United Nations Industrial Development Organization

Global Environment Facility

Bureau Of Energy Efficiency

Detailed Energy Audit Report

M/s Kohinoor Forgings
Nagaur Handtools Cluster

Under GEF-UNIDO-BEE project

Promoting energy efficiency and renewable energy in selected MSME clusters in India

January 2016

pwc

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List of abbreviations

APFC	Automatic Power Factor Controller
AVVNL	Ajmer Vidyut Vitran Nigam Limited
BEE	Bureau of Energy Efficiency
DISCOM	Distribution Company
GEF	Global Environment Facility
HP	Horsepower
kCal	Kilo Calories
kVA	Kilo Volt Ampere
kVAr	Kilo Volt Ampere reactive
kW	Kilo Watt
kWh	Kilo Watt Hour
MSME	Micro, Small and Medium Enterprises
MT	Metric Tonne
PMU	Project Management Unit
UNIDO	United Nations Industrial Development Organization

Acknowledgement

We sincerely thank GEF- UNIDO-BEE for associating PricewaterhouseCoopers Private Limited (PwC) in its prestigious project “Promoting energy efficiency and renewable energy in selected MSME clusters in India” which involves developing and promoting market environment for introducing energy efficiencies in process applications in 12 selected energy-intensive MSME clusters in India. Nagaur handtools cluster is one of them.

We express our sincere gratitude to all following officials of GEF-UNIDO-BEE PMU for their valuable support and guidance during the project:-

- Mr. Milind Deore, Energy Economist, BEE
- Mr. Abhishek Nath, National Project Manager, UNIDO
- Mr. Niranjan Rao Deevela, National Technology Coordinator, UNIDO
- Mr. Ashish Sharma, Project Engineer, BEE

PwC is thankful to Nagaur Handtool Manufacturer’s Association for extending support for this assignment. We are also thankful to Mr. Imdaad Hussain, Owner, Kohinoor Forgings and his team for giving full support during the energy audit. We would like to thank Mr. Rajiv Singhal, Cluster Leader, GEF-UNIDO-BEE Project for providing on-field support during the energy audit.

Executive Summary

Kohinoor Forgings is located in Basni Industrial Area of Nagaur and is involved in manufacturing of claw hammers. It uses EN 8 as raw material which is sheared into appropriate size through a shearing machine. Thereafter, blanks is fed to induction billet heater for heating up to a temperature of around 1150 – 1200 °C. After which the heated blank is rolled and pressed to give the shape of claw-type hammer. Then, the excess material is cut and end cutting is done to ensure the correct size of final product.

During the energy audit, following energy efficiency opportunities were identified:

S.No.	Energy Efficiency measure	Investment (INR)	Savings (INR)	Payback period (months)
1	Installation of poly-V belt on drive shafts	16,950.6	30166.50	6.7

The details about the unit, load profiles, efficiency of billet heater and description of energy conservation measures are discussed in appropriate sections of the report.

1. Project Background

1.1. Background of the project

GEF-UNIDO-BEE is developing and promoting market environment for introducing energy efficiencies in process applications in 12 selected energy-intensive MSME clusters in India which includes Nagaur handtools cluster also.

The overall motive of this assignment is to improve the productivity and competitiveness of units as well as to reduce overall carbon emissions and improve the local environment.

