Cluster Profile
Shimoga foundry industries

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Contents

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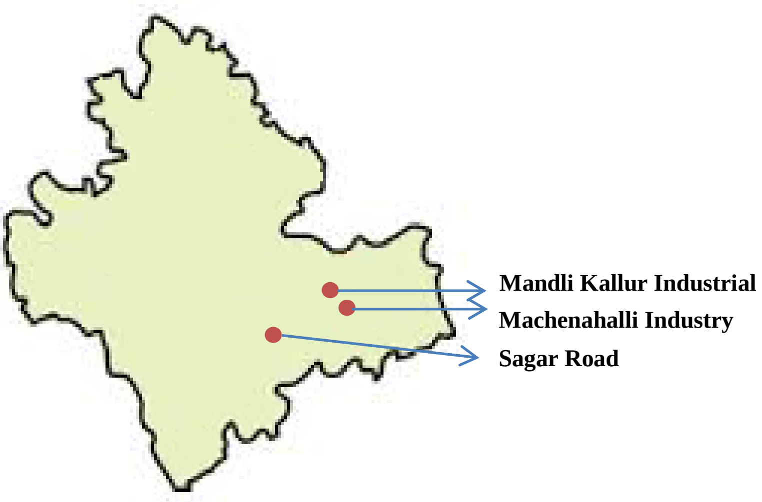
Shimoga foundry industries

Overview of cluster

Shimoga, officially renamed as Shivamogga (means "*Face of Shiva*") is located on the banks of the Tunga River. Shivamogga, situated on the fringe of the Western Ghats is often nicknamed as "Gateway of Malnad" and is about 300 km from capital Bengaluru. City is well connected with national highways (NH206) and railways. The city was ruled by the great Indian dynasties of the Kadambas, Gangas, Chalukyas, Rastrakutas, Keladi and Vijaynagar Kings. Shivamogga is more than just a tourist destination. Its rich tradition in education, fine arts and culture remain deeply etched in its people and place.

Shivamogga district has about 15,000 industries in four major industry estates. Agro, automobile, engineering and foundry industry are prominent in the cluster. There are about 12 large industries in cluster. Majority investment in district has been in food & beverages, engineering and mechanical industries. The foundry units in the district have been very successful in producing quality products for domestic and international market. Apart from this the city also has an IT Park for data centres, call centres, aerospace, robotics, etc.



There are 45 foundries and associated units in Shivamogga producing around 50,000 tonnes of castings every year. Foundries provide employment to about 5,500 people. All units use induction furnace based, none of the foundries use cupola for melting. Foundry units are located in three industrial areas around city: Machenahalli, Mandli Kallur and Sagar road, with one unit still situated in the city. The total collective power demand of foundry cluster is about 30 MVA. Total annual turnover of foundries is Rs 650 crores, out of which 12.5% is coming from exports. The cluster is known for exporting quality castings to 26 countries in five continents. The combined annual turnover of three large foundries in the cluster is about Rs 210 crore. Cluster has foundries with green sand moulding, investment casting as well as resin bonded shell moulding and centrifugal castings. Equal quantities of steel and iron castings are produced. Apart from having quality accreditations, many foundries have received several quality award and vendor awards. There are three large foundries in cluster namely Shanthala Spherocast, Technorings and Malnad Alloy Castings. Major castings buyer from cluter are Cummins, Kirloskar, KSB, BEML, Godrej, Escorts, Emerson, etc.

Product types and production capacities

The cluster has 23 iron foundries, 15 steel foundries, one on-ferrous foundry and six associated units (machining and chemicals). Foundries cater to following sectors: automobile, oil engines, compressor, mining and earth moving equipment, roads and infrastructure building machinery, general engineering parts, vales and pumps etc. Cluster procures raw material from Nagpur, Hyderabad, Bombay and parts of Karnataka.

