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

Ludhiana Forging Cluster

Baseline Energy Audit Report
Allied Engineers

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	:	**Allied Engineers**
Address	:	C-64, Phase –V, Focal Point, Ludhiana -10
Contact Person	:	Smt. Parvinder Kaur Narual & Mr. Gursharan Singh Narula (Cell No. 9814089881 / 9876589881)
Products	:	Bolts, Nuts and Auto Parts
Production		800 Kgs per day
DIC Number		030091200431 (Part-II)
Bank Details		Bank of Baroda, Clock Tower, Ludhiana Account Number: 01030200000099
TIN / PAN No.	:	PAN: AAEFA9107A; TAN: JLDA01211A
Contract demand		164 kVA

2. Existing Major Energy Consuming Technology

FO Based re-heating technology

- Conventional Technology with higher losses
- Prevailing energy consumption is 0.09 liters of FO per kg of the production

Lathes Machine

- Manually operated lathe machines for machining job work including threading, turning, grinding, drilling etc.
- Electrical motor rating of 3 HP with production of 50-60 pieces per hour per set of lathe machine.

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Savings Measures

- Replacement of FO fired re-heating furnace with 50 kW induction re-heating furnace
- Replacement of manual lathe machines by two numbers of CNC based Special Purpose Machine (SPM) for turning operation

Table 1: *Cost Economic Analysis*

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (Years)
Induction re-heating furnace (50 kW)	62	125,353	936,510	1.9
SPM - Turning Machine (2 Nos)	76	544,504	1,100,000	2.0
Total		**669,858**	**2,036,510**	

Introduction

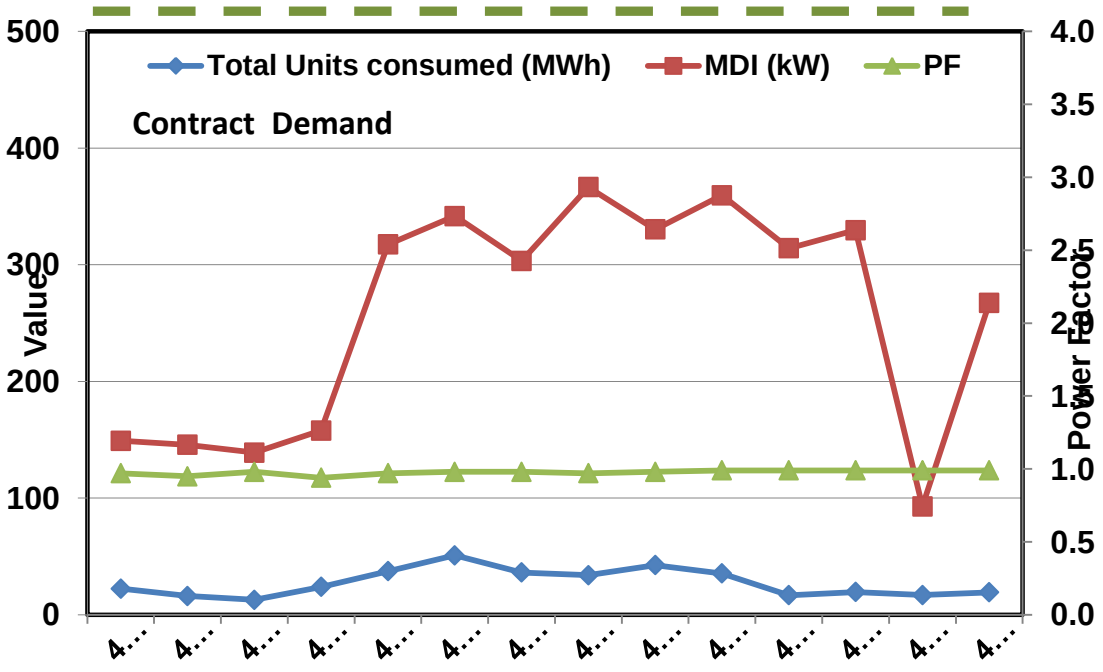
1.1 ABOUT THE UNIT

M/s Allied Engineers is engaged in manufacturing of different types of nuts, bolts, and auto parts in various sizes as per the customer requirement. The manufacturing unit is located at 1st Lane, Partap Chowk, Sangeet Cinema, Ludhiana - 141001, Punjab.

