National Program

on

Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India

Jamnagar Brass Cluster

Detailed Energy Audit Report
Ravi Brass Industries

Submitted to

Submitted by

InsPIRE Network for Environment

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Abbreviations

BEE	Bureau of Energy Efficiency
BR	Blue Red
DBs	Distribution Boxes
FRPB	Fiber Reinforced Plastic Blades
GEF	Global Environment Facility
HP	Horse Power
HT	High Tension
ISI	Indian Standards Index
ISO	International Organization for Standardization
kCal	Kilo Calories
Kg	Kilogram
kV	Kilo Volts
kVA	Kilo Volt Ampere
kW	Kilo Watts
kWh	Kilo Watt Hour
LT	Low Tension
MDI	Maximum Demand Indicator
MSME	Ministry of Micro Small and Medium Enterprises
MT	Metric Ton
PF	Power Factor
RY	Red Yellow
SEB	State Electricity Board
SEC	Specific Energy Consumption
SME	Small and Medium Enterprise
UNIDO	United Nation's Industrial Development Organization
VFD	Variable Frequency Drive
YB	Yellow Blue

About the Project

The project titled "Promoting Energy Efficiency and Renewable Energy in Selected MSME clusters in India" supported by Global Environment Facility (GEF), United Nations Industrial Development Organization (UNIDO), and Bureau of Energy Efficiency (BEE) aims to bring down the energy consumption in Jamnagar Brass cluster located in Jamnagar (Gujarat) by supporting them to adopt Energy Efficient and Renewable Energy practices. There are more than 4,000 Small and Medium Enterprise (SME) Brass units operating in the various industrial pockets of the district. InsPIRE Network for Environment, New Delhi has been appointed as the executing agency to carry out the activities in the cluster.

The activities to be conducted under the proposed energy efficiency study in Jamnagar Brass Cluster include following:

- Conducting Pre-activity Workshop
- Comprehensive energy audit in 6 Brass units
- Discussion with 3 cluster experts and 2 equipment suppliers to develop best operation practice document for 5 key technologies
- Enumeration of common regularly monitorable parameter at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same
- Identification of set of energy auditing instruments that should be used for carrying out periodic energy audits in the units
- Conducting 3 post energy audit technical workshops for knowledge dissemination

As part of the activities conducted under the energy efficiency study in Jamnagar Brass cluster, detailed energy audits in 6 Brass units in Jamnagar was conducted in the month of July'2015.

Executive Summary

Name of SME unit : M/s Ravi Brass Industries

Location of the SME unit : Plot No. 3631, Road No. I, G.I.D.C., Phase - III, Dared, Jamnagar, Gujarat

Based on the measurements carried out and data collected during field visit in the month of July'2015 and analysis of the data, process wise scope for energy efficiency improvement are identified and relevant recommendations are made. The proposed energy saving measures along with the annual savings, investment required and the simple payback period is given the Table 1 below:

Table 1: *Cost Economic Analysis*

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year / months)
1	Switching off the main grid power supply to transformer during non-operation of Induction furnace	10,161	Nil	Immediate
2	Avoiding overfilling of metals in the Induction Furnace	68,400	Nil	Immediate
3	Avoiding super heating of metals in the Induction Furnace	18,000	Nil	Immediate
4	Ladle Preheating	36,000	Nil	Immediate
5	Installation of timers in Cooling Tower (CT) fan system	13,697	20,000	1 year 6 months
6	Replacing conventional blades of cooling tower fans with Energy Efficient Fiber Reinforced Plastic Blades (FRPB)	9,131	17,000	1 year 10 months
7	Installation of 40 KVAr Automatic Power Factor Correction Panel	90,059	59,986	9 Months
8	Replace conventional ceiling fan with Energy Efficient (BLDC) Ceiling fan	22,141	72,000	3 year 1 month
9	Replace 55W florescent tube light with T-8 (20W) LED light	27,081	25,350	11 months
	Total	**294,670**	**194,336**	

▶ Induction Furnace:

Induction furnace is the most energy intensive equipment being used in the unit. The unit has installed induction furnace of 100 kW capacity. Based on the detailed measurement carried out at the unit, it was found that cold start of the furnace consumes 18% more electrical power. It was observed that, 33% (3 of 9) melts were on "furnace holding" mode consuming nearly 8.3% more power. The energy consumption, in terms of kWh per tons of molten metal (as defined as SEC {Specific Energy Consumption}), comes to 340 (excluding the SEC for furnace cold start). Further, there were many deficiencies observed in the current operation practice including no data logging, scrap loading above coil level etc. To improve the energy performance, it is suggested to maintain log records of type and quantity of scrap material being used and electricity consumed for every charge. Further specific format for following the best practices are also developed to be utilized as the guiding document.

It is suggested to avoid overfilling of metals in the furnace above the induction coil. It is recommended to avoid overheating of the metal to save energy; this would also avoid increase in material burning loss. Furthermore, ladle preheating is suggested to save energy. On the cooling circuit for induction furnace, it is suggested to use energy efficient fan blades and timers to cut power supply at pre-set time.

- **Electric Motors:**

The unit has several motors of different size and capacity installed in different areas of the foundry. Most of the motors are less than 5 HP and operated depending on requirements. A properly balanced voltage supply is suggested to maintain which would help in assuring a voltage balance while minimizing voltage losses. It is further suggested to install automatic power factor correction panel.

