COMPREHENSIVE ENERGY AUDIT REPORT

"PROMOTING ENERGY EFFICIENCY AND RENEWABLE ENERGY IN SELECTED MSME CLUSTERS IN INDIA"

Humma Tools

S-191, Industrial Area, Jalandhar, Punjab – 144004

14-05-2015

Submitted to

ENERGY IS LIFE
B E E
CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

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Submitted by

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As a part of this assignment, work in Jalandhar Handtools cluster was awarded to DESL and DESL is grateful to GEF-UNIDO-BEE PMU for their full-fledged coordination and support throughout the study.

The study team is indebted to Mr. Surinder Singh, owner for showing keen interest in the energy audit and also thankful to the management of M/S Humma Tools for their wholehearted support and cooperation for the preparation of this comprehensive energy audit report, without which the study would not have steered to its successful completion. Special thanks to other members of the unit for their diligent involvement and cooperation.

It is well worthy to mention that the efforts being taken and the enthusiasm shown by all the plant personnel towards energy conservation and sustainable growth are really admirable.

Last but not the least, the interaction and deliberation with Mr. Sukh Dev Raj, President, Hand tool manufacturers association, Jalandhar, technology providers and all those who were directly or indirectly involved throughout the study were exemplary. The entire exercise was thoroughly a rewarding experience for DESL.

DESL Team

DESL Team

Project Head	**Mr. R. Rajmohan** Chief Executive Officer
Team leader and co-coordinator	**Mr. Suparno R Majumdar** Consultant
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	Mr. Vishnu P Project Associate
	Mr. Oisik Mishra Project Associate

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ABBREVIATIONS

Abbreviations	Expansions
APFC	Automatic Power Factor Correction
BEE	Bureau of Energy Efficiency
CEA	Comprehensive Energy Audit
CFL	Compact Fluorescent Lamp
CRV	Chromium Vanadium
DESL	Development Environergy Services Limited
DG	Diesel Generator
EE	Energy Efficiency
EPIA	Energy Performance Improvement Action
FO	Furnace Oil
GEF	Global Environment Facility
HSD	High Speed Diesel
HVAC	Heating Ventilation and Air Conditioning
LED	Light Emitting Diode
LT	Low Tension
MD	Maximum Demand
MS	Mild Steel
MSME	Micro, Small and Medium Enterprises
MT	Metric Tons
MTOE	Million Tons of Oil Equivalent
MV	Mercury Vapour
No.	Number
PF	Power Factor
PID	Proportional-Integral-Derivative
PNG	Piped Natural Gas
PSPCL	Punjab State Power Corporation Limited
R & C	Radiation & Convection
RE	Renewable Energy
SEC	Specific Energy Consumption
SEGR	Specific Energy Generation Ratio
SLD	Single Line Diagram
SME	Small and Medium Enterprises
UNIDO	United Nations Industrial Development Organization

VFD	Variable Frequency Drives

EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE) in association with the United Nations Industrial Development Organization (UNIDO) and Global Environment Facility (GEF) is implementing a project titled "Promoting energy efficiency and renewable energy technology in selected MSME clusters in India". The objective of the project is to give impetus to energy efficiency initiatives in the micro, small and medium enterprises (MSMEs) sector in India.

As part of this project, DESL has been engaged to implement the project in the MSME ceramic cluster in Jalandhar, Punjab. There are about 400 units scattered over three industrial areas in Jalandhar, viz. focal point, old industrial area and basti area. The major products manufactured include spanners and wrenches, pliers, screw drivers, etc with an average annual production of 50,000 metric tons for the cluster.

The project awarded to DESL consists of six major tasks:

- Conducting pre–activity cluster workshop defining the agenda of this engagement.
- Comprehensive energy audit in 6 selected units.
- Development of cluster specific best operating practices document for the top 5 energy using equipments / processes in the industry.
- Identification of a set of energy auditing instruments that should be used for carrying out periodic energy audits in the units.
- Enumeration of common regularly monitorable parameters at the process level which have impact on energy performance and listing of appropriate instrumentation for the same.
- Conducting 3 post energy audit training workshops based on preceding outputs of this activity.

Brief Introduction of the Unit

Table 1: Details of Unit

Name of the Unit	M/S Humma Tools
Constitution	Private Limited
MSME Classification	Small
No. of years in operation	NA
Address: Registered Office	S-191, Industrial Area, Jalandhar – 144 004
Administrative Office	S-191, Industrial Area, Jalandhar – 144 004
Factory	S-191, Industrial Area, Jalandhar – 144 004
Industry-sector	Hand Tools
Products Manufactured	Threading Taps, Round Dies, Complete Tap & Die Boxes
Name(s) of the Promoters / Directors	Mr. Surinder Singh

Comprehensive Energy Audit

The study was conducted in 3 stages:

- **Stage 1:** Walk through energy audit of the plant to understand process, energy drivers, assessment of the measurement system, assessment of scope, measurability, formulation of audit plan and obtaining required information
- **Stage 2:** Detail energy audit data collection & field measurements for performance evaluation of equipments / system, estimation of savings potential, technology assessment and understanding of project constraints
- **Stage 3**: Data analysis, initial configuration of projects, savings quantification, vendor consultation, interaction with unit, and freezing of projects for implementation and preparation of energy audit report

The production process of the unit

The main process equipment in the unit includes the following:

The production process includes blanking, heating, forging, trimming, broaching, grinding, barreling, heat treatment, shot blasting, calibration, polishing, electroplating and packing.

The raw materials used are mainly MS and CRV steel. The raw materials are first cut in a cutting machine. After cutting, the work piece is then trimmed and sent for head preparation. After head preparation, the work piece is placed on milling machine where it is machined to the required size and shape. Post milling, the work piece (job) is heated in a heat treatment furnace to attain the desired metallurgical properties like strength, stability and durability. After heat treatment, the work piece is grinded and finally polished and sent for packing and dispatch.

The main process equipments are cutting machine, trimming machine, milling machine, grinding machine and heat treatment furnace.

Identified Energy Performance Improvement Actions

The comprehensive energy audit covered all the equipments which were operational during the field study. Thermal energy constitutes 43% (HSD) and grid electricity constitutes 57% of the total plant energy consumption. The identified energy performance improvement actions are given in Table – 2.

Table 2: Summary of EPIA

Sl. No.	Name of the project	Estimated energy savings			Monetary savings	Estimated investment	Simple payback period
		Electricity		HSD			
		kWh/y	kVAh/y	Liter/y	Rs. lakh/y	Rs. lakh	y
1	Improvement in power factor (PF) of the plant		9030.0		0.8	1.20	1.5
2	Replacement of present DG sets with new EE DG sets			2002.6	1.00	5.00	5.0
3	Installation of Energy Monitoring System on sectional energy consuming area	2054.4			0.2	0.25	1.4
4	Replacement of 15 no. of in-efficient old (and several times rewound) motors with EE motors in various sections of the plant	5851.7			2.0	4.56	2.3
5	Retrofit of 40 watt CFL lights with LED tube light of 16 watt	13349			1.2	1.73	1.5
6	Replacement of 60 watt incandescent lamp with 18 watt LED light	2574			0.23	0.23	1.0
	Total	23828.9	9030.0	2002.6	5.4	13.0	2.4

The projects proposed shall result in energy savings of up to 34.80 % and energy cost savings of up to Rs. 5.40 lakh/year in the plant on implementation.

1 INTRODUCTION

1.1 Background and Project objective

Bureau of Energy Efficiency (BEE) in association with the United Nations Industrial Development Organization (UNIDO) and Global Environment Facility (GEF) is implementing a project titled "Promoting energy efficiency and renewable energy in selected MSME clusters in India". The objective of the project is to provide impetus to energy efficiency initiatives in the micro, small and medium enterprises (MSMEs) sector in India.

The targeted 12 MSME clusters under the project and the indicative information are given in the table below:

Table 3: List of 12 targeted MSME clusters covered under the project

Sl.No	Sub – sector	Cluster
1	Brass	Jagadhri, Jamnagar
2	Ceramic	Khurja, Morbi, Thangarh
3	Dairy	Gujarat, Madhya Pradesh
4	Foundry	Belgaum, Coimbatore, Indore
5	Hand tools	Jalandhar, Nagaur

The objectives of this project are as under:

- Increasing capacity of suppliers for energy efficiency (EE) and renewable energy (RE) based products, service providers and financing institutions;
- Increasing the levels of end-use demand and implementation of EE and RE technologies and practices by MSMEs;
- Scaling up of the project to national level;
- Strengthening policy, institutional and decision making frameworks.

1.2 Scope of work for Comprehensive Energy Audit

The general scope of work for comprehensive energy audits is as follows:

- Data Collection
  - Current energy usage (month wise) for all forms of energy for the period April-2014 to March-2015 (quantity and cost)
  - Data on production for corresponding period (quantity and cost)
  - Data on production cost and sales for the corresponding period (cost)
  - Mapping of process
  - Company profile including name of the company, constitution, promoters, years in operation, and products manufactured
  - Existing manpower and levels of expertise
  - List of major equipments and specifications

- Analysis:
  - Energy cost and trend analysis
  - Energy quantities and trend analysis
  - Specific consumption and trend analysis
  - Performance evaluation of major energy consuming equipments / systems
  - Scope and potential for improvement in energy efficiency
- Correlate monthly production data with electricity and fuel consumption for a period of 12 months of normal operation for individual sections of the overall plant.
- Detailed process mapping to identify major areas of energy use.
- To identify all opportunities for energy savings in the following areas:
  - Electrical: Power Factor, transformer loading, power quality, motor load, compressed air systems, conditioned air systems, cooling water systems, lighting load, electrical metering, monitoring and control system.
  - Thermal: Furnaces, steam and hot water systems (including hot water lines tracing, pipe sizes, insulation), heat recovery systems, etc.
- Evaluate the energy consumption vis-à-vis the production levels and to identify the potential for energy savings / energy optimization (both short term requiring minor investments with attractive payback, and mid to long term system improvement needing moderate investments and with payback period of 5years).
- Classify parameters related to EE enhancements such as estimated quantum of energy savings, investment required, time-frame for implementation, payback period, re-skilling of existing manpower, etc. and to classify the same in order of priority.
-
- Design an "energy monitoring system" for effective monitoring and analysis of energy consumption, energy efficiency.