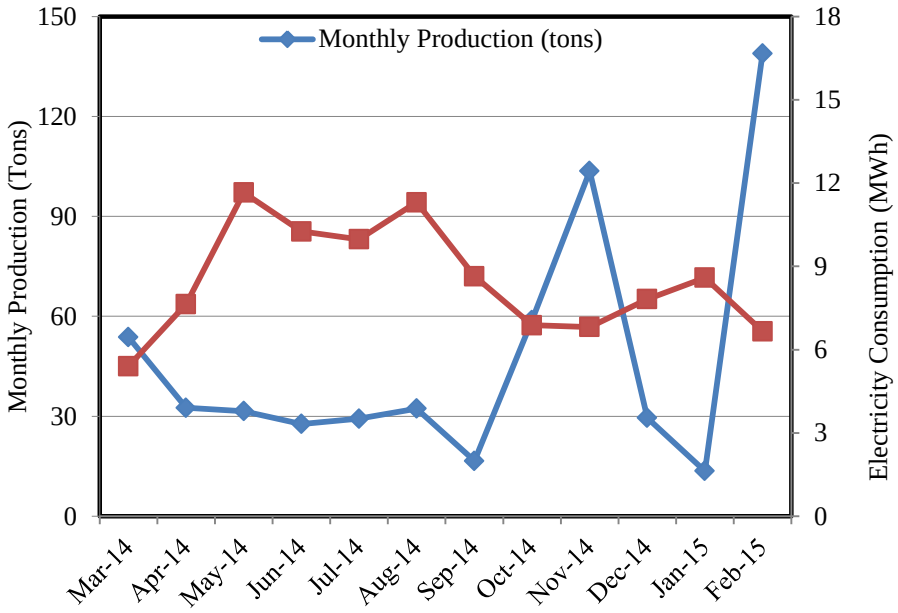
The raw material procured by the unit for making bolts and other auto components include Mild Steel, EN8, EN15 etc.

The daily production lies in the range of 800 - 850 kgs per day. Allied engineers is using primary energy, namely, Furnace Oil (FO) and Electricity supply from SEBs for various process and utility applications in premises. The average monthly FO consumption in the unit is 1800 liters. It was observed that the average monthly electricity consumption is 81589 kWh. Figure 1.1 depicts monthly electricity consumption vis-à-vis total monthly production of the unit for last one year.

To manufacture the products, the unit has installed a FO based re-heating furnace, a forging press, pressing machine, grinding/ facing/ trimming lathes, threading machine etc.



(a) - Monthly variation of production and electricity consumption



(b) – Monthly variation of production and specific electricity consumption

Figure 1.1: ***Electricity consumption and production details***

According to the assessment of the energy consumption data collected, the specific thermal energy consumption and specific electrical energy consumption is 0.09 L/kg (918 kcal/kg) of product and 4.08 kWh/kg (129.67) of product respectively. The total specific energy consumption (in kCal) is 3508.33 kCal/ kg of product. Details of annual electrical and thermal energy consumption and specific energy consumption details in Allied engineers is presented in table below:

Table 1.1: ***Details of Allied engineers***

SN	Parameter	Value	Unit
1	Name and address of unit	M/s Allied Engineers	
2	Contact person	Mr Gusharan Singh Narula	
3	Manufacturing product	Bolts, Nuts and Auto Parts	
4	Daily Production	800 Kgs per day	
	Energy utilization		
5	Average monthly electrical energy consumption	81589	kWh per month
6	Average monthly thermal (FO) energy consumption	1800	Liters per month
7	Average specific thermal energy consumption^1	0.09	Liter /kg of product
		918	kCal/kg of product
8	Specific electrical energy consumption^2	4.08	kWh/Kg of product
		3508.33	kCal/kg of product
9	Specific energy consumption	4426.33	kCal/kg of product
10	Electrical energy cost	30.60	Rs/Kg of product
11	Thermal energy cost	4.5	Rs/kg of product
12	Total energy cost	35.10	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 manufacturing of forged products at Allied Engineers are presented below:

