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Energy Audit: Case Study of A Wheel Manufacturing Industry

Highligting the Energy Conservation Opportunities in the Manufacturing Sector

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***Abstract*— Increase in energy demand globally has forced the energy cost to rise up. One of the major sectors which are responsible for the high energy consumption worldwide is industrial sector. Developing countries like India, Bangladesh, and Pakistan etc are having huge imbalance between the demand and supply of electricity. To drive the growth of nation it is must to reach at the balance point in demand and supply. In industrial sector, commercial buildings we have higher consumption pattern observed, that can be reduced by implementing Energy Conservation Measures. The typical features of any typical industry is determined by the quantity and type of raw materials, its production technology, organization of technical equipment and level of automation. All The above factors add to variation in the using up of special energy carriers. This paper throws light over the consumption of energy profile of a typical wheel rim manufacturing plant. It describes technical, maintenance as well as economical factors that can be applied in a comprehensive analysis to achieve energy efficiency in the confectionery industry to assist the choice of the best available technology.**

I. INTRODUCTION

The main aspect of the non structural approach to the energy conservation is about change in human behavior. The definition of the behavioral change for the energy conservation according to the dictionary of energy is the change in the daily activities of a person in the individual or as whole organization that reflect the commitment towards the energy conservation.

Human activities are an essential factor in conservation of energy. It not only leads to the financial benefits for an organization but also proves as the best practice to trim down the gap between demand and supply.

Many researchers have reported that individual effort for the conservation of energy is the best method to reduce the electricity deficit in India. Energy conservation can be defined by reducing the energy demand without making any sacrifice in the production quality and working output of any organization or unit.

II. ENERGY SCENARIO IN INDIA

Availability of power has a critical role in economic development as well as overall enhancement of lifestyle of the country. India stands fifth in the world for the energy demand. The installed capacity of India is 255 GW. The breakup of this generation from different sources is:

1. Thermal (Coal, Gas, Diesel) - 177 GW [1].
2. Nuclear- 4780 MW [1].
3. Hydro- 40798 MW [1].
4. Renewable sources- 31692 MW [1].

The annual electricity generation of our country in last two decades has seen a growth of 191 GW, from 66GW in 1991 to 255GW in 2014. In India breakup of demand as per sector is:

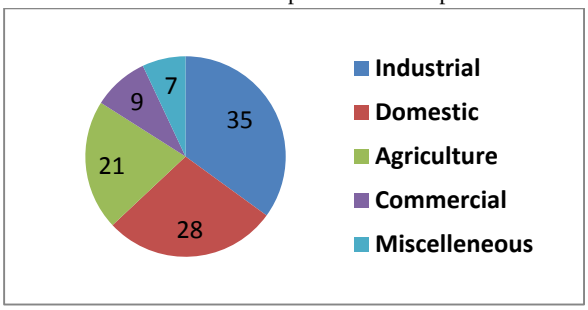

Fig. 1. Energy consumption in main sectors

From the above figure it is observed that industries are the major consumption areas of electricity. So it is essential for us to concentrate on the energy intensive sectors and try to improve the performance of them to conserve energy. This paper mainly focuses on the energy intensive industry. The case study of an industry is dicussed in the later chapters which will give a brief idea of how much savings can be achieved in an industry. The potential of energy conservation options, which provides savings to the consumer, utility and society as well, has, therefore, to be fully extracted [2].

A. Introduction to Energy Audit

An energy audit is a survey, inspection and analysis of energy flow to conserve energy in an industry, it is a process to reduce the amount of energy consumed within the industry without

negatively affecting the output. According to national energy conservation laws and regulations for energy consumption, investigation and energy audit management [3].

Energy Audit activities in general order includes:

- Classification of all energy systems
- Assessment of conditions of the systems
- Analysis of impact of enhancement to those systems.
- Preparation of energy audit report and recommendations to improve the energy efficiency of the particular industry.

All the economic and energy conservation measures recommendations are made once the whole energy data is gathered and audit is done. In developing countries like India we are emphasizing more on the increase in the installed capacity of the country, rather than that we should focus more on the energy conservation methods that will reduce the energy deficiency in India up to a great extent. Researchers and their studies have revealed that energy auditing and management can save India Rs.1800 crore per annum as there is a big prospective to save energy in industrial, commercial as well as corporate buildings. In requisites of electricity, these saving are equal to installation of 5250MW.

