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ELECTRICAL ENERGY AUDIT
(A CASE STUDY OF TOBBACO INDUSTRY)

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ABSTRACT

Energy plays a central role in all organizations, especially those that are energy intensive. A detailed study to establish and investigate, energy balances for specific plant department or items or process equipment has been carried out. Whenever possible, checks of plant operations has been carried out over extended periods of time, at nights and at weekends as well as during normal day time working hours, to ensure that nothing is overlooked. In present work the electrical audit of power plant has been successfully completed and it is concluded that the total energy saving potential of 26,271 kWh per year is possible by implementing the above recommendations. Hence the total saving Rs. 3.49 Lakhs per year with initial investment of Rs. 1.67 Lakhs and the overall payback period will be 6 months.

Keywords: *Energy audit, energy conservation, payback period, and consumption pattern.*

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INTRODUCTION:

Energy conservation is a most talked subject in the world today. Every industries, commercial complexes, offices, institutions, offices, hospitals etc. are now totally dependent on electricity [3]. The demand and the cost of electricity are continuously increasing and availability is limited. Presently, the energy auditing is becoming more popular to cut down electricity bill and reduce the recurring expenditures [2, 6]. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy [5].

In any industry, the three top operating expenses are often found to be energy (both

electrical and thermal), labour and materials. Energy auditing will not only save money but it also improves the quality of electrical energy supply. The most of the saving is possible without any investment, just by modifications and proper tuning without affecting the manufacturing processes [4].

COMPANY PROFILE:

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management program.

MANUFACTURING PROCESS

The manufacturing process includes the following:
Cased Leaf Drying process
Stem process, Lamina process and Secondary Manufacturing Division operation

CASED LEAF DRYING PROCESS

CLD plant is for the treatment of Burley Grades of leaf tobacco. Basic raw material is heavily cased burley tobacco 25% to 26% moisture bulked for

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minimum four hours, which is fed to Cased leaf dryer. After this the product is heated in 1st heating chamber by updraft hot air flow where the temperature is 120°C to 125°C. The product is then passed through 2nd and 3rd heating chamber where the hot air flow is downdraft at a temperature of 130°C.

The output of heating chamber is cooled in cooling chamber at ambient temperature and moisture is kept 4% to 6%. Then the product passes through three re-ordering chambers where steam/water spray is used. Moisture content in the tobacco after re-ordering chamber would be 14% to 16%. This tobacco is then stored in silos [7].

STEM PROCESS

Stem process includes removing stem from packages, stem conditioning, bulking, flattening and cutting. This cut stem is passed through Steam Tunnel System and CRS dryer. CRS is collected after Classifier & Dust sieve.

LAMINA PROCESS

Tobacco packages with 11% to 12% moisture content are passed through Thermo vacuum chambers and the moisture content is increased to 14% to 15%. The tobacco is then fed to direct conditioning and casing cylinder via Bale loosener auto feed where the moisture of tobacco is increased to 21%. This tobacco is stored in sandwich mixing silos and by air lifting it is passed in tobacco cutting machine. After adding CRS/F.S. the cut tobacco is dried in dryer and then passed through cooling cum flavoring cylinder. The final product is collected in skips or bags at constant weight.

SECONDARY MANUFACTURING DIVISION OPERATION

Secondary Manufacturing Division (SMD) operation involves making, packing and wrapping of Cut Tobacco from Cut Tobacco Stores. After this CFC filling and taping is done respectively and gives BSR. Basic raw material for SMD is the final product of Primary Manufacturing Division (PMD) after the Lamina process where the final product collected in skips of bags at constant weight is kept in cut tobacco stores where 64% to 68% humidity is maintained. Secondary manufacturing division is fully automated with modern manufacturing facilities. To supplement the automation, the GDX2 packers to match superior quality Hinge lid packs with higher efficiency and output with better quality

ENERGY CONSUMPTION AND ELECTRICITY BILLS

The MGVCL power supply is coming to the plant with the help of 11 kV feeders. Present contract demand of the plant is 750 kVA and the minimum billable demand is 638 kVA, which is 85% of the contract demand.

The monthly electricity bill for last one year showing kWh consumption, M.D, P.F, L.F and total amount in Rs., time of use units are tabulated in Table-1.

