role of Education –, 6th National Conference on Synergy with Energy, India Energy show 2010, September 24-25, 2010, Tagore Hall, Paldi, Ahmedabad, page 19.

Author Profile

Mr. Mehulkumar J. Panchal is B.E.(Electrical), qualified GATE-2000 (Electrical) with 91.6 percentile. M.E.(Electrical) and pursuing Ph.D (Electrical) from the Pacific University, Udaipur, Rajasthan in the July -2011 Batch. He is Bureau of Energy Efficiency, (Government of India) certified Energy Auditor cum Energy Manager having Registration No. EA – 13732 in the year 2012. He is currently working as Junior Assistant Electrical Inspector (Class-II) in the Office of the Chief Electrical Inspector, Gandhinagar under the Electrical Inspectorate, Government of Gujarat. His work involves administration of various Electricity laws, Regulations prevailing in the Gujarat state i.e. The Electricity Act, 2003, Central Electricity Authority Regulations, 2010, Bombay Electricity Special power Act, 1946, The use of Electrical Energy order, 1999 and work related to Energy Audit. He is involved in Scrutiny of drawing approval of temporary and permanent Electrical Installation of the distribution companies, HT/EHT consumers in the Gujarat state. He has participated in many conferences and seminars. He has actively organized Energy awareness programs and Energy Conservation Seminars in the Noble Group of Institution, Junagadh and C U Shah University, Wadhwancity, Surendrangar in the Gujarat State in support with Gujarat Energy Development Agency, Gandhinagar (A state level nodal agency of Government) during the Ph. D. tenure. His Fields of interest and research are Electical Safety, Energy conventional, Energy Audit, Generation, Transmission and Distribution of conventional /non conventional energy

Dr. Ved Vyas Dwivedi, Professor, Gujarat Technological University, Ahmedabad; Pro-VC in C U Shah University, wadhwancity, Gujarat-INDIA; is a Ph. D., M.E., B.E. (all E.C. Engineering) has submitted his Post-doctorate report; is a recognized Ph. D. guide for 06 candidates in R. K. Univ. Rajkot (Gujarat), Pacific Univ. Udaipur, J.J.T. Univ. Jhunjhunu; 02 Ph. D. theses and 36 M Tech dissertations submitted, and no. of papers published ~ 125, no. of expert talks delivered ~ 47 in international conferences, workshops, STTP…; completed 03 research projects / consultancy (Govt. and nongovernment organizations). His fields of research interest are energy-sensor-wireless-optical-radar-satellite-RF technologies and systems.

Rajendra Aparnathi. received his B.E (Electrical Engineering) degree from Bhavnager University,qualified GATE-2009, and M.E. (Industrial Electronics) from the Faculty of Technology and Engineering,Maharaja Sayajirao University of Baroda. P.hd*(Pursuing) CUShah University, Wadhwancity, Surendranagar, Gujarat: INDIA. The major fields of interest are Industrial Automation and Power Systems. He joined C U Shah College of Technology and Engineering, C U Shah University, Gujarat-India and Gujarat Technology University, Gujarat, India and as an Assistant Professor. Now he is the tutor of graduate students and Post graduate students majoring in Power Electronics and Drives. In recent years his research interests focus on the field of renewable energy, especially on the inverter technology. He also worked on R&D project with companies of repute in the field of electrical electronics engineering