BASE LINE ENERGY AUDIT REPORT

"SUPPORTING NATIONAL PROGRAM ON ENERGY EFFICIENCY IN SMES FOR INDORE(FOOD) CLUSTER"

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Udyog Nagar, Indore

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Submitted to

ENERGY IS LIFE
BEE
CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

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Submitted by

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ACKNOWLEDGEMENT

DESL places on record its sincere thanks to Bureau of Energy Efficiency (BEE) for vesting confidence in DESL to carry out the assignment "Conducting Base line energy audit in Indore SME food clusters" under their national project *"Supporting National Program on Energy Efficiency in SMEs for Indore (Food) cluster".*

As a part of this assignment, work in Indore and Ujjain food cluster was awarded to DESL, and DESL is grateful to BEE for their full-fledged coordination and support throughout the study.

The study team is indebted to Mr. Manish Agrawal, Owner, for showing keen interest in the energy audit and also thankful to the management of M/s Suresh Chand Ramesh Chand for their wholehearted support and cooperation for the preparation of this Base line 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. Suresh Agrawal, President, Association of pulses manufacturers (APM), Indore, 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

Project Head	**Mr. R. Rajmohan** **Chief Executive Officer**
Team leader and co-coordinator	Mr. Suparno R. Majumdar Consultant
Team Members	Mr. Prabhat Sharma Project Analyst
	Mr. B. Ram Suresh Project Analyst

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ABBREVIATIONS

Abbreviations	Expansions
BEE	Bureau of Energy Efficiency
DESL	Development Environergy Services Limited
DG	Diesel Generator
EE	Energy Efficiency
EPIA	Energy Performance Improvement Action
HSD	High Speed Diesel
LT	Low Tension
MD	Maximum Demand
MSME	Micro, Small and Medium Enterprises
MT	Metric Tons
MTOE	Million Tons of Oil Equivalent
No.	Number
PF	Power Factor
SEC	Specific Energy Consumption
SEGR	Specific Energy Generation Ratio
SLD	Single Line Diagram
SME	Small and Medium Enterprises
VFD	Variable Frequency Drives

EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE) is implementing a project titled "Supporting National pPogram on Energy Efficiency in SMEs for Indore (Food) cluster". The objective of the project is to provide impetus to energy efficiency initiatives in small and medium enterprises (SMEs) of Indore food Cluster in Madhya Pradesh.

DESL has been engaged to implement the project in the SME food cluster in Indore and Ujjain in Madhya Pradesh. There are about 200 units scattered over Indore and Ujjain. The major products processed in these food industries include poha (rice flakes) and various types of pulses (dal) – toor, masoor, chana, arahar, moong etc.

The project awarded to DESL consists of 18 major tasks:

- Conducting pre–activity cluster workshop defining the agenda of this engagement
- Conducting initial walk through energy audits within 5 selected units of the cluster
- Identifying and proposing two energy efficient process technologies to BEE
- Identifying at least 5 local technology/service providers of the above technologies in the cluster
- Identifying 20 SME units willing to implement and demonstrate the above two technologies
- Assistance to BEE for entering into contract with each of the 20 shortlisted SME units
- Conducting Comprehensive Energy Audits in 20 SME units
- Development of technology specific case studies (Audio, Visual and Print) for each technology.
- Developing best operating practices(BOP) document for the top 5 energy equipment/processes in the industry cluster
- 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 post energy audits in each of the above 20 units to verify energy savings
- Verification and submission of relevant documents (evidence of implementation and commissioning of EE technology) to the BEE
- Assisting BEE in conducting five post energy audits
- Submission of progress report in hard and soft versions (Word, presentation) to BEE.
- Submission of draft document to BEE within seven days from issue of LOI by BEE

Brief Introduction of the Unit

Table 1: Details of Unit

Name of the Unit	M/s Suresh Chand Ramesh Chand
Constitution	Partnership
MSME Classification	Small
No. of years in operation	NA
Address: Registered Office	6/7,Udyog Nagar musakhedi, Indore, Madhya Pradesh
Administrative Office	6/7,Udyog Nagar musakhedi, Indore, Madhya Pradesh
Factory	6/7,Udyog Nagar musakhedi, Indore, Madhya Pradesh
Industry-sector	Food
Products Manufactured	Pulses
Name(s) of the Promoters / Directors	Mr. Manish Agrawal

Baseline energy audit

The study was conducted in 3 stages:

- **Stage 1:** Walk through the plant for assessment of the measurement system and accessibility of measurement points
- **Stage 2:** Baseline energy audit, data collection and field measurements for performance evaluation of equipments/ systems, estimation of savings potential, technology assessment and understanding of project constraints
- **Stage 3**: Data analysis, configuration of projects, savings quantification and preparation of baseline energy audit report

The production process of the unit

The production process description is as follows:

The unit purchases raw pulses from nearby agricultural markets, and in some cases also imports them from abroad. The pulses are cleaned in vibrating cleaners to remove dust and sand particles which come along with the raw pulses from agricultural fields. The outer cover from the cleaned pulses is removed in a rotary shaft covered with emery rolls. The pulses are again cleaned in a vibrating cleaner (Chalne machine) to separate the removed husk from the pulses (dal). The dal (without the husk) is then passed over a screw conveyer where water is sprayed on it. The wet dal is then heated in a dryer to reduce its moisture content and also to soften it. From the drier, the dal is conveyed to grinder machine (Chakki) where it is broken down into 2 parts as per requirements. Post breaking, the dal is finally cleaned in cleaner machines, packed and dispatched.

It was observed that the unit has 2 sections – raw material (kaccha) and post finishing (pakka). In both these sections, there were one main motor (and one standby) which was operating most of the machines like fadfadiya, chalne, grinder, elevators, screw conveyer, etc through a common shaft and flat-belt-pulley drives. When a machine is not in operation, the operator just de-couples the pulley connected to that machine from the common shaft.

Identified Energy Performance Improvement Actions (EPIA)

The baseline energy audit covered all the equipment which were in operation during the time of field study. The dal milling process requires both electrical and thermal energy. Thermal energy used is wood blocks. Wood is used for generating hot air in a hot air generator and constitutes approximately 35% of the total energy cost of the unit. The balance energy cost is for electrical usage.

Major areas of electrical energy consumption in the unit are raw material section motor (kacha counter) and finished section motor (pakka counter), blower, compressor, etc. Measures proposed for reduction of electrical energy consumption include replacement of existing motors with energy efficient motors, VFD on dust removal blower and VFD on compressor motor.

Measures proposed for reduction of thermal energy consumption include excess air control and skin loss reduction by insulation.

The identified energy performance improvement actions (EPIAs) are given in the table below.

Table 2: Summary of EPIAs

Sl. No.	Energy Performance Improvement Action (EPIA)	Annual electricity savings	Annual fuel savings	Investment cost	Monetary energy cost savings	Payback period
		kWh / y	Wood (kg / y)	Rs. Lakh	Rs. Lakh / y	y
1	Replacement of old and inefficient motors with EE motors (Pakka counter motor, 15 HP X 1 number + kaccha counter motor, 30 HP X 1 number + Emery roll motor, 15 HP X 1 number + Dust collector motor, 20 HP X 1 number with VFD + Polisher motor, 20 HP X 1 number + Elevator motors, 3 HP X 5 numbers)	23,781		4.55	1.49	3.06
2	Energy savings by installation of VFD of blower-1 of sortex machine	6,371		1.64	0.40	4.11
3	Energy savings by installation of VFD on air compressor (screw type)	6,722		1.69	0.42	4.02
4	Fuel savings by controlling excess air supplied for combustion in hot air generator of dryer	-	8,682	0.95	0.52	1.82
5	Refurbishing damaged insulation of hot air generator and dryer		8,644	2.26	0.52	4.36
	Total	**36,874**	**17,326**	**11.09**	**3.35**	**3.31**

- With the implementation of these EPIAs, overall cost savings of Rs. 3.35 Lakh can be achieved.