B. Types of Energy Audits

The energy auditing course would provide positive results in drop of energy billing cost for which apposite protective and cost efficient maintenance and quality control programmes are necessary leading to better manufacturing and economic utility activities. We can mainly classify energy audit into three main phases:

- Phase I- Preliminary energy audit
- Phase II-General energy audit
- Phase III- Detailed energy audit [4]

III. INTRODUCTION ABOUT THE PLANT

A typical wheel rim manufacturing plant is one of India's leading HCV (Heavy Commercial Vehicles) manufacturer offering transport solutions for a new competitive age in India's fast-growing economy.

Its product range covers the full range of heavy-duty applications in mining, construction, power, petroleum, roads and highways, other infrastructure projects and general cargo transportation.

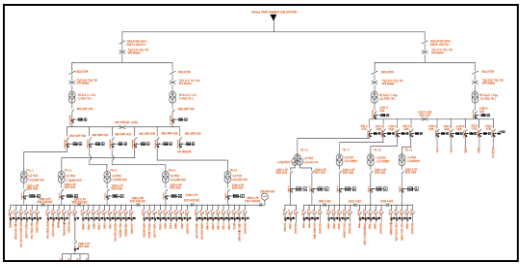

Fig. 2. Single line diagram of the Plant

A. Products Manufactured by the plant

It manufactures component for the automotive and general engineering industries. The company manufactures world-class wheel rims for cars, trucks, tractors and several other vehicle categories. It also manufactures skin panels, inner panels and compressor shells.

Wheel rims:

It is one of the India's largest single-location facilities for wheel rim manufacturing, with an installed capacity of 15 million wheel rims per year for a range of automobiles.

Press shop (stampings):

Its press shop caters to the needs of a diverse range of industries. Clients include automotive, white goods and general engineering companies. Its state-of-the-art press shop can shape 100,000 tonnes of products per annum.

B. Components of production cost

Production cost can be broken down into various components which contribute significantly in the overall cost. These are primarily the energy and material costs. The energy cost components in manufacturing the finished are as follows:-

- Power Supply From Grid
- Power generation through DG set
- Compressed Air
- Chilled Water
- Hot water
- Water
- Lighting & Illumination

C. Energy Guzzlers in the plant

Large amount of energy in above mentioned forms are used in the plant. These can be further classified into various equipment. These are termed as Energy Guzzlers. Following table gives the energy consumption of Energy Guzzlers in the plant

So. No	**Unit**	**Consumption In kWh**
1	Car line - 1	23711
2	Car line - 2	88095
3	Car line - 3	7546
4	Utilities Car	14781
5	Tractor Line	23082
6	Utilities Tractor	14781
7	Wheel Testing & AC - Car & Tractor line	2096
8	Plant lighting & AC - Car & Tractor lines	22037
9	TR losses & Meter Difference car & Tractor lines	16106
10	Truck Line	138690
11	Utilities - Truck line	42233
12	Plant Lighting & AC - Truck Lines	10343
13	TR losses & Meter Difference - Truck line	8964
14	Paint Plant - 1	62227
15	Paint Plant - 2	102312
16	Utilities - Paint shop	12848
17	AACL Admin	16578
18	AACL Canteen	8252
Total kWh		**614682**

TABLE I. ENERGY CONSUMPTION IN THE PLANT

The electricity bills for the last one year were provided by the plant. They were analyzed to see if there can be any savings that can be achieved. Some graphs were plotted as a part of analysis and they are:

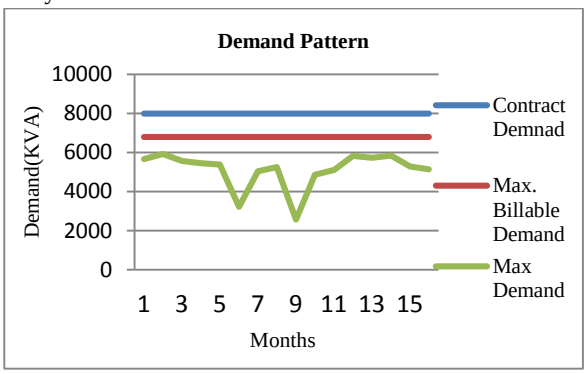

Fig. 3. Demand Analysis of the plant

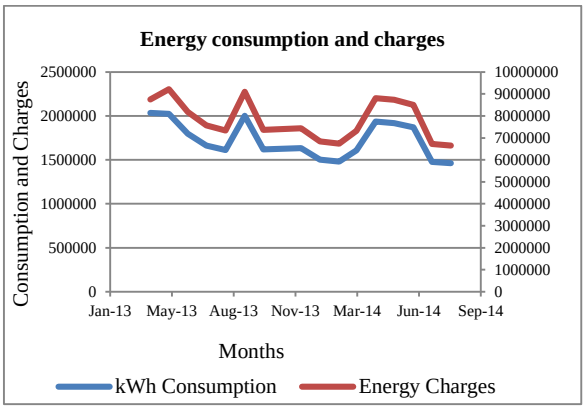

Fig. 4. Energy consumption and charges

D. *Compressed Air*

There are total 4 compressors installed in the plant to cater the compressed air requirement of the plant. All compressors are connected in a ring system. Compressed air required for the pneumatic applications of the machines. Set pressure points for the plants are 5.9-6.8 bars. Details of all compressors are as follows:-

Sr no	Description	capacity (kW)
1	Air compressor 1	160
2	Air compressor 2	160
3	Air compressor 3	90
4	Air compressor 4	90
Total		**500**

TABLE II. AIR COMPRESSOR DETAILS

E. *Chillers*

Chilled water is used for the Machine cooling, product cooling. Each section is equipped with the separate Chiller. Required chilled water temperature for the machines is in the range of 14 - 16. There are total 9 chillers installed in the plant out of which only 4 were working and rest all were stand by

Performance Analysis of Chillers		
S.No	***Chiller no.***	***Flow rate(l/h)***
1	Chiller (carline 2)	13270
2	Chiller (Paint Shop 2)	44580
3	Chiller (Paint Shop 1)	NW
4	chiller (truck line)	17800

TABLE III. CHILLER DETAILS

F. *Lighting and AC load*

The lighting & AC load inventory of entire plant is as follows:

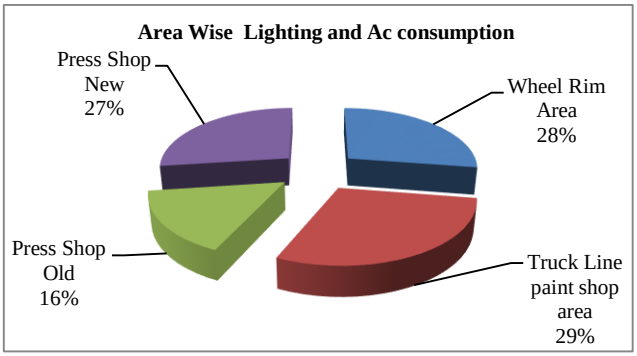

Fig. 5. Lighting and Ac load details

Lighting load of the plant is 290 kw, while AC load used for office cooling is 47 Kw.

IV. ENERGY CONSERVATION AND RECOMMENDATIONS

After thorough analysis, calculations and trial runs (during audit), following energy conservations opportunities have been identified:

A. *Reduction in Contract Demand*

The contract demand of the plant was observed to be more as the max demand of the plant never crossed 6000KVA as observed from the electricity bills. So it was recommended to reduce the contract demand to achieve a saving of Rs 47.53Laks/annum.

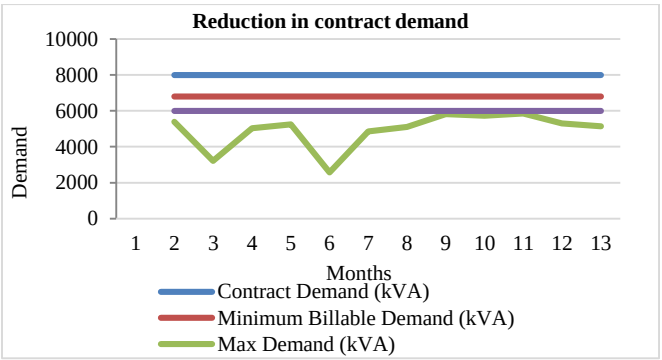

Fig. 6. Reduction in contract demand

B. *Savings by arresting Leakages in compressor*

Leakage test was done on the compressors to see if there is any leakage and basic analysis was done to quantify the savings that can be achieved by reducing the leakage.

By arresting the leakages of compressed air system, a saving of Rs 22.99 Lakhs/annum can be achieved.