- **Installation of energy lightings:**

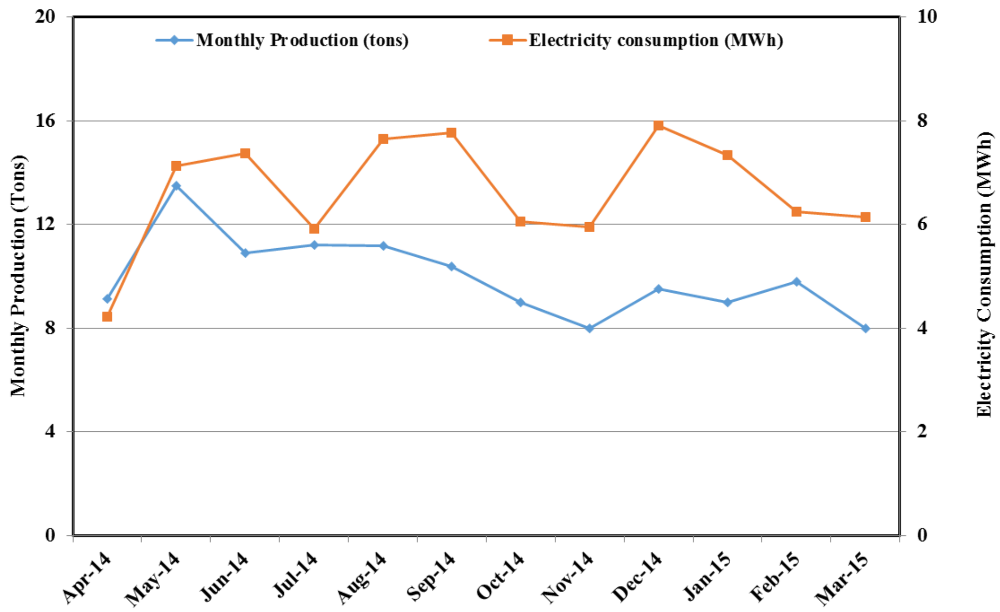
The unit has installed conventional lighting fixtures and ceiling fans in their factory premises which are presently consuming a significant amount of energy. Replacement of these fixtures with energy efficient equivalent will lead to significant savings in terms of energy consumption of the unit.

Introduction

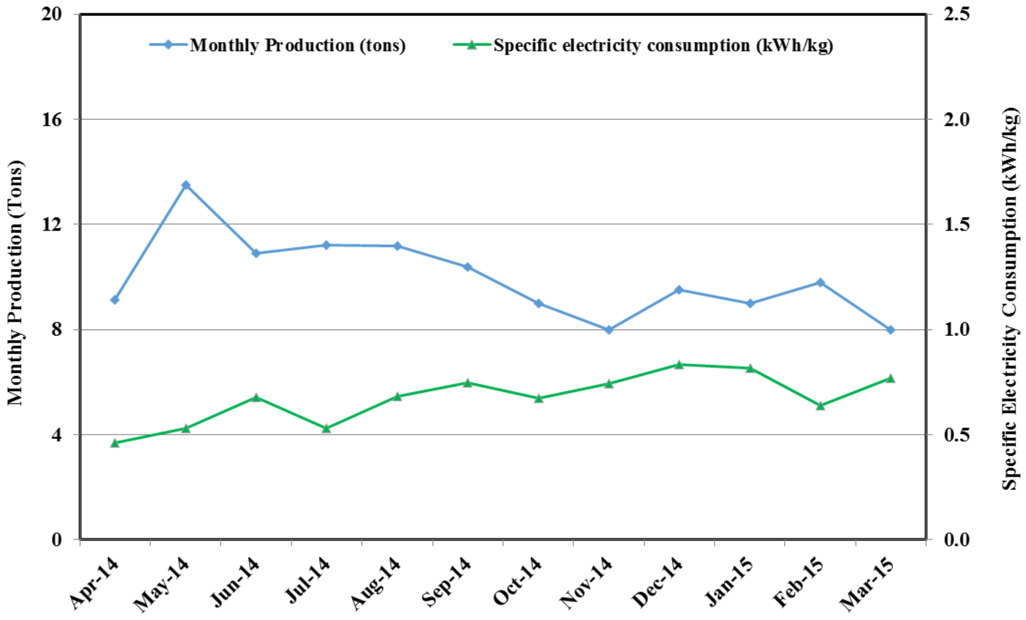
1.1 ABOUT THE UNIT

Ravi Brass Industries is an ISO 9001:2008 certified company and is engaged in leading manufacturing and exporting wide range of Brass Components, Brass Power Cord Pin, Brass Modular Switch Parts, Switch Parts, Brass Wiring Accessories, Electrical Wiring Accessories, RoHs Compliant Brass Pin, ISI type Brass Pin, European Type Brass Pin, Brass Pin for Mobile Charger, 2 & 3 Pin Moulded Plugs Pin, Brass Pin for Mosquito Repellent Machine, Soldering Type Brass Pin, Cramping Type Brass Pin, and Brass Electrical Accessories as per customer's specification.

The installed plant capacity is 500 MT per annum. The unit uses electricity supply from SEBs for various process and utility applications in premises and FO for reheating furnace. Figure 1.1 depicts monthly electricity consumption vis-à-vis total monthly production of the unit for last one year.



(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***

Inference: It can be observed from the above figures that the monthly energy consumption is directly proportional to the production for a month. However, specific energy consumption is inversely proportional to the production. Lower the productivity of the plant, higher is the specific electricity consumption. This implies that lower productivity means lower utilization of the equipment thus leading to higher downtime and high specific energy consumption.

However, as observed in Figure a and b above, anomalies in direct relationship between production and electricity consumption can be observed in certain months like June 2014 and July 2014. For the month of June 2014, the unit has a low production and a high energy consumption and reverse in the month of July 2014, wherein the unit has a high production with low energy consumption. These anomalies can be related to reasons such as lower productivity due to low demand, idle running of machines, higher rate of rejections, lower utilization and high peak hour operations.

Major electricity consumption is required by electrical induction furnace for scrap melting operation.