1 INTRODUCTION

1.1 Background and Project objective

Bureau of Energy Efficiency (BEE) is implementing a project titled “Supporting National program on Energy Efficiency in SMEs for Indore (Food) cluster”. The objective of the project is to provide impetus to energy efficiency initiatives in small and medium enterprises (SMEs) sector in Indore (including Ujjain) food cluster in India.

The objectives of this project are as under:

- Identifying energy efficient process and technologies that can be implemented by units in the Indore food cluster;
- Identifying 20 SME units within the cluster that are willing to implement and demonstrate the above technologies in their units;
- Facilitating Bureau of Energy Efficiency (BEE), New Delhi to sign tri-partite Memorandum of Understanding (MoUs) with the 20 SME units of Indore food cluster (that are willing to implement the energy efficient technologies) and their cluster association;
- Conducting Baseline Energy Audits in 20 SME food units of the Indore food cluster who have signed MOUs with BEE;
- Establishing baseline energy efficiency scenario for the 20 units against which energy savings will be computed post implementation;
- Facilitate the 20 SME units in implementing the proposed energy efficient technologies in their units;
- Conducting post implementation energy audits in the 20 SME units to establish the actual energy savings in those units;
- Development of technology specific case studies (audio-visual and print) for each technology (during pre-implementation, implementation and post implementation stages).

1.2 Scope of work of baseline energy audit

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

- Data Collection
    - Current energy usage (month wise) for all forms of energy from Jan-2015 to Nov-2015 (quantity and cost)
    - Data on production for corresponding period (quantity)
    - Mapping of process
    - List of major equipment and specifications
    - Baseline energy measurements for the process / equipment for which energy efficient measures were proposed
- Analysis
    - Energy cost and trend analysis
    - Energy quantities and trend analysis
    - Specific consumption and trend analysis
    - Performance evaluation of identified energy consuming equipment / systems

- Quantification of energy cost savings by implementing EE measures / technologies
- Classification of 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.

1.3 Methodology

1.3.1 Boundary parameters

Following boundary parameters were set for coverage of the audit:

- Audit covered all the identified energy intensive areas and equipment for which energy efficiency improvement measures were proposed
- 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

Following flow chart illustrates the methodology followed for carrying out the project:

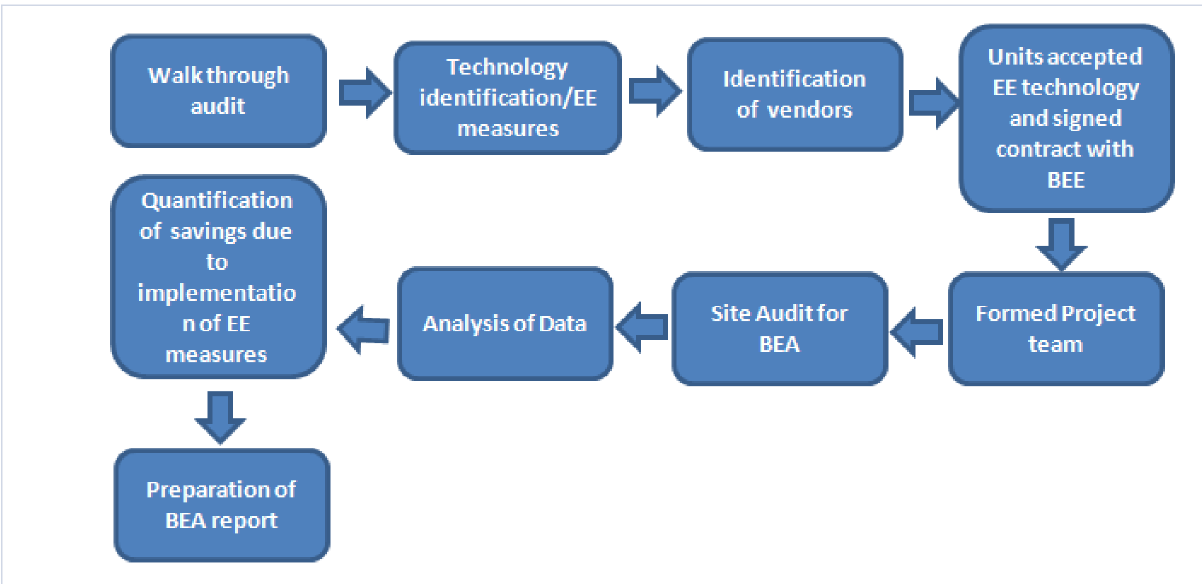

Figure 1: General methodology

The study was conducted in following stages:

Stage 1: Identification of units and conducting walk through energy audits in 5 units to understand the process and its energy intensiveness, identification of energy saving technologies, assessment of the measurement system, proposing energy efficient technologies to BEE and units for acceptance

Stage 2: Identification of vendors for implementation of energy efficient technologies and facilitating BEE to sign tripartite MoUs with the units that are willing to implement the EE technology and their cluster association

Stage 3: Formation of project team for conducting baseline energy audits (BEA) in the units that have signed MOUs with BEE; and conducting BEA in those units – carrying out on-site measurement of energy parameters, collection of historical energy use data for analysis.

Stage 4: Data analysis, quantification of energy savings (in the processes / equipment) post measurements, and preparation of baseline energy audit report.

1.3.3 Base line energy audit – field assessment

A walk around the unit was carried out before the baseline energy audit with a view to:

- Collect historical energy consumption data
- Obtain cost and other operational data for understanding the impact of energy cost on the unit's financial performance
- Assess the energy conservation potential for the identified EE measures.
- Check for accessibility of measurement points for measurement of energy parameters

The equipment and technologies identified for study are as follows:

- Main common motors of pakka and kaccha sections
- Hot air generator of dryer

Further activities carried out by the team during BEA study included:

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

Baseline audit methodology involved system study to identify the energy losses (thermal / electrical) and proposing 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 various instruments used for energy audit are followings:

Table 3: Energy audit instruments

Sl. No.	Instruments	Make	Model	Parameters measured
1	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
2	Power Analyzer – 3 Phase (for balance load) with 1 CT and 2 PT	Elcontrol Energy	Nanovip	AC Current, Voltage, Power Factor, Power, Energy, Frequency, Harmonics and data recording for minimum 2 sec interval

Sl. No.	Instruments	Make	Model	Parameters measured
3	Flue Gas Analyzer	Kane-May	KM-900	O2%, CO2%, CO in ppm and Flue gas temperature, Ambient temperature
4	Digital Temp. & Humidity meter	Testo	610	Temp. & Humidity
5	Vane Type Anemometer	Testo	410	Air velocity
6	Digital Infrared Temperature Gun	Raytek	Minitemp	Distant Surface Temperature

1.3.4 Baseline 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's database or through vendor interactions as required
- Configuration of individual energy performance improvement actions
- Preparation of draft 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 Suresh Chand Ramesh Chand
2	Constitution	Partnership
3	Date of incorporation / commencement of business	NA
4	Name of the contact person Mobile/Phone No. E-mail ID	Mr. Manish Agrawal 9827031553 NA
5	Address of the unit	6/7,Udyog Nagar Musakhedi, Indore, Madhya Pradesh
6	Industry / sector	Food
7	Products manufactured	Pulses
8	No. of operational hours	12
9	No. of shifts / day	1
10	No. of days of operation / year	330