From the table it is observed that the M.D (actual) varies from a maximum value of 489 kVA in the month of Nov-10 to a minimum value of 319 kVA in the month of Feb-11. [1]

LOAD FACTOR:

The load factor (L.F) variation of the plant is shown in Figure-04 and is also tabulated in Table-10. It is observed that the lowest value of 37% load factor was in the month of March-2010 due to lowest units' consumption. The maximum value of 59% was in the month of Feb-2011 due to highest units' consumption [8].

POWER FACTOR:

The variation of power factor for last one-year is shown in the Figure 03 and is tabulated in Table 10. It is observed that the power factor value for last year varies between 0.996 and 0.999. The value of power factor obtained for last year is found to be satisfactory [9].

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Specific Energy Consumption (SEC)

The tobacco manufactured in Primary Manufacturing Division (PMD) is accounted in tons and cigarettes manufactured in SMD are accounted in millions. Hence it is very difficult to calculate the specific energy consumption of the whole plant. Therefore SEC is calculated for individual plants. The total monthly production obtained and the energy consumed on monthly basis for the Year 2010-11 is tabulated in Table-2 & 3.

Table-1.Electricity Bill for the Year 2010-2011 Contract Demand= 750 kVA, 85% of C.D = 638 kVA

Month	Units Consumed (kWh)	M.D. Actual (kVA)	M.D. Billing (kVA)	P.F.	Days	L.F. (%)	Billing Amount (Rs.)	Avg. Unit Cost (Rs./kWh)	Rebate (Rs.)
Mar-10	94488	342	638	0.999	31	37	580194	6.1	-10583
Apr-10	123912	363	638	1.0	30	47	747501	6.03	-12081
May-10	127744	404	638	0.999	31	43	770457	6.03	-12206
Jun-10	140648	381	638	1.0	30	51	838893	5.96	-13713
Jul-10	126192	382	638	0.999	31	44	761811	6.03	-12058
Aug-10	134936	375	638	1.0	31	48	807135	5.98	-13156
Sep-10	130576	402	638	1.0	30	45	783477	6.0	-12731
Oct-10	146000	401	638	0.999	31	49	866831	5.93	-13950
Nov-10	128136	489	638	0.996	30	36	769840	6.00	-11493
Dec-10	137224	396	638	1.0	31	46	816573	5.95	-13379
Jan-11	136854	378	638	1.0	31	48	814491	5.95	-13344
Feb-11	127112	319	638	1.0	28	59	764665	6.01	-12393
Total/Avg.	**15,53,822**			**0.999**			**93,21,868**	**5.9**	**-1,51,087**

Note: **Avg.Rs./kWh=Rs.5.9/-**

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Table-2. Actual Power & Fuel Consumption during the Period of April -2010 to January -2011

Month	PMD Production (Ton)	Units Consumed	SEC (Unit Per Ton Tobacco)
	PMD Tobacco		
Apr-10	165.137	**20057**	**121.46**
May-10	157.644	21568	136.81
Jun-10	127.715	18172	142.29
Jul-10	178.150	25120	141.00
Aug-10	176.835	24518	138.65
Sep-10	160.376	23217	144.77
Oct-10	134.631	21274	158.02
Nov-10	146.419	22789	155.64
Dec-10	131.635	19033	144.59
Jan-11	103.755	18676	180.00
Total/Avg.	**1482.297**	**214424**	**146.323**

Table 3. Production Details

Month	Production (Million)	Unit Consumed	Unit /Million	Production (Million)	Unit Consumed	Unit /Million
	Plain Cigarette			Filter Cigarette		
Apr-10	35.484	7429.995	**209.390**	**89.581**	49822.26	**556.170**
May-10	27.956	6739.912	241.090	89.311	47167.82	528.130
Jun-10	23.902	5720.944	239.350	115.989	52361.03	451.431
Jul-10	11.740	5356.023	456.220	107.779	58474.96	542.545
Aug-10	15.176	5511.999	363.205	106.523	51601.55	484.417
Sep-10	10.254	5263.583	513.320	107.149	67769.6	632.480
Oct-10	13.490	6880.035	510.010	138.751	66155.09	476.790
Nov-10	14.268	5528.993	387.510	103.009	55890.11	542.575
Dec-10	16.398	6158.007	375.534	132.807	69889.42	526.248
Jan-11	20.810	6143.903	295.238	123.435	63792.57	516.811
Total/Avg.	**189.478**	**60733.39255**	**359.0867**	**1114.334**	**582924.4**	**5257.597**