Based on their average production levels, foundry units can be categorised under A, B and C categories as follows:

Category A: 200 tonnes per month
Category B: 70 tonnes per month
Category C: 25 tonnes per month

Categorization of foundries

Type	Production (tonne/month)	Employment (Nos)	Turnover (Rs crore/year)
Category A	200	200	25
Category B	70	150	10
Category C	25	75	5

Majority units fall under category B and in category A and C have nine and eight units respectively. The total production of castings in the cluster is about 170 tonnes per day (about 50 thousand tonnes per annum). Very few units are running round-the-clock (three shifts), majority of units are under-utilizing the facility and run at average capacity utilization less than 60%. Major products include valves & pumps, earth moving & mining, machine tools, railways and automobile and are shown in figure.

Major castings produced in the cluster

Energy scenario in the cluster

Electricity is the major sources of energy for the foundries. All steel foundries and few iron foundries use LPG also. The major raw materials used include base metals (scrap, pig iron, borings scrap and foundry returns) and alloys (ferro-silicon, ferro-manganese, etc.).

Electricity to foundries is supplied by Mangalore Electricity Supply Company Limited (MESCOM). The foundries have high-tension connection at 11 kV voltage and fall under connection type HT-2(a). The industry follow scheduled weekly-off system for electricity supply from MESCOM. LPG is used in numerous applications ranging from core heating, ladle pre-heating, gas-cutting and more. LPG is procured from local market. All foundries have diesel generator sets, which they run to meet emergency demand in foundry during unscheduled outages, though the consumption of diesel is marginal in total energy consumption. The details of major energy sources and tariffs are shown in table.

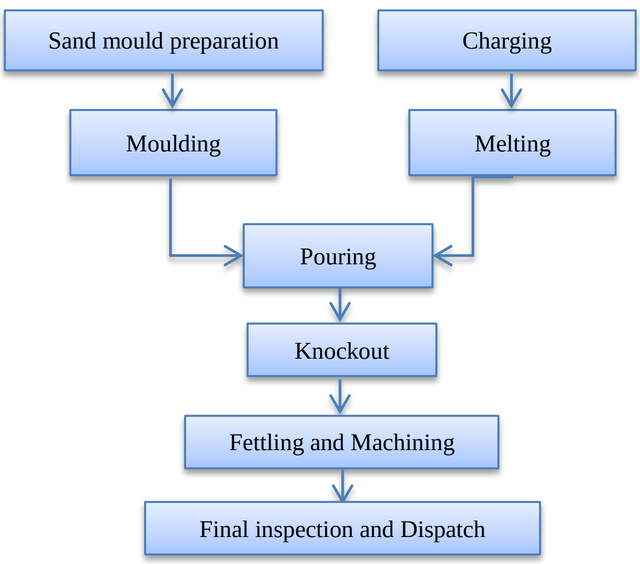
Prices of major energy sources

Source	Remarks	Price
Electricity	Energy charge	Up to 100,000 kWh: Rs 5.88/kWh Beyond 100,000 kWh: Rs 6.18/kWh Time zone 22-06 hr: Rs -1.25/kWh Time zone 06-18 hr: Rs +0.00/kWh Time zone 18-22 hr: Rs +1.00/kWh
	Demand charge	Minimum billing @ 75% of contract demand Normal: Rs 170/kVA Excess: Rs 340/kVA`
LPG	19 kg cylinder	Rs 1,050 – 1,200/cylinder
	17 kg cylinder	Rs 1,000 – 1,100/cylinder

Production process

The major steps of process are mould sand preparation, charge preparation followed by melting, pouring, knockout and finishing. The steps are explained below.

1. **Mould sand preparation**. Fresh sand is mixed with bentonite and other additives and mixed in muller to make green sand. Plants use sand mixers and sievers in general, few plants have complete sand handling plant equipped with sand cooler. Few units follow resin sand, investment casting process.
2. **Moulding.** The mould sand is pressed manually or by pneumatic machines on the pattern to prepare the mould. Generally, the mould is divided into two halves - the cope (upper half) and the drag (bottom half), which meet along a parting line. Both mould halves are contained inside a box, called a flask, which itself is divided along this parting line. The mould cavity is formed by packing sand around the pattern (which is a replica of the external shape of the casting) in each half of the flask. The sand can be packed manually, but moulding machines that use pressure to pack the sand are also commonly used.
3. **Charging.** The raw material such as pig iron, scrap, foundry returns and other alloys are weighted and charged in the induction furnace for melting.
4. **Melting.** The metal charge is melted in induction furnace. The operator test chemistry of melt by drawing a sample and checks the molten metal temperature. The operator adjusts chemistry by alloying and brings the temperature to required level. This process runs in parallel with moulding.
5. **Pouring.** After melting, the molten metal is transferred and poured into the moulds using ladles operated either manually, by mono-rail or using overhead cranes.
6. **Knock-out.** The moulds are left to cool for certain time after which the castings are knocked-out from the mould either manually or using a vibratory knock-out machine.