3 DETAILED TECHNICAL FEASIBILITY ASSESSMENT OF THE UNIT

3.1 Description of manufacturing process

3.1.1 Process & Energy flow diagram

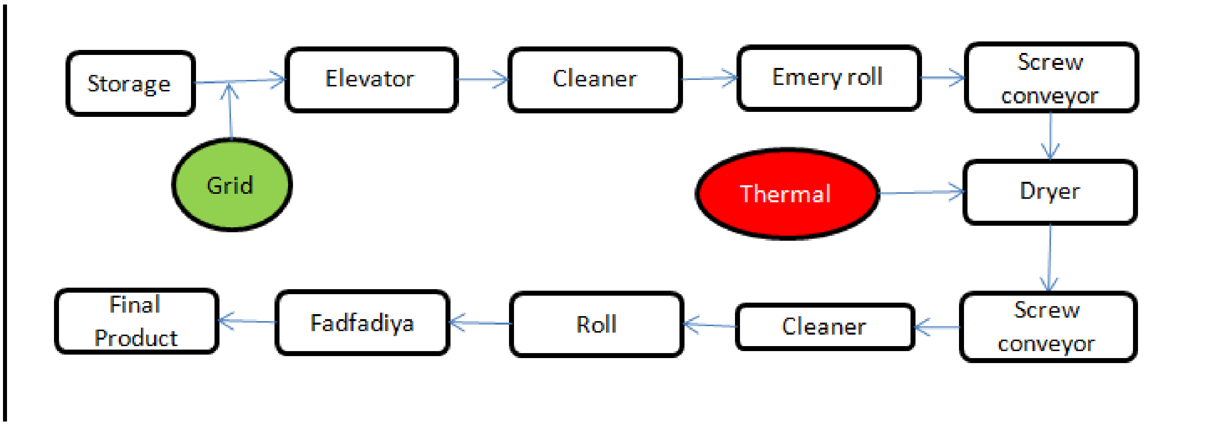

Figure 2: Process flow diagram

3.1.2 Process description

M/s Suresh Chand Ramesh Chand Industries is a pulse (dal) manufacturing unit. The process description is as follows:

The unit purchases raw pulses from nearby agricultural markets, and in some cases even imports them from abroad. The pulses are cleaned in vibrating cleaners to remove dust and sand particles which come along with the raw pulses from agricultural fields. The outer cover from the cleaned pulses is removed in a rotary shaft covered with emery rolls. The pulses are again cleaned in a vibrating cleaner (Chalne machine) to separate the removed husk from the pulses (dal). The dal (without the husk) is then passed over a screw conveyer where water is sprayed on it. The wet dal is then heated in a dryer to reduce its moisture content and also to soften it. From the drier, the dal is conveyed to grinder machine (Chakki) where it is broken down into 2 parts as per requirements. Post breaking the dal is finally cleaned in cleaner machines, packed and dispatched. It was observed that the unit has 2 sections – raw material (kaccha) and post finishing (pakka). In both these sections, there were one main motor (and one standby) which was operating most of the machines like fadfadiya, chalne, grinder, elevators, screw conveyer, etc through a common shaft and flat-belt-pulley drives. When a machine was not in operation, the operator just de-coupled the pulley connected to that machine from the common shaft.

3.2 Inventory of process machines / equipment and utilities

Major energy consuming equipment in the plant are:

- **Main common motor of raw material counter (Kacha counter):** A main common motor operates the raw material common shaft to which most of the machines (in raw material section) are coupled through flat belts and pulley drives. Various machines connected to this common shaft are 6 elevators, 4 screw conveyor, 4 cleaners with fans and dust collecting blower.

- **Roll:** The Emery rolls are used for removing the outer cover of the dal. It has a separate motor.
- **Main common motor of finished material counter (Pakka counter):** A common main motor operates the finished material common shaft to which most of the machines (in finished material section) are coupled through flat belts and pulley drives. There are two main motors for finished material section. 4 cleaners with fans, 6 screw conveyors, 3 grinding machines and 5 elevators are connected to motor-1 of 15 H.P (rated) and 1 buffer roll, 3 screw conveyors and 1 elevator to 20 HP (rated) motor.
- **Polisher:** Polisher is used for polishing the dal in the final stage. It has a separate motor.

3.2.1 Types of energy used and description of usage pattern

Both electricity and thermal energy are used in different processes. The overall energy usage pattern in the unit is as follows:

- Electricity is obtained from only one source-grid:
    - From the Utility, M.P. Paschim Kshetra Vidyut Vitaran Co. Ltd
- Thermal energy is used for following applications:
    - Wood in hot air generator of dryer

Total energy consumption pattern for the period Jan-15 to Oct-15, from different sources is as follows:

Table 5: Energy cost distribution

Particulars	Energy cost distribution		Energy use distribution	
	Rs. Lakh	% of total	MTOE	% of total
Grid –electricity	6.76	65	7.62	30
Thermal – Wood	3.62	35	18.10	70
Total	**10.38**	**100**	**25.71**	**100**

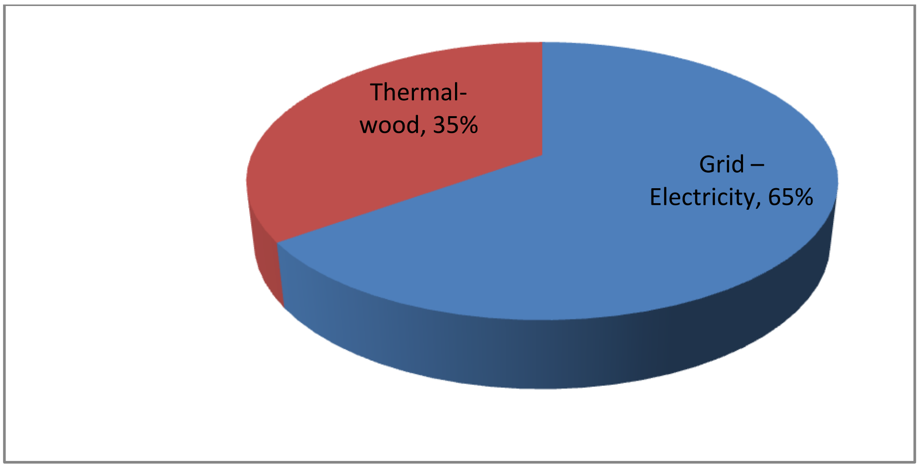

Figure 3: Energy cost share

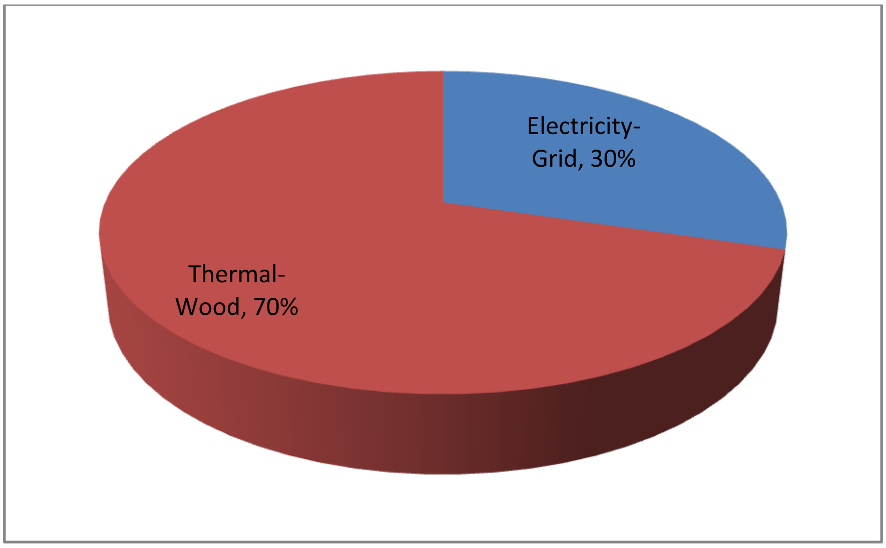

Figure 4: Energy use share

Major observations are as under:

- The unit uses both thermal and electrical energy for production. Electricity is sourced from the grid. Thermal energy (wood) consumption is in hot air generator for generation of hot air which is used for drying of dal in the dryer.
- Wood used in hot air generator accounts for 35% of the total energy cost and 70% of overall energy consumption.
- Electricity used in the process accounts for 65% of the energy cost and 30% of overall energy consumption.