According to the assessment of the energy consumption data collected, the monthly electrical energy consumption is approximately 6,647 kWh and the specific electrical energy consumption is 0.67 kWh per kg of product. The total specific energy consumption is 576.2 kCal per kg of product. Details of annual electrical, thermal energy consumption and specific energy consumption details in M/s Ravi Brass Industries are presented in Table 1.1 below:

Table 1.1: ***Details of M/s Ravi Brass Industries***

SN	Parameter	Value	Unit
1	Name and address of unit	Ravi Brass Industries, Plot No. 3631, Road No. I, G.I.D.C., Phase - III, Dared, Jamnagar, Gujarat	
2	Contact person	Mr Rajesh J. Vachhani (Managing Director), Phone: 0288 – 2730774	
3	Manufacturing product	Brass Electrical Accessories	
4	Production	500 ton/annum	
	Energy utilization		
5	Average monthly electrical energy consumption	6,647	kWh per month
6	Electrical specific energy consumption	0.67	kWh/kg of product
7	Specific energy consumption	576.2	kCal/kg of product
8	Electrical energy cost	4.89	Rs/kg of product
9	Total energy cost	4.89	Rs/kg of product

Note:
Thermal equivalent for one unit of electricity is 860 kCal/kWh.
The unit operates for 25 days a month (1 shift of 8 effective hours per day).
Cost of Electricity = Rs. 7.3 per unit (average cost calculated from electricity bills)

1.2 ENERGY AUDIT METHODOLOGY

The primary objective of the energy audit was to study prevailing energy consumption pattern and to identify scope for energy efficiency improvement through technical intervention as well as inclusion of best operation practices. Figure 1.2 depicts the flow chart of activities being adopted for detailed energy audit study.

The activities for the current project started with organization of a pre-activity workshop attended by local unit owners, representatives from UNIDO. During the workshop, project objectives along with support required from the units were also discussed. After this workshop, six units for further consideration of energy audit studies were selected by the local association.

After selection of units, preliminary information relating to the energy consumption by the units was collected in a structured questionnaire. The intent of this preliminary data collection was mainly to get preliminary details about the units to make the energy audit process more effective. A copy of the same questionnaire is attached as ***Annexure 1***. Thereafter, field visit to selected industries was carried on a mutually decided dates. During energy audits, detailed data related to specific fuel consumption, various losses, operation practices being followed at the units were measured and collected. Further the gathered data is analyzed to assess prevailing energy consumption of each unit. Further, based on the observation as well as data analysis recommendations related to energy conservation opportunities are also made. List of measuring instruments used during detailed energy audit are summarized in Table 1.2.

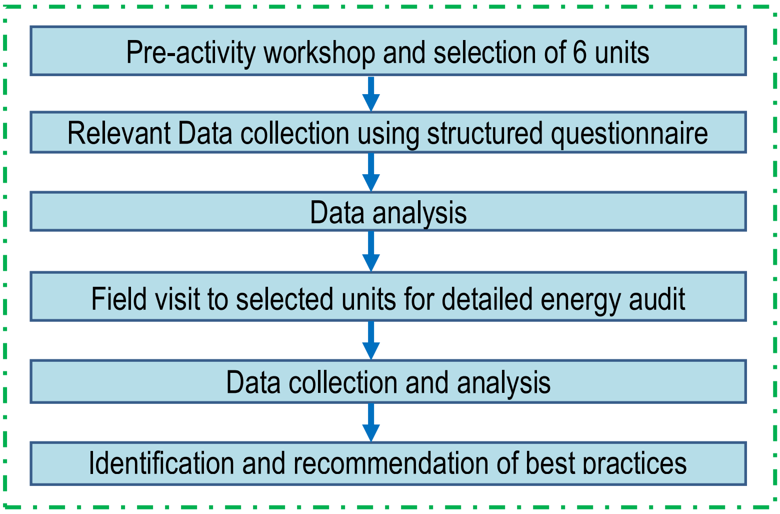


Figure 1.2: ***Flowchart depicting sequence of activities followed for carrying out detailed energy audit***

Table 1.2: ***List of instruments used during energy audit***

SN	Name of Instrument	Make / Model
1	Three Phase Power Quality Analyzer	Fluke/434/UNI
2	Single Phase Power Quality Analyzer	Fluke/43B
3	Ultra Sonic Water Flow Meter	GE Panametrics/PT878
4	Rotating Vane Anemometer	Prova Ltd., Taiwan/AVM -05
5	Lux Meter	Metravi/1332
6	Portable Non-contact Infrared Thermometer	Raytek, USA/ST 80
7	Flue Gas Analyzer	Kan May, KM 900

Present Process, Observations and Proposed Technology

2.1 PRODUCTION PROCESS OF PLANT

Ravi Brass Industries is involved in production of finished brass products like Brass Components, Brass Power Cord Pin, Brass Modular Switch Parts, Switch Parts, Brass Wiring Accessories, Electrical Wiring Accessories, RoHs Compliant Brass Pin, ISI type Brass Pin, European Type Brass Pin, Brass Pin for Mobile Charger, 2 & 3 Pin Moulded Plugs Pin, Brass Pin for Mosquito Repellent Machine, Soldering Type Brass Pin, Cramping Type Brass Pin, and Brass Electrical Accessories. The process flow chart being followed in the unit is shown in Figure 2.1. The detailed description of each step along with the type of energy input and details related to critical parameters are provided in subsequent paragraphs.

- **Raw Material Sorting:**

Different type of raw materials (mostly rejected brass items or components, like bathroom fittings and pipes) is received from suppliers. The raw material is manually sorted based on their material composition.

Metal Melting:

The sorted material is subjected to melting in the induction furnace. Based on the final product requirement, raw material composition in the induction furnace is decided. Scrap material is heated to around 1050^{0}C. The process requires electrical energy input for induction furnace as well as for pumps and motors being used in the cooling circuit of induction furnace. The critical parameters to be observed in this process are composition of the molten metal and its temperature.