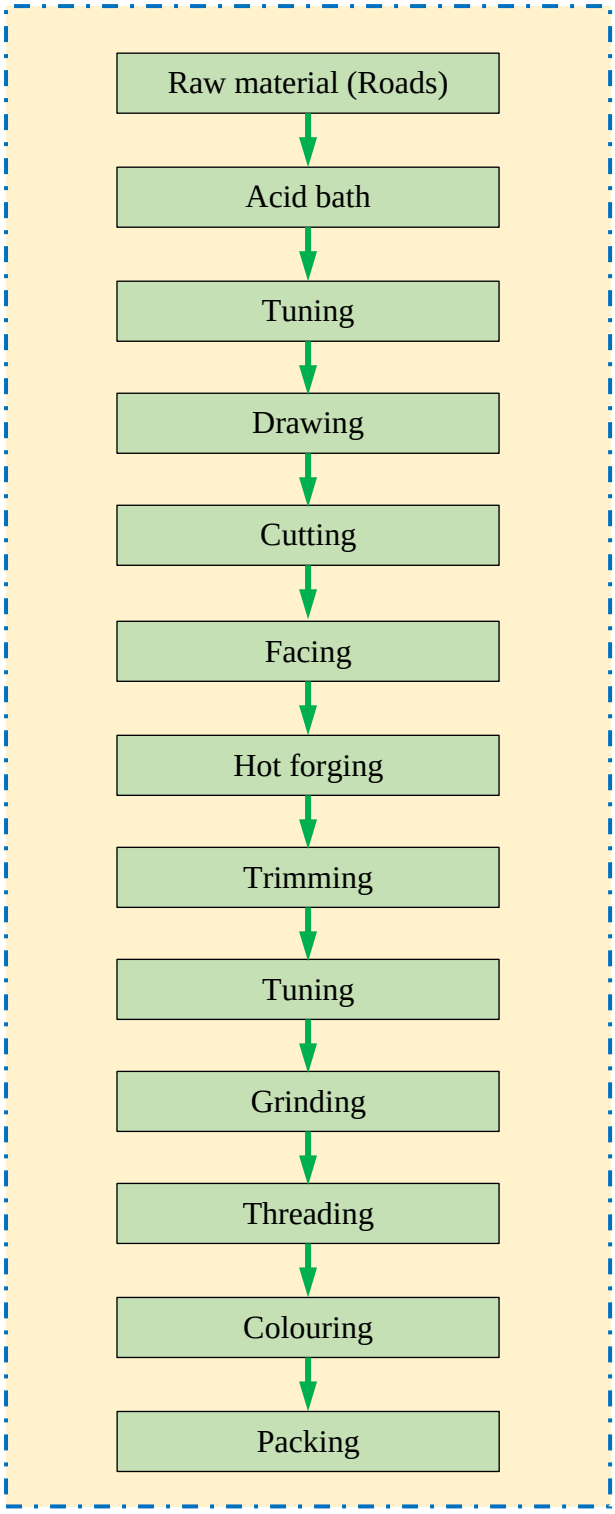


Figure 1.2: ***Production process***

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/tons), etc.