3.3 Analysis of electricity consumption by the unit

3.3.1 Electricity load profile

Following observations have been made from the utility inventory:

- The plant and machinery load is 86 kW
- The single phase load is about 1kW (for lighting and office equipment like ceiling fans, computer, etc)

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

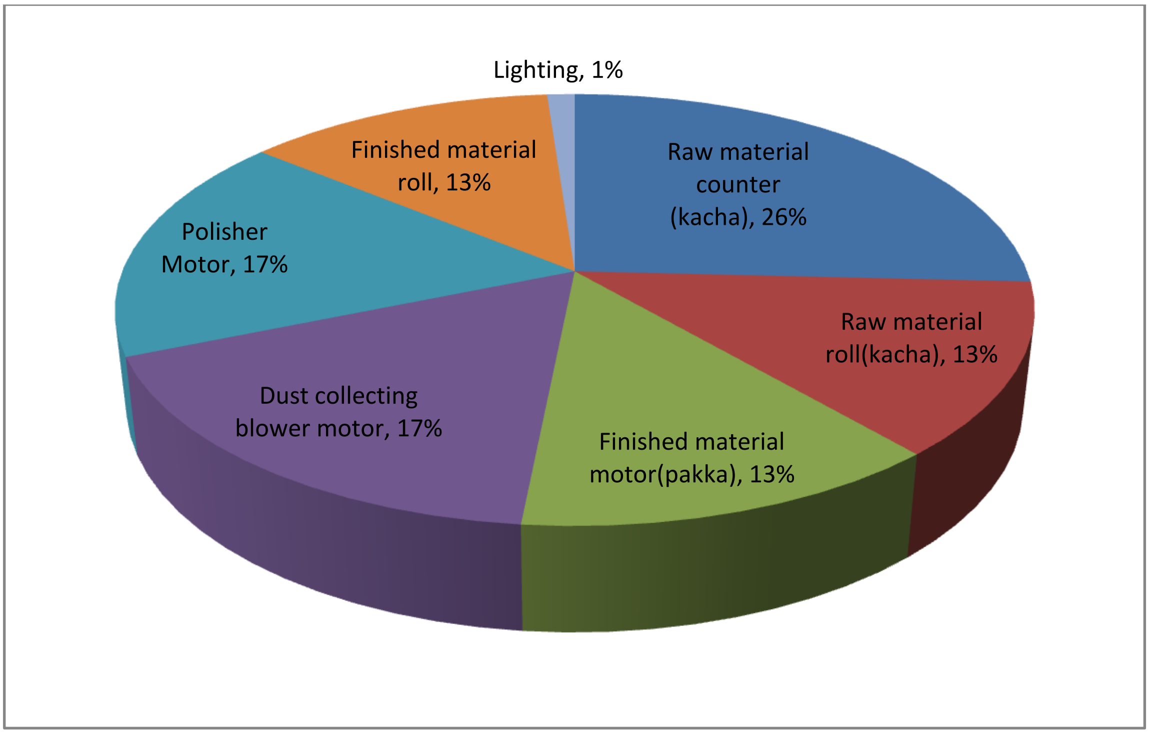

Figure 5: Details of connected load

As shown in the pie chart of connected loads, raw material counter motor, polisher, dust collecting blower, finished material counter motor, emery rolls and lighting account for 26%, 17%, 17%, 13%, 26% and 1% respectively for the connected load of the plant.

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 6: Area wise electricity consumption (estimated)

Particulars	Percentage
Raw material counter (kacha)	30%
Raw material roll (kacha)	12%
Finished material motor(pakka)	15%
Dust collecting blower motor	17%
Polisher motor	13%
Finished material roll	11%
Lighting	1%
Total	100%

This is represented graphically in the figure below:

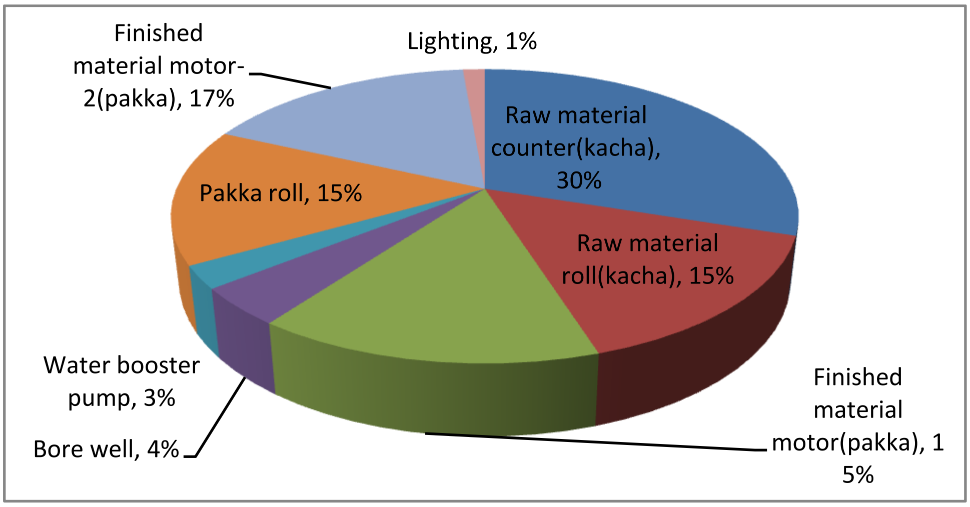

Figure 6: Area wise electricity consumption

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).

3.3.2 Sourcing of electricity

The unit is drawing electricity from only one source:

- Utility (M.P. Paschim Kshetra Vidyut Vitaran Co. Ltd) through regulated tariff
- There is no DG set in the unit

As there is no DG set in the unit, the share of grid is 100% in electricity cost. It is about Rs. 6.76 Lakh per annum.

3.3.3 Supply from utility

Electricity is supplied by M.P. Paschim Kshetra Vidyut Vitaran Co. Ltd. The unit has one LT energy meter provided by the distribution company within its premises. Details of the supply are as follows:

a)	Power Supply	:	440 V line
b)	Contract Demand	:	130 HP
c)	Nature of Industry	:	LT – G

The tariff structure is as follows:

Table 7: Tariff structure

Particulars	Tariff Structure	
Present energy charge	5.74	Rs./kWh
Electricity duty	0.516	Rs./kWh
TOD rebate	0	Rs./kWh
TOD surcharge	0	Rs./kWh
Power factor surcharge	0	Rs./kWh

(As per Sep-2015 bill)

