DETAILED PROJECT REPORT

ON

ENERGY EFFICIENT OIL FIRED REHEATING FURNACE

(1200 kg/hr)

(JAMNAGAR BRASS CLUSTER)

Bureau of Energy Efficiency

Prepared By

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Reviewed Bv

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(JAMNAGAR BRASS CLUSTER)

BEE, 2010

Detailed Project Report on Energy Efficient Oil Fired Reheating Furnace (1200 kg/hr)

Brass SME Cluster, Jamnagar, Gujarat (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: ***JAM/BRS/ERF/14***

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Winrock International India

New Delhi

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List of Abbreviations

MT	Metric Tonne
kWh	kilo Watt Hour
GoI	Government Of India
MoMSME	Ministry of Micro Small and Medium Enterprises
GHG	Green House Gas
BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
O&M	Operational & Maintenance
NPV	Net Present Values
ROI	Return on Investment
IRR	Internal Rate Of Return
DSCR	Debt Service Coverage Ratio
PBT	Profit Before Tax
PAT	Profit After Tax
ID	Induced Draft
FD	Forced Draft
DBT	Dry Bulb Temperature
SIDBI	Small Industries Development Bank of India

EXECUTIVE SUMMARY

Winrock International India is executing BEE-SME program in Jamnagar Brass Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Jamnagar is known as the brass city of India, it has been an important industrial centre since long for brass related parts. All the units in Jamnagar Brass cluster had been operating in traditional conditions and most of equipments/utilities using in cluster were procured from the local suppliers. They are making the equipments on their traditional expertise, which had remained unchanged over the years. Hence this cluster was chosen for energy efficiency improvements by implementing energy efficient technologies, so as to facilitate maximum replication in other brass clusters in India.

Major energy sources being used in manufacturing of Brass parts in Jamnagar Brass cluster are electricity and fuels such as Coal, Furnace Oil and Liquid petroleum gas. This depends on application of technology, process requirement, availability, and economic and safety point of view. The two forms of energy being used in manufacturing of Brass parts in typical Brass unit are electrical energy and thermal energy. Electrical energy is being used in melting of Brass in induction furnaces, operation of electrical utilities and thermal energy is being used in Brass melting operation.

Function of the reheating furnace in brass industries is reheating of raw material. During energy use and technology audit studies in various brass industries in Jamnagar brass cluster, it was observed that most of the brass units are using inefficient reheating furnace for reheating the brass billets and efficiencies of existing reheating furnace is low.

Implementation of proposed energy efficient oil fired reheating furnace having capacity 1200 kg/hr equipped with waste heat recovery system having efficiency more that existing furnace would save about 33048 litre of oil per year.

This DPR highlights the details of the study conducted for assessing the potential for replacement of conventional oil fired reheating furnace by new energy efficient oil fired reheating furnace , possible energy saving, and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis for three different scenarios and schedule of project Implementation.

This bankable DPR also found eligible for subsidy scheme of MoMSME for "Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises" under "National Manufacturing and Competitiveness Programme". The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table:

S.No	Particular	Unit	Value
1	Project cost	₹(in Lakh)	9.35
2	Fuel saving	litre/year	33048
3	Monetary benefit	₹(in Lakh)	8.66
4	Debit equity ratio	Ratio	3:1
5	Simple payback period	years	1.08
6	NPV	₹(in Lakh)	23.02
7	IRR	%	72.48
8	ROI	%	28.24
9	DSCR	Ratio	3.87
10	Process down time	Days	7
11	CO_2 reduction	Tons/year	107

The projected profitability and cash flow statements indicate that the proposed project implementation i.e. energy efficient reheating furnace with existing reheating furnace will be financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Jamnagar Brass Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up gradation through studies and pilot projects in these SMEs clusters.

***Major activities in the BEE -SME program are furnished below*:**

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up gradation projects in clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion

1 INTRODUCTION

1.1 Brief introduction about Cluster

Jamnagar, known as the brass city of India, has been an important industrial centre since long for brass related parts. Jamnagar is inhabited by a various types of brass related work units which include Brass foundry; Brass parts manufacturing, Electroplating and Extrusion units. There are about 3500 brass related units alone in Jamnagar. Majority of these Brass units in Jamnagar are in operation since last 20 years. All these units are located in pockets of Shankartekri, MP Shah Udyognagar, Patel colony and Dared areas.

Jamnagar Brass cluster like many other clusters was in dire-straits with regard to the energy efficiency and conservation. In almost all units, whether big or small, there had been no conscious effort to take up energy conservation and energy efficiency measures as a part of day to day operations. Many a times, the small scale entrepreneur was not even aware of measures that could bring down the percentage energy cost, which automatically brings down the manufacturing cost. Some of the bigger units had experimented with few parameters to improve energy efficiency in the units, but the results and outcome was confined to them only. All the units in Jamnagar Brass cluster had been operating in traditional conditions and most of equipments/utilities using in cluster were procured from the local suppliers. They are making the equipments on their traditional expertise, which had remained unchanged over the years.

Till now there has been very little focus on energy conservation activities in the units. Also, there have been no concrete external interventions as well to help the small units come out of their shell and rise up to the necessary energy efficiency benchmarks. The raw material requirement of the Jamnagar Brass cluster is met mainly from the following three sources:

- Old brass, copper and bronze utensils
- Imported brass scrap and honey
- Brass scrap from ship breaking yard

Apart from the Brass scrap; copper, zinc, led, other metal alloys and clay etc are also used as raw material depends on the final product requirement

Majority of the raw material requirement in Jamnagar Brass cluster is met through imports. The countries from which it is imported are USA, Singapore, Gulf and European countries. The imported raw material is available mainly in three forms i.e. Honey scrap, Dross of brass & Pale in the form of strips.

1.1.1 Existing production process

The production process mentioned in the below chart is almost similar to most of brass part manufacturing units in the Jamnagar brass cluster. However, depending on the final product, quality of final product manufacturing unit and raw material properties, stated process flow is altered to suit the requirement of industry.