1.3 Methodology

1.3.1 Boundary parameters

Following boundary parameters were set for coverage of the audit:

- Audit covered all possible energy intensive areas and equipments which were in operation during the field study
- All appropriate measuring systems including portable instruments were used
- The identified measures normally fall under short, medium and long-term measures

1.3.2 General methodology

The following flow chart illustrates the methodology followed for carrying out different tasks:

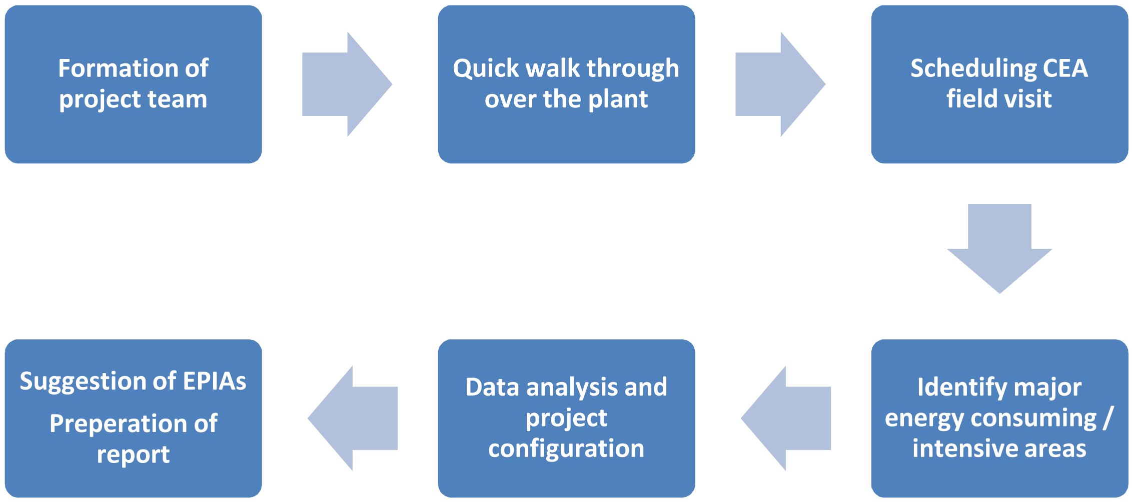

Figure 1: General methodology

The study was conducted in 3 stages:

- **Stage 1:** Walk through energy audit of the plant to understand the process, energy drivers, assessment of the measurement system, assessment of scope, measurability, formulation of audit plan and obtaining required information
- **Stage 2:** Detailed energy audit- testing and measurement for identification of savings potential, technology assessment and understanding of project constraints
- **Stage 3**: Data analysis, initial configuration of projects, savings quantification, vendor consultation, interaction with the unit and freezing of projects for implementation and preparation of energy audit report

1.3.3 Comprehensive energy audit – field assessment

A walk through was carried out efore the audit with a view to:

- Understand the manufacturing process and collect historical energy consumption data
- Obtain cost and other operational data with a view to understand the impact of energy cost on the units financial performance
- Assess the energy conservation potential at a macro level
- Finalize the schedule of equipments and systems for testing and measurement

The audit identified the following potential areas of study:

- Heating and forging
- Electrical motors used in process
- Fans and lighting loads

Further activities carried out by the team after walk through study included:

- Preparation of the process and energy flow diagrams
- Study of the system and associated equipments

- Conducting field testing and measurement
- Data analysis for preliminary estimation of savings potential at site
- Discussion with the unit on the summary of findings and energy efficiency measures identified

Audit methodology involved system study to identify the energy losses (thermal / electrical) and then finding solutions to minimize the same. This entailed data collection, measurements / testing of the system using calibrated, portable instruments, analyzing the data / test results and identifying the approach to improve the efficiency. The following instruments were used during the energy audit:

Sl.No.	Instruments	Make	Model	Parameters Measured
01	Power Analyzer – 3 Phase (for un balanced Load) with 3 CT and 3 PT	Enercon and Circutor	AR-5	AC Current, Voltage, Power Factor, Power, Energy, Frequency, Harmonics and data recording for minimum 1 sec interval
02	Power Analyzer – 3 Phase (for balance load) with 1 CT and 2 PT	Elcontrol Energy	Nanovip plus mem	AC Current, Voltage, Power Factor, Power, Energy, Frequency, Harmonics and data recording for minimum 2 sec interval
03	Digital Multi meter	Motwane	DM 352	AC Amp, AC-DC Voltage, Resistance, Capacitance
04	Digital Clamp on Power Meter – 3 Phase and 1 Phase	Kusam - Meco	2745 and 2709	AC Amp, AC-DC Volt, Hz, Power Factor, Power
05	Flue Gas Analyzer	Kane-May	KM-900	O2%, CO2%, CO in ppm and Flue gas temperature, Ambient temperature
06	Digital Temperature and Humidity Logger	Dickson		Temperature and Humidity data logging
07	Digital Temp. & Humidity meter	Testo	610	Temp. & Humidity
08	Digital Anemometer	Lutron and Prova	AM 4201 And AVM-03	Air velocity
09	Vane Type Anemometer	Testo	410	Air velocity
10	Digital Infrared Temperature Gun	Raytek	Minitemp	Distant Surface Temperature
11	Contact Type Temperature Meter	Testo	925	Liquid and Surface temperature
12	High touch probe Temperature Meter	CIG		Temperature upto 1300 deg C
13	Lux Meter	Kusum Meco (KM-LUX-99) and Mastech		Lumens
14	Manometer	Comark	C 9553	Differential air pressure in duct
15	Pressure Gauge	Wika		Water pressure 0 to 40 kg

1.3.4 Comprehensive energy audit – desk work

Post audit off-site work carried out included:

- Revalidation of all the calculations for arriving at the savings potential
- Quick costing based on DESL database or through vendor interactions as required
- Configuration of individual energy performance improvement actions
- Preparation of audit report

2 ABOUT THE MSME UNIT

2.1 Particulars of the unit

Table 4: General particulars of the unit

Sl. No.	Particulars	Details
1	Name of the unit	M/s. Humma Tools
2	Constitution	Private Limited
3	Date of incorporation / commencement of business	NA
4	Name of the contact person Mobile/Ph. No. E-mail ID	Mr. Surinder Singh +91-181 – 2290109,2490299 halo98@rediffmail.com
5	Address of the unit	S-191, Industrial Area, Jalandhar, Punjab-144004
6	Industry / sector	Hand Tools
7	Products manufactured	Threading taps, round dies, complete tap & die boxes
8	No. of operational hours/day	12
9	No. of shifts / day	1
10	No. of days of operation / year	300
11	Whether the unit is exporting its products (yes / no)	Yes

3 DETAILED TECHNICAL FEASIBILITY ASSESSMENT OF THE UNIT

3.1 Description of manufacturing process

3.1.1 Process & Energy flow diagram

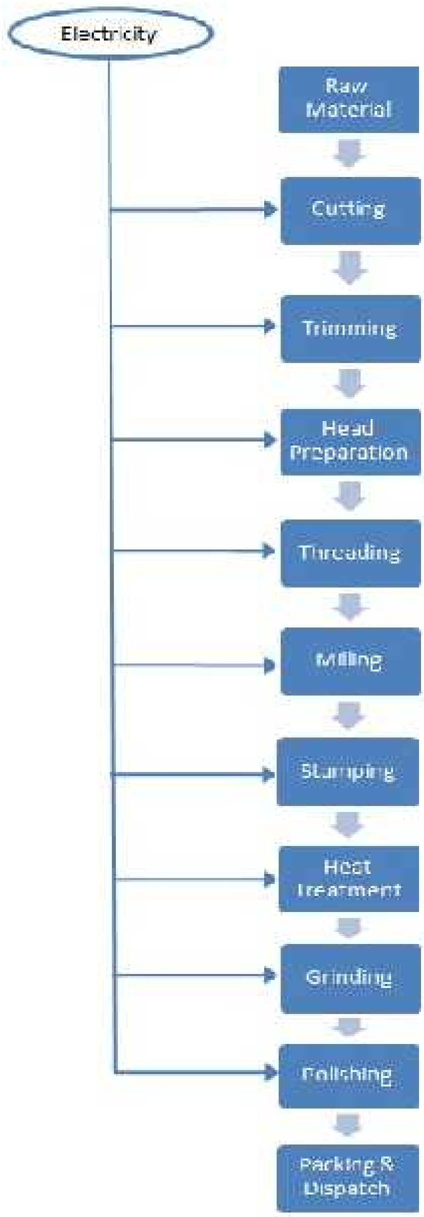

Figure 2: Process flow diagram

3.1.2 Process description

M/s. Humma Tools is a manufacturer of threading taps, round dies, complete tap and die boxes.

The process description is as follows:

Raw Material

The main raw materials used are round and flat Mild Steel and Chromium Vanadium Steel.

Cutting

It is a process in which metal work piece is removed from the primary metal strip. The piece removed is called blank metal scrap.

Trimming

In trimming processes, the forged material is pressed to provide it a uniform shape by removing the unnecessary burrs along the edges. The speed of the presses is controlled and it travels at a low speed when it comes down and exerts maximum pressure just before pressing.

Head preparation and threading

It is done to provide grooves on the work piece for various applications and providing a smooth finish.

Milling

It is similar to grinding in which edges of the material are made smooth.