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

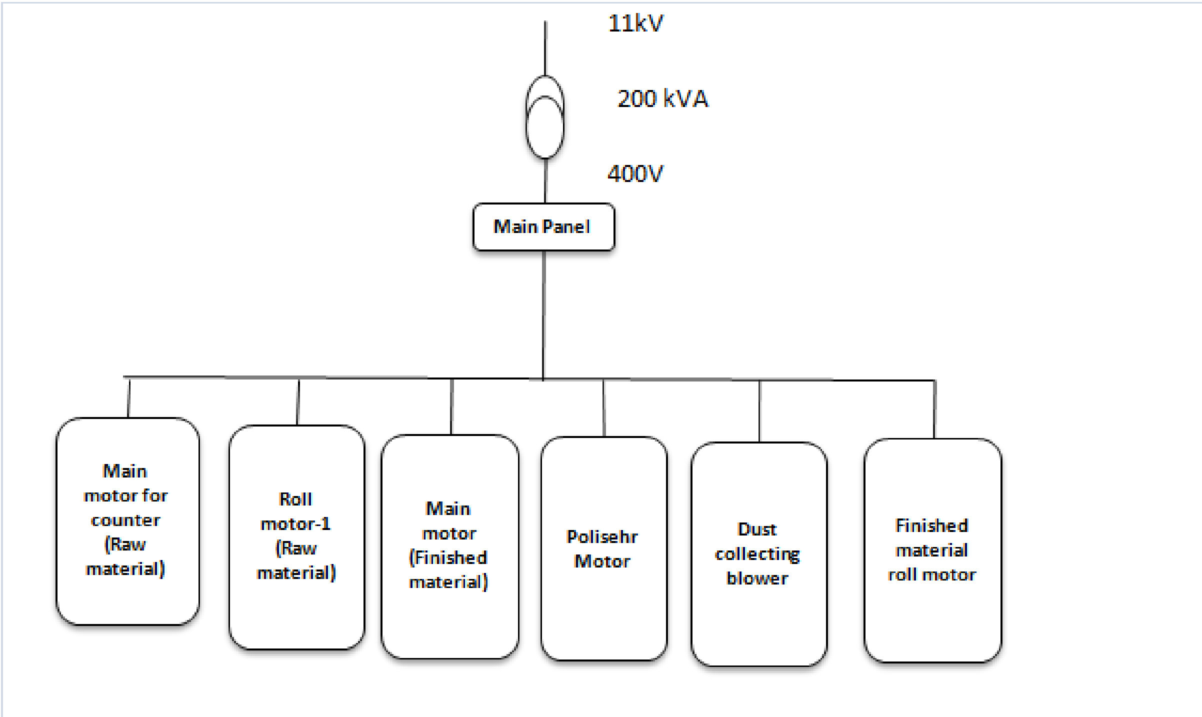

Figure 7: SLD of electrical load

Power factor

The power factor of the unit varies from 0.78 to 0.97 according to electricity bill. However, during the energy audit study, measurement of the power factor was done by logging the main incomer. The average power factor measured was found to be 0.68 with the maximum being 0.93.

3.3.4 Month wise electricity consumption

Month wise total electrical energy consumption from different sources is shown as under:

Table 8: Electricity consumption & cost

Electricity consumption		
Months	**kWh**	**Rs./month**
Dec-14	11,113	78,260
Jan-15	10,363	73,148
Feb-15	19,249	122,130
Mar-15	5,614	46,916
Apr-15	6,735	61,940
May-15	10,973	62,722
Jun-15	7,919	47,270
Jul-15	3,597	23,849
Aug-15	3,981	42,544
Sep-15	2,674	33,928
Oct-15	2,189	39,475
Nov-15	4,173	43,705
Total	**88,580**	**675,887**

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

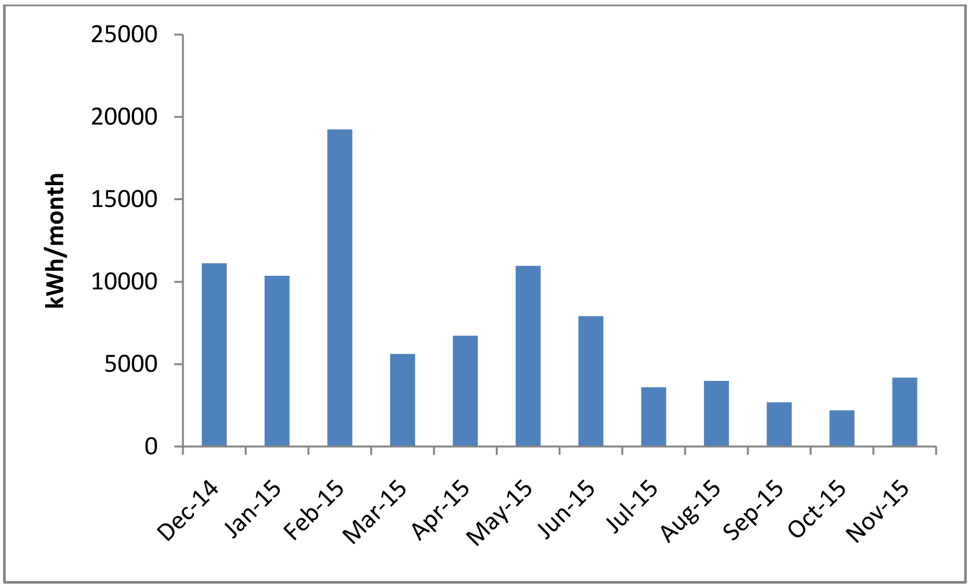

Figure 8: Month wise variation in electricity consumption from different sources

As shown in the figure above, the consumption of electrical energy was on the higher side during the month of Feb-2015. However, the electricity consumption during the months of Sep and Oct-2015 was less, because the production during those months was low. The corresponding month wise variation in electricity cost is shown graphically in the figure below:

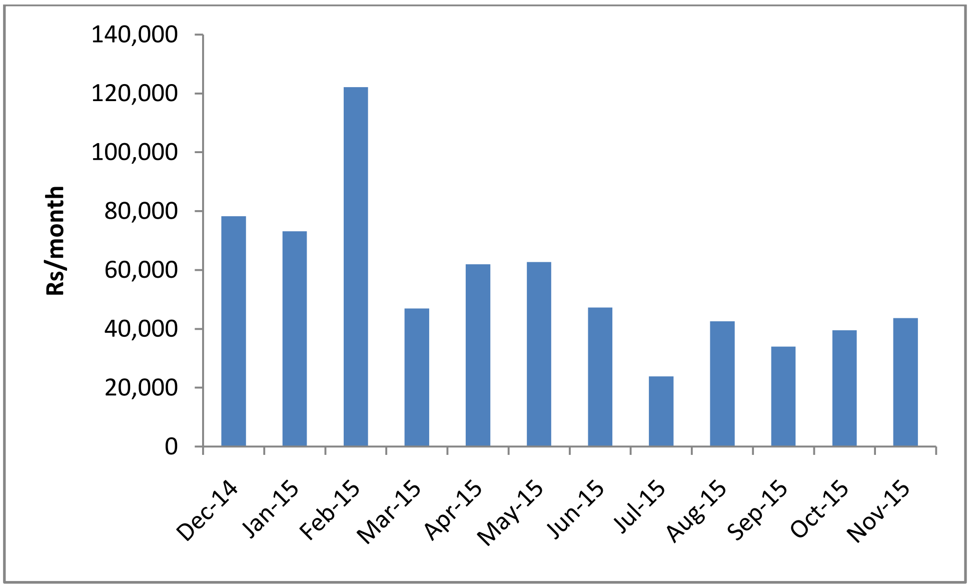

Figure 9: Month wise variation in electricity cost from different sources

The annual variation in cost of energy from utility is shown in the figure below:

3.4 Analysis of thermal consumption by the unit

Fuel used in the hot air generator is wood which is purchased at the rate of Rs. 6 to 7/kg. Average annual wood consumption is 624 quintals costing Rs. 3.62 Lakh.

3.5 Specific energy consumption

Annual production data was provided by the unit. Based on the available information, various specific energy consumption parameters have been estimated as shown in the following table.

Table 9: Overall specific energy consumption

Parameters	Unit	Value
Annual grid electricity consumption	kWh	88,580.00
Annual wood consumption	kg	62,397.00
Annual energy consumption; MTOE	kgOE	25,713.01
Annual energy cost	Lakh Rs.	10.38
Annual production	MT	4377
SEC; Electrical	kWh/MT	20.24
SEC; Overall	kgOE/MT	5.87
SEC; Cost based	Rs./MT	237.15

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
  - 1kgOE : 10,000 kCal
- GCV of wood : 2,900 Kcal/kg
- CO_2 Conversion factor
  - Grid : 0.89 kg/kWh
  - Wood : 1.12 tons/ ton

3.6 Baseline parameters

Following are the general baseline parameters, which have been considered for 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 the landed rates.

Table 10: Baseline parameters

Parameters	Unit	Value
Electricity rate	Rs./ kWh	5.74
Weighted average electricity cost	Rs./ kWh	6.26
Annual operating days	days	330
Operating hours per day	h/day	12
Production	MT/y	4,377.34
GCV of grid electricity	kCal/kWh	860
GCV of wood	kCal/kg	2,900
GCV of diesel	kCal/kg	11,840
Cost of diesel	Rs./l	52

Density of diesel	kg/l	0.8263
CO_2 Emission factor - grid	kg/kWh	0.89
CO_2 Emission factor - wood	tons/ton	1.12

3.7 Identified energy conservation measures in the plant

Diagnostic Study

A detailed study was conducted during BEA in the unit. Observations regarding energy performance of various processes / equipment were recorded, and a few ideas of EPIAs were developed. Summary of key observations is as follows:

3.7.1 Electricity Supply from Grid

The electrical parameters at the main electrical incomer feeder from the supplier- M.P. Paschim Kshetra Vidyut Vitaran Co. Ltd, were recorded by using the portable power analyzer instrument.