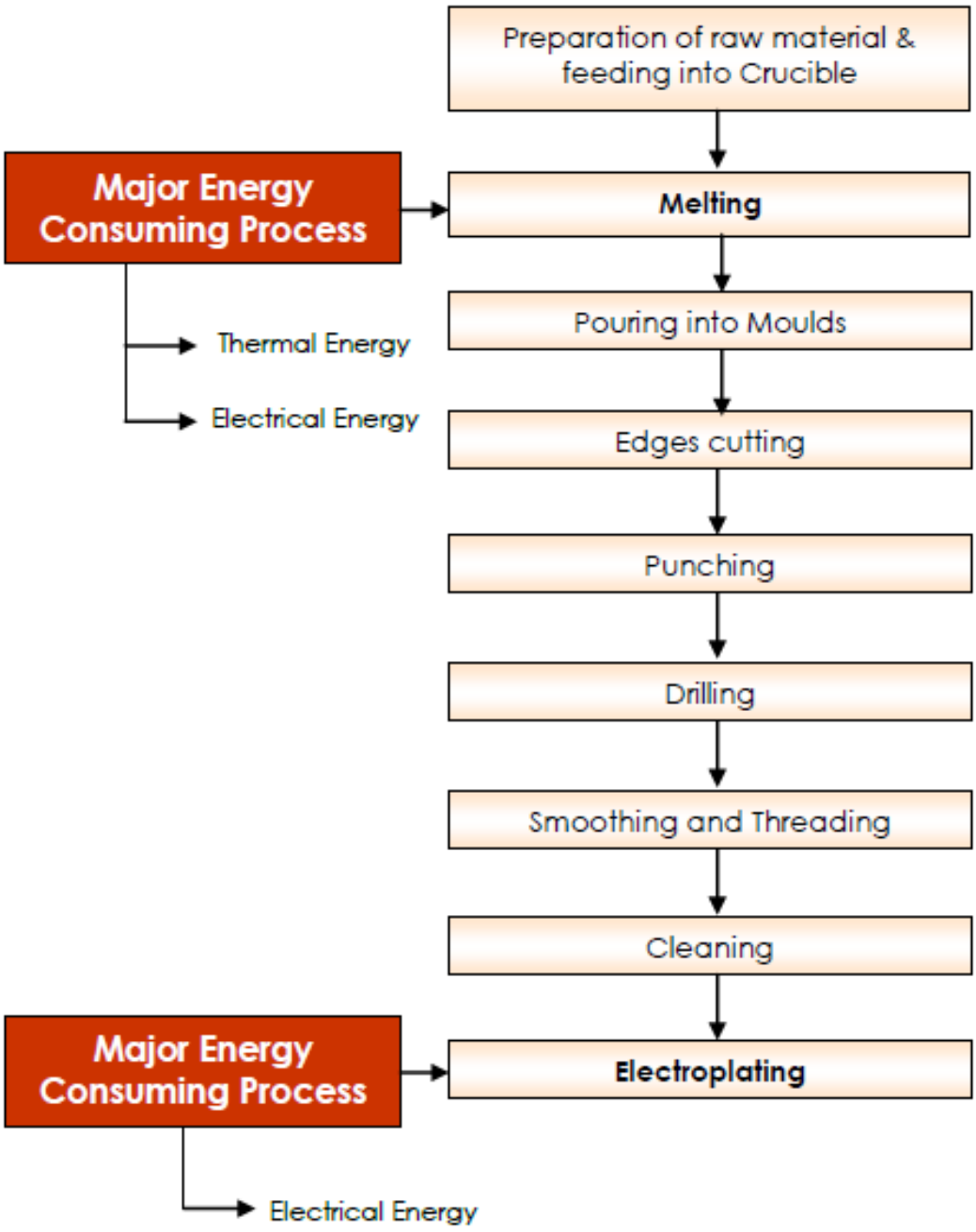

Figure 1.1: Process flow chart

1.2 Energy Performance in Jamnagar Brass cluster

Major energy sources being used in manufacturing of Brass parts in Jamnagar Brass cluster are electricity and fuels such as Coal, Furnace Oil and Liquid petroleum gas. This depends on application of technology, process requirement, availability, and economic and safety point of view. The two forms of energy being used in manufacturing of Brass parts in typical Brass unit are electrical energy and thermal energy. Electrical energy is being used in melting of Brass in induction furnaces, operation of electrical utilities and thermal energy is being used in Brass melting operation.

Energy consumption (thermal energy & electrical energy) in Brass unit depends on type of unit and final product manufacturing in unit. Annual electrical energy and thermal energy consumption in typical Brass foundry, Extrusion unit, Machining and Electroplating unit is presented in below bar chart

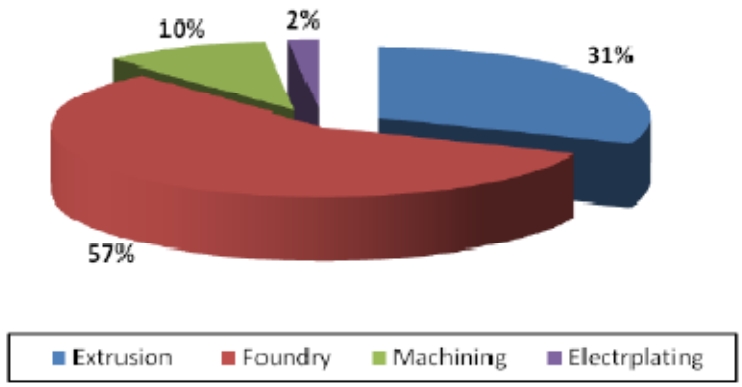

Figure 1.2: Percentage of energy consumption in different type of unit

1.2.1 Specific energy consumption

Specific electrical and thermal energy consumption in brass unit is varying on the final product manufactured in that unit. Specific energy consumption specific energy cost in different brass unit is shown in Table 1.1 & Table 1.2 below:

Table 1.1 Specific energy consumption in various brass units

S.No.	Type of units	Unit	Value
1	Brass foundry unit	kCal/kg of brass rod	1013-1057
2	Brass extrusion unit	kCal/kg of brass rod	1037-1186
3	Brass machining unit	kCal/kg of final product	473.04
4	Brass electroplating	kCal/kg of final product	875.21

Table 1.2 Specific energy cost in various brass units

S.No.	Type of units	Unit	Value
1	Brass foundry unit	₹/kg of brass rod	3.17-3.02
2	Brass extrusion unit	₹/kg of brass rod	5.64-5.194
3	Brass machining unit	₹/kg of final product	3.24
4	Brass electroplating unit	₹/kg of final product	5.99

1.3 Identification of existing technology/ equipment

1.3.1 Description of equipment

During energy use and technology audit studies in various brass industry in Jamnagar brass cluster, it was observed that most of the brass units are using inefficient reheating furnace for reheating the brass billets and it is found that the efficiencies of existing reheating furnace is low. Performances of various reheating furnaces in Jamnagar Brass units are evaluated and analyze the quantum of various losses in Reheating furnace were analyzed.

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Figure1.3 Existing furnace operations

From energy use and technology gap audit studies in various brass industries in Jamnagar brass cluster, below mentioned things are identified:

- Energy efficiency improvement opportunities

- Environment and safety improvement of workers
- Design flaws in the conventional oil fired reheating furnace
- Operational & maintenance practices in conventional reheating furnace

1.3.2 Technical gap in conventional oil fired reheating furnace

Technology gaps/design flaws in conventional oil fired reheating furnace system are identified and described below in detail

➢ **Air-Fuel Ratios:**

From energy use and technology studies it was observed that, air fuel ratio is not proper maintained. This reduces the furnace efficiency by 3-5%.

➢ **Location of Chimney:**

In majority of industries, chimney is located at centre of reheating furnaces; this causes the poor heat transfer between flue gasses and charge; this automatically leads to poor heat transfer efficiency between flue gas and reheating material.

➢ **Waste Heat Recovery System:**

This is the one of the area where major amount of heat energy is lost; in majority of the units is not installed waste heat recovery system to recover the heat from flue gasses. In a few cases it was observed that efficiency of existing waste heat recovery system is poor. Around 35% of heat input energy to reheating furnace is lost in the flue gasses.