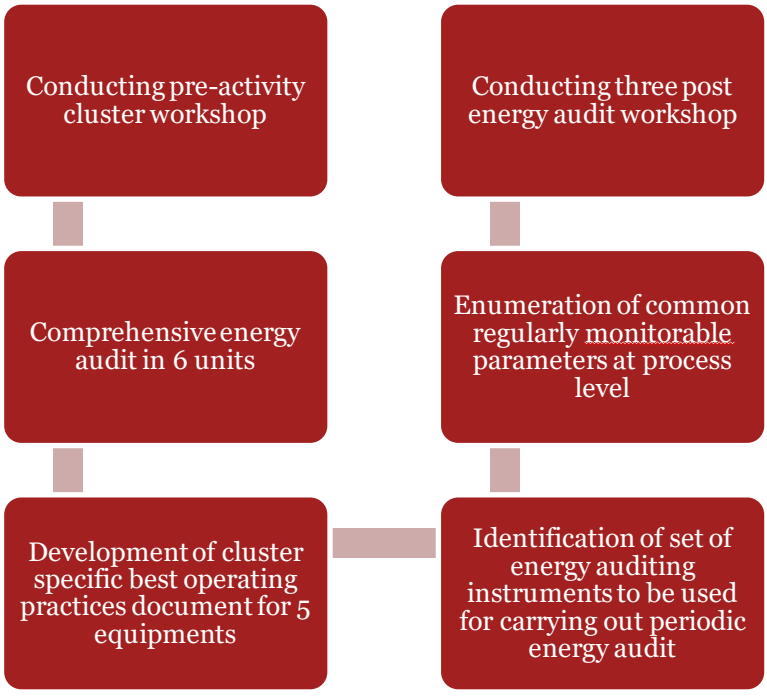
1.2. Introduction to assignment

Under GEF-UNIDO-BEE project 'Promoting energy efficiency and renewable energy in selected MSME clusters in India' India', PwC has been appointed for conducting activities of energy audit and dissemination in the Nagaur Handtools Cluster.

1.3. Scope of services

The activities being conducted by PwC under this assignment are shown at **Error! Not a valid bookmark self-reference.**.

Figure 1: Scope of services



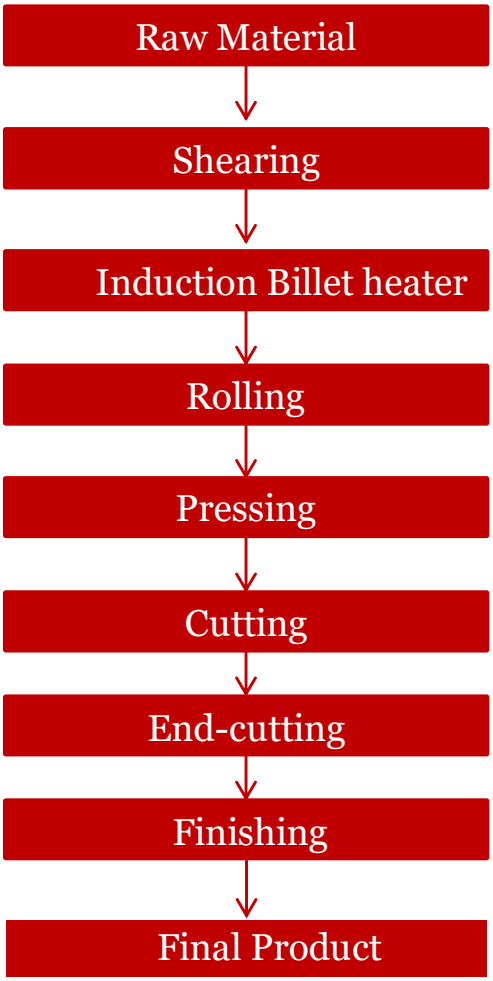
This current report has been prepared under the task 2 of above scope of services i.e. conducting comprehensive energy audits in 6 units in the cluster.

2. Energy Audit at Kohinoor Forging

2.1. Process flow

The process flow at Kohinoor Forging is shown at Figure 2 below. The raw material (EN 8) is sheared into appropriate size through a shearing machine. Thereafter, blanks is fed to induction billet heater for heating up to a temperature of around 1150 – 1200 °C. After which the heated blank is rolled and pressed to give the shape of claw-type hammer. Then, the excess material is cut and end cutting is done to ensure the correct size of final product. Post end cutting final finishing is provided. This is depicted in the following figure.

Figure 2: Process flow



The specialized instruments that were used during the energy audit included:

- Non-contact Infrared Thermometer (Testo-845 and Extech)
- 3-phase Power Analyzer (Krykard, Circuitor)
- Digital Tachometer (Extech-461995)

Details about the make of energy audit instruments are provided at **Annexure A.**

This report presents the field measurements, design and operational data and data analysis.

2.2. Baseline information of Kohinoor Forging

In order to assess the present energy consumption levels and possible energy efficiency measures at 'Kohinoor Forging' basic and general information was collected during the audit conducted on 8th and 9th June 2015.

The details of energy audit of unit are provided below.

2.2.1. About the Unit

This unit is located in Basni Industrial Area of Nagaur. The baseline profile of the unit is presented in Table 1.

