BEE's National Program
on
Energy Efficiency and Technology Up-gradation in SMEs

Ludhiana Forging Cluster

Baseline Energy Audit Report
Hindustan Hammers

Submitted to

Submitted by

InsPIRE Network for Environment

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About The Project

The project BEE's National Program on "Energy Efficiency and Technology Up gradation in SMEs - Ludhiana Forging Cluster" supported by Bureau of Energy Efficiency (BEE), Ministry of MSME and Ludhiana Auto Parts Manufacturers Association aims to bring down the energy demand of forging industries located at Ludhiana by supporting them to implement Energy Efficient Technologies in the SME units.

Executive Summary

1. Unit Details

Unit Name	:	**Hindustan Hammers**
Address	:	E-592, Phase- VII, Focal Point, Ludhiana -10
Contact Person	:	Mr. Munish Gupta & Mrs Usha Gupta (Cell No: 9316066666)
Products	:	Agriculture, Earthmoving, Auto Parts etc.
Production	:	5 TPD
DIC Number	:	160936315
Bank Details	:	ICICI Bank, Chandigarh Road, Ludhiana Account Number, 057805001437
TAN / PAN No.	:	PAN No: AACFH3430R
Contract demand	:	500 kVA

2. Existing Major Energy Consuming Technology

FO Based re-heating technology

- Conventional Technology with higher losses
- Prevailing energy consumption 0.12 liters of FO per kg of the production

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Measures

- Replacement of FO fired re-heating furnace with 250 kW induction re-heating furnace

Table 1: *Cost Economic Analysis*

Proposed Technology	Estimated Energy Savings (%)	Savings (in Rs.)	Investment (in Rs.)	Simple Payback period (Years)
Induction re-heating furnace (250 kW)	71	1,704,091	2,229,025	1.3
Total		**1,704,091**	**2,229,025**	

Introduction

1.1 ABOUT THE UNIT

M/s Hindustan Hammers Pvt. Ltd is engaged in manufacturing of different types of agriculture, earthmoving, auto parts and all types of engineering forging items. The manufacturing unit established in 1993 is located at E-592, Phase-VII, Focal Point, Ludhiana -141010, Punjab.

The unit operates in 2 shifts of 10 hrs. First shift starts from 8 AM to 6 PM and second shift starts from 10 PM to 8 AM. The operations in the unit are stopped from 6 PM to 10 PM as this being peak load periods.

The unit uses long rods made up of EN-8D 60 mm, 63 mm, 50 mm and MS material purchased locally for making its final products. The raw material is inspected for its quality on sample basis.

The daily production of the unit is around 5 tons per day. The unit utilizes primary energy, namely, Furnace Oil (FO) and Electricity supply from SEBs for various process and utility applications in premises. The monthly FO consumption of the unit is around 12500 liters and cost comes to around Rs. 6.25 Lakhs monthly (@ Rs. 50/ Liter). The monthly average electricity consumption of the unit is 49576 units resulting into total electricity bill of Rs. 4 lacs per month. The FO is purchased from local fuel supplier as well as from reliance industries and electricity is purchased from Punjab State Power Corporation Limited. To manufacture the products, the unit has installed a FO based re-heating furnace, a forging press, grinding and shot blast machine etc.

According to the assessment of the energy consumption data collected, the specific thermal energy consumption and specific electrical energy consumption is 0.1 L/kg (1020 kcal/kg) of product and 0.41 kWh/kg (1374 kcal/kg) of product respectively. The total specific energy consumption (in kCal) is 1374 kCal/ kg of product. Details of annual electrical and thermal energy consumption and specific energy consumption details in M/s Hindustan Hammers is presented in table below:

Table 1.1: ***Details of Hindustan Hammers***

SN	Parameter	Value	Unit
1	Name and address of unit	M/s Hindustan Hammers, E-592, Phase-VII, Focal Point, Ludhiana - 141010	
2	Contact person	Mr. Munish Gupta	
3	Manufacturing product	Agriculture, Earthmoving, Auto Parts etc.	
4	Daily Production	5 TPD	
	Energy utilization		
5	Average monthly electrical energy consumption	51530	kWh per month
6	Average monthly thermal (FO) energy consumption	12500	Liters per month
7	Average thermal specific energy	0.12	Liter /kg of product

SN	Parameter	Value	Unit
	consumption	1020	kCal/kg of product
8	Electrical specific energy consumption	0.41	kWh/Kg of product
		354.53	kCal/kg of product
9	Specific energy consumption	1374.53	kCal/kg of product
10	Electrical energy cost	3.09	Rs/Kg of product
11	Thermal energy cost	5	Rs/kg of product
12	Total energy cost	8.09	Rs/kg of product

Note:

^1: Specific gross calorific value of FO is considered as 10,200 kcal / liters

^2: Thermal equivalent for one unit of electricity is 860 kCal/kWh.