➢ **Preheating of Charge and Combustion Air:**

In majority of the systems it was observed that, there is no system to preheat the charge and air.

➢ **Insulating Material:**

Furnace lining of the existing furnace was done with the locally available firebricks. The firebricks with low alumina content tend to get worn out in a short duration. Also, the insulation required for plugging heat loss through the furnace was usually done with locally available red bricks, which do not serve the purpose of insulation.

➢ **Burner:**

Majority of units are using locally fabricated burners for the combustion of fuel oil. These burners were either a far copy of a properly designed burner or sometimes substandard and locally designed. Many a times, oil could be seen leaking from the burner joints. Same types of burners were used for a large range of fuel flow rates.

- **Selection and Size of Blower System:**

A proper capacity blower is necessary for combustion air to be delivered at correct pressure and in appropriate volume. The existing blowers in the majority of the units are either locally fabricated without any proper design parameters or are under/over- sized without any consideration for correct air pressure.

- **Inadequate Sizing of Heating and Pumping Unit:**

In majority of the units it was observed that heating and pumping system are not designed properly. This is mainly due to lack of awareness about the standard oil temperature and pressure at the combustion stage and the benefits thereof.

1.3.3 Specification of exisitng furnace

Detailed specification of existing oil fired reheating furnace is furnished in Table 1.3 below:

Table 1.3 Specification of existing furnace

S. No	Details	Units	Value
1	Capacity	TPH	1.2
2	Fuel used		Furnace oil
3	Operational hours	Hrs/year	2000
4	Furnace length	Inches	264
5	Furnace width	Inches	90
6	Furnace height	Inches	54
7	Width of charging door	Inches	21
8	Width of discharging door	Inches	21

1.3.4 Role in the process

Function of the reheating furnace in brass industries is to reheat the raw material. Reheating is one of the major energy and time consuming process in the overall manufacturing process in brass industry. Apart from the energy and time, final product quality will also depend on time and temperature of reheating of raw material.

1.3.5 Need for up gradation of existing equipment

From the above sections it is clear that reheating cost is one of the major costs in the overall brass manufacturing process, in typical brass manufacturing industry, which comes out to be ₹ 1.036 per kg. This is approximately 20% of overall energy cost i.e. ₹ 5.2 - 5.6 per kg.

The efficiency of the existing installed conventional reheating furnace is 18.73 % only. Existing reheating furnaces being used in majority of the industries are of very primitive design; have poor preheating of charge, they do not have waste heat recovery system and poor heat transfer efficiency between hot flue gasses & billets. All these things will lead to increase in energy consumption in reheating furnace.

Advantages of replacing the conventional furnace with Energy Efficient furnace are:

- Improved product quality
- Saving in reheating time - it automatically leads to energy savings
- Improved working environment
- Productivity improvements

1.4 Baseline energy consumption of existing equipment

Energy consumption in oil fired reheating furnace would depend on below mentioned things:

- Design of furnace
- Burner design and position
- Poor heat transfer efficiency

Energy use and technology audit studies were conducted in various units of Jamnagar brass cluster to establish the baseline energy consumption of oil fired reheating furnace and the reports of same are attached in Annexure – 1.

1.4.1 Design and operating parameters

Major operating parameters to improve performance of existing furnace are:

- Preheating of charge and combustion air
- Insulating material.
- Selection and size of blower system.
- Inadequate sizing of heating and pumping unit.
- Burner design

1.4.2 Specific fuel consumption

Fuel consumption of typical oil fired reheating furnace of adequate capacity is around 37.03 litre/tonne of production. Performance of existing oil fired reheating furnace was evaluated and same is presented in Annexure 1.

1.4.3 Energy audit methodology

Predefined methodology was adopted to evaluate the performance of oil fired reheating furnace, same was furnished below:

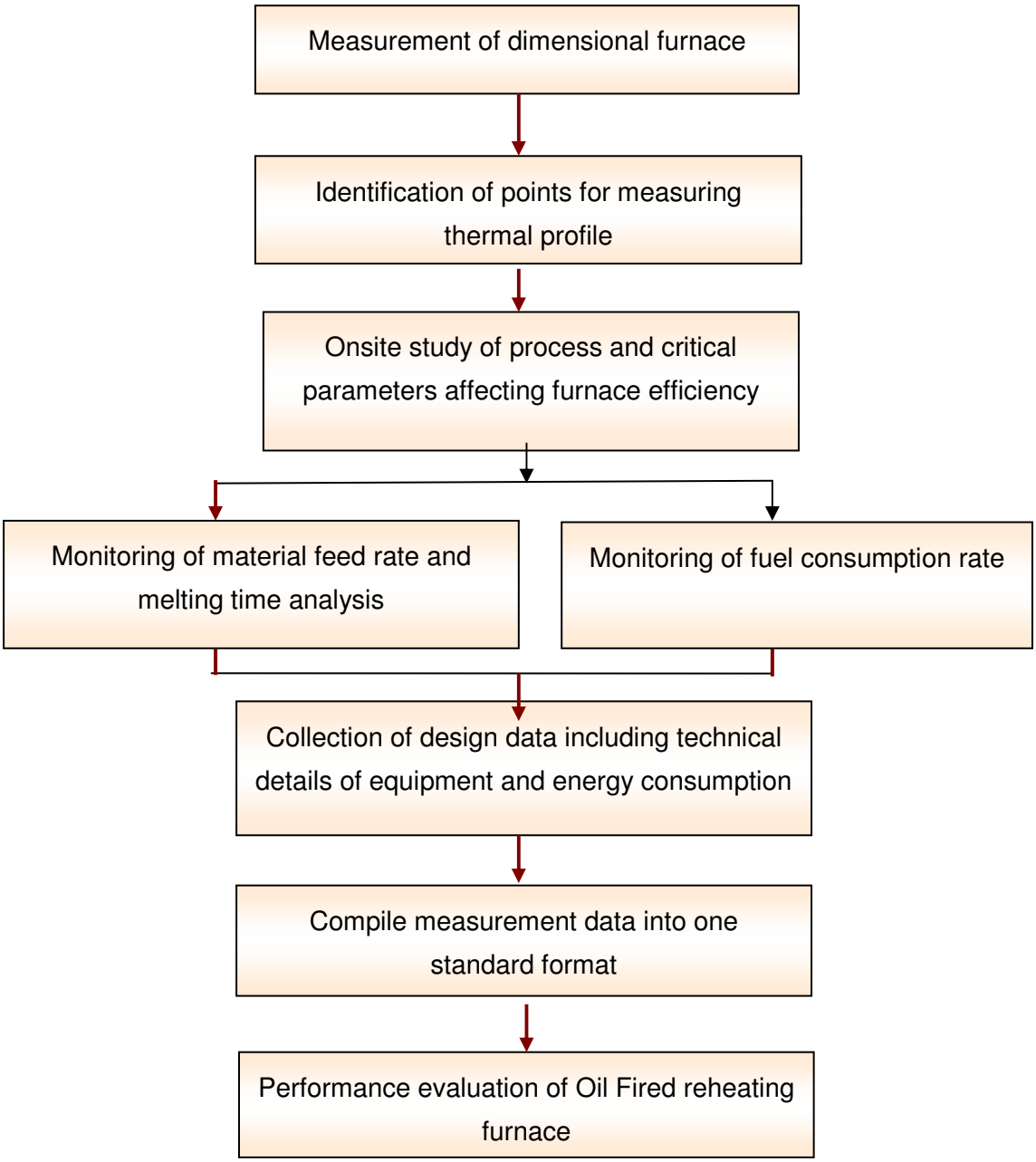


Figure1.4: Energy audit methodology

1.5 Barriers in adoption of proposed technology/equipment

The processes to do with technology and innovations in SMEs are different from those that take place the large firm context. Technology in the SME sector has an increasingly complex or combinative character, most of the SMEs units in cluster are regarded for their labour intensive and the capability work with local resources. In the past, SME entrepreneurs are stressed less emphasis on technology due to cut the initial cost of plant /machinery. Major barriers in the up gradation of technology in the cluster are non availability of technology; distrust on technology supplier, lack of information about energy efficiency among small and medium enterprises still persists, preventing increased adoption of efficient technologies and non availability of skilled manpower and cost of new technologies. Details of the other barriers in the implementation of energy efficient technologies/equipments in the Jamnagar Brass cluster are presented in below sections.

1.5.1 Technological Barrier

As majority of the entrepreneurs in cluster are not aware of the energy losses in the plant, there may be a strong feeling that the energy efficiency initiatives in manufacturing facility can have a cascading effect of failure in critical production areas directly or indirectly connected if the intended performance of the replaced / retrofitted equipment falls below design values.

There is a strong feeling in the Brass unit entrepreneurs that, energy efficiency initiatives are difficult and they do not wish to take the risks such as business interruption due to production loss vis-a-vis the drive to save energy. These can however be overcome by motivating them to attend the awareness programs and use the detailed report on the benefits of the measures identified and cost benefit analysis. Further, sourcing of expertise on maintenance service provider or training by the equipment supplier will definitely overcome the barriers.

1.5.2 Financial Barrier

Significant amount of investment is not commonly seen in most of Jamnagar Brass industries. Further, from the business perspective for any industry owner, it is more viable, assured and convenient to invest on project expansion for improving the production capacity, rather than make piecemeal investment in retrofit and replace options for energy savings. Investment returns on large capacity addition or technology adoption shows up prominently in terms of savings and helps in benchmarking operations. Further, there is a strong feeling among the industry owners that, energy conservation initiatives of replacement and retrofit nature is not a common practice as it involves large capital investment against low returns. In view of this, and given the limited financial strength of

entrepreneurs from Brass units in Jamnagar, they would not take the risks to invest in energy efficiency measures.

1.5.3 Skilled manpower

Skilled workers are locally available to run the machines available in Jamnagar. However, there is hardly any engineer employed in these enterprises and the production process remains traditional. This is one of the lacunae of the Jamnagar Brass Parts cluster.

Specialized training with local service providers for better operation and maintenance of equipments, importance of the energy and its use will create awareness among workforce. These programs should be organized with equipment suppliers.

2 EQUIPMENT OPTION FOR ENERGY EFFICIENCY IMPROVEMENT

2.1 Description of proposed equipment

Proposed energy efficient oil fired reheating furnace equipped with waste heat recovery system. Use of scientifically designed burners equipped with air fuel ratio controller to improve reheating furnace efficiency. Insulated and designed efficiently to minimize losses. Due to all above mentioned modifications, saving in reheating time can be achieved with improved product quality and improved efficiency of the system.

Figure2.1: Energy efficient reheating furnace

2.1.1 Comparison of conventional with new rehating furnace

Technical, economic, Environmental, safety aspects of conventional reheating furnace and energy efficient oil fired furnace are compared on life cycle of equipment, same is presented in Table 2.1 below:

Table 2.1 Comparison of conventional equipment and proposed equipment

S. No	*Parameters*	Conventional oil fired reheating furnace	Energy efficient oil fired reheating furnace
1	Oil consumption	High	Low
2	Environment pollution	High	Low
3	Safety of workers	Poor	Good
4	Maintenance	High	Low
5	Operational cost	High	Low
6	Availability of local service providers	Yes	Yes

S. No	Parameters	Conventional oil fired reheating furnace	Energy efficient oil fired reheating furnace
7	Waste heat recovery system	Not installed	Installed
8	Insulation	Poor	Good
9	Temperature gauges	Not installed	Installed

From the above table it is clear that Energy efficient oil fired reheating furnace has significant advantages in Energy, Environmental, Economic & safety aspects. It is technically justifiable to install energy efficient oil fired reheating furnace in place of conventional oil fired reheating furnace.

2.1.2 Suitability over existing system

The proposed equipment is completely replaced the existing system and suitable with the existing process.

2.1.4 Technical specifications

Specification for energy efficient oil fired reheating furnace varies from industry to industry and can be provided to vendor as per the need. A general specification of new furnace is furnished in Table 2.2 below:

Table 2.2 Technical specifications

S.No	Details	Units	Value
1	Name of Equipment	NA	Energy Efficient Reheating furnace
2	Model	NA	---
3	Capacity	kg/hr	1200
4	Blower motor	HP	7.5
5	Oil plant motor	HP	0.5
6	Reheating oral size(W x H x L)	inch	90 x 54 x 264
7	Billet chamber size(W x H x L)	inch	21 x 27 x 240

2.1.5 Superiority over existing system

Energy efficient Oil fired reheating furnaces are available with waste heat recovery and equipped with designed burners with air fuel ratio control to improve reheating furnace efficiency.

2.1.6 Availability of proposed equipment

The technology identified for implementation is available locally and are indigenously produced. The technology/ equipments will be procured from local equipment suppliers. The proposed equipment is locally manufactured by well known vendor in Jamnagar brass cluster for making energy efficiency equipments in cluster.

The equipment identified is available in the State of Gujarat (Jamnagar) and implemented successfully in few units in the cluster. The investment required for implementation of the identified measures has good financial returns and the proposed measure is technically and financially viable.

2.1.7 Equipment providers

Technology/service provider selected for implementation of the proposed energy efficiency project has long years of experience in implementation of energy efficiency projects. This technology/service provider is having in house R&D team to develop the new technologies / equipments, which are energy efficient & eco friendly. Recommended supplier having the trust in cluster on products developed by them. Details of equipment suppliers are furnished in Annexure 7.

2.1.8 Terms and conditions in sales of Energy efficient reheating furnace

The terms and condition of sales of new energy efficient oil fired reheating furnace from the proposed supplier is given at Annexure 8.

2.2 Process down time during implementation

The process down time for implementing the replacement of conventional furnace with energy efficient furnace will take one week. The implementation can be taken up during weekly holiday, or other holidays, so that the process down time can be reduced.

2.3 Suitable unit for proposed equipment

The studies on energy use and technology audit revealed that the proposed energy efficient reheating furnace is suitable for the unit having production capacity is 1200 kg/hr.