- **Metal Pouring:**

The molten metal from the induction furnace is poured into sand moulds using ladle after visually checking its temperature by its colour. The molten metal composition is checked by using breaking the rods and seeing the colour and grain size. This method of checking the metal composition is very primitive in nature.

- **Fettling:**

In this process, sand moulds after adequate cooling are subjected to manual knockout to separate casting and the sand. The sand is again recycled and used in subsequent charges whereas castings are further subjected to series of machining processes.

- **Wire Drawing, Boring and Cutting:**

In this process, casting products (brass rods in the present case) are subjected to series of machining process including drawing, boring and cutting. Wire drawing is essentially carried out to make the outer dimensions uniform. Thereafter, boring operation is carried out to create internal hole in the rod and finally these rods are cut into small pieces based on the requirement of product. Electricity is used as energy input to power small size motors to carry out these operations.

- **Electroplating:**

The products obtained from the previous step is subjected to electroplating which uses electric current to reduce dissolved metal cations so that they form a coherent metal coating on an electrode. This process is primarily used to change the surface properties (e.g. abrasion and wear resistance, corrosion protection, lubricity, aesthetic qualities, etc.) of the product.

- **Final Inspection and Dispatch:**

Products received from the electroplating section are finally subjected to inspection and dispatched if found suitable after quality checks.