^3: The unit operates for 25 days a month (1 shift of 8 effective hours per day).

1.2 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at M/s Hindustan Hammers (refer Figure 1.1). The raw material in round or square shape is first cut into pieces of required sizes using shearing machines. After cutting, these pieces are heated in an oil fired re-heating furnace to a temperature of around 1300 ^{0}C. These heated pieces are subjected to forging into the required shape using required shape dies. After forging, these pieces are subjected to trimming for removal of unwanted material from sides. Thereafter, the metal piece is naturally cooled for around 4 to 5 hrs. After cooling, grinding of the material is carried out using grinders. Finally these grinded pieces are put in shot blast machine to improve their surface finish. At last, material is dispatched after proper inspection.

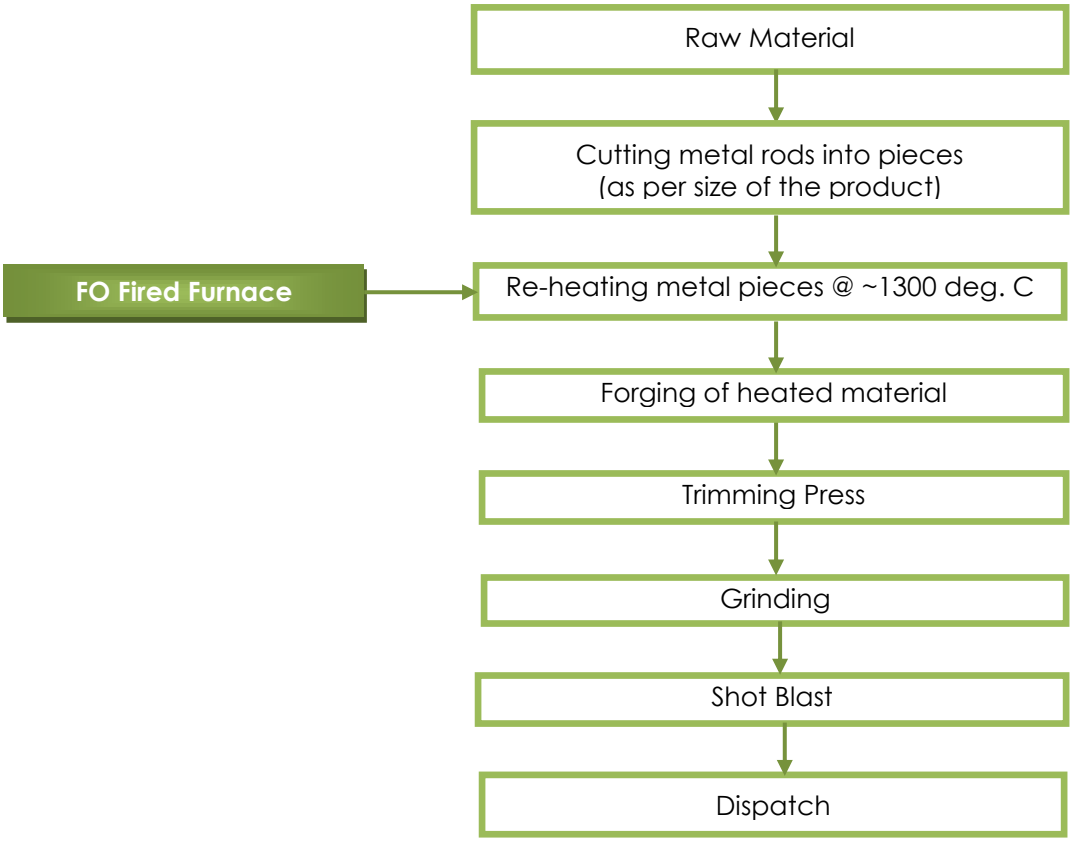


Figure 1.1: ***Process flow diagram***

Figure 1.2: ***Raw material being used in the unit***

Figure 1.3: ***Long rods being cut into small pieces using shearing machines***

Figure 1.4: ***Cut pieces being put into the furnace***

Figure 1.5: ***Heating of the material inside the oil fired reheating furnace***

Figure 1.6: ***Forging press and heated material being forged in the press***