7. **Finishing.** The finishing operation involves removal of runners/risers, shot blasting and cleaning of castings. This is followed by fettling and machining. In case of steel casting heat treatment is also an integral part finishing operations.

A simplified process flow diagram of a typical foundry is given in the figure.

Technologies employed

Some of the major foundry processes/equipment are described below.

Induction furnace

(i) Melting furnace

All the units melt raw material using medium frequency induction furnace. Majority of units are equipped with induction furnace of 300kg, 500kg or 1 tonne capacity crucible. Most of the induction furnaces are SCR based. The specific energy consumption of furnace for melting varies in range of 600 – 750 and 700 - 850 kWh per tonne for iron and steel castings respectively.

(ii) Moulding and core preparation

Preparation of the mould is an important process in casting industry. Cores are placed inside the moulds to create void spaces. Cores are baked in ovens which are usually electrical fired. Moulds are either prepared manually or using pneumatic moulding machines (ARPA lines).

Moulding machine

(iii) Sand preparation

Sand preparation is done using sand mixers and sand sievers. Sand mixers have typical batch size of 100 to 500 kg. The connected load of these mixers is in the range of 10 to 30 kW. Few plants have sand handling plant along with sand cooler of capacity 5 to 20 tonnes per hour, the connected load of such plant is about 75 to 100 kW.

(iv) Auxiliary system

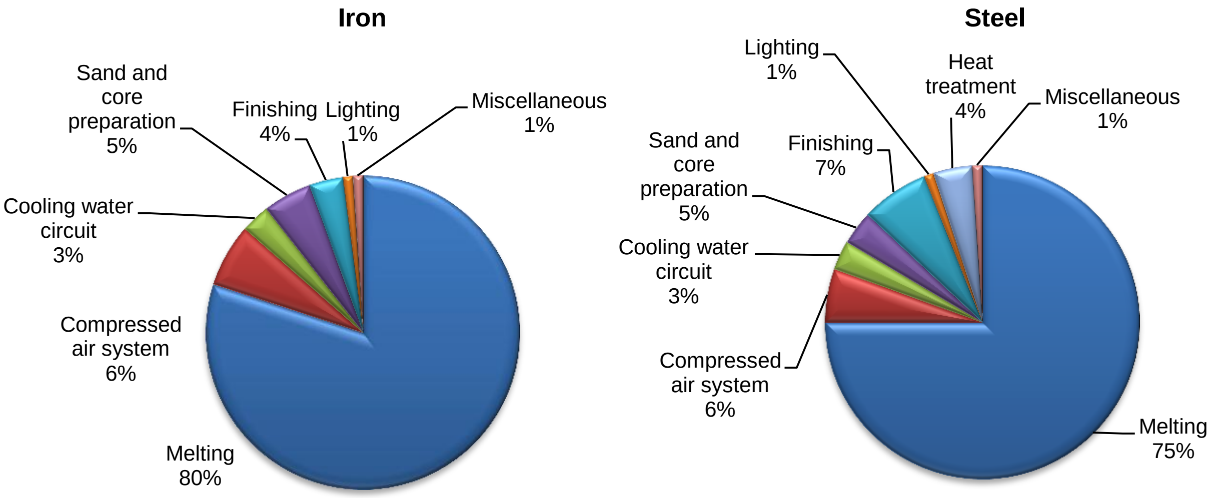
Air compressors: Foundry utilizes compressed air in number of process applications which includes mould preparation, pneumatic fettling and application of cleaning of mould, core and general cleaning. Typically foundry have compressor of FAD rating 100 to 300 cfm with power rating of 15 to 45 kW.