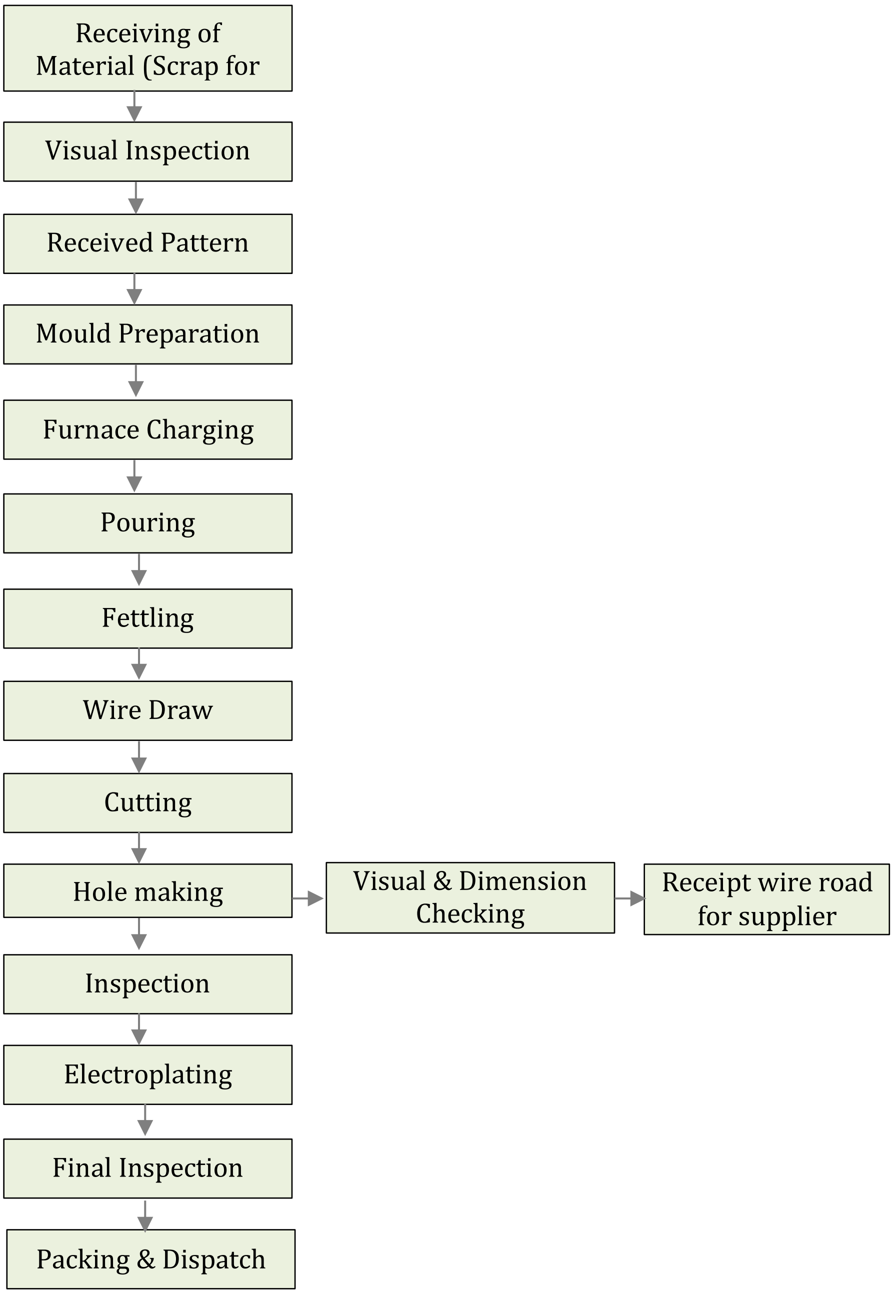


Figure 2.1: ***Process flow diagram***

Pictorial Representation of Production Process

Figure 2.2: ***Raw Material being used in the induction furnace***

Figure 2.3: ***Sand Muller for preparation of moulding sand***

Figure 2.4: ***Preparation of sand mould***


Figure 2.5: ***Scrap melting in the induction furnace***


Figure 2.6: ***Removal of scrap from induction furnace***

Figure 2.7: ***Pouring of molten metal into sand moulds***

Figure 2.8: ***Rods produced after knockout section***

Figure 2.9: ***Wire drawing process***

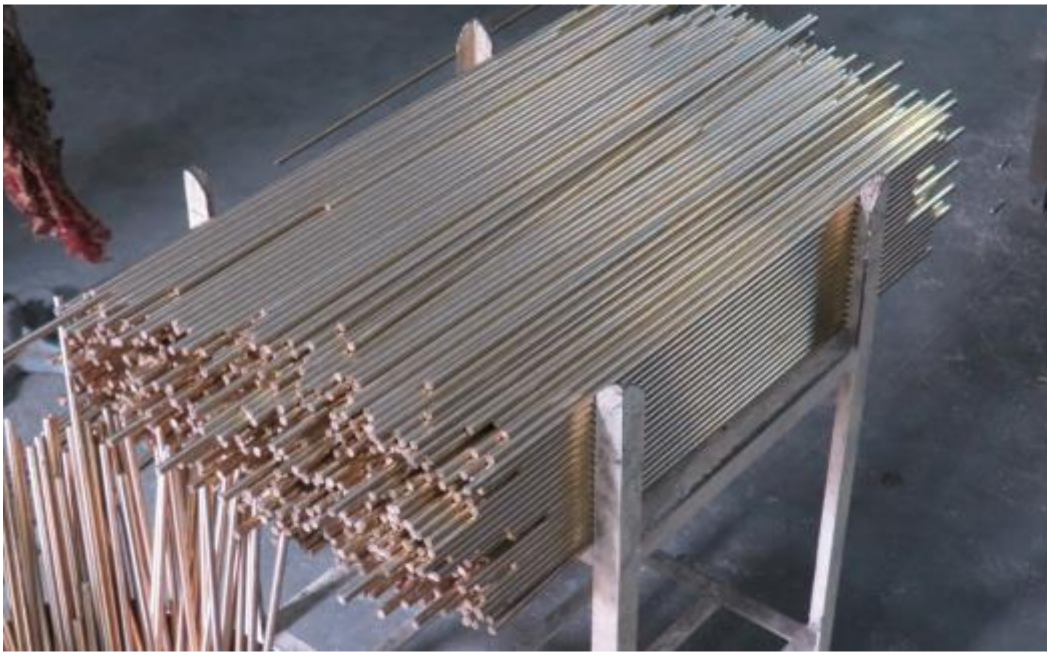


Figure 2.10: ***Rods after drawing operation***

Figure 2.11: ***Boring of rods***

Figure 2.12: ***Piece after cutting***

Figure 2.13: ***Products subjected to electroplating operation***

Figure 2.14: ***Drying of pieces***

Figure 2.15: ***Final products being manufactured***

2.2 PRESENT TECHNOLOGIES ADOPTED

Most of the electrical motors implemented in the unit are of very small size 0.5 HP to carry out machining operations. Figure 2.16 provides the operation wise distribution of electrical energy consumption for a typical month. It can be observed that furnace (100 kW) consumes almost 67 % of the electrical energy followed by motors of capacity less than 5 HP (29%). Further process wise details pertaining to energy consumption in the unit are summarized in Table 2.1.

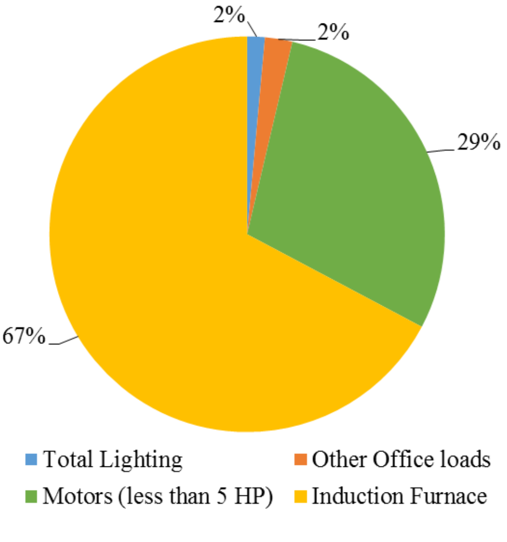


Figure 2.16: ***Operation wise distribution of electrical energy consumption***

Table 2.1: *Process wise energy consumption information*

SN	Equipment	Number	Energy Source	Rated Capacity	Daily operation in hours	Days per month
1	Induction Furnace	1	Electricity	Induction Furnace (100 kW)	10 hours (furnace) 15 hours (cooling motor/pumps)	25
2	Face cutting	1	Electricity	2 HP	8-10 hours	25
3	Drawing	2	Electricity	5 HP (each)	10 hours	25
4	Straightening	2	Electricity	0.5 HP (each)	10 hours	25
5	Cutting and Boring	38	Electricity	0.5 HP (each)	10 hours	25
6	Soap Wash Machine	1	Electricity	5 HP	7 hours	25
7	Electroplating	1	Electricity	1 kW	7-10 hours	25
8	Dryer Machine	1	Electricity	0.5 HP	7-10 hours	25

2.3 DETAILED ENERGY AUDIT

During the field visit to the unit detailed measurement of the following equipment were carried out. Following sections provides present observations and recommendations for each equipment to improve energy efficiency.

2.3.1 Electrical Panels:

- **Present System:**

The unit has installed two transformers of capacity 100 kVA each. One transformer is dedicated to machining works and the other transformer is for the Induction Furnace. Both the transformers received supply from 33 kV feeder and stepdown to 440 V. The voltage Total Harmonic Distortion (THD) was measured to be in the range of 1.4 to 2.8%.

- **Observations:**

It was observed that the Phase to Phase (RY, YB and BR) voltage at main distribution board in the LT side for both the transformer was lower than the prescribed norms. The values of the measurement performed are provided in table 2.2 below. This voltage deviation affects the operation of machineries and operation of the Induction Furnace.