Figure 1.7: ***Trimming press and material after trimming operation***

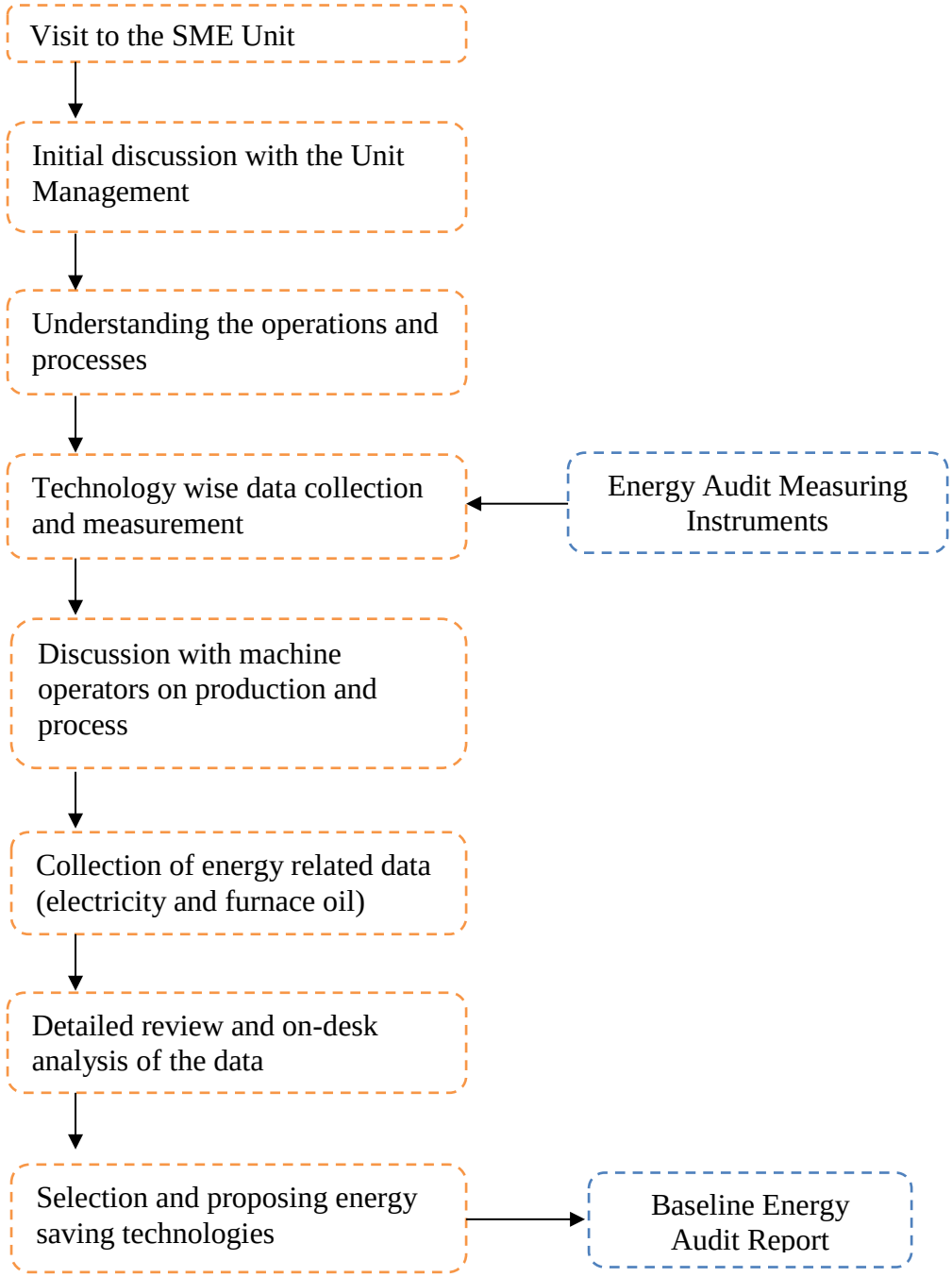
Figure 1.8: ***Finished product***

Figure 1.9: ***Grinding of the pieces***

Figure 1.10: ***Pieces after grinding***

1.3 ENERGY AUDIT METHODOLOGY

The primary objective of the energy audit was to quantify the existing fuel consumption pattern and to determine the operating efficiencies of existing systems. The key points targeted through energy audits were determination of specific fuel consumption, various losses, operation practices like hot metal temperature, production, fuel consumption, scale formation etc. Pre – planned methodology was followed to conduct the energy audits. Data collected at all above steps was used to calculate various other operating parameters like material feeding rate (Kg/hr), fuel firing rate, specific fuel consumption (kg/tonne), etc.



1.4 PRESENT TECHNOLOGIES ADOPTED

The list energy consuming installed in M/s Rajindra Forge Pvt. and used for forging process are as follows. The unit has installed four oil fired heating furnaces of different capacity for carrying out heating operation. Unit has also installed one induction furnace of smaller capacity. With each re-heating furnace, forging press is attached. For carrying out the finish operation, unit has also installed shot ballast machine. Based on the observation made during audit, it was found that most of the energy consumption is in the heating furnaces.