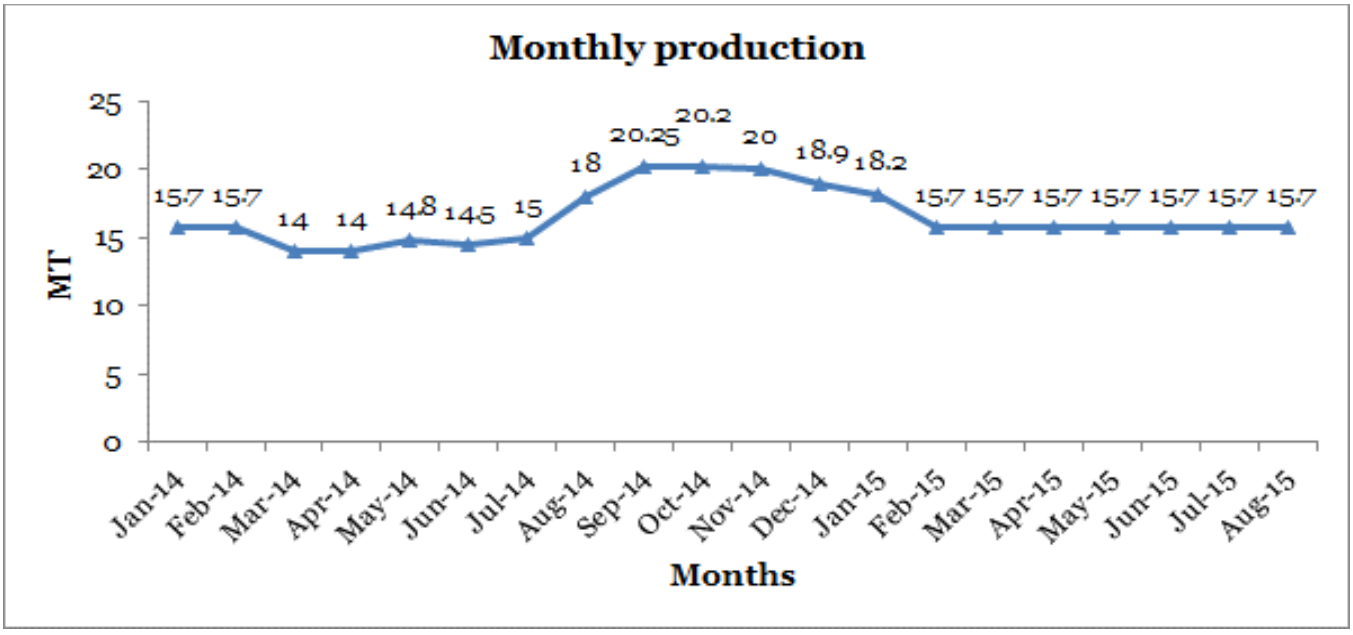
Table 1: Baseline profile

Parameters	Details
Name of the unit	Kohinoor Forging
Name & contact number of contact person	Mr. Imdaad Hussain Mobile - 9460223142
Date of Audit	8th and 9th June 2015
Raw material	EN-8
Final product	Hammer (1 pound)
Furnace	Induction billet heater
Fuel used	Electricity
Press hammer weight	500 kg
Daily production	2200 pieces
Operating hours/day	7 hours
Sanction load	150 kVA

2.3. Monthly trend of production

The audit team has collected monthly production data from the unit and the same has been depicted in the following figure.

Figure 3: Monthly production data



2.4. Past electricity bill analysis

The electricity bills of unit are based on medium industry tariff (HT-5) specified by AVVNL. The details of this tariff category are:

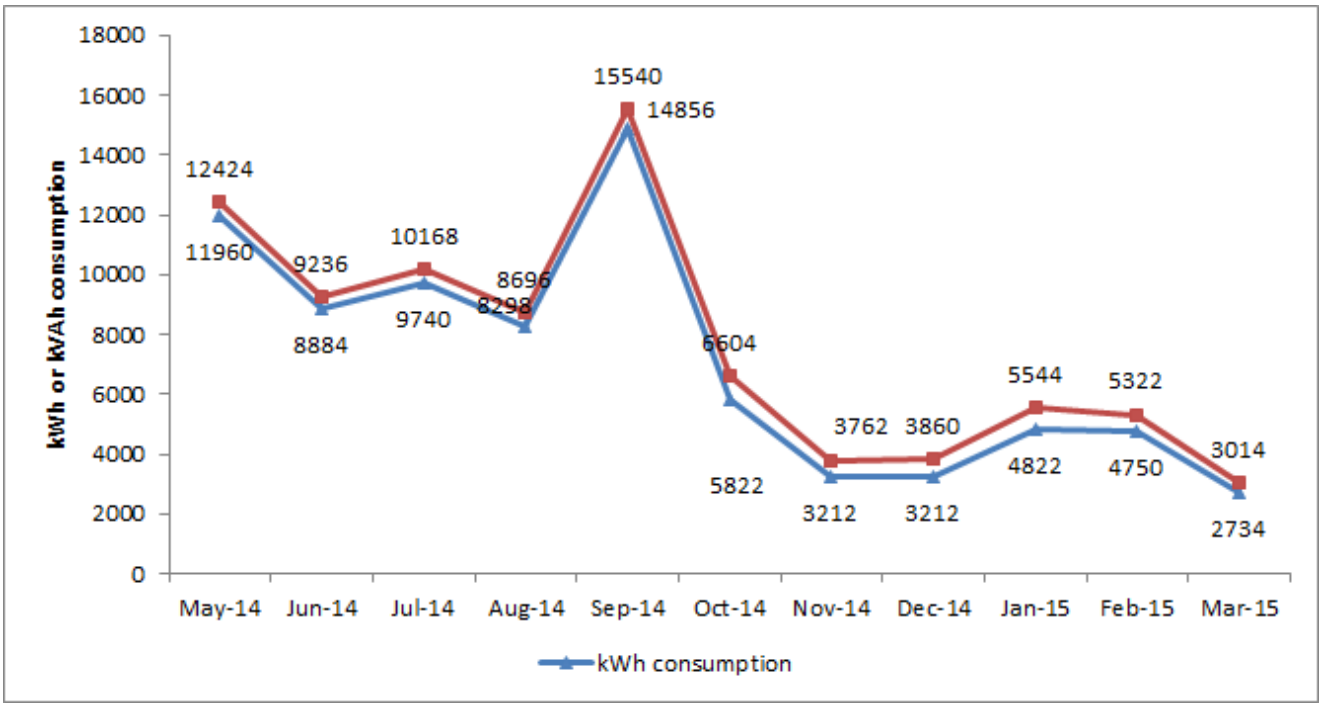
Table 2: Tariff description

Parameter	Specifications
Category description	Sanction load above 150 hp
Fixed charges	INR 150/ kVA
Energy charges	INR 5.5/ kWh

* Electricity tariff has been revised to INR 6.50 from March 2015

The team has collected electricity bills from January 2014 to February 2015 for the purpose of analysis. A graph showing pattern of energy consumption is shown below.