Table 2.2: ***Phase to phase voltage range for both the transformers***

SN	Section	Rating of Transformer (kVA)	LT Voltage Range (Volts)		
			R-Y	Y-B	B-R
1	Machinery Section	100	380	381	379
2	Induction Furnace	100	396	399	397

It was observed that there is no provision to switch off the incoming power supply from the mains to the transformer when the furnace is not in operation.

It was observed that the main cable in the distribution boxes (DBs) is overheated which may lead to safety issues (refer Figure 2.17).

Figure 2.17: ***Visual observation of electrical connections***

Recommendations

- It is suggested to monitor continuously the Low Tension (LT) voltage for two to three days during full operation of the unit and in case any voltage deviation is observed. It is suggested to change the transformer tap setting with the help of Distribution Company. This may be due to either lower tail end HT voltage or wrong transformer tap setting.
- It was found that the induction furnace is not disconnected from the grid main supply when the induction furnace is not in operation, this results in energy loss as fixed (or no load) loss in the distribution transformer. It is suggested to switch off main grid power supply to the transformer when induction furnace is not in operation. This would result in energy saving of around 1,392 units per annum without any investment (See Table 2.3). Considering per unit cost of Rs. 7.3, this measures would provide annual benefit of around Rs. 10,161.

Table 2.3: ***Cost Economic Analysis***

SN	Energy Efficient Measure	Estimated Energy savings (kWh/Year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year)
1	Switching off the main grid power supply to transformer during non-operation of Induction furnace	1,392	10,161	Nil	Immediate

- It is suggested to check the load balancing in each phases. It is also suggested to use proper size of cables according to the load and proper cable glands in each of the phases. It is further suggested not to use wooden boxes for main distribution panel to avoid any safety related issue.

2.3.2 Induction Furnace:

- **Present System and Observations:**

The unit has installed induction furnace (100 kW) supplied by Indopower furnace to carry out scrap melting in the unit. (Refer: Table 2.4 for furnace specifications). Total of 9 to 10 melts are produced daily. The furnace operation starts early in the morning 6 am and till 2:30 pm (daily operation of around 8 to 9 hours). The scrap material is melted to a temperature of 1020 to 1050^{0}C.

Table 2.4: ***Furnace specifications***

Model/Make	Indo Power
Energy Input	Electricity, 100 kW
Crucible Capacity	250 kg

The present operation of induction furnace was studied and recorded capturing the power consumption, time taken to carry out each sub-activities, input material, furnace rheostat setting (kW consumption), etc. The present operational practice was discussed with the management and the furnace operator. Based on the field visit observations, following observations are made:

- Total material heated per charge is around 300 kgs as against the crucible capacity of 250 kgs. The total time taken per charge is around 96 minutes of which 67 minutes was for melting operation and rest 29 minutes was for pouring operation.
- The average energy consumption, in terms of kWh per tons of molten metal (as defined as SEC), of the unit is in the range of 470 to 500 kWh per ton.
- It is observed that no data log book is being maintained incorporating material input / output and electricity consumption details.
- There was no reduction in the power of the furnace during pouring or even during furnace holding. Further, pouring time is also higher (29 min).
- Burning losses in the system are found to be in the range of 2~4 %.
- It was observed that the furnace operator overloads the furnace or loads the metal above the induction coil. Furnace overloading actually consumes more power as well as takes more time to melt. Furnace overloading is common practice adopted, assuming that more metal is melted.
- It was also observed that the heel metal is kept in the furnace which again is also a bad practice adopted and consumes more energy.

The demonstration of the energy saving using the best practices resulted immediate benefit to the unit by saving 23% of energy used as shown in Table 2.5.

Table 2.5: ***Induction Furnace Trail Data***

No. of Trial Charge	Power Consumption (kWh)	Total time to melt (HH:mm)^	Total pouring time (hh:mm)	Total Billet Weight (Kg.)	SEC (kWh per ton)	SEC savings (kWh per ton)	Percentage saving
1	115	1.07	0.29	315.55	364	110	23%

^ includes time taken for single sample analysis

Figure 2.18: ***Heating of material in induction melting furnace***

Recommendations:

- The observations made along with recommendations were discussed with the furnace operator and management. The key recommendations made are following:
  - Best Practice #1 (Material Log Book): Maintain log records of type and quantity of scrap material being used and electricity consumed for every charge (See ***Annexure 2***).
  - Best Practice #2 (Furnace Loading & Operation): Level of molten metal should not exceed the level of induction furnace coil (See ***Annexure 3***).
  - As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy.
  - Holding of furnace should be avoided by proper planning in advance for sample analysis / testing and make available moulds.
  - Heel metal should be avoided.
  - During checking of metal composition (or sample testing) and pouring of molten metal in moulds, power supply to the induction furnace should be reduced to around 25% of the full capacity.
- For cooling of the Induction furnace cooling circuit and Cooling Tower (CT) is used. It is suggested to install timers in the cooling tower fan system and also replace the conventional cooling tower fan blades with Fibre Reinforced Plastic Blades (FRPB) which leads to sufficient energy saving owing to the better aerodynamic shape of its blades.
- It is further recommended to use graphite piece to cool down the furnace after shutting down. This graphite peace absorbs heat from the furnace with in duration of 10-12 minutes, as a result of this furnace cools down quickly. This way of heat removal from the furnace reduces the duration of cooling water pump operation resulting into significant energy saving

The cost economic analysis of the above suggested measures are compiled in Table 2.6. It can be observed that all the measures suggested towards energy efficiency improvements of furnaces have good energy saving with attractive payback.