3 ECONOMIC BENEFITS OF NEW EQUIPMENT

Energy use and technology audit studies were conducted in various units of the Jamnagar brass cluster to evaluate the performance of existing furnace, technical gaps in existing furnace and analyzed energy, economic, environmental and social advantages of energy efficient reheating furnace over conventional reheating furnace.

3.1 Energy & monetary benefits

3.1.1 Fuel Saving

Energy use and technology audit studies revealed that reheat operation in reheating furnaces depends on the design of the furnace, type and position of burners. Analysis was carried out on conventional reheating furnace and specific fuel consumption was found out to be 37.03 litre/tonne, whereas, specific energy consumption with proposed energy efficient reheating furnace is 23.26 litre/tonne. The implementation of energy efficient reheating furnace will reduce the specific fuel consumption by 13.77 litre/tonne (37%). Total annual production capacity is 2400 tons hence, total oil saving would be 33048 litre.

3.1.2 Electricity saving

Project implementation will not save electricity while its implementation will increase electricity consumption of about 11800 kWh per year.

3.1.2 Monetary benefit

Annual monetary savings due to implementation of energy efficient reheating furnace is about ₹ 8.66 lakh per annum. Details of monetary saving and fuel saving calculation are furnished at Annexure 3.

3.2 Environmental benefits

3.2.1 Reduction in fuel consumption

Most of units in the cluster are using oil for oil fired reheating furnace; by implementing the proposed energy efficient oil fired reheating furnace in place of conventional furnace will reduce consumption of oil.

3.2.2 GHG emission reductions

Energy consumption of proposed energy efficient oil fired reheating furnace is 37% less than conventional reheating furnace; it automatically leads to reduction of GHGs emissions by implementing proposed furnace in-place of conventional oil fired furnace. Reduction of GHGs emissions leads to improved environment and better compliance with environmental regulations.

3.2.2 CDMability of the project

The proposed project saves about 33048 litres of oil per year for oil fired reheating furnace. This roughly corresponds to 107 tonnes of CO2 emission reduction or 107 CERs. Considering at the cluster level, 200 units implement the technology yielding to a total savings of about 21400 CERs per annum which can be a suitably sized small scale CDM project.

3.3 Social benefits

3.3.1 Impact on working environment

Replacement of conventional furnaces with energy efficient fired oil furnaces will reduce furnace skin temperature, closed combustion chamber & temperature control of oil fired reheating furnaces, all those things will improves the working condition & safety of workers near to oil fired reheating furnace.

3.3.2 Impact on manpower skills

Proposed energy efficient reheating furnace components were procured from other companies and also generate employment during installation and commissioning. As training will be provided by equipment suppliers will improve the technical skills of manpower required for operation of the equipment.

3.3.3 Impact on wages/emoluments

The awareness among the technologies and training retained during implementation of the project will lead to increase the wages of the employees indirectly, as it improves the technical skills of the workforce during operation and maintenance of equipments. Further, the remuneration will improve in the market or in other companies for the work force.

3.4 Other benefits (If any)

3.4.1 Productivity improvements

Due to improved design of oil fired reheating furnace will improves melting temperature; this automatically reduces melting time of brass. It was observed that reheating is one of major time consuming area, reduction in cycle time and specific fuel consumption in brass manufacturing unit will improve productivity of the units in Jamnagar brass cluster.

3.4.2 Quality improvements

Most of the brass manufactured in Jamnagar brass industries is temperature sensitive. As already discussed in above chapters that inbuilt design of automatic temperature control

system in energy efficient oil fired reheating furnace will control temperature of material inside the furnace, this automatically improves quality of material.

3.4.3 Easy operation& maintenance

Operation and maintenance of new energy efficient reheating furnace is easy and economical.

4 ECONOMICS & IMPLEMENTATION OF NEW SYSTEM

4.1 Cost of project implementation

4.1.1 Equipment cost

Technical and financial quotations of proposed energy efficient reheating furnace are collected from reputed vendors. Cost of furnace having production capacity of 1200 kg/hr is ₹ 8.50 lakh only as per the quotation provided at Annexure 8.

4.1.2 Other cost

Erection & commissioning cost is ₹ 0.85 lakh only. Details of project cost are furnished in Table 4.1 below:

Table 4.1 Details of proposed equipment installation cost

S.No	Particular	Unit	Value
1	Equipment cost	₹ (in Lakh)	8.50
2	Erection & Commissioning cost	₹ (in Lakh)	0.85
3	Other misc. cost	₹ (in Lakh)	0.00
4	Total cost	₹ (in Lakh)	9.35

4.2 Arrangement of funds

Proposed financing for the replacement of conventional furnace with energy efficient furnace is made considering a debt equity ratio of 3:1, which is normally allowed by financial institutions for financing energy efficiency projects. On the basis of debt equity ratio of 3:1 the promoter's contribution works out to 25% of the project cost and the balance would be term loan from the Bank / FIs.

4.2.1 Entrepreneurs contribution

Total cost (Equipment and erection& commissioning) of project works out to be ₹ 9.35 lakh. Out of which entrepreneur's contribution is 25%, which work out to be ₹ 2.34 lakh.

4.2.2 Loan amount

75% of the project cost would be available as term loan from the banks/financial institutions, which works out to be ₹ 7.01 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI's rate of interest for energy efficient projects. The loan tenure is 5 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 Financial Indicators

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 8 years, being period, with in which the entire term loan would be repaid. The financials have been worked out on the basis of certain realistic assumptions, which are outlined below

- The project is expected to achieve monetary savings of ₹ 8.66 lakh per annum, based on 12 hours and 300 days working.
- The operational and Maintenance cost is estimated at 4% of cost of fixed assets with 5% increase every year to take care of escalations.
- The erection and commissioning charges is estimated at 10% of the total project cost for the plant and machinery
- Interest on term loan is estimated at 10%. The tenure of the loan is considered 5 years and repayment starts after 6 months from the first date of disbursement of loan in 60monthly installments.
- Depreciation is provided as per the rates provided in the companies Act.
- Income tax provision is made as per IT Act 1961.
- Based on the above assumptions, profitability and cash flow statements have been prepared.

4.3.2 Simple payback period

Simple payback period of replacing conventional furnace with energy efficient furnace is 1.08 year.

4.3.3 Net Preset Value (NPV)

The Net present value of the investment on project is at @10.00% interest works out to ₹ 23.02 lakh.

4.3.4 Internal rate of return (IRR)

After tax Internal Rate of Return of the project is works out to be 72.48%. Thus the project is financially viable.

4.3.5 Return on Investment (ROI)

The average return on investment of the project activity works out at 28.24%.

Details of all the financial parameters for the replacement of conventional furnace with energy efficient furnace are presented in Table 4.2 below:

Table 4.2 Financial parameters of energy efficient furnace

S. No	Parameter	Unit	Value
1	Simple payback period	Years	1.08
2	NPV	₹ in lakh	23.02
3	IRR	%age	72.48
4	ROI	%age	28.24
5	DSCR	Ratio	3.87

4.4 Sensitivity analysis

In different situation fuel saving may increase or decrease on the basis of this scenarios a sensitivity analysis in realistic, pessimistic and optimistic scenario has been carried out which is as under

- Fuel saving increased by 5%
- Fuel saving decreased by 5%

Table 4.3 Sensitivity analysis

Particulars	IRR	NPV	ROI	DSCR
Normal	72.48%	23.02	28.24%	3.87
5% increase in fuel savings	77.06%	24.79	28.35%	4.08
5% decrease in fuel savings	67.52 %	21.24	28.12%	3.66

Assuming all provision and resource input would remain same during sensitivity analysis

4.5 Procurement and implementation schedule

Total time required for implementation of proposed project is about 13 weeks from the date of financial closure. Detailed procurement and implementation schedules are furnished at Annexure 6.