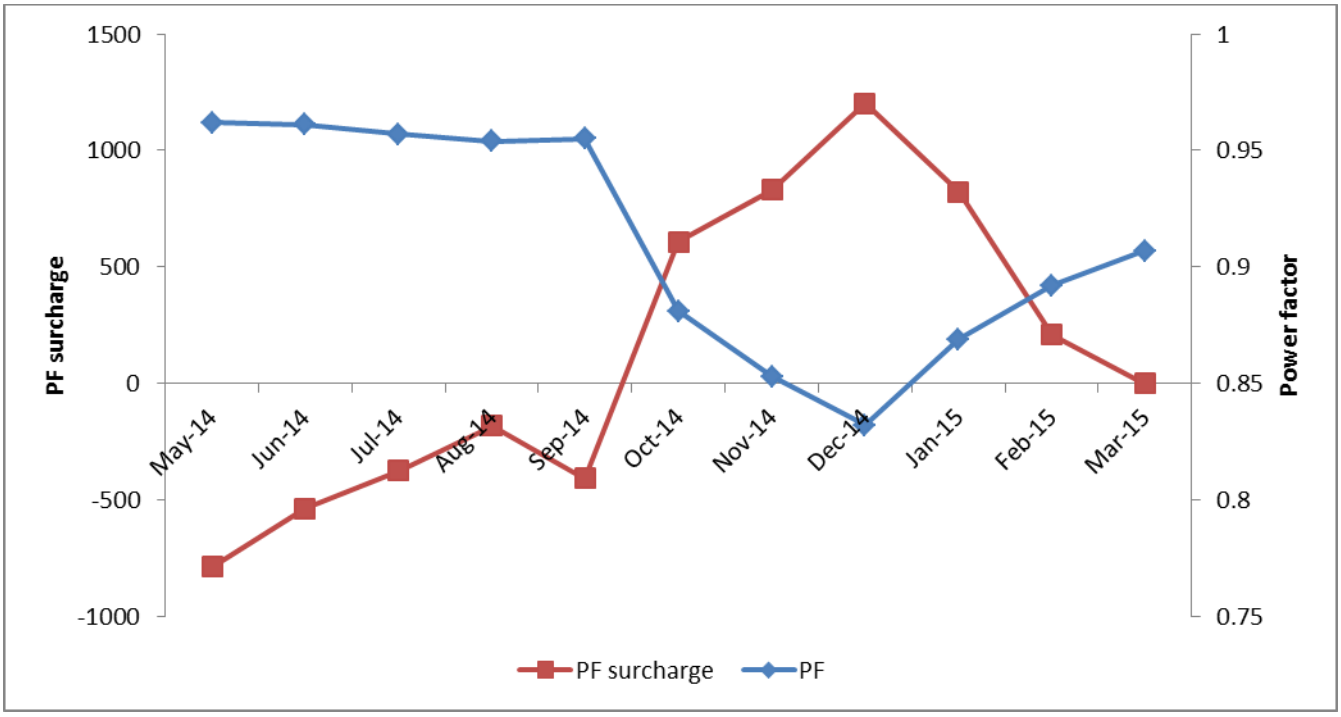
Figure 4: Energy consumption pattern



It can be inferred from above figure that the energy consumption peaked in month of September, apart from September consumption was high in the months of May, July and January. Further, the average energy consumption, for the said period, is 6571 kWh/month.

Similarly, the power factor profile as well as power factor surcharge paid by the unit are shown in following figure.

Figure 5: Power factor profile and power factor surcharge



Above graph depicts the relation between the Power factor surcharge or incentive paid/received by the unit. For power factor above 0.95, incentive was provided as a percentage of total Energy charge. From May'14 to September'14, unit was able to maintain the Pf above 0.95 and received a cumulated incentive of INR 2293. However, post May'14 due to power factor less than 0.95, unit paid a total surcharge of INR 3757.69.

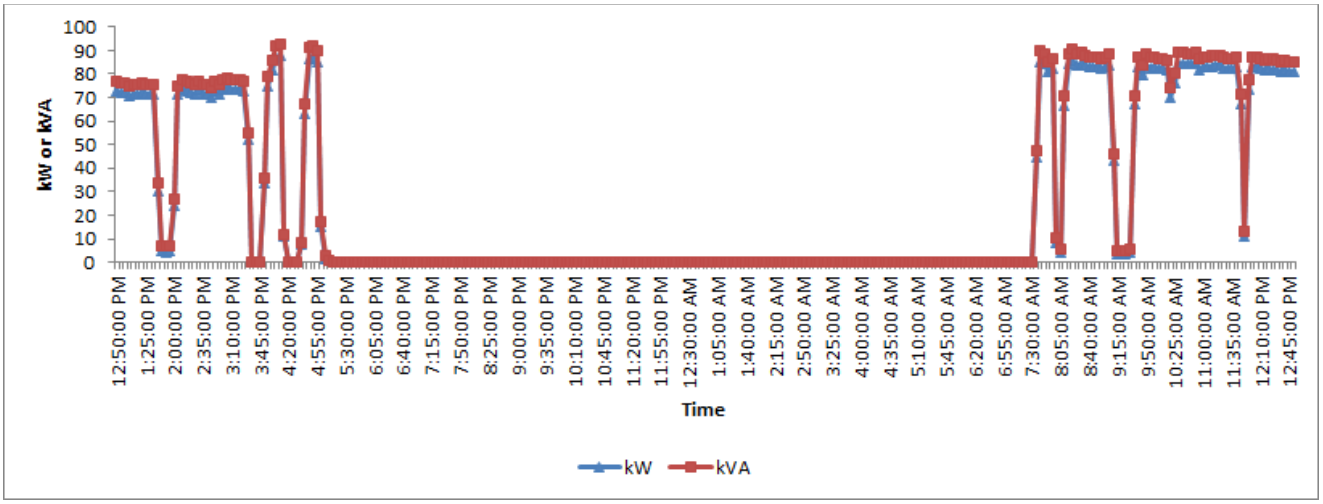
2.5. Load profile of Kohinoor Forgings Handtools

In order to derive the load profile of the unit, many electrical parameters were measured by using a sophisticated portable 3-phase power analyser (KRYKARD).