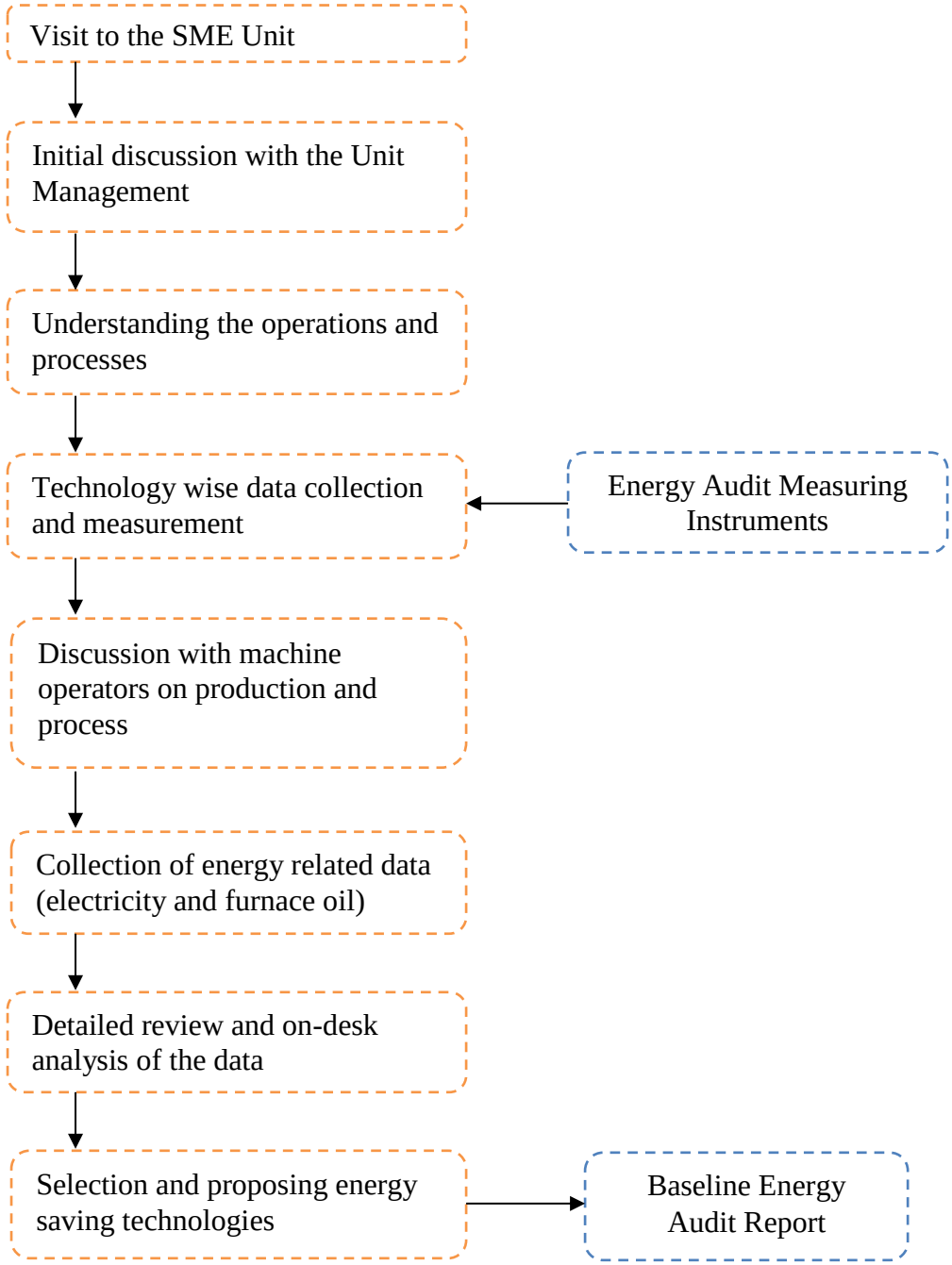


Figure 1.3: ***Energy audit process***

Present Process, Observations and Proposed Technology

2.1 RE HEATING FURNACE (FURNACE OIL FIRED)

2.1.1 Present Process

Allied engineers has installed three furnaces Oil (FO) fired heating furnace to heat the metal pieces for forging process. The metal pieces to be forged are heated to a temperature of 1150 - 1200 ◦ 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 into the product.