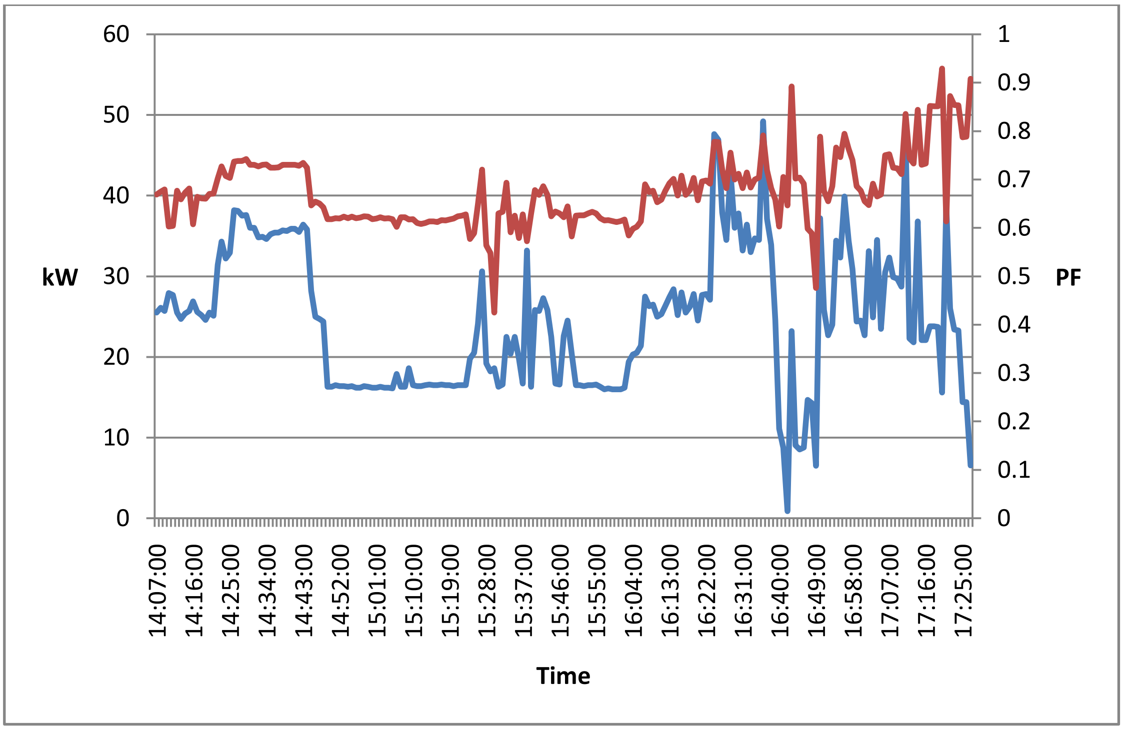

Figure 10: Load (kWh) and PF profile

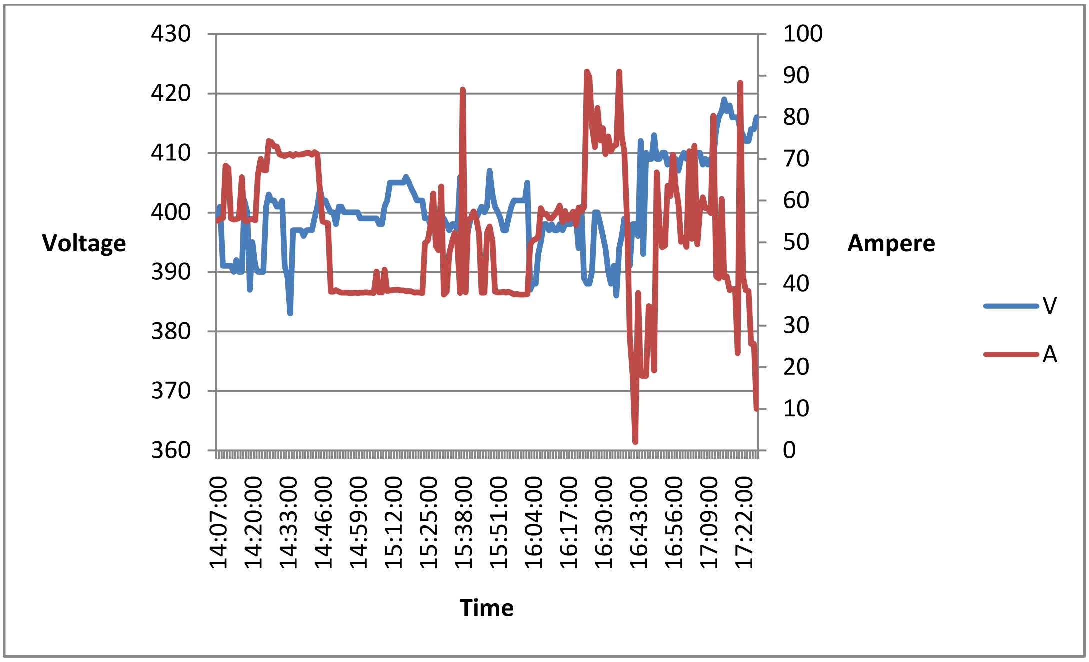

Figure 11: Voltage and Current profile

Following observations have been made:

Table 11: Diagnosis of electric supply

Name of area	Present set-up	Observations during field study & measurements	Ideas for energy performance improvement actions
Electricity demand	M.P. Paschim Kshetra Vidyut Vitaran supplies the required power to the unit through a transformer. The unit has a LT connection. The contract demand of the unit is 130 H.P	As per the electricity bill analysis, it was found that the electricity tariff was Rs. 6.26/kWh and the PF according to the electricity bill was about 0.90 (Average from Jan-15 to Oct-15).	No EPIAs suggested.
Power factor	Unit has an LT connection and billing is in kWh. PF paid by the unit is as per the utility bill.	The average PF found during the measurement was 0.68 and maximum was measured as 0.93.	No EPIAs suggested.
Voltage variation	The unit has no separate lighting feeder and no servo stabilizer for the same.	The average voltage profile of the unit was 401 V.	No EPIAs suggested.

3.7.2 Electrical consumption areas

The equipment-wise consumption of electrical energy was measured in consultation with the unit. This is indicated in Table 6 of this report. Around 99% of energy consumption is for carrying out dal milling operations and about 1% is for lighting.