Heat Treatment

Heat treatment is done to impart the required metallurgical properties to the work piece that will benefit the working life of manufactured equipment (hand-tool). The main processes involved are hardening, quenching and tempering. Electrical heat treatment furnaces are used for this purpose.

Grinding

In grinding, the material is moved against grinding stones and proper surface finish is imparted on the work piece and it is smoothened.

Polishing

The final polishing and smoothening is done using a vibrating machine. The finished product is placed in the vibrating machine in a bath of ceramic medium, and subjected to continuous vibrations. The ceramic material and the work-pieces are placed on the vibrating polishing machines. Due to the vibration action of this machine, the work-piece and the ceramic materials (in the form of solid stones) rub against each other, and in this process the work-piece gets polished.

3.2 Inventory of process machines / equipments and utilities

The major energy consuming equipments in the plant are:

- **Cutting Machine:** Here the raw material is cut into required shapes
- **Trimming:** In this process, all the protruded edges and projections are trimmed off
- **Milling machine:** The machine is used to remove materials from edges to give a better edge finish. Large motors are employed in this machine
- **Heat treatment furnace:** The heat treatment furnace consists of heaters for hardening and tempering process
- **Grinding machine:** After heat treatment, the material is sent for grinding for smooth surface finish

3.2.1 Types of energy used and description of usage pattern

Electricity is used in different manufacturing processes. The overall energy use pattern in the unit is as follows:

- Electricity is being sought from two different sources:
    - From the Utility, Punjab State Power Corporation Limited (PSPCL)
    - Captive backup Diesel Generator sets for the whole plant

Total energy consumption pattern for the period, April-14 to March-15, from different sources are as follows:

Table 5: Energy cost distribution

Particulars	Energy cost distribution		Energy use distribution	
	Rs. Lakhs	% of Total	MTOE	% of Total
Grid –Electricity	5.45	71	5.9	57
Diesel –DG	2.23	29	4.4	43
Total	**7.68**	**100**	**10.3**	**100.00**

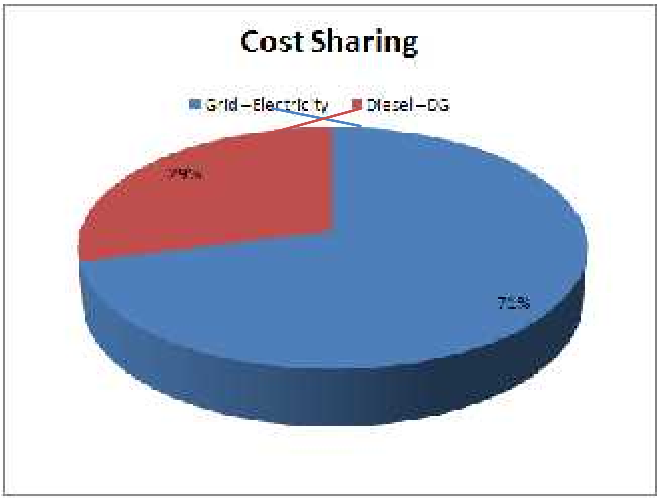

Figure 3: Energy cost share

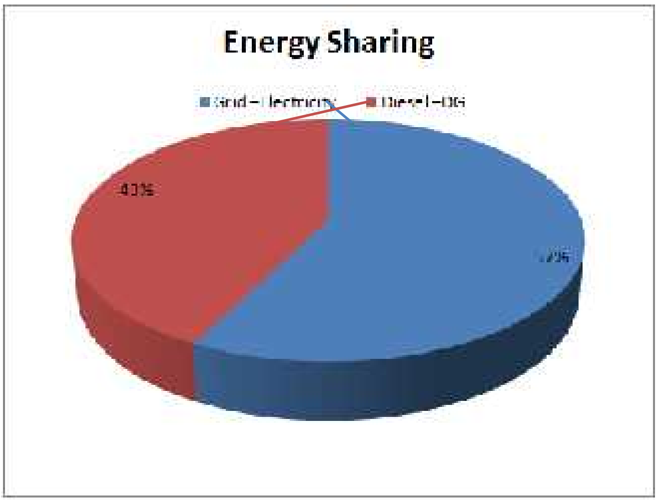

Figure 4: Energy use share

The major observations are as under

- The unit uses electrical energy for manufacturing operations. Electricity is sourced from the grid and self generated through DG sets in absence of power from the grid.
- The grid electricity used in the process accounts for 71% of the energy cost, and diesel used for self generation is 29% of the overall cost.

3.3 Analysis of electricity consumption by the unit

3.3.1 Baseline parameters

Following are the general baseline parameters, which have been considered for the techno-economic evaluation of various identified energy cost reduction projects as well as for the purpose of comparison after implementation of the projects. The rates shown are landed rate.

Table 6: Baseline parameters

Electricity Rate (Excluding Rs/kVA)	5.87	Rs./ KVAH inclusive of taxes
Weighted Average Electricity Cost	8.83	Rs./ kWh for 2013-14
Percentage of total DG based Generation	11%	
Average Cost of HSD	50	Rs./ liter
Annual Operating Days per year	300	Days/yr
Annual Operating Hours per day	12	Hr/day
Production	70	MT

3.3.2 Electricity load profile

Following observation has been made from the utility inventory:

- The plant and machinery load is 42.3 kW
- The utility load (lighting and fans) is about 2.7 kW including the single phase load
- The plant's total connected load is 45 kW

A pie chart of the entire connected load is shown in the figure below:

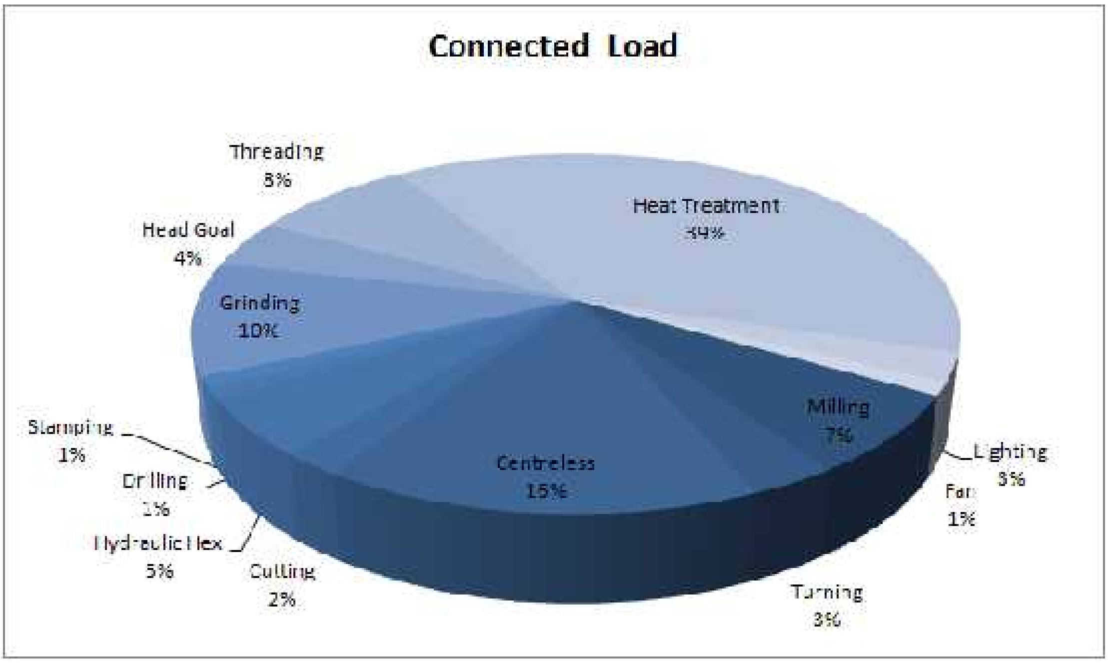

Figure 5: Details of connected load

As shown in the pie chart of connected load, the share of connected load is spread across heat treatment (39%), centre-less (16%), grinding (10%), threading (8%), milling(7%), hydraulic hex (5%), head goal (4%), turning (3%), cutting (2%), drilling and stamping (1%) each. Lighting and fan load contributes together for around (4 %) of the connected load.

An analysis of area wise electricity consumption has been computed to quantify the electricity consumption in the individual processes. The area wise energy consumption details are shown as under:

Table 7: Area wise electricity consumption (estimated)

Consumption	kW	kWh/year	% of Total
Milling	0.5	1086.95	1.4%
Turning	0.5	1926.28	2.5%
Centre less	3.3	7193.26	9.4%
Cutting	1.1	2373.84	3.1%
Hydraulic Hex	2.2	4795.20	6.3%
Drilling	0.5	756.00	1.0%
Stamping	0.5	756.00	1.0%
Grinding	4.5	6436.80	8.4%
Head Goal	2.2	4747.68	6.2%
Threading	4.2	9011.52	11.8%
Heat Treatment	8.2	29354.28	38.5%
Lighting	1.5	5437.44	7.1%
Fan	0.7	2419.20	3.2%
Total	**29.9**	**76294.45**	**100.0%**

This is represented graphically in the figure below:

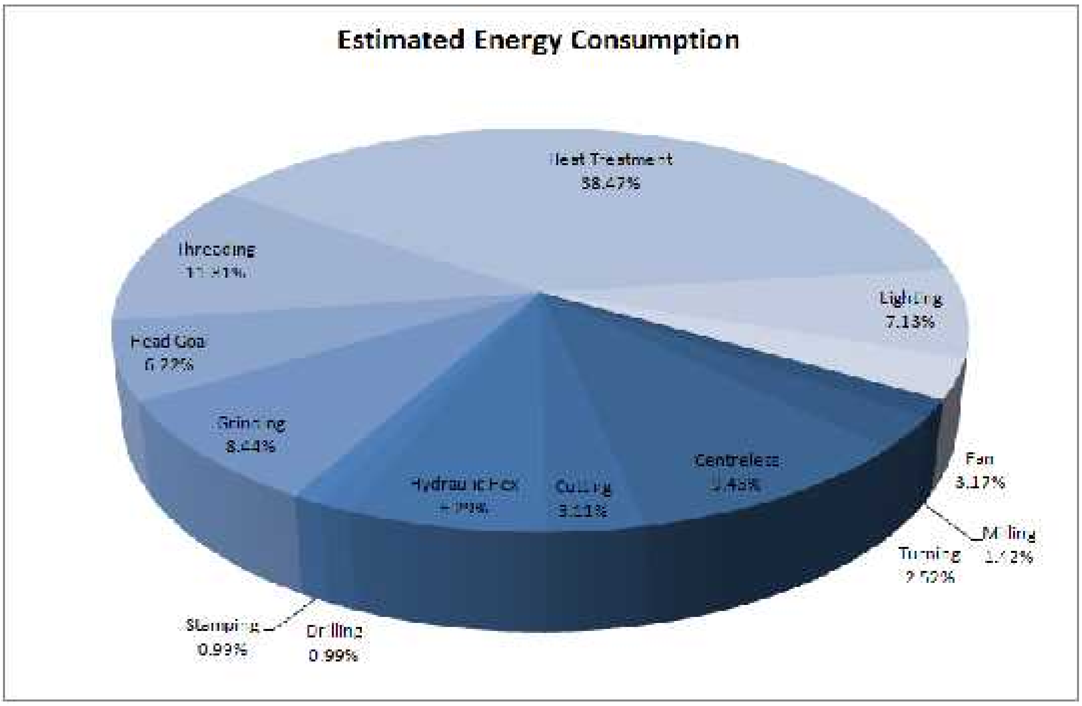

Figure 6: Area wise electricity consumption

There is a small difference between the estimated energy consumption and actual consumption recorded (<1%). This is attributed to assumptions made on operating load (based on measurement), diversity factor and hours of operation (based on discussion with plant maintenance).

3.3.3 Sourcing of electricity

The unit is drawing electricity from two different sources:

- Utility (PSPCL) through regulated tariff
- Captive DG set which is used as a backup source and supplies electrical power in case of grid power failure

The share of utility power and DG power is shown in the table and figure below:

Table 8: Electricity share from grid and DG

	Consumption (kWh)	%	Cost (Rs. Lakh)	%
Grid Electricity	68,478	89	5.4	71
Self Generation	8,598	11	2.2	29
Total	**77,076**	**100**	**7.7**	**100**

This is graphically depicted as follows:

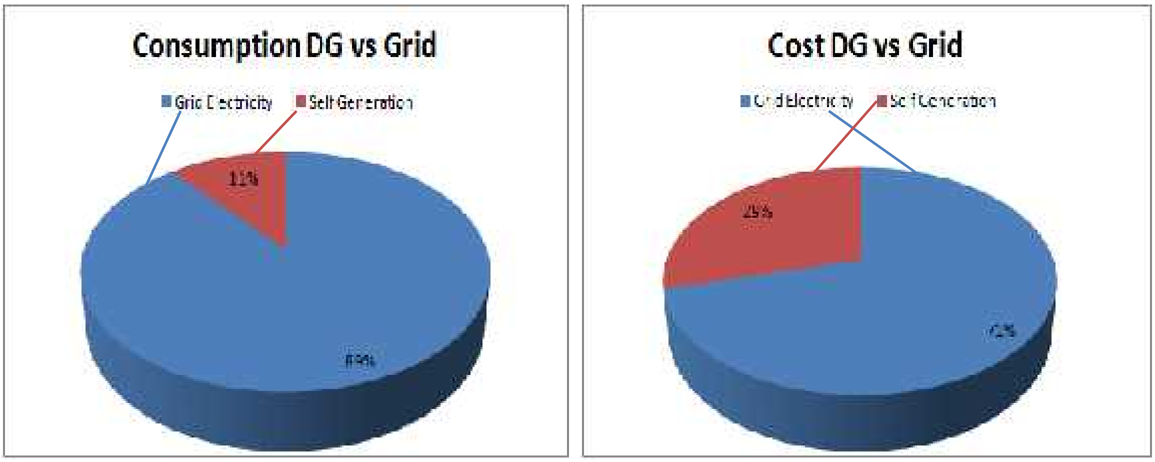

Figure 7: Share of electricity by source and cost

The share of electrical power as shown in the above chart indicates the condition of power supply from the power utility. The requirement of power supply from backup source, i.e. DG set is about 11% of the total power which is not very high. Although the share of DG power in term of kWh is just 11% of the total electrical power, it is about 29% in terms of total cost of electrical power. The high cost of DG power could be attributed to rise in the price of diesel. For economical operation of the plant, utilization of DG set needs to be minimized; however, this depends upon the grid supply condition as well as power requirement of the plant.

3.3.4 Supply from utility

Electricity is supplied by PSPCL. The unit has one HT energy meter provided by the distribution company in the premise. Details of the supply are as follows:

a) Power Supply : 11 kV line
b) Contract Demand : 109.56 kVA
c) Sanctioned Load : 98.6 kW
d) Nature of Industry : LT – G

The tariff structure is as follows:

Table 9: Tariff structure

Particulars	Tariff structure	
Energy Charges	5.87	Rs./kVAh
Fuel Surcharge	0.03	Rs./kVA
Electricity duty	0.77	Rs./kVAh
Municipality tax	0.00	Rs./kVAh
Other surcharges	0.10	Rs./kVAh

(As per bill for February – 15)

Table 10: Electricity Bill Analysis

Month	Sanctioned Load	Contract Demand	Recorded Maximum Demand	PF	Electricity Consumption		Energy Charges	Energy Charge Rs/ kVAh	Fuel Surcharge	Fuel Charge Rs/ kVAh	Electricity Tax	Electricity Duty Rs/kVAh	Other Tax and surcharges	Other charges/kVAh	Total Charge	Total Energy Charge
	kW	kVA	kVA		kVAH	kWH	Rs.		Rs		Rs.		Rs		Rs.	Rs / kVAh
April	98.6	109.6	55.4	0.9	6690	5707	39271	5.9	179.4	0.03	5128.6	0.8	669.4	0.1	45405.6	6.8
May	98.6	109.6	55.4	0.9	6690	5707	39271	5.9	179.4	0.03	5128.6	0.8	669.4	0.1	45405.6	6.8
June	98.6	109.6	55.4	0.9	6690	5707	39271	5.9	179.4	0.03	5128.6	0.8	669.4	0.1	45405.6	6.8
July	98.6	109.6	55.4	0.89	6510	5677	38215	5.9	162.0	0.02	4989.0	0.8	651.4	0.1	44174.4	6.8
August	98.6	109.6	55.4	0.88	6796	5806	39894	5.9	185.8	0.03	5210.5	0.8	680.0	0.1	46127.5	6.8
September	98.6	109.6	55.4	0.85	6987	5772	41012	5.9	206.0	0.03	5358.3	0.8	699.0	0.1	47432.3	6.8
October	98.6	109.6	55.4	0.81	7367	5749	43245	5.9	251.0	0.04	5654.5	0.8	737.0	0.1	50044.0	6.8
November	98.6	109.6	55.43	0.96	5366	5135	31498	5.9	67.0	0.01	4103.0	0.76	537.0	0.10	36362.0	6.78
December	98.6	109.6	55.43	0.95	6225	5909	36541	5.9	125.0	0.02	4767.0	0.77	623.0	0.10	42213.0	6.78
January	98.6	109.6	55.43	0.94	6226	5819	36547	5.9	116.0	0.01	4766.0	0.77	623.0	0.10	42209.0	6.78
February	98.6	109.6	55.43	0.68	9239	6301	54233	5.9	242.0	0.02	7082.0	0.77	924.0	0.10	62638.0	6.78
March	98.6	109.6	55.43	0.95	5495	5196	32256	5.9	260.0	0.04	4227.0	0.77	550.0	0.10	37450.0	6.82

The single line diagram of electrical distribution system is shown in the figure below:

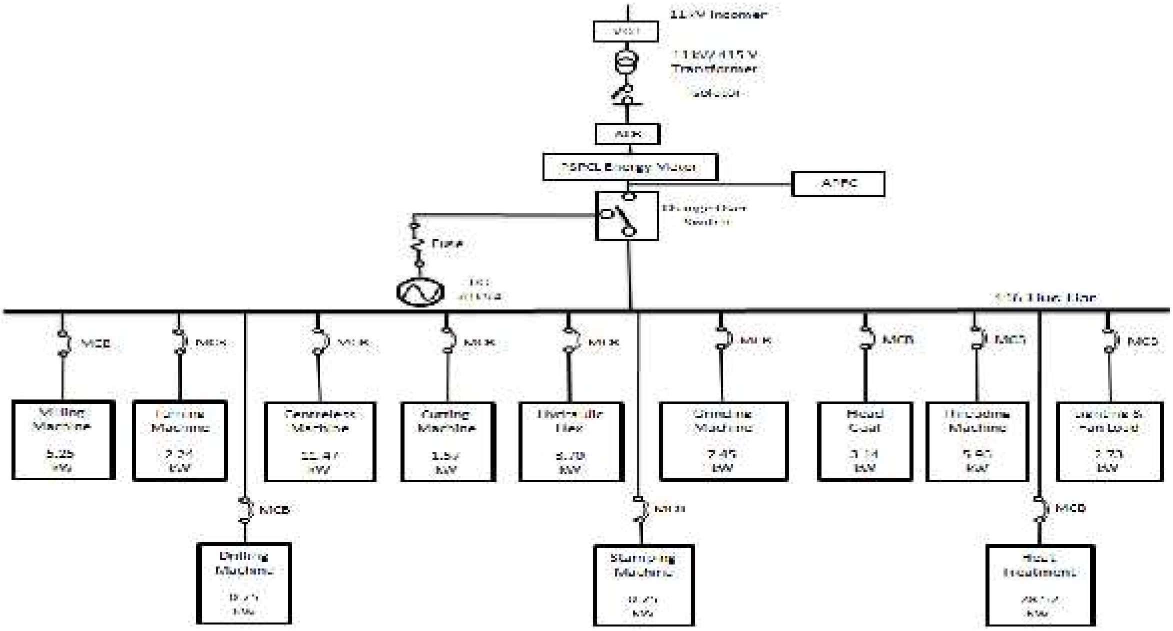

Figure 8: SLD of electrical load

Power factor

The utility bills of the unit reflect the plant's monthly power factor; however, the study was made by logging of the main incomer whereby the average power factor was found to be 0.991 with the maximum being 1.