2.1.2 Observations

The exiting furnace is old having conventional design with manual control option for fuel firing. Since, the efficiency of such furnace is lower, new technology induction furnaces maybe 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. 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.

The specific energy consumption of furnace oil was observed to be around 0.09 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 and varies with the product size (Ref Table 2.1). Therefore, it is proposed to replace both these existing re-heating technology (FO Based) with Energy Efficient Induction Reheating furnaces.

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

2.1.4 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 2.1. The detailed calculation to finalize the size of induction furnace is provided as ***Annexure 3***.

Table 2.1: ***Cost Economic Analysis of proposed induction furnace***

Parameter	Unit	Value
Furnace oil consumption on existing re-heating furnace	Liters/hr	9
Production in terms of Kg	Kg/hour	100
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.09
Cost of energy consumption	Rs./Kg	4.5
Power consumed by proposed induction furnace (rated capacity 50 kW operating at 45 kW)	kW	45
Production in terms of Kg	Kg/hr	110
Specific energy consumption on induction reheating furnace	kWh/Kg	0.41
Cost of energy consumption	Rs./Kg	4.03
Reduction in cost of energy required	Rs./Kg	0.47
Operating hours	Hrs	8
Annual operating days	Days	300
Annual cost savings	Rs	125,353
Investment required for Induction furnace (50 kW)	Rs	936,510
Simple payback period	Years	1.9

As per the detailed calculations done, it is proposed to install an induction re-heating furnace of capacity 50 kW for carrying out heating of heavier metal pieces. Based on the discussion with concerned person in the unit, it came out that maximum weight of the

individual piece is around 0.6 kgs. The cycle time required to re-heat the metal piece of 0.6 kgs would be around 20 secs.

The cost of energy saved per Kg of material forged is calculated as Rs. 4.03. The investment required for implementing the induction technology is estimated to about Rs 9.36 Lakhs with annual saving of Rs 9.12 Lakhs. The simple payback period of the technology is 1.9 years.

2.2 SPECIAL PURPOSE MACHINES (SPM)

2.2.1 Present Process:

Allied engineers has installed manually operated lathe machines for various components machining job work like facing, turning, grinding, drilling etc. These machine runs on electrical motors having the capacity of 3 hp with production/ machining of 60- 70 pcs/hr.

2.2.2 Observations

Since these machines are manually operated, the process through which components are manufactured is very slow and time consuming. Apart from the slow process, the components manufactured are not very precise, identical and of high quality. Some times what happens that the machine keeps on running even there is no component on the machine or the operator is busy in some other work. All these factors lead to the loss of energy and production of low quality components.

2.2.3 Conclusion

In order to promote the energy efficiency and reduction in the overall energy cost in the factory, it is recommended to replace the existing manual machines by automatic special purpose machine (SPMs). Since the modified machines will run on the pre-installed programming technique, the consumption of electricity will only happen when there is a function or operation required on the component. In the ideal condition the machine will remain in dead mode/ no operation mode.

Apart from the operation, the machine automatically loads the component for machining. The cycle time of the each component will be fixed in the business logic of the PLC / SPM machine therefore each component will take specific time for processing or machining. The SPM machines results in 30-50% percent of the energy savings depending upon the type of component, operation, material, cycle time etc.

Benefits of the Automatic SPM/ CNC machines:

- Reduced energy consumption
- Faster operation and reduced down time
- Improved product quality and symmetrical product dimensions
- Higher productivity
- Environment friendly technology

2.2.4 Cost Economics Analysis

The comparison of production on old manual/ conventional lathe machine and modified SPM machine, specific energy consumption, cost savings, investment required and simple payback period of the investment on SPM machines is given in Table 2.2.