Details of the observations, measurements conducted and ideas generated for 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>Existing Motors - Main motor of pakka counter (15 HP), main motor of kaccha counter (30 HP), Emery Roll motor (15 HP), Dust collector motor (20 HP), Polisher machine motor (20 HP), and 5 number of elevator motors (5 X 3 HP each)</td><td>All the mentioned motors were very old and were running for over 8 years. During this time-period, they have been re-wounded several times which has de-graded their efficiencies.</td><td>Study was conducted on all the mentioned motors and the total results are tabulated below.
The results of the study are as below:
<table>
<tr><th>Machine</th><th>Avg. Voltage</th><th>Total kW</th><th>Avg. PF</th></tr>
<tr><td>Existing all motors</td><td>406</td><td>81.50</td><td>0.78</td></tr>
</table></td><td>Replacement of existing motor with EE motor</td></tr>
<tr><td>Compressor</td><td>There is a screw compressor in the unit for supplying compressed air to sortex machine.</td><td>Study was conducted on Compressor at the time of BEA.
The results of the study are as below:
<table>
<tr><th>Machine</th><th>Avg. Voltage</th><th>Avg. kW</th><th>Avg. PF</th></tr>
<tr><td>Compressor</td><td>404</td><td>10.97</td><td>0.71</td></tr>
</table></td><td>VFD on Compressor is suggested</td></tr>
<tr><td>Dust collecting blower-1 for sortex machine</td><td>The plant has installed a dust collecting blower of 12.5 H.P for collecting dust from sortex machine</td><td>Study was conducted on dust collecting blower-1 at the time of BEA.
The results of the study are as below:
<table>
<tr><th>Machine</th><th>Avg. Voltage</th><th>Avg. kW</th><th>Avg. PF</th></tr>
<tr><td>Big blower</td><td>400</td><td>8.04</td><td>0.79</td></tr>
</table></td><td>VFD on dust collecting blower-1 is suggested</td></tr>
<tr><td>Dust collecting blower-2 for sortex machine</td><td>The plant has installed a chilka collecting blower of 12.5 H.P for collecting chilka from sortex machine</td><td>Study was conducted on chilka collecting blower-2 at the time of BEA.
The results of the study are as below:
<table>
<tr><th>Machine</th><th>Avg. Voltage</th><th>Avg. kW</th><th>Avg. PF</th></tr>
<tr><td>Small blower</td><td>400</td><td>3.33</td><td>0.79</td></tr>
</table></td><td>No EPIAs suggested for this blower</td></tr>
<tr><td>Hot air supply blower for dryer (Dryer FD fan)</td><td>A FD fan of 10 H.P is installed for supplying hot air to the dryer</td><td>Study was conducted on FD fan of dryer at the time of BEA.
The results of the study are as below:
<table>
<tr><th>Machine</th><th>Avg. Voltage</th><th>Avg. kW</th><th>Avg. PF</th></tr>
<tr><td>Small blower</td><td>407</td><td>8.74</td><td>0.92</td></tr>
</table></td><td>No EPIAs suggested on FD fan of dryer</td></tr>
<tr><td>(ID-cum-combustion air supply) fan of hot air generator</td><td>An ID fan of 1.5 HP is installed with the Hot air generator which also supplies the combustion air to the hot air generator</td><td>Study was conducted on ID fan of hot air generator at the time of BEA.
The results of the study are as below:
<table>
<tr><th>Machine</th><th>Avg. Voltage</th><th>Avg. kW</th><th>Avg. PF</th></tr>
<tr><td>ID fan</td><td>405</td><td>1.05</td><td>0.68</td></tr>
</table></td><td>No EPIAs suggested on ID fan of hot air generator</td></tr>
</table>

3.7.3 Thermal consumption areas

As discussed in the earlier sections, about 35% of total energy cost of the plant and 70% of the total energy usage is in the hot air generator of dryer. The details of present set-up, key observations made and potential areas for energy cost reduction have been mentioned in the table below:

Name of area	Present set-up	Observations during field study & measurements	Proposed energy performance improvement actions
Hot air Generator	The fuel used for heating the air in the hot air generator is wood. The air required for combustion of wood in hot air generator is supplied by using the ID fan which was also performing the function of a FD fan	The amount of wood required for generating the requisite hot air for drying the dal was calculated during BEA. The O_2 level in flue gases coming out of the hot air generator was about 13.23%. This reflects high amount of excess air supplied than required for efficient combustion. This also results in high heat loss due to dry flue gases. During the field study, the skin temperature of the dryer was measured to be 81°C which is high. This results in loss of heat from surface of dryer due to radiation and convection.	Control of excess air supplied for combustion in hot air generator Insulation of hot air generator is proposed

4 EE TECHNOLOGY OPTIONS AND TECHNO–ECONOMIC FEASIBILITY

During BEA of the plant, all energy consuming equipment and processes were studied. The analysis of all major energy consuming equipment and appliances were carried out, which have been already 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: Replacement of old plant motors with EE motors

Technology description

The new EE motors are more efficient than the old and several times re-wounded motors. They consume less power than the old motors resulting in energy savings.

Study and investigation

The unit has raw material counter common motor (30 HP) which runs 8 elevators, 1 screw conveyor and 4 cleaners with fans; a finished material counter common motor (15 HP) which runs 13 elevators, 6 cleaners with fans, 2 grinders (Chakki) and a dust collecting blower which are very old and re-wounded several times. Apart from them, the plant also has an emery roll motor (15 HP), dust collector blower motor (20 HP), polishing machine motor (20 HP) and individual motors for 5 elevators each of 3 HP. All these motors were very old and several times re-wound. The running efficiencies of these motors have de-graded due to wear and tear and effects of re-winding them several times. During BEA, these motors were studied and it was found that their efficiencies were poor.

Recommended action

It is recommended to replace these motors with new energy efficient motors. The cost benefit analysis for this energy conservation measure is given below:

Table 12: Cost benefit analysis (EPIA 1)

Particulars	Units	As Is	To Be
Rated capacity of main motor - Pakka counter	HP	15	15
Rated capacity of main motor - Kaccha counter	HP	30	30
Rated capacity of emery roll motor	HP	15	15
Rated capacity of dust collector motor	HP	20	20
Rated capacity of polisher motor	HP	20	20
Rated capacity of 5 elevators	HP	15	15
Total kW of all motors	kW	85.79	85.79
Total power consumed by all the motors	kW	81.50	75.50
Running hours per day	h / day	12	12
Running days per year	days / y	300	300
Total energy consumption	kWh / y	322,742	298,961
Total energy savings per year	kWh / y		23,781

Cost of electricity	Rs. / kWh	6.26	6.26
Total monetary savings per year	Rs. / y		148,869
	Rs. Lakh / y		1.49
Total Investment	Rs. Lakh		4.55
Simple payback period	y		3.06

4.2 EPIA 2: VFD on dust collection blower-1 from sortex machine

Technology description

Installation of VFD on the blower-1 of sortex machine controls the speed of blower according to the flow of dusty-air which results in reduction of power consumption when flow of air is less.

Study and investigation

The unit has a dust collection blower-1 for sortex machine of 12.5 HP rated which sucks dust from sortex machine. The flow rate of air is not constant and depends on the process. During audit, it was observed that the inlet damper of the blower was controlling the air-flow to the blower which was increasing the pressure drops across it. By installing a VFD and controlling speed of blower during periods of less air flow will result in power savings during those periods.

Recommended action

It is recommended to fully open the dampers of the blower and control air flow through it by installing VFD with the blower motor and controlling its speed as per load requirements.

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

Table 13: Cost benefit analysis (EPIA 2)

Parameters	Unit	As Is	To Be
Motor Rating	kW	9	9
Average power consumption	kW	8	6.44
No of operating hrs per day	h/day	12	12
Operating Days per Year	day/y	330	330
Average electricity consumption per year	kWh/y	31,856	25,485
Annual electricity saving per year	kWh/y	6,371	
Electricity Tariff	Rs./kWh	6.26	
Annual monetary savings	Rs. Lakh/y	0.40	
Estimate of Investment	Lakh Rs.	1.64	
Simple Payback	y	4.11	

4.3 EPIA 3: VFD on Compressor motor

Technology description

Installation of VFD on the screw type air compressor for sortex machine varies the speed of compressor motor according to the load requirements which results in reduction of average power consumption.

Study and investigation

The unit has installed a screw compressor of 18.5 kW rating for supplying compressed air to the sortex machine.

During audit, loading and unloading time of the compressor was measured and the average loading time was 30.6 seconds and average unloading time was 84.4 seconds. During unloading, the compressor does not do any useful work, so by installing a VFD, the compressor speed can be reduced, thereby reducing its power consumption during unloading periods.