Pumps: Induction furnace requires cooling of coils in crucible and cooling electronic panel. Two pumps running on DM water serve this purpose. One pump runs on raw water through cooling tower and cools the DM water in a heat exchanger. Foundries in general have end suction mono-block pumps serving the purpose.

Air compressor

Energy consumption

Foundry uses two main forms of energy: electricity and/or LPG. Melting accounts for a major share of about 75-80% of total energy consumed in a foundry unit. The other important energy consuming areas include moulding, core, sand preparation and finishing. The steel foundries have heat treatment process which accounts for about 4-5% of total input energy. The share of energy usage in a typical iron and steel foundry is given in the figure.



Typical energy use in a foundry

(i) Unit level consumption

The specific energy consumption (SEC) varies considerably in a foundry depending on the type of furnace and degree of mechanisation. The specific energy consumption of furnace for melting varies in range of 600 – 750 and 700 – 850 kWh per tonne for iron and steel castings respectively. Typical energy consumption of a unit is given in table.

Typical energy consumption in cupola based foundry units

Production – saleable castings (tonnes/year)	Electricity (kWh/year)	LPG (tonne/year)	Total energy (toe/year)	Annual energy bill (million INR/year)
300	600,000	0	51.6	6.0
850	1,400,000	10	132.9	12.0
2,400	3,300,000	20	308.8	27.0

(ii) Cluster level consumption

The total energy consumption of foundry unit in the cluster is estimated to be 5,450 tonnes of oil equivalent.

Energy consumption of the Shimoga foundry cluster (2015)

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2/yr)	Annual energy bill (million INR)
Electricity	58.3 million kWh	5,010	57,134	500
Thermal (LPG)	350 tonne	440	1,045	20
	Total	**5,450**	**58,179**	**520**

Energy-saving opportunities and potential

Some of the major energy-saving opportunities in the foundry units in the cluster are discussed below.

(i) Replacement of inefficient induction furnace with energy efficient IGBT furnace

Older induction furnaces having higher SECs e.g. 750 kWh per tonne of molten metal or higher can be replaced with energy efficient IGBT (Insulated Gate Bipolar Transistor) furnaces. With IGBT furnaces, an SEC level of about 550 kWh per tonne of molten metal can be achieved. The capital investment made on EE furnace has attractive payback period of less than one year. The other advantages of an energy efficient 24-pulse IGBT furnace are: higher power factor (~0.97) and lower total hormanic distortion in current.

IGBT Furnace

(ii) Lid mechanism for induction furnace

Most of the induction furnaces do not have a lid which results in higher heat losses due to radiation and convection (about 6% of energy input). A lid mechanism helps in reducing these losses in an induction furnaces and the payback period for installation of lids is less than one year.

Lid mechanism

(iii) Reduction in rejections

A large number of foundries have high rejection level (~10%), which can be brought down to below 5% through improved process control. This can be achieved with no or marginal investments. As the units do not produce multiple products and the castings are limited, the rejection level can be reduced with little process improvement itself.

(iv) Cleaning of runner and risers before re-melting

Foundry returns i.e. runners and risers constitute a significant share of charge material. Further foundry returns will have moulding sand sticking to them (4 to 5% by weight). If not cleaned, this will lead to slag formation and hence higher energy consumption levels. By using shot/tumble blast, the sand be cleared from foundry returns before returned to induction furnace for re-melting. This would result in considerable energy saving and would require marginal or no investments.

(v) Providing glass wool cover for ladle

The ladles used for transfer of molten metal from furnace to moulds are usually not covered resulting in radiation losses. The heat loss can be reduced by providing covers for ladles which would result in energy savings and would require very low investment.

(vi) Retrofitting air compressor with variable frequency drive

During normal operation, an air compressor operated on unloading position for more than half the time. Installation of 'variable frequency drive' (VFD) to the air compressor will minimise the unload power consumption. The investment for VFD is about Rs 2-3 lakh and has a simple payback period of about 2 years.

(vii) Arresting the compressed air leakage

Compressed air is an expensive utility in a plant. In a large number of foundry units, air leakages in piping system are quite high (above 20%) and generally go unnoticed. The compressed air leakage can be brought down to about 5% with good housekeeping practices. The foundry can save a considerable amount of energy by controlling compressed air leakages with no investment.