ANNEXURE

Annexure-1 Energy audit reports of conventional reheating furnace

Energy audit report of reheating furnace report at Unit-1:

Reheating Furnace is the one of the major energy consuming equipments in production process of Brass in Unit-1. Detailed Performance assessment of the reheating furnace at Unit-1 is presented in the tables below.

Efficiency of reheating furnace was evaluated by two methods:

- Direct method
- Indirect method

Both these methods require measuring of a number of operational parameters of the reheating furnace. The indirect method has an advantage over the simpler direct method that various heat losses from reheating furnace can be quantified and accounted. However, efficiency is calculated using both the methods and the results are presented along with the measured data in the following Tables below.

Data collected at unit 1 during reheating furnace operation.

S.No.	Parameter	Unit	Value
1	Total material fed	kg	661
2	Total fuel fed	Ltrs	25
3	Flue gas temperature	Deg C	423
4	O2/ excess air	% age	14.18

Direct Method

The above data have been used to calculate the efficiency of reheating furnace in table below. The following table presents the efficiency calculation by direct method.

Efficiency calculations using direct method

Parameters	Units	Value
Mass of material during study	Kg	661
Temperature of inlet billet	Deg C	80
Temperature of outlet billet	Deg C	821
Temperature difference	Deg C	741

Parameters	*Units*	*Value*
Specific heat of material	kCal/kg-deg C	0.09
Heat contained in material	kCal	44082.09
Total fuel supplied	Litres	25
Specific gravity of fuel	---	0.88
Calorific value of fuel	kCal/kg	9800
Total heat input to furnace	kCal	215600
Furnace efficiency	% age	20.44

The above table shows the reheating furnace efficiency, as obtained by direct method is 20.44%.

Indirect Method

Major heat losses encountered in the operation of reheating furnace are computed and provided in table below. The reheating furnace thermal efficiency is evaluated by indirect method, where in the efficiency is arrived at by subtracting the total heat losses from 100%.

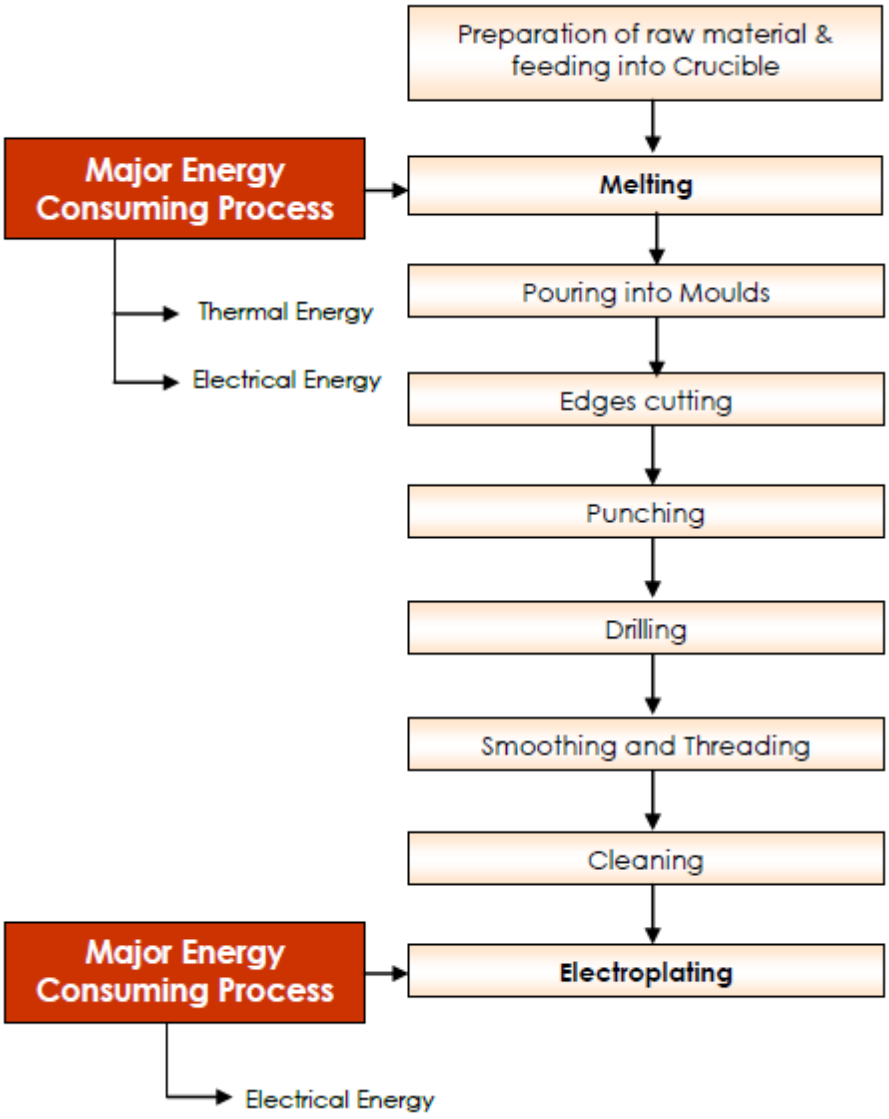
Energy efficiency using indirect method

S.No	Parameters	Units	Value
1	Measured O2 in flue gas	% age	14.18
2	Measured CO in flue gas	ppm	158
3	Excess air used for combustion	% age	207.92
4	Total air used for combustion	kgs of air	41.38
5	Heat loss due to dry flue gas	% age	43.90
6	Heat losses due to moisture in air	% age	0.23
7	Heat loss due to hydrogen in fuel	% age	29.38
8	Heat loss due to moisture in air	% age	0.15
9	Heat loss due to CO formation	% age	0.09
10	Heat loss due to radiation	%	7.88
11	Total losses	%	81.63
12	Reheating furnace efficiency- Indirect method	%	18.73

The above table shows the reheating furnace efficiency, as obtained by indirect method is 18.73%.

Annexure 2 Process flow diagram

Process flow diagram of typical brass industry in Jamnagar Brass cluster is furnished in figure below:



Annexure-3 Detail technical assessment report

Brass manufacturing units in unorganized sector has these characteristics; low engineering, limited technology innovation, poor R&D base, low level of human resource on knowledge of technology and operational skill etc. This sector also faces deficiencies such as the lack of access to technology, technology sharing, lack of strong organizational structure, professional attitude etc.

Majority of Brass units in Jamnagar Brass cluster are using low end technologies in their processes and utilities. The performance of those processes/equipments is poor as compared to the technologies available in the market. There are various technological gaps which were identified in units as under:

- Lack awareness on the technologies available
- Lack of awareness on quantum of energy loss and its monetary benefit
- Lack of awareness among the workforce etc.