Table 1.2: ***List of energy consumption equipment installed***

SN	Equipment	Number	Energy Source	Rated capacity	Hrs of operation	Production
1	Cutting machine	01	Electricity	30 HP	20	120-150 pieces per hr
2	Oil Fired Heating Furnace	01	Electricity & Furnace Oil	25 ltrs/hr, Thermal 7.5 HP, 5 HP Electrical	20	250 kg per hrs
3	Forging Press	02	Electricity	1.25 tons (75 HP) & 1.5 tons (100 HP)	20	250 kg per hrs
4	Trimming machines	02	Electricity	30 HP		
	Grinding Machine	2	Electricity	3 HP	20	2.5 tons per day
7	Shot Blast	01	Electricity	14 HP each,	10	300 – 350 kg/hr
6	Induction Furnace	01	Electricity	250 kW + 22 kW	15	7 tons per day

Present Process, Observations and Proposed Technology

2.1 ELECTRICITY CONSUMPTION PATTEN

The unit has got connected load of 200 kW and electricity supply is received at a voltage of 11 KV. The contract demand of the unit is 500 kW which has been increased in March 2015. Earlier contract demand was 200 kW. In one month, the MDI increased beyond 200 kW. Based on the electricity data for the last one year, the average MDI is observed to be 181 kW. The power factor in the unit is found to be in the range of 0.95 to 0.99. Figure 2.1 provides the monthly variation of MDI in the unit.