Maximum demand

Maximum demand as reflected in the utility bill is 55.43 kVA from the bill analysis.

3.3.5 Self – generation

The unit has 1 DG set of 70 kVA. The unit does not have a system for monitoring the energy consumption and fuel usage in the DG. However, diesel purchase records are maintained by the unit. The DG performance was assessed during the audit and specific fuel consumption (SFC) was calculated as 1.93 kWh / litre.

Table 11: Diesel used for self generation

Month	Diesel Consumption in DG Set	Power Generation	Cost of Diesel
	Litre	kWh	Rs.
Apr-14	372	716	18,580
May-14	372	716	18,580
Jun-14	372	716	18,580

Month	Diesel Consumption in DG Set	Power Generation	Cost of Diesel
	Litre	kWh	Rs.
Jul-14	372	716	18,580
Aug-14	372	716	18,580
Sep-14	372	716	18,580
Oct-14	372	716	18,580
Nov-14	372	716	18,580
Dec-14	372	716	18,580
Jan-15	372	716	18,580
Feb-15	372	716	18,580
Mar-15	372	716	18,580
Total	**4,459**	**8,598**	**222,954**

3.3.6 Month wise electricity consumption

Month wise total electrical energy consumption from different sources is shown in the table below. Since the data for the months of April, May and June-2014 were not provided by the unit, therefore average value has been computed for these months. Similarly, value for the DG for all the months has been computed:

Table 12: Electricity consumption & cost

Months	Electricity Used (kWh)			Electricity Cost (Rs.)		
	Grid	**DG**	**Total**	**Grid**	**DG**	**Total**
	kWh	**kWh**	**kWh**	**Rs**	**Rs.**	**Rs.**
Apr-14	5,707	716	6,423	45,406	18,580	63,985
May-14	5,707	716	6,423	45,406	18,580	63,985
Jun-14	5,707	716	6,423	45,406	18,580	63,985
Jul-14	5,672	716	6,388	44,174	18,580	62,754
Aug-14	5,806	716	6,523	46,128	18,580	64,707
Sep-14	5,772	716	6,488	47,432	18,580	66,012
Oct-14	5,749	716	6,465	50,044	18,580	68,624
Nov-14	5,135	716	5,851	36,362	18,580	54,942
Dec-14	5,909	716	6,625	42,213	18,580	60,793
Jan-15	5,819	716	6,535	42,209	18,580	60,789
Feb-15	6,301	716	7,017	62,638	18,580	81,218
Mar-15	5,196	716	5,912	37,450	18,580	56,030
Total	**68,478**	**8,598**	**77,076**	**544,867**	**222,954**	**767,821**

The month-wise variation in electricity consumption is shown graphically in the figure below:

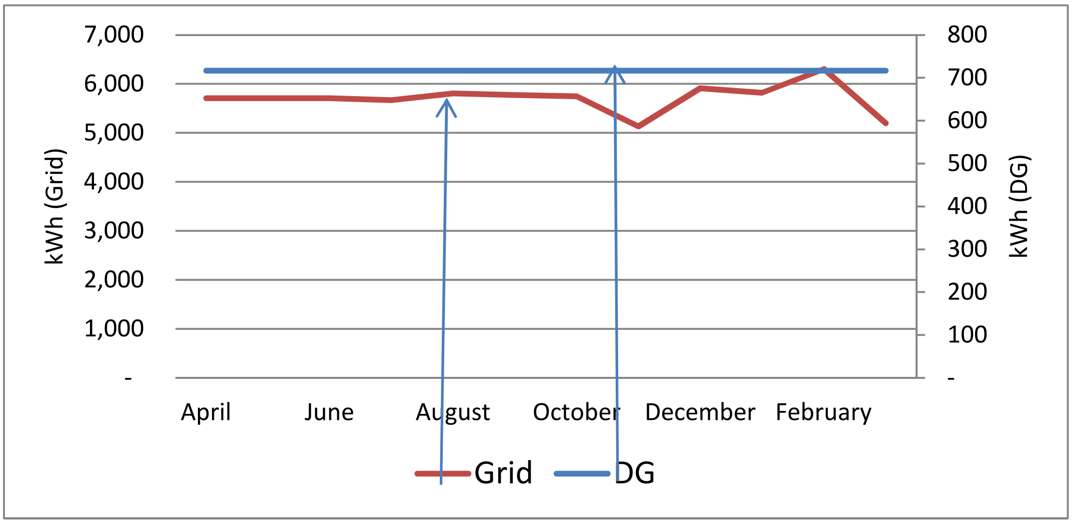

Figure 9: Month wise variation in electricity consumption from different sources

As shown in the figure above, the consumption of electrical energy is on higher side during the months from December ’14 to February ’15, and it is fluctuating over the remaining period. However, it could be noticed that electricity consumption during November ‘14 was less because the plant was shut down for a particular period of time due to maintenance. The corresponding month wise variation in electricity cost is shown graphically in the figure below:

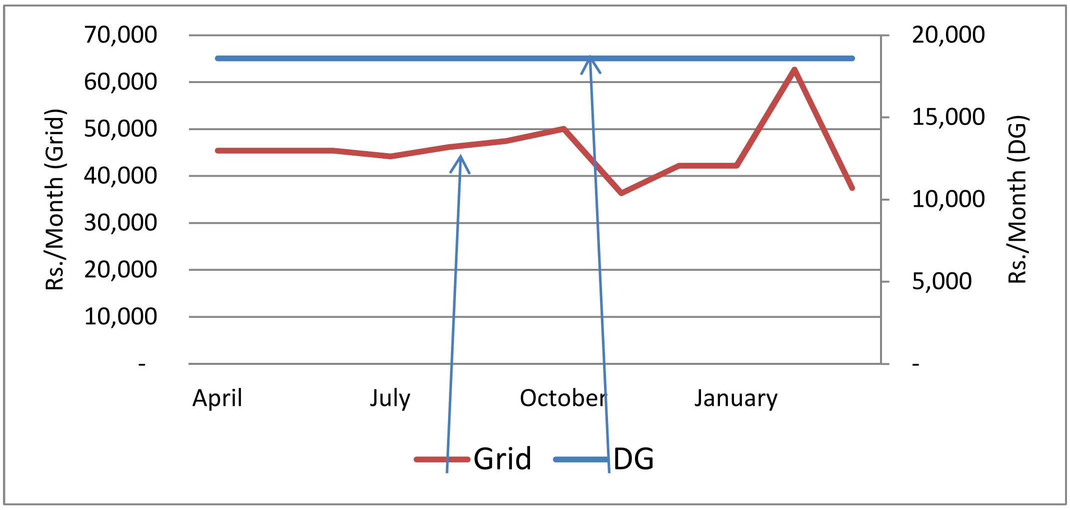

Figure 10: Month wise variation in electricity cost from different sources

From the utility bill analysis, it is seen that the cost per unit of kWh consumption goes down with the rise in consumption. As the consumption goes high, the share of fixed charge becomes low and vice versa.

The annual variation of cost of energy from utility as well as DG set is shown in the figure below:

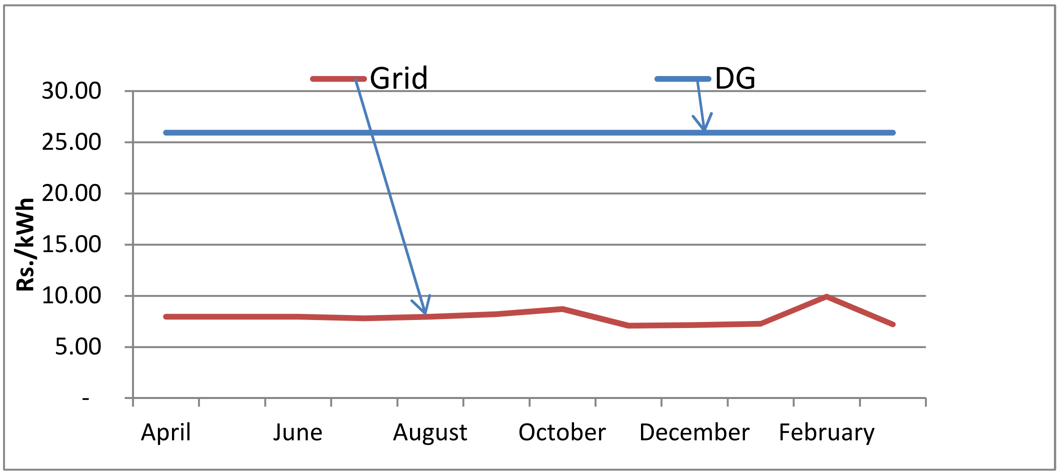

Figure 11: Average cost of power (Rs./kWh) from different sources

From the above graph, it clearly indicates that the cost of electrical energy from DG set is very high, nearly 3 times the cost of utility power.