Table 2.6: *Cost Economic Analysis*

SN	Energy Efficient Measure	Estimated Fuel savings (kWh/year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year / months)
1	Avoiding overfilling of metals in the Induction Furnace	9,120	68,400	Nil	Immediate
2	Avoiding super heating of metals in the Induction Furnace	2,400	18,000	Nil	Immediate
3	Laddle Preheating	4,800	36,000	Nil	Immediate
4	Installation of timers in cooling tower fan system	1,826	13,697	20,000	1 year 6 months
5	Installation of energy efficient fiber reinforced plastic blades (FRPB)	1,217	9,131	17,000	1 year 10 months
	Total	**19,363**	**145,228**	**37,000**	

2.3.3 Motor Loadings

Present System:

The machining department of the Unit employs several numbers of small sized motors (0.5 HP, 38 nos.) to carry out different machining operations. During visit, measurement of selected motors was carried out and results are presented in the following section.

Observations:

During field visit, measurement related to motor loading for different motors (generally motors of high capacity and longer operating hours were chosen) being used in the machining department was carried out. The loading of the motors varies from 43.4 % to 139.8%. The results are summarized in Table 2.7

Table 2.7: *Motor Loading*

Equipment Section	Current (Amps)				Voltage (Volts)	PF	Actual Power (kW)	Rated Motor (HP)	Loading (%)
	R	Y	B	Average					
Railing Machine-1	1.5	1.6	1.5	1.53	381	0.48	0.49	1.5	43.40
Railing Machine-2	2.0	1.9	1.9	1.93	388	0.59	0.77	2.0	51.38
Wire Drawing Machine	9.0	9.0	9.0	9.00	389	0.86	5.21	5.0	139.8

Recommendations:

1. Oversized and undersized motors should be replaced with motors according to load requirements. Motors operating around 50% of rated load are not efficient and should be immediately replaced with appropriately sized energy-efficient motors.
2. A properly balanced voltage supply is essential for a motor to reach its rated performance. Equal loads on all three phases of electric service would help in assuring a voltage balance while minimizing voltage losses.
3. Based on the results, it is found that PF of the motors is found to be lower (range 0.48 to 0.86). The PF can be improved by installing suitable sized capacitors across motors.

4. During field visit it was observed that the wire drawing machine motor (5 HP) is overloaded (loading of 140%). It is suggested to install overload protection device to avoid overloading and burnout of the device.
5. The cost economic analysis of installing capacitors across motors having low PF would require an investment of Rs. 6,219; resulting into saving 18,871 KWh annually, thereby saving Rs. 141,531 (see Table 2.8). It can be observed that the measures suggested towards energy efficiency improvements will have good payback period of less than a month.

Table 2.8: *Cost Economic Analysis*

SN	Energy Efficient Measure	Estimated Energy savings (kWh/Year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years / months)
1	Installation of capacitors across motors having low power factor	18,871	141,531	6,219	< 1 month

2.3.4 Installation of Energy Efficient Pumps and Ceiling Fans

Present System:

The unit has installed conventional lighting fixtures in the factory premises, comprising of florescent tube lights, compact florescent lamps and halogen lights. The ceiling fans used in the factory premises are of traditional design, consuming significant amount of energy. The unit has 24 nos. of conventional design ceiling fans of 60 W each and 39 nos. of florescent tube lights of 55 W each.

Observations:

During the plant visit, a study was carried out to find out the energy saving potential from replacement of lightings and ceiling fans with energy efficient equipment and fixtures. A detailed compilation of energy consumed by the lighting and ceiling fan was carried out and compared vis-à-vis to the use of energy efficient lightings and ceiling fans. In order to find out the capacity required for the new equipment, a detailed load analysis study was carried out in the existing units. For lightings, existing lux level was checked and desired capacity of replaced energy efficient lighting based on the existing lux level was determined. Similarly for ceiling fan, capacity determination on the basis of application was carried out.

Recommendations:

Based on the observation made at site and detailed analysis of the existing system, it is suggested to replace the existing lighting and ceiling fan with energy efficient lightings and ceiling fans. The table below summarizes the list of equipment and fixtures to be replaced with energy efficient equipment and fixtures:

Table 2.9: ***Replacement of conventional lightings and ceiling fans with energy efficient equivalents***

Existing system	Propose system
55W florescent tube light – 39 Nos.	T-8 (20W) LED light – 39 Nos.
60W conventional ceiling fan – 24 Nos	Energy Efficient (BLDC) Ceiling fan (28W) – 24 No's

The estimated annual savings, estimated investment and simple pay-back for replacement of existing lightings and ceiling fans with energy efficient equivalent is summarized below:

Table 2.10: ***Cost-benefit analysis – installation of energy efficient ceiling fans, and lightings***

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year / months)
1	Replace conventional ceiling fan with Energy Efficient (BLDC) Ceiling fan	22,141	72,000	3 year 1 month
2	Replace 55W florescent tube light with T-8 (20W) LED light	27,081	25,350	11 months

2.3.5 Exploring opportunity for renewable energy usage

During field visit, opportunities of using renewable energy applications were explored. However, based on the higher temperature requirement in the operation process possibility of using solar thermal technology for thermal applications may not be applicable. Further, there was also constrained related to the area. Finally, during discussion with unit owner, possibility of using renewable energy was ruled out due to lesser anticipated savings against the cost and operational complexity associated with renewable energy interventions.

Annexure 1:

Questionnaire*

Energy Audit – Questionnaire Form

"Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India – Jamnagar Brass Unit"

Name of the MSME unit:	RAVI BRASS INDUSTRIES
Address:	PLOT NO: 3631, I ROAD. PHASE 3 DARED, JAMNAGAR
Ph. No:	0288 – 2730774
Name of the respondent	RAJESH VACHHANI
Designation:	DIRECTOR (M. D.)