(viii) Reduction in pressure setting of air compressor

The pressure setting of air compressors are often much higher than the actual air pressure requirement in the plant. The typical unload and load pressure settings are 7.5 and 6.5 bar respectively. Reducing the compressed air pressure as per end-use requirements will result in high energy savings. Reduction of generation pressure by one bar can lead to energy saving of 5-6%.

(ix) Replacement of rewound motors with energy efficient motors

Motor burn-out is not a rare phenomenon in foundries, this is a result of number of factors including power quality, overloading, etc. Rewinding of motors is cheap solution followed by foundry-men but it result in a drop in efficiency of motor by 3 – 5%. It is better to replace all old motors which has undergone rewinding two or more times. The old rewound motors may be replaced with EE motors (IE3 efficiency class). This would results into significant energy savings with simple payback period of 2 to 3 years.

(x) Replacement of inefficient pumps with energy efficient pumps

Very often the pumps used in cooling water circuit of an induction furnace are inefficient and selection is not done on technical basis. This results in higher power consumption. The inefficient pumps may be replaced with energy efficient pumps. The investments are paid back in a year or two.

Energy efficient pump

(xi) Replacement of inefficient lighting with energy efficient lighting

The foundry units use fluorescent tube light (FTL-T12) and mercury vapour lamp (HPMV) for lighting. Some units were using CFLs. Replacing them with HPMV with induction lamp and FTL-T12 with FTL-T5 can lead to energy saving of around 20–30%.

Major stakeholders

The major stakeholders of Shimoga foundry cluster include IIF (Institute of Indian Foundrymen – Shimoga Chapter) and District Industries Centre (DIC). The IIF (Shimoga Chapter) was formed in 2012 and has organized a number of events for the foundry units. The DIC provides incentives to MSMEs such as Back Ended Interest Subsidy Scheme. Under this scheme, MSMEs can avail 3% interest subsidy (subject to a maximum of Rs 10 lakhs) on term loans loan on technology.

Cluster development activities

The IIF (Shimoga Chapter) is actively involved in cluster development activities. They have formed some sort of special purpose vehicle for promoting and pushing for development of a “Common Facility Centre” at Shivamogga for foundries. The main requirements are casting testing, Coordinate Measuring Machines (CMM) and radiography. At present, the foundries have to send samples to Bangalore for testing purposes which is quite time consuming. Despite many attempts from cluster, the CFC is not moving forward due to issues pertaining to land acquisition and environmental clearances.

About TERI

A dynamic and flexible not-for-profit organization with a global vision and a local focus, TERI (The Energy and Resources Institute) is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to tackling issues of global climate change across many continents and advancing solutions to growing urban transport and air pollution problems, TERI's activities range from formulating local and national level strategies to suggesting global solutions to critical energy and environmental issues. The Industrial Energy Efficiency Division of TERI works closely with both large industries and energy intensive Micro Small and Medium Enterprises (MSMEs) to improve their energy and environmental performance.

About SDC

SDC (Swiss Agency for Development and Cooperation) has been working in India since 1961. In 1991, SDC established a Global Environment Programme to support developing countries in implementing measures aimed at protecting the global environment. In pursuance of this goal, SDC India, in collaboration with Indian institutions such as TERI, conducted a study of the small-scale industry sector in India to identify areas in which to introduce technologies that would yield greater energy savings and reduce greenhouse gas emissions. SDC strives to find ways by which the MSME sector can meet the challenges of the new era by means of improved technology, increased productivity and competitiveness, and measures aimed at improving the socio-economic conditions of the workforce.

About SAMEEEKSHA

SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) is a collaborative platform set up with the aim of pooling knowledge and synergizing the efforts of various organizations and institutions - Indian and international, public and private - that are working towards the development of the MSME sector in India through the promotion and adoption of clean, energy-efficient technologies and practices. The key partners are of SAMEEEKSHA platform are (1) SDC (2) Bureau of Energy Efficiency (BEE) (3) Ministry of MSME, Government of India and (4) TERI.

As part of its activities, SAMEEEKSHA collates energy consumption and related information from various energy intensive MSME sub-sectors in India. For further details about SAMEEEKSHA, visit http://www.sameeeksha.org