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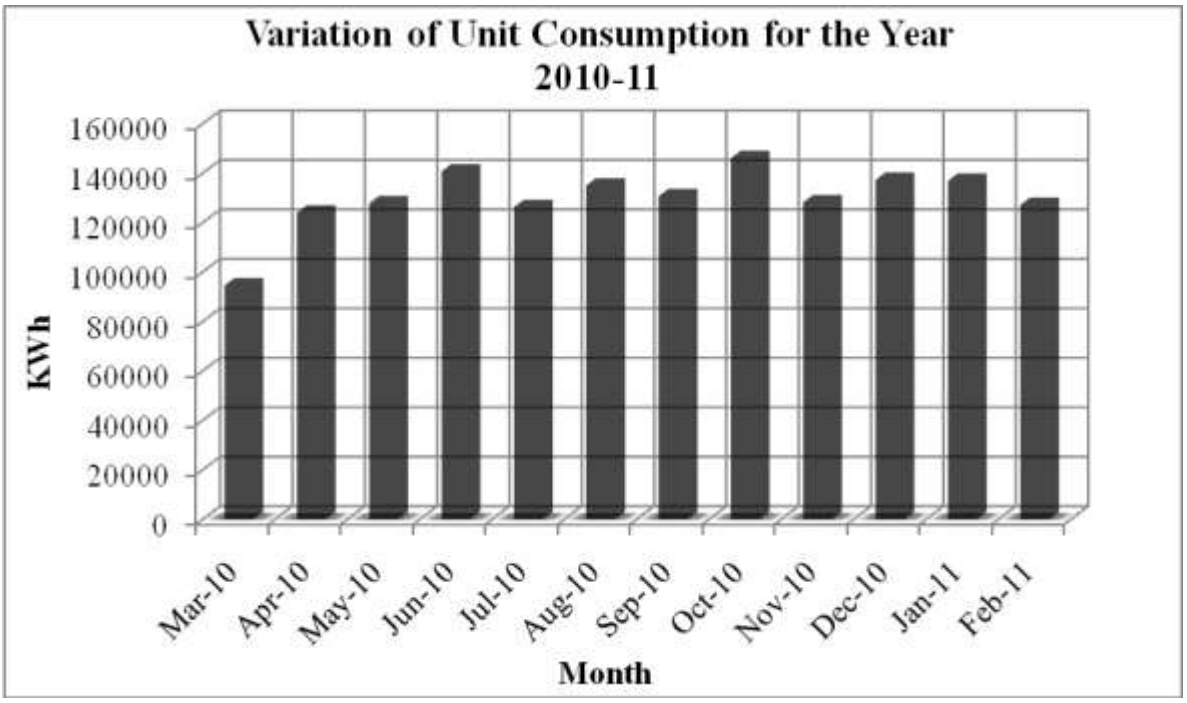