There is a tremendous need for this industry to modernize/upgrade its technology and adopt energy efficient technologies in some of the areas. Further, as per the discussions made with the some of the progressive managements, they are interested in improve the efficiency their units by replacing the conventional technology with energy efficient technologies in market.

The various factors which influence the management towards implementation energy efficiency and energy conservation projects in brass unit in Jamnagar Brass Cluster are:

- Energy efficiency and energy conservation is a low cost investment option which reduces energy consumption
- Low capital investment
- The energy efficiency improvement will enhance the plant management to be competitive in local and global markets by reducing production cost
- To conserve depleting fossil fuels
- The energy efficiency and conservation reduces GHG emissions because of low carbon dioxide and particulate emissions
- Energy efficiency and conservation is a viable strategy to meet future energy needs of the expanding plans in the industry

- The energy efficiency and conservation places no financial and administrative burden as no separate manpower is required and only training of operation and maintenance of the technologies adopted is envisaged

S.No.	Parameter	Units	Value
1	Efficiency of existing reheating furnace	% age	18
2	Specific fuel consumption of conventional reheating furnace	liters/tonne	37.03
3	Efficiency of energy efficient reheating furnace	% age	28.00
4	Specific fuel consumption of energy efficient reheating furnace	liters/tonne	23.26
5	Savings in fuel consumption	liters/tonne	13.77
6	Annual production capacity	tonne	2400
7	Annual fuel savings after replacing conventional reheating furnace with energy efficient reheating furnace	liters/annum	33048
8	Total connected load	HP/kW	8/5.9
9	Cost of fuel	₹/liter	28
9	Annual electricity cost @ ₹ 5/kWh	₹ in lakh	0.59
10	Annual monetary saving	₹ in lakh	8.66
11	Implementation cost	₹ in lakh	9.35
12	Simple payback period	years	1.08

Annexure-5:Detailed cash flow evaluations

Name of the Technology	Reheating Furnace		
Rated Capacity	12000 kg		
Details	**Unit**	**Value**	**Basis**
Installed Capacity	kCal/hr	12,000	
Total operating hours	Hrs	2000	
Total production	Tons	2400	
Proposed Investment			
Cost of plant & Machinery	₹(in lakh)	8.50	Feasibility Study
Erection & Commissioning (10% of plant machinery)	₹(in lakh)	0.85	Feasibility Study
Total Investment	₹(in lakh)	9.35	Feasibility Study
Financing pattern			
Own Funds (Internal Accruals)	₹(in lakh)	2.34	Feasibility Study
Loan Funds (Term Loan)	₹(in lakh)	7.01	Feasibility Study
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10.00	SIDBI Lending rate
Estimation of Costs			
O& M Costs	%(on Plant & Equip)	4.00	Feasibility Study
Annual Escalation	%	5.00	Feasibility Study
Estimation of Revenue			
Fuel saving	liter/year	33048	-
Cost	₹/Kg	28	-
Electricity consumption	kWh/Year	11800	-
Cost	₹/kWh	5	-
St. line Depreciation	%	5.28	Indian Companies Act
IT Depreciation	%	80.00	Income Tax Rules
Income Tax	%	33.99	Income Tax Act 2008-09

Estimation of Interest on term loan ***₹(in lakh)***

Years	Opening Balance	Repayment	Closing Balance	Interest
1	7.01	0.60	6.41	0.81
2	6.41	1.20	5.21	0.59
3	5.21	1.24	3.97	0.47
4	3.97	1.32	2.65	0.34
5	2.65	1.65	1.00	0.20
6	1.00	1.00	0.00	0.03
		7.01		

WDV Depreciation ***₹(in lakh)***

Particulars / years	1	2
Plant and Machinery		
Cost	9.35	1.87
Depreciation	7.48	1.50
WDV	1.87	0.37

Projected Profitability ***₹ (in lakh)***

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Revenue through Savings									
Fuel savings	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66	69.31
Total Revenue (A)	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66	69.31
Expenses									
O & M Expenses	0.37	0.39	0.41	0.43	0.45	0.48	0.50	0.53	3.57
Total Expenses (B)	0.37	0.39	0.41	0.43	0.45	0.48	0.50	0.53	3.57
PBDIT (A)-(B)	8.29	8.27	8.25	8.23	8.21	8.19	8.16	8.14	65.74
Interest	0.81	0.59	0.47	0.34	0.20	0.03	-	-	2.43
PBDT	7.48	7.68	7.78	7.89	8.01	8.15	8.16	8.14	63.31
Depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	3.95
PBT	6.99	7.19	7.29	7.40	7.52	7.66	7.67	7.64	59.36
Income tax	-	2.10	2.65	2.68	2.72	2.77	2.77	2.77	18.47
Profit after tax (PAT)	6.99	5.09	4.65	4.72	4.79	4.89	4.89	4.88	40.89

Computation of Tax **₹ (in lakh)**

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit before tax	6.99	7.19	7.29	7.40	7.52	7.66	7.67	7.64
Add: Book depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Less: WDV depreciation	7.48	1.50	-	-	-	-	-	-
Taxable profit	0.00	6.19	7.78	7.89	8.01	8.15	8.16	8.14
Income Tax	-	2.10	2.65	2.68	2.72	2.77	2.77	2.77

Projected Balance Sheet

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Liabilities								
Share Capital (D)	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34
Reserves & Surplus (E)	6.99	12.07	16.72	21.44	26.23	31.12	36.01	40.89
Term Loans (F)	6.41	5.21	3.97	2.65	1.00	0.00	0.00	0.00
TOTAL LIABILITIES (D)+(E)+(F)	15.74	19.62	23.03	26.43	29.57	33.46	38.35	43.23
Assets								
Gross Fixed Assets	9.35	9.35	9.35	9.35	9.35	9.35	9.35	9.35
Less Accm. depreciation	0.49	0.99	1.48	1.97	2.47	2.96	3.46	3.95
Net Fixed Assets	8.86	8.36	7.87	7.38	6.88	6.39	5.89	5.40
Cash & Bank Balance	6.88	11.26	15.16	19.05	22.69	27.07	32.46	37.83
TOTAL ASSETS	15.74	19.62	23.03	26.43	29.57	33.46	38.35	43.23
Net Worth	9.33	14.41	19.06	23.77	28.57	33.46	38.35	43.23
Debt Equity Ratio	2.74	2.23	1.70	1.13	0.43	0.00	0.00	0.00

Projected Cash Flow: ***₹ (in lakh)***

Particulars / Years	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Sources									
Share Capital	2.34	-	-	-	-	-	-	-	-
Term Loan	7.01								
Profit After tax		6.99	5.09	4.65	4.72	4.79	4.89	4.89	4.88
Depreciation		0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Total Sources	9.35	7.48	5.58	5.14	5.21	5.29	5.38	5.39	5.37
Application									
Capital Expenditure	9.35								
Repayment Of Loan	-	0.60	1.20	1.24	1.32	1.65	1.00	-	-
Total Application	9.35	0.60	1.20	1.24	1.32	1.65	1.00	-	-
Net Surplus	-	6.88	4.38	3.90	3.89	3.64	4.38	5.39	5.37
Add: Opening Balance	-	-	6.88	11.26	15.16	19.05	22.69	27.07	32.46
Closing Balance	-	6.88	11.26	15.16	19.05	22.69	27.07	32.46	37.83