Recommended action

It is recommended to install VFD on the compressor. The cost benefit analysis of energy conservation measure is given below:

Table 14: Cost benefit analysis (EPIA 3)

Parameters	Unit	As Is	To Be
Motor rating	kW	19	19
Average power consumption during loading	kW	21	-
Average power consumption during unloading	kW	10.3	-
On Load time in percentage	%	26.61%	-
Off Load time in percentage	%	73.39%	-
Average power consumption	kW	13	10.58
No of operating hrs per day	h/day	8	8
Operating days per year	day/y	330	330
Average electricity consumption per year	kWh/y	34,648	27,926
Annual electricity saving per year	kWh/y	6,722	
W. average electricity tariff	Rs./kWh	6.26	
Annual monetary savings	Rs. Lakh/y	0.42	
Estimate of investment	Lakh Rs.	1.69	
Simple payback	y	4.02	

4.4 EPIA 4: Control of excess air supplied for combustion in hot air generator

Technology description

It is necessary to maintain optimum excess air levels in combustion air supplied for complete combustion of the fuel in hot air generator of dryer. The excess air levels are calculated based on oxygen content in the flue gases. The theoretical air required for combustion of any fuel can be estimated from the ultimate analysis of the fuel. All combustion processes require a certain amount of excess air in addition to the theoretical air supplied. Excess air supplied needs to be maintained at optimum levels, as too much of excess air results in excessive heat loss through the flue gases. Similarly, too little excess air results in incomplete combustion of fuel and formation of black colored smoke in flue gases.

In the wood fired hot air generator, fuel is fired with too much of excess air as can be estimated from the high amount of oxygen percentage in the flue gases. This result in formation of excess flue gases, taking away the heat produced from the combustion and increasing fuel consumption. This also results in formation of excess GHG emissions. It is suggested to control the combustion air being supplied by the induced draft fan (common ID and FD fan) by installing a flue gas analyzer on the flue gas duct and setting the oxygen content in flue gas to 5% by fixing the air-fuel ratio by manually adjusting the combustion air suction damper and maintaining fixed damper positions for different quantities of hot air generation requirements.

Study and investigation

At the time of BEA, it was found that there was no proper measurement and control system installed to maintain the optimum excess air levels. There is no combustion air flow control mechanism for maintaining proper combustion of the fuel. It was found that the oxygen level in the flue gases of the hot air generator was 13.23% which indicates very high excess air levels resulting in high heat loss due to dry flue gas from the hot air generator.

Recommended action

Since the unit is using wood fired hot air generator, the control of excess air is recommended by installing on-line flue gas (oxygen) level indicator on the flue gas duct and setting the oxygen content in flue gas to 5% by fixing the air-fuel ratio by manually adjusting the combustion air suction damper and maintaining fixed damper positions for different quantities of hot air generation requirements.

As a thumb rule, reduction in every 10% of excess air will save 1% in specific fuel consumption. The cost benefit analysis of energy conservation measure is given below:

Table 15: Cost benefit analysis (EPIA 4)

Parameters	UOM	Present	Proposed
Oxygen level in flue gas	%	13.23	5.00
Excess air level	%	170.39	31.25
Flue Gas temperature	^{0}C	120.00	120.00
Saving in fuel	With every 10% reduction in excess air leads to savings in fuel consumption by 1%		
fuel consumption	kg/y	62,397	53,715
Saving in fuel consumption	kg/y		8,682
Cost of fuel	Rs./kg	6	6
Savings in fuel cost	Rs. Lakh/y		0.52
Power consumption by ID fan	kW	5.07	5.07
Annual operating hours	h/y	6,000	6,000
Electrical energy consumed	kWh/y	30,441	30,441

Savings in electrical energy	kWh/y	0.00
Savings in terms of cost of electrical energy	Rs. Lakh/y	0.00
Total savings	Rs. Lakh/Y	0.52
Estimated investment(online oxygen level indicator)	Rs. Lakh	0.95
Simple payback period	y	1.82

4.5 EPIA 5: Insulation of hot air generator

Technology description

Insulating the surface of dryer reduces the radiation and convection losses from the hot air generator surface which in turn helps in saving of fuel fired in the hot air generator.

Study and investigation

The unit has a dryer for drying the dal. The skin temperature of the dryer was measured to be 81^{o}C (avg.) at certain locations

Recommended action

It is recommended to repair and re-insulate the damaged insulation portions of the dryer surface to prevent convection and radiation losses.

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

Table 16: Cost benefit analysis (EPIA 5)

Parameters	Unit	As Is	To Be
Circumference	m	4.22	4.22
Height	m	2.5	2.5
Area	m^2	10.55	10.55
Surface temperature	^{0}C	81	35
Ambient temperature	^{0}C	25	25
No of running hours per day	h	6	6
No of days of operation	days	125	125
Total heat loss	kCal/h	7,562	1,108
Energy Saving	kCal/h	6,455	
Annual energy savings	kCal	13,038,070	
Annual savings in fuel	l/y	8,644	
Annual monetary savings	Lakh Rs./y	0.52	
Investment estimated	Lakh Rs.	2.26	
Payback	y	4.36	

5 LIST OF VENDORS

The details of empanelled local service providers with Bureau of Energy Efficiency, Ministry of Power, GoI for energy equipments are given in the table below:

Table 17 List of empanelled local service providers

S.No.	Name of Agency	Address	Name of Contact Person	Contact Number & Email ID	Technology Supplied
1	Bharmal Traders	20, Udhyog Puri, Nemawar Road, Indore, MP	Mr. Hatim Ali	9827023499; sales@bharmaltraders.com	Electrical & Thermal Engineering (Installation and commissioning)
2	V K Four Agencies Pvt. Ltd	9, Mangal Compound, MR-11, Near BMW / Jaguar Showroom, Dewas Naka, A.B.Road, Indore - 452010. MP	Mr. Kayton Thakkar / Mr. P.K.Jakhetia / Mr. Yogesh Jog	0731 - 4064919, 4065918, 4041603; Vk4apl@gmail.com, vkfourapl@airtelmail.in	ABB make motors, VFDs, Starters, Air compressors (Indo-air make), Pumps (KSB), spares
3	Prithvi Power Engineers Pvt. Ltd.	19/4, West Patel Nagar, New Delhi - 110008	Mr. Abhishek Vigh	0120-425688; prithvipowers@yahoo.com	O2 analyzers, VFDs (Yaskawa make), Control systems
4	Lloyd Insulations (India) Ltd.	Punjstar Premises, 2 Kalkaji Industrial Area, New Delhi - 110019	Mr. K.K.Mitra	011-30882874, 30882877; kk.mitra@lloydinsulation.com, lloyd@del2.vsnl.net.in	Insulation and Refractories
5	Wesman Thermal Engineering Processes Pvt. Ltd.	Wesman Centre, 8 Mayfair Road, Kolkata - 700019	Mr. Malay Ghosh	033-22908050; malay-ghosh@wesman.com	Gas burners, PLC based combustion control system, waste heat recovery, VFDs, Electrical Panels
6	Automation & general electric co.	Plot no. 151, A/B Scm, No. 94, Piplayahna Square (near ocean motor), Indore-452001; MP	Mr. Ashish Patidar	08458860001; 0731-8963996399; patidar@ageco.in	Electric motors - Havells and other makes
7	Yash Engineering & Services	151, Nyay Nagar, Sukhliya, Indore, MP	Mr. Yatendra Hande	0731-4032731; yashenggservices@gmail.com	Air compressor, VFD on air compressors
8	Patel Brothers	97, Ninas Choraha, Ujjain, MP	Mr. Khushwant Patel	0734-2551135; patelbrosujn@yahoo.co.in	Engineering, Installation and commissioning

9	Digital Marketing Systems Pvt. Ltd.	122, Kanchan Bagh, Indore - 452001, MP	Mr. Prafulla Jain	0731-3046800; prafulla@digitalcontrols.org	VFDs, PID controllers
10	PM Projects & Services Pvt. Ltd.	14-B, Ratlam Kothi, Near Hotel Omni Palace, Indore - 452001, MP	Mr. Milind Hardikar	09826052924; 0731-4046265; info@pmprojectsindia.com	Engineering, Design, Installation and commissioning; Thermal heating system, Automation
11	Emerald Infrastructure	76/24, Maksi Road Industrial Area, Behind R.C.Tiles, Ujjain - 456010, MP	Mr. Dharmendra Sharma	0734-2525896; 09926067886; dharm.sharmaa@gmail.com	Engineering, Fabricator, Installation & commissioning