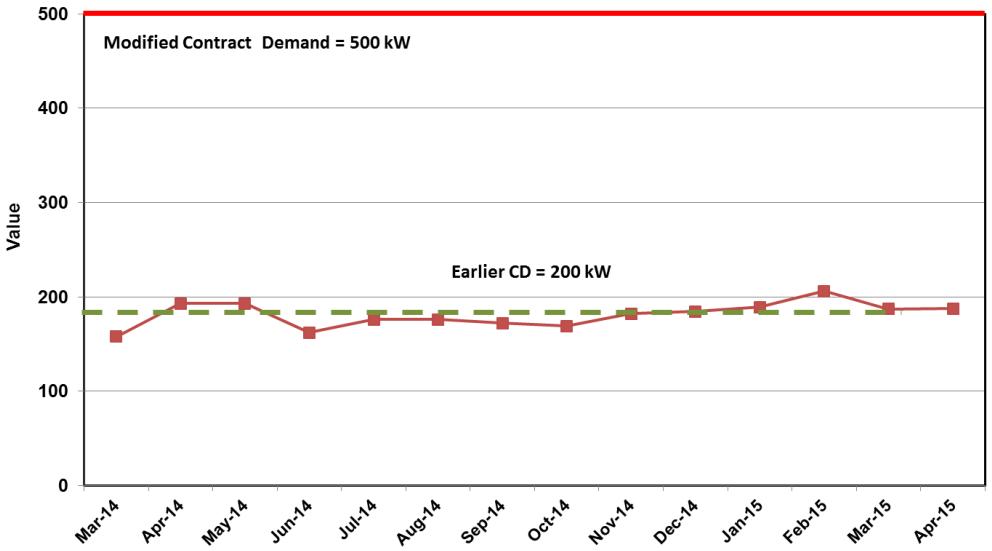


Figure 2.1: *Monthly variation of MDI in the unit*

2.2 HEATING FURNACE (FURNACE OIL FIRED)

2.2.1 Present Process

M/s Hindustan Hammers Pvt. Ltd has installed furnace Oil (FO) fired re-heating furnace to heat the metal pieces for forging process. The metal pieces to be forged are heated to a temperature of around 1300 deg. C. After that, the heated metal piece is then kept on the forging die having the cavity of the product to be formed. The hot metal piece then forged on the forging press. The furnace operates in Batch mode with approximate heating time of 30 to 45 minutes per piece. Apart from the re-heating furnace, a blower of capacity 7.5 HP was also installed to supply the combustion air to the re-heating furnace. Data related to furnace description is provided in table below.

Table 2.1: ***Furnace specifications***

Shell Heating Furnace Dimensions	5 ft x 5 ft x 2.5 ft
Fuel type input	Furnace Oil
Fuel flow	Gravity
Blower motor rating	7.5 HP
Fuel consumption	25 Liters/hr
Hours of operation per day	20 hrs per day

2.2.2 Observations

The exiting furnace is old having conventional design burner with manual control option for fuel firing. Normally a furnace with good design contains pre-heating, heating and soaking zone for effective utilization of heat. However, the present furnace was not found to have soaking zone. Since, the efficiency of such furnace is lower, new technology induction furnaces may be installed for re-heating process. Further, since the flame of the furnace directly hits the surface of the metal during the heating period varying from 20 – 30 minutes deteriorates the atomic/ grain structure of the piece and also leads to the higher scale formation due the oxidation of the metal at high temperature ultimately leading to material/ production loss. Normally the scale loss in the furnace was found to be around 10%. In order to attain the exact temperature profile of the material in less time, 3Ts has to be followed, Time, Turbulence and Temperature, if these three parameters can be followed in a right manner proper temperature can be archive in a minimum time, which would help in reducing the excessive heating of the material and reduction in scale loss.

Figure 2.2: ***Re-heating furnace in operation***

The specific energy consumption of furnace oil was observed to be around 0.1 liters of FO per kg of the production which is higher in comparison to the latest technologies available for carrying out the same purpose. During operation, fuel supply was controlled manually without controlling the air flow rate. Further, there was no provision for measuring the temperature inside the furnace and to what time the

material should be heated. The judgement regarding completeness of heating was taken by the operator based on the color of the heated material.

In addition, the existing reheating furnace usage furnace oil as a source of energy to heat the metal pieces. The burning of FO releases harmful gases like CO, CO_2, SO_X, NO_X, smoke etc. During the visit, it was observed that furnace has no exhaust mechanism, ID fan and flue gas pipe, to pass the flue gases out of the factory. All these factors affect the environment and also the health of the worker handling the furnace and other machineries installed in the factory.

Conclusion:

As per the past studies conducted in forging industries, the replacement of the FO fired re-heating furnace with an induction re-heating furnace saves up to 60% of the energy cost. The production rate of the furnace observed during study is observed to be low (100 – 125 Pieces per hour) and varies with the product size.

Based on the above observations done during the baseline data collection and discussions with the unit management it is proposed to replace the existing re-heating technology (FO Based) with Energy Efficient Induction Reheating furnace.

This replacement would provide following benefits

- Environmental cleaner technology
- Reduces Specific Energy Consumption
- Faster operation and reduced scale formation
- User friendly technology
- Improved quality of the product output
- Higher output with fewer crop cuts or short bars

2.2.3 Cost Economics Analysis

The comparison of FO based re-heating technology and induction technology, specific energy consumption, cost savings, investment required and simple payback period of the investment on induction technology is given in Table 2.2. The detailed calculation to finalize the size of induction furnace is provided as ***Annexure 3***.