3.4 Specific energy consumption

Production data was available from the unit in metric tons (MT). Based on the available information, various specific energy consumption parameters have been estimated as shown in the following table:

Table 13: Overall specific energy consumption

Parameters	Value	UoM
Annual Grid Electricity Consumption	68,478	kWh
Annual DG Generation Unit	8,598	kWh
Annual Total Electricity Consumption	77,076	kWh
Diesel Consumption for Electricity Generation	4,459	Liters
Annual Energy Consumption; MTOE	10.3	MTOE
Annual Energy Cost	7.68	Rs. lakh
Annual Production	70	MT
SEC; Electricity from Grid	1,098	kWh/MT
SEC; Overall	0.146	MTOE/MT
SEC; Cost Based	10,938	Rs./MT

Basis for estimation of energy consumption in terms of tons of oil equivalent are as follows:

- Conversion Factors
  - Electricity from the Grid : 860 kCal/Kwh
  - 1koe : 10,000 kCal
- GCV of HSD : 11,840 kCal/ kg
- Density of HSD : 0.8263 kg/litre
- CO_2 Conversion factor
  - Grid : 0.89 kg/kWh

- Diesel : 3.07 tons/ ton

3.5 Identified energy conservation measures in the plant

Diagnostic Study

A detailed study was conducted during CEA in the unit. Observations regarding energy performance of various process / equipments were recorded and a few ideas of EPIAs were developed. Summary of key observations are as follows:

3.5.1 Electricity Supply from Grid

The electrical parameters at the main incomer from PSPCL supply of the unit were recorded for 3 hours using the portable power analyzer instrument. Following observation has been made:

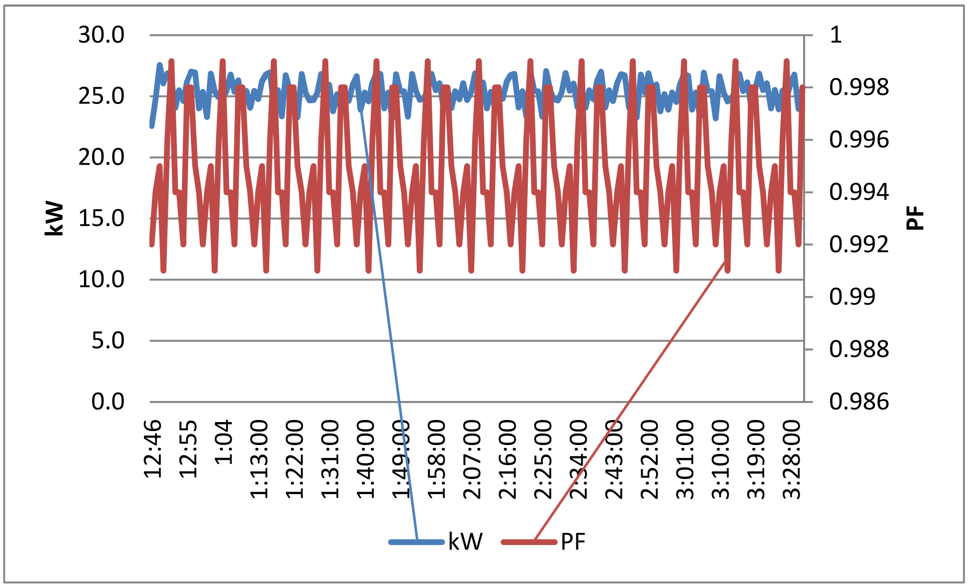

Figure 12: Load profile and power factor

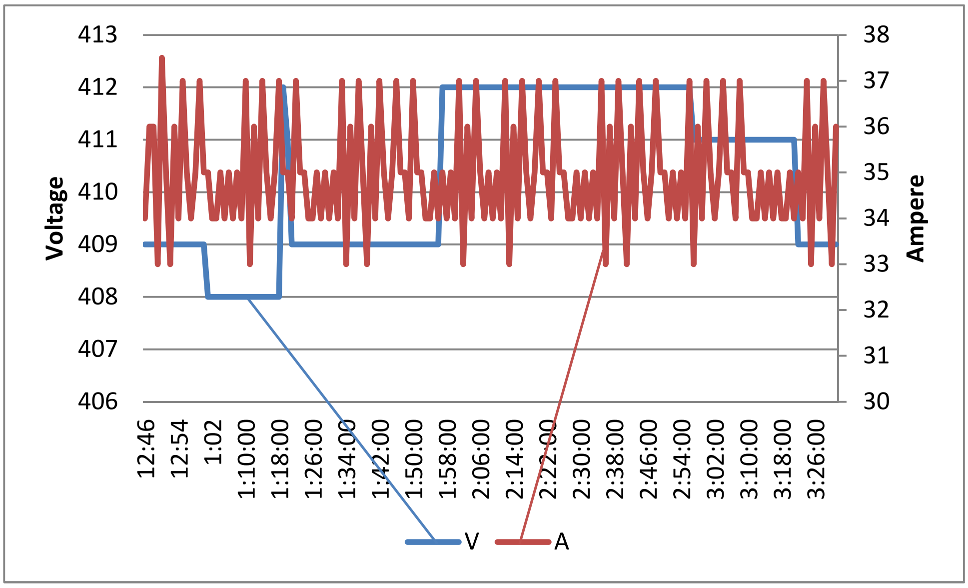

Figure 13: Voltage and Current profile

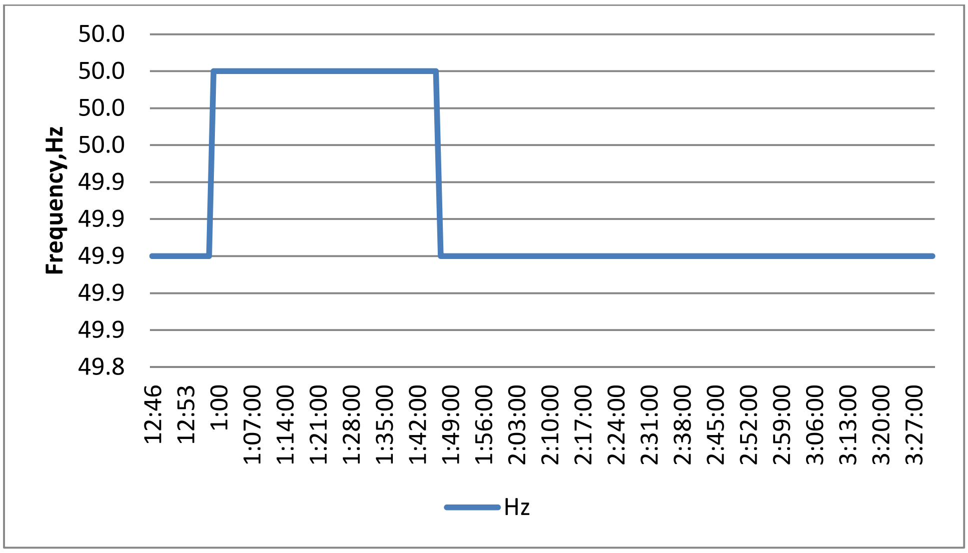

Figure 14: Harmonics profile

Table 14: Diagnosis of electric supply

Name of area	Present set-up	Observations during field study & measurements	Ideas for energy performance improvement actions
Electricity Demand	Power is supplied to this unit from PSPCL through a separate transformer. The unit has a LT connection. The contract demand of the unit is 109.56 kVA.	The maximum kVA from the electricity bill is 55.43 KVA which is less than the contract demand.	No EPIAs were suggested.

Power Factor	Unit has an LT connection and billing is in kVAh. The utility bills reflect the PF of the unit. The unit has an APFC panel installed to control the power factor.	The average PF found during the measurement was 0.995 and maximum was coming upto 1. But as per the electricity bill, average PF was 0.879 which is low.	PF can be improved by addition of capacitors of 22 kVAR to an existing automatic capacitor bank.
Voltage variation	The unit has no separate lighting feeder and no servo stabilizer for the same.	The voltage profile of the unit was satisfactory and it is recommended to put a separate lighting feeder and install a servo stabilizer for lighting and fan load so as to reduce the voltage from 410.31 V (current voltage) to 390 V.	The proposed EE measure was not economically feasible, hence no EPIA is being recommended.

In order to monitor the overall energy performance, the installation of a basic energy monitoring system has been proposed to the unit.

3.5.2 DG Performance

The unit has 1 DG set of 70 kVA. The unit does not have a system for monitoring the energy consumption and fuel usage in the DG, but diesel purchase records are maintained by the unit. As part of the performance testing, measurements were conducted on the DG set by keeping track of the diesel consumed (by measuring the top up to the diesel tank) and recording of kWh generated in the same period. The key performance indicators of the DG sets were evaluated and Specific Fuel Consumption (SFC) of the DG is as follows:

Table 15: Analysis of DG set

Particulars	DG
Rated KVA	70
Specific Fuel Consumption (kWh/Liter)	1.93

The observations made are as under.

- The SFC of DG set if 1.93 kWh/litre
- The power factor is 0.42.
- The present average frequency of the DG Set is 46.53 Hz
  For DG, the total testing time is 21 minutes in which total kWh generated is 2.04. Load profile and power consumption during the test for DG set is given below:

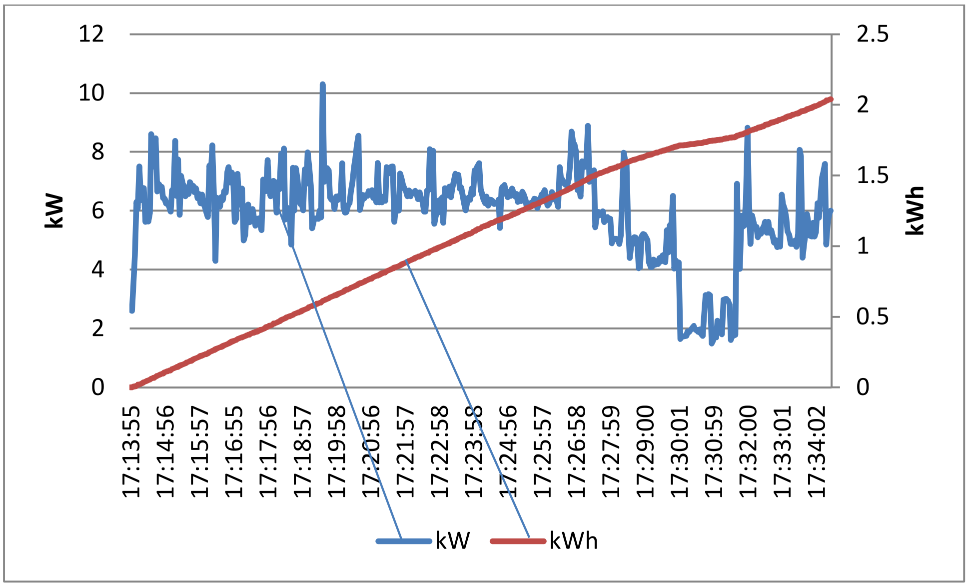

Figure 15: Load and power factor profile of DG set

3.5.3 Electrical consumption areas

The section-wise consumption of electrical energy is indicated in Table 6. Over 96.19% of the energy consumption takes place for carrying out manufacturing operations, and about 3.81% is in utilities.