Figure 1 Variation of kWh for the year 2010-2011

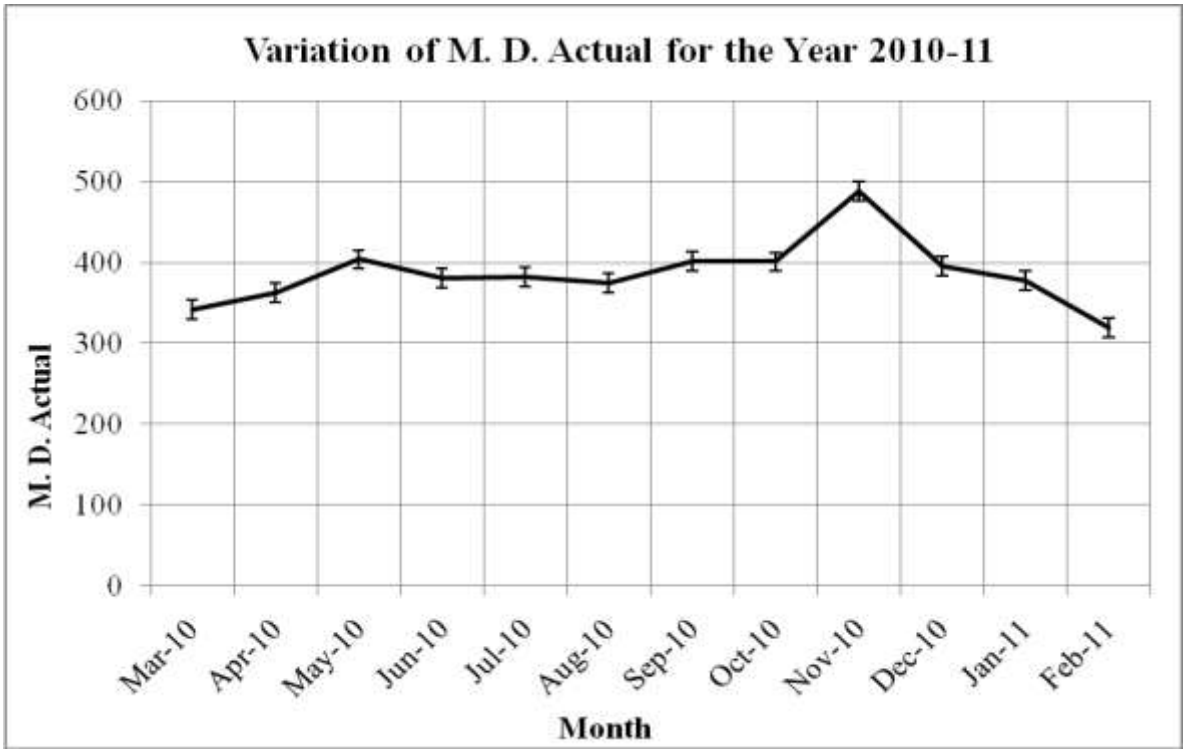

Figure 2: Variation of MD Actual for the year 2010-11

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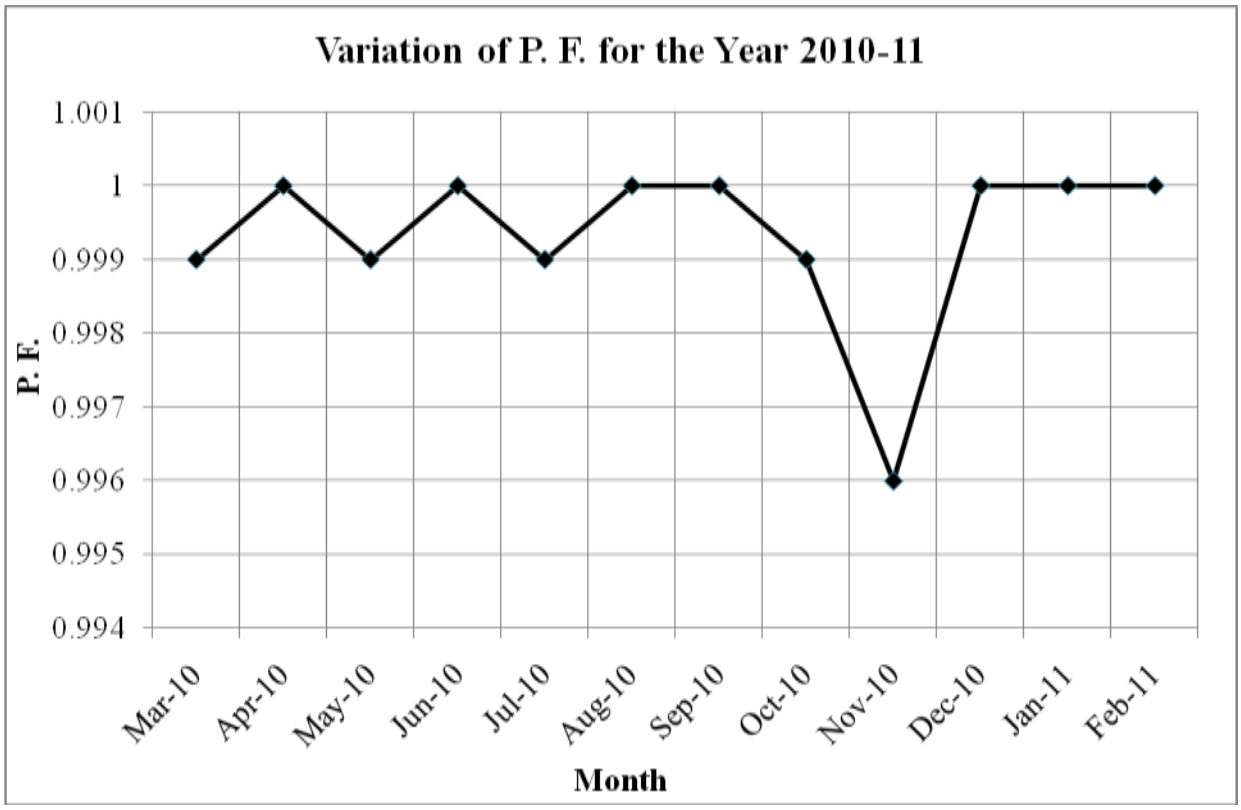