2.5.1. Load (kW) and apparent power (kVA) profile

Load profile and apparent power profile is a graph of the variation in the electrical load versus time. In any electrical system, the vector sum of the active power (kW) and reactive power (kVAr) make up the total (or apparent) power (kVA) used. This is the power generated by a generation station for the user to perform a given amount of work. Total Power is measured in kVA (Kilo Volts-Amperes) and the load or active power is measured in kW (kilowatts) and they become equal as and when the power factor approaches unity. Total electricity charges (units and demand) are based on the load or active power (kW) and apparent power (kVA).

Figure 6: Active power (Load) and apparent power profile during audit



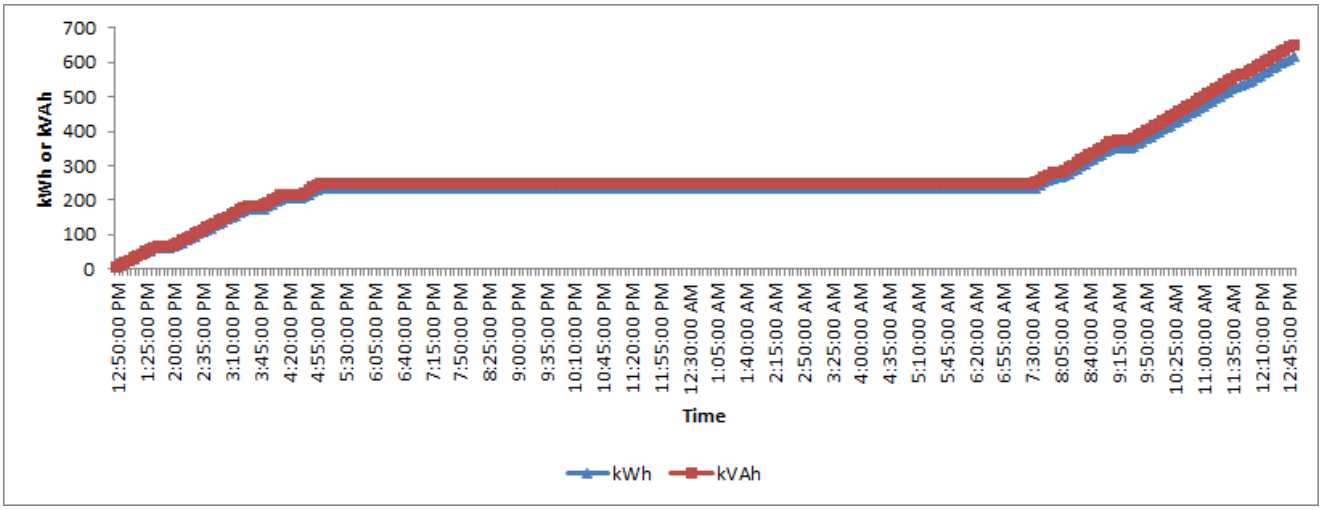
Observations made from the above graph:

- The maximum input power drawn by the unit is 87.6 kW. The graph shows that that the unit stopped operation around 4:45 PM and then began its operation from 7:20 AM onwards.
- Apparent power curve (kVA) line is almost parallel to the active power (kW) line indicating that power factor is on near the desired limit.

2.5.2. Electricity consumption (kWh) profile

Electricity consumption profile is the pattern of the consumption of electricity in the unit during the energy audit. The following graph captures the electricity consumption (kWh) profile of the unit:

Figure 7: Electricity consumption (kWh) and (kVAh) profile during audit



Observations made from the above graph:

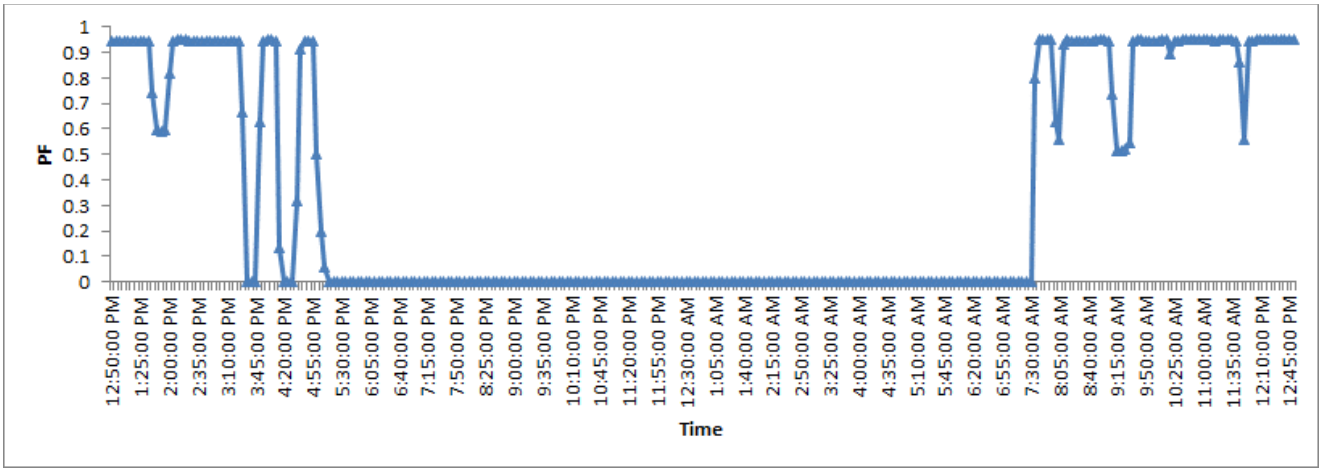
- The unit consumed nearly 140 kWh and around 170 kVAh during the recording period of almost 27 hours.