The details of the observations, measurements conducted and energy conservation measures are as follows:

<table>
<tr><th>Name of area</th><th>Present set-up</th><th>Observations during field Study & measurements</th><th>Proposed Energy performance improvement actions</th></tr>
<tr><td>Turning Machine</td><td>There are 5 turning machines and they account for around 1.25% of total plant energy.</td><td>Two turning machines were studied. The results of the study are below:
<table><tr><th>Machine</th><th>Avg. kW</th><th>Avg. PF</th></tr><tr><td>Turning #1
Turning #2</td><td>0.47
0.37</td><td>0.34
0.33</td></tr></table></td><td>No EPIAs were suggested for turning machines.</td></tr>
<tr><td>Head Goal</td><td>There are 2 head goal machines and they account for around 2.64% of total plant energy.</td><td>One head goal machine was studied. The results of the study are below:
<table><tr><th>Machine</th><th>Avg. kW</th><th>Avg. PF</th></tr><tr><td>Head Goal #1</td><td>1.59</td><td>0.73</td></tr></table></td><td>No EPIAs were suggested for head goal machines.</td></tr>
<tr><td>Milling Machine</td><td>There are 7 millings machines and they account for around</td><td>One milling machine was studied. The results of the study are below:
<table><tr><th>Machine</th><th>Avg.</th><th>Avg. PF</th></tr></table></td><td>No EPIA's were suggested for milling machines.</td></tr>
</table>

<table>
<tr><td></td><td>4.41 % of total plant energy.</td><td><table><tr><th></th><th>kW</th><th></th></tr><tr><td>Milling # 1</td><td>0.50</td><td>0.40</td></tr></table></td><td></td></tr>
<tr><td>Hydraulic Hex Machine</td><td>There are 2 hydraulic hex machines installed and they account for around 3.11% of total plant energy.</td><td>One hydraulic hex was studied.
The results of the study are below:<table><tr><th>Machine</th><th>Avg. kW</th><th>Avg. PF</th></tr><tr><td>Hydraulic Hex #1</td><td>2.46</td><td>0.58</td></tr></table></td><td>No EPIAs were suggested for hydraulic hex machines.</td></tr>
<tr><td>Cutting Machines</td><td>There are 2 cutting machines and they account for around 1.32% of total plant energy.</td><td>One cutting machine was studied.
The results of the study are below:<table><tr><th>Machine</th><th>Avg. kW</th><th>Avg. PF</th></tr><tr><td>Cutting Machine #1</td><td>1.22</td><td>0.75</td></tr></table></td><td>No EPIAs were suggested for cutting machines.</td></tr>
<tr><td>Center less Machine</td><td>There are 4 center less machines and they account for around 9.63% of total plant energy.</td><td>One cutting machine was studied.
The results of the study are below:<table><tr><th>Machine</th><th>Avg. kW</th><th>Avg. PF</th></tr><tr><td>Center less #1</td><td>3.33</td><td>0.57</td></tr></table></td><td>No EPIAs were suggested for center less machines.</td></tr>
<tr><td>Heat treatment section</td><td>In heat treatment section, the study was conducted on both hardening and tempering furnaces.</td><td>Both hardening and tempering furnaces were studied.
The results of the study are below:<table><tr><th>Machine</th><th>Avg. kW</th><th>Avg. PF</th><th>SEC (kWh/T)</th></tr><tr><td>Hardening Furnace</td><td>17.96</td><td>0.99</td><td>297.11</td></tr><tr><td>Tempering Furnace</td><td>9.35</td><td>0.99</td><td>111.07</td></tr><tr><td>Tempering Heater 2</td><td>0.37</td><td>0.41</td><td></td></tr><tr><td>Cooling Blower</td><td>0.98</td><td>0.99</td><td></td></tr></table></td><td>No EPIAs were suggested for heat treatment furnaces.</td></tr>
</table>

4 EE TECHNOLOGY OPTIONS AND TECHNO – ECONOMIC FEASIBILTY

During CEA of the plant, all energy consuming equipments and processes were studied. The analysis of all major energy consuming equipments and appliances were carried out and discussed in the earlier section of this report.

Based on the analysis, Energy Performance Improvement Actions (EPIA) has been identified below:

4.1 EPIA 1: Power Factor Improvement

Technology description

Power factor plays an important role in electricity consumption in industries. If proper power factor is not maintained, it may lead to penalty in the electricity billing. For maintaining the power factor according to the load factor, proper size of capacitor bank is to be connected. The value of capacitors to be connected will vary with respect to load and its existing PF, and this can be controlled using Automatic Power Factor Controller (APFC).

Study and investigation

The average power factor maintained in the unit was found to be 0.88 during the study.

Recommended action

Power factor has to be maintained at 0.99 to avoid penalty from the utility, and so proper sizing of capacitors has to be made which is given in the table below:

Table 16: Sizing of capacitor banks

Parameters	Unit	Value
Present Minimum PF	Cos ø	0.68
Present Maximum PF	Cos ø	0.96
Present Average PF	Cos ø	0.88
Minimum Load	kW	22.5
Maximum Load	kW	27.6
Average Load	kW	25.3
Target Average Power Factor	Cos ø	0.99
Capacitor Bank Capacity at Average Load and Average PF	kVAr	9.4
Capacitor Bank Capacity at Maximum Load and Average PF	kVAr	10.3
Capacitor Bank Capacity at Maximum Load and Minimum PF	kVAr	22.2
Capacitor Bank Capacity at Minimum Load and Minimum PF	kVAr	18.1
Required capacitor bank for PF at Unity	kVAr	22.2
APFC Panel (Rating) for maintaining optimum PF	kVAr	22

Parameters	Unit	Value
Baseline Parameters:		
Present Tariff of Electricity including Tax	Rs./kVAh	8.83

The cost benefit analysis of the energy conservation measure is given below:

Table 17: Cost benefit analysis (EPIA 1)

Parameters	Unit	AS IS	TO BE
Minimum PF	Cos ø	0.68	0.99
Maximum PF	Cos ø	0.96	0.99
Average PF	Cos ø	0.88	0.99
Maximum Load	kW	27.6	27.6
Average Load	kW	25.35	25.35
Capacitor Bank	kVAr	100.0	122.2
Annual Grid Electricity Consumption	kVAh/Year	80,282	71,252
Annual Grid Electricity Consumption	kWh/Year	70,539	70,539
Savings in terms of power consumption	kVAh/Year		9,030
Average weighted cost of electricity	Rs./kVAh		8.83
Annual Monetary Saving	Rs. lakh/Year		0.80
Investment	Rs. lakh		1.20
Payback Period	Year		1.51

4.2 EPIA 2: DG Replacement

Technology description

The replacement of existing DG with a new DG will help in increasing the Specific Fuel Consumption, i.e. kWh generated from 1 liter of diesel. Normally the standard SFC given for new DG is 3.5 kWh/litre.

Study and investigation

The SFC of 70 kVA DG is 1.93 kWh/liter which is very low as per standards.

Recommended action

Replacing the 70 kVA DG with new DG having SFC 3.5 kWh/liter

The cost benefit analysis of the energy conservation measure is given below:

Table 18: Cost benefit analysis (EPIA 2)

Parameters	UOM	AS IS	TO BE
Rated kVA	kVA	70.00	70.00
Operating Hours	hr	1,500	1,500
No of Units generated	kWh/y	8,598	8,598
Annual Diesel Consumption	Liters	4,459	2,457
Specific Energy Consumption	kWh/liter	1.93	3.5
Annual Diesel savings	litre/y		2,003
Diesel Cost	Rs/liter		50
Investment	Rs. lakh		5.00
Monetary Savings	Rs. lakh		1.00
Simple Payback	Years		4.99

4.3 EPIA 3: Energy Monitoring System

Technology description

Installation of energy monitoring system on a unit will monitor the energy consumed by various machines. From this, the benchmark energy consumption can be set with respect to production of the machines. If an increase in energy consumption is noticed for any machine, then the reasons for the increased consumption can be diagnosed and proper remedial actions can be taken.

Study and investigation

As per the analysis done by the team, online data measurement is not done on the main incomer as well as at various electrical panels for the energy consumption. It was also noticed that there were no proper fuel monitoring systems installed in the DG sets like on-line flow-meters.