Figure 3 Variation of Power Factor for the year 2010-11

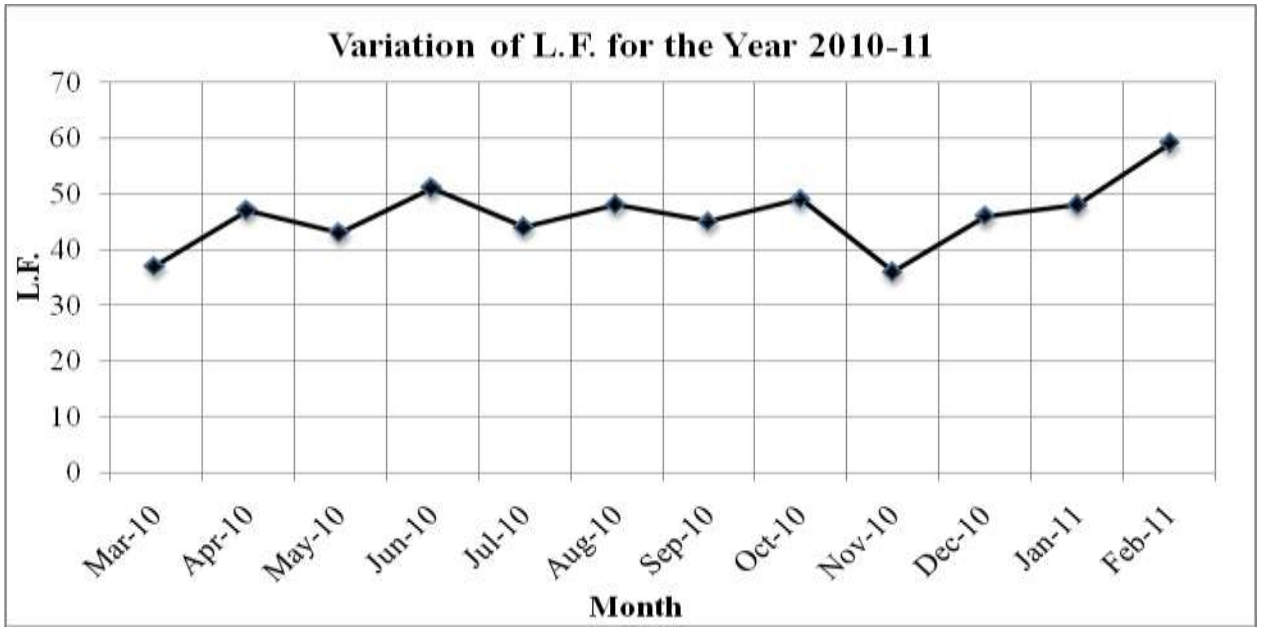

Figure 4 Variation of load factor for the year 2010-11

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Reduction of Contract Demand

The contract demand of the plant is 750 kVA and minimum billable demand is 638 kVA. Form the electricity bill for the last year it is observed that the actual demand of the plant has never crossed the minimum

billable demand. In view of this it is suggested to reduce the present contract demand to 600 kVA there by saving the excess amount being paid to MGVCL. The detailed calculation is given below:

Present Contract Demand	= 750 kVA
Present Minimum Billable Demand@ 85%	= 638 kVA
Present Amount Payable	= Rs. 10.71
LakhsProposed contract demand	= 600 kVA
Proposed Minimum billing demand @ 85%	= 510 kVA
Proposed Amount Payable	= Rs.8.56 Lakhs
Saving in demand per year	= 128 kVA
Amount Saved per Year @ Rs. 140/kVA	**= Rs. 2.15 Lakh**
Investment required	= Negligible

AIR COMPRESSOR ANALYSIS:

Testing of compressor efficiency

The plant consists of number of air compressor for instrumentation and process air requirement. Electrical parameters and pressure measured during the energy audit study are tabulated in Table-2.0 to 4.0. To obtain the volumetric efficiency, anemometer method was performed. The data obtained during the above measurement is utilized to calculate the efficiency of the air compressor and given below:

Table No.:4. Air Compressor Analysis (PMD):