Energy savings by Leakages arresting			
S.No	***Parameters***	***Unit***	***CP3***
1	Loading Time(T)	Min	1.15
2	Unloading Time	Min	0.94
3	FAD(Q)	m^3/min	25.66
4	Leakage @ 1 compressor running	%	55%
5	Allowable leakage	%	10%
6	Leakage quantity(q)	m^3/min	11.5
7	Motor Power Consumption	KW	165.0
8	Leakage quantity per day	m^3/day	16625.0
9	Specific power for air generation	KWH/m^3	0.107
10	Energy Lost due to leakages/day	KWH/Day	1782.0
11	Energy Lost in a year(@330 days)	KWH/Year	534600
12	Average unit price	Rs	4.3
13	Monetary Saving by arresting leakages	Rs/annum	2298780
14	**TOTAL SAVING**	**Lakh/annum**	**22.99**

TABLE IV. COMPRESSOR LEAKAGE SAVINGS

C. Savings in Chiller Plant

It is recommended to use different insulated tanks for storing chilled water out from chillers and the water out from the process. Currently the water from chillers and process is getting mixed in the storage tank. This is reducing the effectiveness of the chillers. Separating the tanks would increase the loading on chillers resulting in improved efficiency and reduced Specific energy consumption of the chillers.

Energy Savings By Use of Two Separate Tanks			
Parameter	**units**	**1**	**2**
Chiller no.	**Nos.**	chiller1 (Butt Welding)	Chiller 2 (Truck Line)
Flow rate	**Lts/h**	13270	17800
Water Temp in	**^oC**	21.9	20.1
Water Temp out	**^oC**	20	19.1
Refrigeration Effect	**Tonnes (TR)**	8.34	5.89
Actual power drawn	**kW**	15.00	17.24
Expected SEC	**kW/TR**	1.80	2.93
Total kW reduction	**kW**	3.2	3.4
Total	**kW**	**6.6**	
Operating Hours	**h**	**7920**	
Annual Energy Savings	**kWh/annum**	**52324**	
Annual Cost Savings	**Rs/Annum**	**224994**	
Total Investment	**Rs**	**4**	

TABLE V. ENERGY SAVINGS IN CHILLER PLANT

D. Lighting Savings

Present Scenario:
Total Number of Incandescent lamps= 1002
Wattage of lamps= 250W
Running hours/day= 12
Total numbers of working day= 365
Energy Consumed= Lamps*Wattage*Running hours
=1002*250*365*12
=1097190 kWh/annum (1)

Conventional incandescent lamps have life span of one year or so while LED is having lifespan of 5-6 years and consumption of electricity is very less in comparison of conventional lamps [5].

After Savings:
We can install LEDs in place of Incandescent lamps:
Total Number of LEDs lamps= 1002
Wattage of LEDs = 120 W
Running hours/day= 12
Total numbers of working day= 365
Energy Consumed= Lamps*Wattage*Running hours
=1002*120*12*365
=526651.2 kWh/annum (2)
Total Savings= (1)-(2)
= 1097190-526651
=570540 kWh/annum (3)

Average cost of Unit= ₹ 4.3/ kWh (4)
Total Savings = (3)* (4)
=24.53 Lakhs/annum

V. CONCLUSION

A prominent quote **"**Energy saved is Energy generated**".** It says that we can meet the demand and supply balance either by generating more electricity or by taking suitable measures to increase energy efficiency of the system. As the demand for power is endlessly increasing and putting pressure on the power utilities companies to raise the capacity to meet the load demand. With having this aim we have elaborated a case study of an industrial unit for the reason that industries are the major energy consumers. The data which is being provided in this paper shows that how we can save electricity by correcting some changes in the system and building it energy efficient. The Indian government should make it obligatory for every industry in the country to conduct independent energy audit.

Benefits of Energy Conservation [6]:

1. Reduction in the energy consumption and its cost
2. Capacity of the grid increases without investment
3. Conservation of natural resources
4. Reduction in Green house gases and Global Warming
5. Energy Security of the nation

VI. REFERENCES

[1] All India region wise generating installed capacity of power" Central authority ministry of power, Government of India. November 2014.

[2] Zhang Jian, Zhang Yuchen, Chen Song, Gong Suzhou; "How to Reduce Energy Consumption by Energy Audits and Energy Management" Issue Date: July31 2011- Aug.2011 on page(s): 1 - 5 Date of Current Version: 12 September 2011.

[3] Gard Analytics, "Energy, Economic and Environmental Research", www.gard.com.

[4] 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.

[5] Fritz W.L.O and Kahn M.T.E., "Energy Efficient Lighting System"' Journal of Energy, Vol.17 No. 4, November 2006

[6] 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.