Recommended action

It is recommended to install online electrical energy monitoring systems (smart energy meters) on the main incomer and on various electricity distribution panels. It is also recommended to install online flow-meters on individual DG sets to measure the oil (HSD) flow. This measure will help in reducing energy consumption by approximately 3% from its present levels, as the load consumption trend can illustrate the deflections if there are any. This will help in taking the appropriate energy analysis and verification action for such deflections. The cost benefit analysis for this project is given below. It is recommended to install the online energy monitoring system on the main incomer &

metering instruments on the electricity distribution panels, as well as fuel monitoring system at DGs and each of the heat treatment furnaces in the plant to reduce the overall energy consumption by 3%. The cost benefit analysis for installation of energy monitoring system in the unit is given below in the table below:

Table 19: Cost benefit analysis (EPIA 3)

Parameters	Unit	As Is	To Be
Energy monitoring savings	%		3.00
Energy consumption of major machines per year	kWh/y	68,478	66,424
Savings in terms of power consumption	kWh/y		2,054
Average weighted cost of electricity	Rs/kWh		8.83
Annual monetary savings	Lakhs Rs/y		0.18
Estimate of Investment	Rs. lakh		0.25
Simple Payback	Years		1.38

4.4 EPIA 4: Replacing old, in-efficient (and several times re-wound) existing motors of a few machines with energy efficient motors

Technology description

Replacing old and inefficient existing motors of the milling machine (1 number), grinding machine (1 number) and centre-fewer machines (1 number) with energy efficient motors will reduce their power consumption by about 50%. The energy efficient motors have minimum losses and are capable of delivering power at efficiency of over 90%.These motors have class F insulation level and are made of high grade materials.

Study and investigation

The unit is having a few motors which have been re-wounded several times and their efficiencies were below 60% in milling section, grinding section and centre less machine.

Recommended action

It is recommended to replace the present motors of the milling machine (7 numbers), grinding machine (5 numbers) and centreless machine (3 numbers) as in table below with energy efficient motors.

The cost benefit analysis for this energy conservation measure is given below:

Table 20: Cost benefit analysis (EPIA 4)

Parameters	UOM	Milling Motor		Grinding		Centreless Machine	
		AS IS	TO BE	AS IS	TO BE	AS IS	TO BE
Rated Power	kW	0.75	0.75	1.49	1.49	3.70	3.7
Efficiency of motor	%	60%	90%	60%	90%	60%	90%
Average Load	kW	0.50	0.34	1.04	0.70	3.33	2.22
Net Power Savings	kW		0.17		0.35		1.11
Running Hours	hr/y		3,600		3,600		3,600
Savings in terms of power consumption	kWh/y		604		1,252		3,996
Average weighted cost of electricity	Rs./kWh		8.83		8.83		8.83
Investment/ Motor	Rs. lakh		0.16		0.28		0.68
No. of motor	Nos.		7		5		3
Total Investment	Rs. lakh		1.12		1.40		2.04
Monetary Savings	Rs. lakh		0.37		0.55		1.06
Simple Payback	Years		0.43		0.51		0.64

4.5 EPIA 5: Replacing existing T-12 tube lights with LED fixtures

Technology description

Replacing conventional T-12 lights with LED lights helps reduce power consumption and also results in higher illumination (lux) levels for the same power consumption.

Study and investigation

The unit is having 103 conventional T-12 tube lights.

Recommended action

It is recommended to replace the above mentioned light fixtures with energy efficient LED lamps to bring down present energy consumption in lighting activities. The cost benefit analysis for the EPIA is given below:

Table 21: Cost benefit analysis (EPIA 5)

Particulars	Unit	Existing	Proposed
		T-12	16 W LED tube light
Power consumed	W	40	16

Power consumed	W	12	0
Total power consumption	W	52	16
Operating Hours/day	hr	12	12
Annual days of operation	day	300	300
Energy used per year/fixture	kWh	187	58
Average weighted cost of electricity	Rs./kWh	8.83	8.83
No. of Fixture	Nos.	103	103
Power consumption per year	kWh/y	19,282	5,933
Operating cost per year	Rs. lakh/y	1.70	0.52
Savings in terms of power consumption	kWh/y		13,349
Monetary savings	Rs. lakh/y		1.18
Investment per fixture of LED	Rs.		1,675
Investment of project	Rs. lakh		1.72
Payback period	Years		1.46

4.6 EPIA 6: Replacing existing incandescent lamps with LED fixtures

Technology description

Replacing conventional incandescent bulbs with LED lamps can reduce power consumption. This will also provide a better illumination (lux) level for the same power consumption compared to traditional lamps.

Study and investigation

The unit is having about 13 incandescent lamps of 60 W each.

Recommended action

All incandescent lamps have to be replaced with energy saving LED lamps which can reduce energy consumption immensely.

The savings assessment has been given in the table below:

Table 22: Cost benefit analysis (EPIA 6)

Particulars	Unit	Existing 60W Incandescent Lamp	Proposed 18 W LED Light
Power consumed	W	60	18
Power consumed	W	13	0
Total power consumption	W	73	18
Operating Hours/day	hr	12	12
Annual days of operation	Day	300	300
Energy used per year/fixture	kWh	263	65

Particulars	Unit	Existing 60W Incandescent Lamp	Proposed 18 W LED Light
Average weighted cost of electricity	Rs/kWh	8.83	8.83
No. of Fixture	Nos.	13	13
Power consumption per year	kWh/y	3416	842
Operating cost per year	Rs. lakh/y	0.30	0.07
Savings in terms of power consumption	kWh/y		2574
Monetary savings	Rs. lakh/y		0.23
Investment per fixture of LED	Rs.		0.0175
Investment of project	Rs. Lakhs		0.2275
Payback period	Years		1.00

5 LIST OF VENDORS

The details of some of the suppliers for energy equipments are given in the table below:

EPIA 1: Power factor Improvement

PF Improvement				
Sl. No.	**Name of Company**	**Address**	**Phone No.**	**E-mail / Website**
1	Cummins Power Generation Contact Person: Mr. Rishi Gulati Senior Manager-Power Electronics	Cummins India Limited Power Generation Business Unit 35/A/1/2, Erandawana, Pune 411 038, India	Phone: (91) 020-3024 8600 , +91 124 3910908	cpgindia@cummins.com rishi.s.gulati@cummins.com
2	Krishna Automation System Contact Person: Mr. Vikram Singh Bhati	ESTERN CHAWLA COLONY, NEAR KAUSHIK VATIKA, GURGAON CANAL BALLBGARH FARIDABAD 121004	Mob: 9015877030, 9582325232	krishnaautomationsystems@gmail.com

EPIA 2: DG Replacement

Sl. No.	**Name of Company**	**Address**	**Phone No.**	**E-mail / Website**
1	Mahindra Powerol Engines & DG set Contact Person: Mr. Pankaj Katiyar Marketing	Jeevan Tara Building,5,Parliament street,delhi-1	Mobile: +91-9818494230	katiyar.pankaj@mahindra.com
2	Cummins Power Generation Contact Person: Mr. Rishi Gulati Senior Manager-Power Electronics	Cummins India Limited Power Generation Business Unit 35/A/1/2, Erandawana, Pune 411 038, India	Phone: (91) 020-3024 8600 , +91 124 3910908	cpgindia@cummins.com rishi.s.gulati@cummins.com
3	BNE Company Contact Person: Mr. Bhavneet Singh, Marketing	7B, Kiran Shankar Roy Road, 3rd Floor, Kolkata 700 001	Mobile : +91- 9831048994	bnecompany@gmail.com, bne_company@yahoo.com

EPIA 3: Energy Monitoring System

Sl. No.	Name of Company	Address	Phone No	E-mail /Website
Automation				
1	Iadept Marketing Contact Person: Mr. Brijesh Kumar Director	S- 7, 2nd Floor, Manish Global Mall, Sector 22 Dwarka, Shahabad Mohammadpur, New Delhi, DL 110075	Tel.: 011-65151223	iadept@vsnl.net ,info@iadeptmarketing.com
2	Aimil Limited Contact Person: Mr. Manjul Pandey	Naimex House A-8, Mohan Cooperative Industrial Estate, Mathura Road, New Delhi - 110 044	Office: 011-30810229, Mobile: +91-981817181	manjulpandey@aimil.com
3	Panasonic India Contact Person: Mr. Neeraj Vashisht	Panasonic India Pvt Ltd Industrial Device Division (INDD) ABW Tower,7th Floor, Sector 25, IFFCO Chowk, MG Road,Gurgaon - 122001, Haryana,	9650015288	neeraj.vashisht@in.panasonic.com

EPIA 4: Replacement of old motors with Energy Efficient Motors

Sl. No.	Name of Company	Address	Phone No.	E-mail
1	Havells India Contact Person: Mr. Niranjan Sanghvi	QRG Towers, 2D, Sec-126,Express way,Noida-201304,UP	Mr. Niranjan Sanghvi (9314060101), Mr.Vishwanathan (9899104105), Mr Sanjeev Nayyar (9818499726)	niranjan.singhvi@havells.com
2	Crompton Greaves- Dealer Contact Person: Mr. Ajay Gupta	New Delhi-110019	Mobile : 9811888657	Email: NA

EPIA 5 & EPIA 6: Energy Efficient Lights

Sl. No.	Name of Company	Address	Phone No.	E-mail
1	Osram Electricals Contact Person: Mr. Vinay Bharti	OSRAM India Private Limited, Signature Towers, 11th Floor, Tower B, South City - 1,122001 Gurgaon, Haryana	Phone: 011-30416390 Mob: 9560215888	vinay.bharti@osram.com
2	Philips Electronics Contact Person: Mr. R. Nandakishore	1st Floor Watika Atrium, DLF Golf Course Road, Sector 53, Sector 53 Gurgaon, Haryana 122002	9810997486, 9818712322 (Yogesh-Area Manager), 9810495473 (Sandeep-Faridabad)	r.nandakishore@phillips.com, sandeep.raina@phillips.com
3	Bajaj Electricals Contact Person: Mr. Kushgra Kishore	Bajaj Electricals Ltd,1/10, Asaf Ali Road, New Delhi 110 002	9717100273, 011-25804644 Fax : 011-23230214 ,011-23503700, 9811801341(Mr. Rahul Khare), (9899660832) Mr. Atul Baluja, Garving Gaur(9717100273), 9810461907 (Kapil)	kushagra.kishore@bajajelectricals.com, kushagrakishore@gmail.com; sanjay.adlakha@bajajelectricals.com