2.5.3. Power factor profile of the unit

Power factor is an important parameter for the unit since its billing is based on kVAh wherein power factor plays a major role. Also, DISCOM's supplying power to the units impose power factor surcharge on the bills in case the power factor is below 0.90.

The following graph captures the power factor profile of the unit:

Figure 8: Power factor profile during audit



Observations made from the above graph:

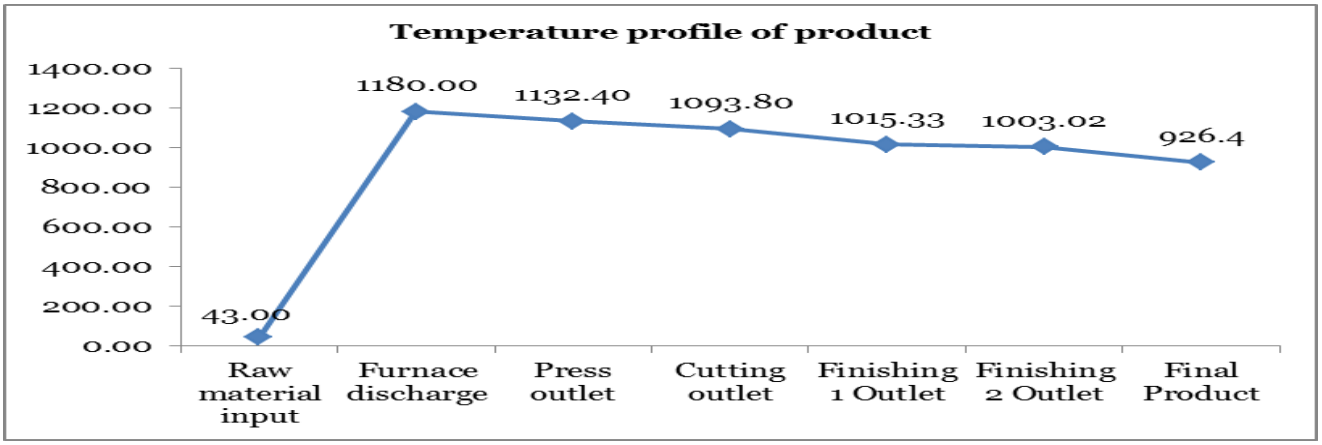
- The power factor of the unit is good which justifies the incentive which unit received over last 12 months.

2.6. Temperature profile of process

2.6.1.1. Temperature profile

During the baseline energy audit, temperature was measured at various stages of the process such as raw material temperature, heater discharge, rolling mill outlet, press outlet, cutting outlet and final product. The temperature profile is presented at following figure.

Figure 9: Temperature profile from raw material to final product



There is total temperature drop of around 254°C from heater outlet till final product.

2.7. Efficiency of induction billet heater

Furnace efficiency calculation by direct method involves comparison of useful heat content in the stock with the total electrical energy input to the heater. Efficiency for the induction billet heater is calculated by direct method in table below.

Table 3: Efficiency of induction billet heater

Parameter	Unit	Value
Production on audit day	kg/day	939.4

Parameter	Unit	Value
Billet output	kg/hr	134.2
Electricity consumption	kWh/hr	63.14
Conversion of kWh to KCal	kCal/kWh	860.42
Specific heat of the material	kCal/kg °C	0.12
Material charging temperature	°C	43.00
Material discharge temperature	°C	1,180.00
Induction billet heater efficiency	**%**	**33.71**

It can be seen from above table that efficiency of heater is around 33.71%.