1. **Year of Establishment: 1994**
2. **Type of Products: a) Power Cord Brass Pin**
   b) ________________
   c) ________________
3. **Installed Capacity : 100 kW (For furnace) and 70 kW (For manufacturing unit)**
4. **Operating hrs per day : 11 Hrs.**
5. **Connected Load : 100 HP (kVA or kW please specify)**
6. **Supply Voltage : 420 Volt**
7. **Annual Energy Consumption/ Production:**

Financial Year (April to March)	2012	2013	2014
Coke consumed (kg)	56000	60000	40000
Cost of coke (in Rs.)	1288000	1380000	920000
Electrical units consumed (In kWh)	102857	137142	317142
Electricity charges (in Rs.)	720000	960000	2220000
LDO/HSD/ FO consumption (L)	--	--	--
Fuel Cost (in Rs.)	--	--	--
Production (Kg)	84000	102000	114000

*Unit specific questionnaire were sent to units prior to the conduction of energy audits. Some portion of the questionnaire was not filled or left blank by the units, due to lack of understanding. However, data used for the energy audit calculations and reporting were subsequently collected during the physical visit of the energy audit team to the site.

8. Source and Calorific Value of Fuels:

Fuel	Source	Calorific Value (kCal)
Coke (Kg)		
HSD (L)		
LDO (L)		
FO (L)		
Fuel	**Source**	
Electricity (kWh)	Paschim Gujarat Vij Company Limited	

9. Monthly Energy Consumption and Production Data:

Month	Production (kg)	Coke consumption (kg)	Electricity consumption (kWH) RBI – Ravi Brass Industries, E.F.- Electrical furnace	HSD/LDO /FO (L)	Any other fuel (specify units)
April, 14	9150	--	4226 RBI/ 2541 E.F	--	--
May, 14	13500	--	7139 RBI/11084 EF	--	--
June, 14	10900	---	7382 RBI/18090 EF	--	--
July, 14	11200	--	5926 RBI/14323 EF	--	--
August, 14	11185	--	7649 RBI/7834 EF	--	--
September, 14	10390	--	7777 RBI/ 32458 EF	--	--
October, 14	9000	--	6053 RBI/20262 EF	--	--
November, 14	8000	--	5949 RBI/20206 EF	--	--
December, 14	9500	--	7915 RBI/29072 EF	--	--
January, 15	9000	--	7346 RBI/ 29005 EF	--	--
February, 15	9800	--	6252 RBI/ 27705 EF	--	--
March, 15	8000	--	6146 RBI/22870 EF	--	--

10. Duration of electricity supply: ___11___Hours/ day

11. Cost variables per Kg of Production:

Cost Variable	Cost/ kg of production
Electricity Cost	4.50 Rs. / kg.
Coke Cost	--
Fuel Cost (LDO/HSD/FO) etc.	--
Labour Cost	4.00 Rs. /kg.
Material Cost	310 Rs. /kg.
Other Cost	20 Rs. /kg.
Total Production Cost	338.5 Rs. /kg.

12. Major Energy Consuming Equipment:

SN	Equipment	Energy source	Make/ Supplier	Year of Installation	Technical Specification/ capacity	Use	Comments
1	Electric Furnace	Electricity	Indo Power	2014	100 kW	Melting	

13. **Factory Layout (Please provide sketch of factory layout):**

14. **Please provide detailed manufacturing process for each major products manufactured:**

15. **Any Energy Efficient Technology installed in the unit:**

Technology	Specification	Cost (Rs.)	Year of Installation
-----	Press Machine ATA-25A	15,00,000	April 2015

16. **Any Energy Efficient Technology the management wants to implement in the unit:**

Technology	Cost	Use

17. **Any factory expansion plan:**

In Future: 1) Press Machine ATA-25A (6 Nos.) of machine to Purchase.
2) Plastic Moulding Machine for Three Pin Plug.

Annexure 2:

Material Log Book – Induction Furnace

Furnace ID:	…………………………	**Date**	…………………	**Charge Number**	………..	**Material Type**	…………………

Time Details

Melting		**Holding**		**Pouring**	
Start Time (A)	………..	Start Time (D)	………	Start Time (G)	………
End Time (B)	………..	End Time (E)	………	End Time (H)	………
Total time (C) = (B) – (A)	………..	Total time (F) = (D) – (C)	………	Total time (I) = (F) – (E)	………

Temperature Details

Melting Temperature (^{0}C)	……………………
Tapping Temperature (^{0}C)	……………………
Pouring Temperature (^{0}C) at start of pouring	……………………
Pouring Temperature (^{0}C) at end of pouring	……………………

Electricity Consumption (kWh)

Initial Reading (J)	……………………..
Final Reading (K)	……………………..
Total Electricity consumption (L) = (K)-(J)	……………………..

Material Input

SN	**Material Type**	**Quantity (kg)**
1	……………………………………	……………...
2	……………………………………	……………...
3	……………………………………	……………...
4	……………………………………	……………...
5	……………………………………	……………...
6	……………………………………	……………...
7	……………………………………	……………...
Total Input Material (M)		……………...
Total Material Output (N)		……………...
Material Lost (O) = (M) – (N)		……………...
Specific Electricity consumption (kWh/tons) (P) = (L) * 1000/ (M)		……………...

Remarks: Please capture any other information related to operation like reason for furnace holding, higher time taken for furnace holding etc…

Annexure 3:

Best Operating Practice

Following are the best practices to be followed for efficient operation of induction furnaces

- Maintain log records of type and quantity of scrap material being used and electricity consumed for every charge
- Loading of scrap material should always be done till the induction furnace coil height.
- As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy. Use of molten metal temperature measurement device to measure the required temperature.
- Holding of furnace should be avoided by proper planning of moulds / shells in advance.
- Heel metal in the induction furnace should be avoided.
- During pouring and scrap composition measurement, power supply to the induction furnace should be reduced to around 25% of the full capacity.