Sr. No	**Parameters**	**Air Comp.#2**	**Air Comp.#1**
1.	Location	PMD	
2.	Make & Type	Ingersoll	
3.	Rated capacity and pressure	60CFM,12.3 kg/cm^2	
4.	Motor Rating (kW)		
5.	**Full Load** Voltage (V)	414	421
6.	Load Current (Amp.)	12.8	11.25
7.	Power Factor	0.83	0.77
8.	Motor Input Power (kW)	7.62	6.32
9.	Motor Load (%)	62	51
10.	Measured Air Velocity(m/sec)	15	13
Sr. No	**Parameters**	**Air Comp.#2**	**Air Comp.#1**

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11.	Suction Area (m^2)	0.00158	0.00158
12.	Calculated Air Flow(m^3/sec)	0.0237	0.02054
13.	Calculated Air Flow(m^3/hr)	85	74
14.	Calculated Air Flow (CFM)	48	41
15.	Operating pressure (kg/cm^2)	Load Pressure = 8 kg/cm^2, Unload Pressure = 5 kg/cm^2	Load Pressure = 8 kg/cm^2, Unload Pressure = 5 kg/cm^2
16.	Frequency (Hz)	49.5	49.6
17.	**Volumetric efficiency (%)**	**80**	**68**
18.	Computed Specific Power Consumption (kW/cfm)	0.158	0.154

From the above table it can be seen that the volumetric efficiency of air compressor #1 and air compressor #2 is 68 % and 80%.The volumetric efficiency of air compressor # 1 on lower side compared to that of air compressor #2 so it is suggested to check and clean the suction air filter and perform proper maintenance and overhauling of air compressor #1 to improve the efficiency close to 80 %.

Present Power consumption of Air Compressor #1 = 6.32 kW

Power saving potential @ 75% = 0.75 kW

Units Saved per Year = 3600 kWh

Considering 300 days/year and 16 hrs/day operation

Amount Saved per Year @ Rs. 5.16/kWh **= Rs. 0.18 Lakh**

App. Investment = Rs. 0.10 Lakh

Payback Period = 7 months

LIGHTING EFFICIENCY STUDIES:

Golden Tobacco Limited, Vadodara consists of different type of lamps for illuminating different areas inside and outside of the plant site. The lighting load measurement of plant was conducted both during day and the results obtained are tabulated below:

Total lighting load during Day time = 49.08 kW

more than 230 volts, it increases the power consumption by the

Reducing lighting supply voltage to 230 volts:

For lighting load, 230 volt is the ideal supply for getting the required lumens. If the supply voltage is lamps, reduces its burning life and more failure rates [10].

Hence it is suggested to install a servo stabilizer to reduce the lighting voltage to 230 volts. The detailed power saving calculation is given below:

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Table5.Lighting Load Analysis (Day Time)

Sl. No.	Particulars	Volts	Amps.	P.F.	kW	Remarks
1.	Production Shop Floor.	239	125.5	0.89	27	Higher Voltage
2.	Production Office	240	44.5	0.71	8.08	
3.	Administration Building	241	59.9	0.96	14.0	

Day Time:

Total Lighting Load at higher voltage = 49.08 kW
Avg. Higher Supply voltage measured = 240 volts
Power saving potential by maintaining 230 volts in the lighting feeder = 4.0 kW
Energy saving potential = 13,200 kWh
Considering 330 days and 10 hrs operation per day

During Night Time major lighting load consists of Production Office and Production Shop Floor:

Night Time:

Total Lighting Load at higher voltage = 35.08 kW
Power saving potential by maintaining 230 volts in the lighting feeder = 2.87 kW
Energy saving potential = 9,471 kWh
Considering 330 days and 10 hrs operation per day
Total Energy saving potential (Day Time + Night Time) = 22,671 kWh
Amount Saving per Year @ Rs.4.50/kWh **= Rs. 1.16 Lakh**
Approximate investment required = Rs. 1.50 Lakh
Payback Period = 16 months

CONCLUSION

The electrical audit of power plant has been successfully completed and during the audit we found that there are many problems in the power plant through which huge amount of electrical energy is wasting , so we have suggested to the client that they reduced the supply voltage to 230 V and contract demand to 600 kVA. They also maintain the pumps, compressors, fans etc. regularly due to regular maintenance and by implements the suggestions they will be able to save approximately Rs. 3.49 lakhs per year and total investments will be approximately Rs. 1.67 lakhs and the overall payback period will be 6 months. After implementing the suggestions total annual energy saving potential will be 26,271kWh per year.

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