2.8. Material loss during production

As observed in the process flow, material loss happens in following forms:

- Burning loss
- Cuttings after pressing
- End cuttings after sizing of product

We have captured these parameters to assess the burning loss as well as other material loss during the production process. The assessment is tabulated below:

Table 4: Material loss during production

Parameter	*Unit*	*Value*
Weight of raw material	kg/piece	0.427
Weight of final product	kg/piece	0.359
Weight of cuttings	kg/piece	0.052
Weight of end-cuttings	kg/piece	0.014
Material loss in cuttings & end-cuttings	kg/piece	0.066
Total material loss	kg/piece	0.068
Burning loss	kg/piece	0.0014
Burning loss	%	**0.34**
Total material loss	%	15.97

2.9. Specific energy consumption

Specific Energy Consumption for the product is calculated by aggregating individual specific energy consumption of fuel and electricity, as shown in table next.

Table 5: Specific energy consumption

Parameter	Unit	Value
Production	kg/day	939.4
Electricity consumption	kWh/day	616.95
Electricity consumption in heater	kWh/day	409.64
Specific electricity consumption	kWh/Tonne	**436**

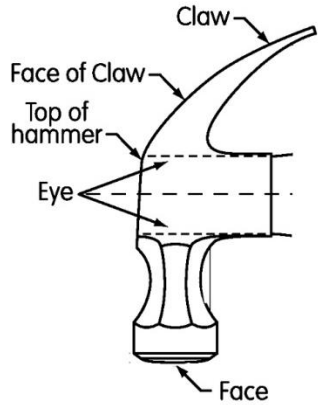
3. Energy Conservation Measures

During the energy audit, we have identified installation of poly-V belt in drive shaft as one of the dominant energy conservation measure. We have analysed this option next.

3.1. Measure 1: Installation of poly-V belt in drive shafts

Recommendation

Since the unit has different drives for different machines employing V-belts. However, if we replace existing V-belts with poly-V belts then it will give significant savings in electricity consumption of motors as well as lower slippage losses.



S.No.	M/C	Belt Type	Belt Length(inch)
1.	Face/ball shaping M/C	V - Belt	111.6
2.	Blank Cutting M/C	V - Belt	180
3.	Claw shaping/cutting M/C	V – Belt	123.6
4.	Bending/eye/end cutting M/C	V – Belt	156

Energy and financial savings

The following parameters and assumptions have been considered to estimate the energy savings and financial viability of this option:

Table 6: Installation of poly-V belt in drive shafts – Assumptions and parameters considered for estimation of energy and financial savings

Assumptions and Input parameters		
Assumptions		
Particulars	Unit	Value
Efficiency of V-belt	%	0.85
Efficiency of poly V-belt	%	0.92
Hours of operation per day	Hours	7
Annual operation days	Days	300
Tariff	INR/kWh	6.5
Present Scenario		
kW consumed	kW	29
kW at drive shaft	kW	24.65
Proposed scenario		
kW consumed	kW	26.79
kW at drive shaft	kW	24.65
Cost elements		
Cost of 9.3 feet poly-V belt	INR	3311.73
Cost of 15 feet poly-V belt	INR	5341.50

Cost of 10.3 feet poly-V belt	INR	3667.83
Cost of 13 feet poly-V belt	INR	4629.30
Total cost	INR	16950.36
Benefits		
Power savings	kW	2.21
Annual electricity savings	kWh/annum	4641
Monetary electricity savings	INR	30166.50
Simple payback period	Months	6.7

The implementation of this recommendation will help Kohinoor to save around INR 30,166.50 per year by installing poly-V belts with an investment of INR 16950.36. The simple payback period of this investment is around 6.7 months.

Annexure A: List of Energy Audit Instruments

PwC has multiple energy audit instruments kits. All the instruments are of have high quality, precision and are periodically calibrated. The instruments are capable to cover all electrical and thermal measurements required in the plants. A list of instruments used by PwC during the audit are shown below:

S. No.	Name of the Instrument	Make	Quantity Used
Thermal Instruments			
1	Non-contact Infrared Thermometer (Testo-845 and Extech)	Testo (USA), Extech (USA)	2
Electrical Instruments			
3	3-phase Power Analyzer	Circutor and Extech	3
Others			
6	Digital Tachometer (Extech-461995)	Extech (USA)	1

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