Table 2.2: ***Cost economic analysis***

Parameter	Unit	Value
Furnace oil consumption on existing re-heating furnace	Liters/hr	25
Production in terms of Kg	Kg/hour	250
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.12
Cost of energy consumption	Rs./Kg	5
Power consumed by proposed induction furnace (rated capacity 50 kW operating at 26 kW)	kW	103
Production in terms of Kg	Kg/hr	250
Specific energy consumption on induction reheating furnace	kWh/Kg	0.412
Cost of energy consumption	Rs./Kg	3.09
Reduction in cost of energy required	Rs./Kg	1.91
Operating hours	Hrs	20

Parameter	Unit	Value
Annual operating days	Days	300
Annual cost savings	Rs	1,704,091
Investment required for Induction furnace (50 kW)	Rs	2,229,025
Simple payback period	Years	1.3

As per the detailed calculations done, it is proposed to install an induction re-heating furnace of capacity **250 kW** (proposed for larger products also). On the day of study, Paddy cutting blades were under process and the data was collected for the same. To reheat the metal pieces, the proposed furnace must be run at 203 kW with production of 250 kg/ hour. The cycle time required to re-heat the metal piece of 4 kgs was calculated as 1 minute approximately.

The cost of energy saved per Kg of material forged is calculated as Rs. 1.91. The investment required for implementing the induction technology estimated as Rs 22.29 Lakhs with annual saving of Rs 17.04 Lakhs. The simple payback period of the technology is 1.3 years.

Annexure 1

Basic details and energy utilization pattern of Hindustan Hammers (India)

SN	Parameter	Value	Unit
1	Name and address of unit	M/s Hindustan Hammers, E-592, Phase-VII, Focal Point, Ludhiana - 141010	
2	Contact person	Mr. Munish Gupta	
3	Manufacturing product	Agriculture, Earthmoving, Auto Parts etc.	
4	Daily Production	5 TPD	
	Energy utilization		
5	Average monthly electrical energy consumption	51530	kWh per month
6	Average monthly thermal (FO) energy consumption	12500	Liters per month
7	Average thermal specific energy consumption	0.1	Liter /kg of product
		1020	kCal/kg of product
8	Electrical specific energy consumption	0.41	kWh/Kg of product
		354.53	kCal/kg of product
9	Specific energy consumption	1374.53	kCal/kg of product
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Note:

^1: Specific gross calorific value of FO is considered as 10,200 kcal / liters

^2: Thermal equivalent for one unit of electricity is 860 kCal/kWh.

^3: The unit operates for 25 days a month.

Annexure 2

Induction furnace capacity and heating cycle time calculation

Induction furnace capacity calculations:

Induction furnace design standard: 2.7 – 3 kg/ kW/hr

Hourly material to be heated = 250 Kg

Induction furnace capacity requirement (theoretical) = 250/2.7 kW/hr
= 92.6 kW/hr

As discussed with technology manufacturer, we have taken the lower value 2.7 kg/kW/hr for calculations.

Induction furnace capacity requirement (actual) (efficiency = 90%) = 92.6 kW/hr /0.90
= 103 kW/hr
= 103 kW approximately

Heating cycle time calculation:

Hourly material to be heated = 250 kg
Weight of the metal pieces = 4 gram
No. of pieces to be heated in an hour = 62 pieces
Heating time required per piece = 1 minute approximately

Keeping in mind the variety of products manufactured by Hindustan Hammers (India) having variable weight, size, geometry, composition etc. induction furnace of 150 kW is proposed.

Note:

*** For more accurate capacity options, induction furnace manufacturer should be consulted prior to the implementation*

Annexure 3

Energy saving calculation for Induction furnace

Parameter	Unit	Value
Furnace oil consumption on existing re-heating furnace	Liters/hr	25
Production in terms of Kg	Kg/hour	250
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.12
Cost of energy consumption	Rs./Kg	5
Power consumed by proposed induction furnace (rated capacity 150 kW operating at 103 kW)	kW	103
Production in terms of Kg	Kg/hr	250
Specific energy consumption on induction reheating furnace	kWh/Kg	0.412
Cost of energy consumption	Rs./Kg	3.09
Reduction in cost of energy required	Rs./Kg	1.91
Operating hours	Hrs	20
Annual operating days	Days	300
Annual cost savings	Rs	1,704,091
Investment required for Induction furnace (250 kW)	Rs	2,229,025
Simple payback period	Years	1.3

Note:

*** The cost of induction furnace is an indicative value gathered from discussions with furnace suppliers. It may vary according to the heating requirement and the material to be heated.*