Table 2.2: ***Cost Economic Analysis of proposed SPM for turning operation***

Parameter	Unit	Value
Power consumed by conventional turning machine	kW	6.714
Production on conventional turning machine	Pcs/hr	55
Specific power consumption on conventional machine	kWh/Pcs	0.122072727
Power consumed by SPM turning machine (motor capacity 5HP) @ 80% Loading	kW	2.984
Production on SPM turning machine (Projected)	Pcs/hr	100
Specific power consumption on SPM machine	kWh/Pcs	0.030
Reduction in specific power consumption	kWh/Pcs	0.092
Percentage savings	%	75.6
Operating hours	Hrs	10
Annual operating days	Days	300
Annual electricity savings	kWh	27,670
Annual cost savings	Rs.	272,252
Investment required	Rs.	550,000
Simple payback period	Years	2.0

As per the detailed calculations done, it is proposed to convert existing manual lathes into automatic Special Purpose Machines (SPMs). The specific power consumption on a manual machine is 0.030 kWh/ pcs whereas the specific power consumption in modified SPM machine would be around 0.092 kWh/pcs resulting in 75.6% savings in electrical energy. The investment required for making an SPM machine would be around Rs 5.5 Lakhs with annual saving of Rs 2.72 Lakhs. The simple payback period of the technology is 2 years.

Annexure 1

Basic details and energy utilization pattern of M/s Allied engineers

SN	Parameter	Value	Unit
1	Name and address of unit	M/s Allied Engineers	
2	Contact person	Mr Gusharan Singh Narula	
3	Manufacturing product	Nuts, Bolts and other Auto Parts	
4	Daily Production	800 Kgs per day	
	Energy utilization		
5	Average monthly electrical energy consumption	81589	kWh per month
6	Average monthly thermal (FO) energy consumption	1800	Liters per month
7	Average specific thermal energy consumption^1	0.09	Liter /kg of product
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9	Specific energy consumption	4426.33	kCal/kg of product
10	Electrical energy cost	30.60	Rs/Kg of product
11	Thermal energy cost	4.5	Rs/kg of product
12	Total energy cost	35.10	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.

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 = 110 Kg

Induction furnace capacity requirement (theoretical) = 110/2.7 kW/hr
= 40.74 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%) = 40.74 kW/hr /0.90
= 45.26 kw/hr
= 45 kW approximately

Heating cycle time calculation:

Hourly material to be heated = 110 kg
Weight of the metal pieces = 600 gram
No. of pieces to be heated in an hour = 183 pieces
Heating time required per piece = 20 seconds approximately

Keeping in mind the variety of products manufactured by Allied engineers (India) having variable weight, size, geometry, composition etc. induction furnace of 50 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	9
Production in terms of Kg	Kg/hour	100
Specific energy consumption on FO based re-heating furnace	Liters/Kg	0.09
Cost of energy consumption	Rs./Kg	4.5
Power consumed by proposed induction furnace (rated capacity 50 kW operating at 45 kW)	kW	45
Production in terms of Kg	Kg/hr	110
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Cost of energy consumption	Rs./Kg	4.03
Reduction in cost of energy required	Rs./Kg	0.47
Operating hours	Hrs	8
Annual operating days	Days	300
Annual cost savings	Rs	125,353
Investment required for Induction furnace (50 kW)	Rs	936,510
Simple payback period	Years	1.9

Note:

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

Annexure 4

Energy saving calculation for SPM machines – Turning Operation

Parameter	Unit	Value
Power consumed by conventional turning machine	kW	6.714
Production on conventional turning machine	Pcs/hr	55
Specific power consumption on conventional machine	kWh/Pcs	0.122072727
Power consumed by SPM turning machine (motor capacity 5HP) @ 80% Loading	kW	2.984
Production on SPM turning machine (Projected)	Pcs/hr	100
Specific power consumption on SPM machine	kWh/Pcs	0.030
Reduction in specific power consumption	kWh/Pcs	0.092
Percentage savings	%	75.6
Operating hours	Hrs	10
Annual operating days	Days	300
Annual electricity savings	kWh	27,670
Annual cost savings	Rs.	272,252
Investment required	Rs.	550,000
Simple payback period	Years	2.0

Note:

*** The cost of SPM machines is an indicative value gathered from discussions with SPM machine suppliers. It may vary from operation to operation and product to product.*