IRR **₹ (in lakh)**

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Profit after Tax		6.99	5.09	4.65	4.72	4.79	4.89	4.89	4.88
Depreciation		0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Interest on Term Loan		0.81	0.59	0.47	0.34	0.20	0.03	-	-
Cash outflow	(9.35)	-	-	-	-	-	-	-	-
Net Cash flow	(9.35)	8.29	6.17	5.60	5.55	5.49	5.41	5.39	5.37
IRR	72.48%								
NPV	23.02								

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.28	0.29	0.31	0.32	0.34	0.36	0.38	0.39
Sub Total*(G)*	0.28	0.29	0.31	0.32	0.34	0.36	0.38	0.39
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13
Interest on Term Loan	0.81	0.59	0.47	0.34	0.20	0.03	0.00	0.00
Depreciation (H)	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Sub Total (I)	1.40	1.18	1.06	0.94	0.81	0.64	0.62	0.63
Sales (J)	8.66	8.66	8.66	8.66	8.66	8.66	8.66	8.66
Contribution (K)	8.38	8.37	8.35	8.34	8.32	8.31	8.29	8.27
Break Even Point (L= G/I)	16.64%	14.08%	12.72%	11.26%	9.68%	7.76%	7.47%	7.56%
Cash Break Even {(I)-(H)}	10.75%	8.18%	6.81%	5.34%	3.75%	1.82%	1.51%	1.59%
Break Even Sales (J)*(L)	1.44	1.22	1.10	0.98	0.84	0.67	0.65	0.66

Return on Investment **₹ (in lakh)**

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Net Profit Before Taxes	6.99	7.19	7.29	7.40	7.52	7.66	7.67	7.64	59.36
Net Worth	9.33	14.41	19.06	23.77	28.57	33.46	38.35	43.23	210.18
									28.24%

Debt Service Coverage Ratio ***₹ (in lakh)***

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Cash Inflow									
Profit after Tax	6.99	5.09	4.65	4.72	4.79	4.89	4.89	4.88	31.12
Depreciation	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	2.96
Interest on Term Loan	0.81	0.59	0.47	0.34	0.20	0.03	0.00	0.00	2.43
Total (M)	8.29	6.17	5.60	5.55	5.49	5.41	5.39	5.37	36.51

DEBT

Interest on Term Loan	0.81	0.59	0.47	0.34	0.20	0.03	0.00	0.00	2.43
Repayment of Term Loan	0.60	1.20	1.24	1.32	1.65	1.00	0.00	0.00	7.01
Total (N)	1.41	1.79	1.71	1.66	1.85	1.03	0.00	0.00	9.44
Average DSCR (M/N)	3.87								

Annexure-6:Details of procurement and implementation plan

Procurement and implementation schedule of energy efficient reheating furnace are presented below.

Activity	Weeks												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Energy data reconfirmation													
Technical discussion & finalization													
Collection of vendor quotes													
Order placement													
Material receipt													
Installation & Commissioning													
Measurement of savings													
Certification of savings													

Annexure-7:Details of equipment and service providers

Name of company	Micro Hydraulic
Address of company	Plot -215/2, Phase-II, GIDC, Dared, Jamnagar – 361005 (Gujrat) Tele fax : 0288-2730005 Mobile : 09327422654 0984283806 Email : praksh@micohydraulics.com Website : www.micohydraulics.com

Annexure 8: Quotations of energy efficient reheating furnace

MICO HYDRAULICS
Plot - 215/2, Phase-II, G.I.D.C., Dared, Jamnagar-361005.
(GUJARAT-INDIA) Tele-Fax : O. (0288) 2730005 M. 93274 22654
Mobile : 98242 83806 e-mail : prakash@micohydraulics.com
Website : www.micohydraulics.com

Mfg. of : Metal Extrusion Press and all types of Hydraulics Press

Ref. : Date :

QUOTATION NO. MH/124/10-11 DATE: 14.09.2010

M/S.WINROCK INTERNATIONAL INDIA
788 UDYOG VIHAR
PHASE -V,
GURGAON - 122 001

Sub : Quotation for One No. Billet Re Heating Furnace for the capacity of 1200 kgs/hrs.

Dear Sir,

We are much pleased to offer you our most competitive price for your enquiry for the One No. **Billet Pre Heating Furnace for the capacity of 1200 kgs/hrs.**

One No. Billet Heating Furnace, Fabrication Body with Fire Bricks, Cera Wool, without Chimney as per details given hereunder :

Re Heating Oral size (W X H X L)		**90 inch X 54 inch X 264 inch.**
Billet Chamber Size (W X H X L)	:	**21 inch X 27 inch X 240 inch.**

Internal portion of top side and two oppsite side of Heating Chamber will be fitted with Cera Wool. At the Bottom side of the Chamber one layer will be with 40% Bricks and the other layer will be with 70% Bricks.

The Furnace will be supplied with Oil Plant , Air Blower with Motor and Burner. **(make Westam Thermal Enggrs.)**

OIL PLANT MOTOR	:	0.5 HP =	1 Nos.
BLOWER MOTOR	:	7.5 HP =	1 Nos.

PRISE :	**EX-FACTORY, JAMNAGAR (RUPEES EIGHT LACS FIFTY THOUSAND ONLY)**	**RS. 8,50,000/-**

Contd,,2...

MICO HYDRAULICS
Plot - 215/2, Phase-II, G.I.D.C., Dared, Jamnagar-361005.
(GUJARAT-INDIA) Tele-Fax : O. (0288) 2730005 M. 93274 22654
Mobile : 98242 83806 e-mail : prakash@micohydraulics.com
Website : www.micohydraulics.com

Mfg. of : Metal Extrusion Press and all types of Hydraulics Press

Ref. :

Date :

PAGE NO.2.

1	**DELIVERY**	The Delivery of the Billet re-heating Furnace will take 06 to 08 Weeks from the date of purchase order alongwith necessary advances.advances.
2	**PAYMENT**	40% Advance alongwith purchase order and balance towards our performa invoice before delivery of the goods.
3	**CANCELLATION**	You shall not cancel the order once placed in any matter. In case of cancellation of the placed order, the adavance amount will not be returned in any condition.
4	**TAXES :**	Will be charged Extra as applicable at the time of despatches.
5	**C.EXCISE**	Will be charged Extra as applicable at the time despatches.

We hope you will find our offer most competitive and favour us with your valued order at the earliest.
How ever if you require any further information or clarification, please feel free to contact us.

Thanking you,

FOR MICO HYDRAULICS

PROPRIETOR

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

Winrock International India

788 Udyog Vihar, Phase V
Gurgaon – 122 001, Haryana
Tel: +91-124-4303868
Fax: +91-124-4303862
Website: www.winrockindia.org

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535

Website: www.techsmall.com