Cluster Profile
Howrah Foundry industries

Promoting Energy Efficiency in SMEs
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Original work of TERI done under the project "INDIA: TERI-SDC Partnership: Scaling up Energy Efficient Technologies in Small Enterprises (EESE)"

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Suggested format for citation

TERI. 2016
Cluster Profile Report – Howrah foundry industries
New Delhi: The Energy and Resources Institute 10 pp.
[Project Report No. 2014IE15]

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This document is an output of a research exercise undertaken by TERI supported by the Swiss Agency for Development and Cooperation (SDC) for the benefit of MSME sector. While every effort has been made to avoid any mistakes or omissions, TERI and SDC would not be in any way liable to any persons/organisations by reason of any mistake/ omission in the publication.

Published by

T E R I Press
The Energy and Resources Institute
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IHC Complex, Lodhi Road
New Delhi-110 003
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Contents

ACKNOWLEDGEMENTS

Overview of cluster 1

Product types and production capacities 1

Energy scenario in the cluster 3

Production process 3

Technologies employed 5

Energy consumption 5

Energy-saving opportunities and potential 7

Major stakeholders 8

Cluster development activities 9

Acknowledgements

TERI places on record its sincere thanks to the Swiss Agency for Development and Cooperation (SDC) for supporting the long-term partnership project focusing on energy intensive MSME clusters in India.

TERI team is indebted to Indian Foundry Association (IFA) for providing support and information related to foundry units in Howrah cluster. TERI extends its sincere thanks to Mr B N Agarwal (Chairman, IFA) and Mr Akash Madhogaria (Vice Chairman, IFA) for organizing field visits and interactions with foundry entrepreneurs during the study for the preparation of this cluster profile report.

Last but not least, our sincere thanks to MSME entrepreneurs and other key stakeholders in the cluster for providing valuable data and inputs that helped in cluster analysis.

Howrah foundry industries

Overview of cluster

Howrah is hemmed in between the river Hooghly on the east and the river Rupnarayan on the west intersected by the Damodar. The district of Howrah came into limelight with the opening of railways in 1854, following British mercantile colonialism of India. Howrah is presently known as industrial city, has over 3,000 industries registered[1]. Agro, jute and cotton, steel re-rolling, embroidery, engineering spare parts and foundry industry are prominent in the cluster. Howrah is well connected by road and railways. Two major national highways NH-2 and NH-6 are connected to Howrah.

Source: Google map

The emergence of foundry industry in Bengal started in mid-19^{th} century, based on necessity of spares for jute and cotton industries. By the end of First World War, Bengal foundries took shape into what is known presently as Howrah cluster. After independence the small and medium sized industries owned by the British were sold to the new entrepreneurial community of Marwaris. These firms continue to remain with the second/third generation of Bengali entrepreneurs. In its peak the cluster had over 500 foundries largely due to availability of cheap pig iron and coke and a large pool of skilled/semi-skilled labour. But over past decade many non-Bengali industrialists moved out of state and large number of Bengali owned small foundries were closed down. Inadequate availability of quality raw material, shortage of power, poor infrastructure and active trade unionism are some of the main reasons for the decline of the cluster[2]. The existing industries are also 3-4 decades old and very little investment towards modernization of plant and machinery is done after initial commissioning.

There are about 320 foundries located in Howrah cluster. These foundries provide direct employment to about 15,000 people. All units use cupola for melting, few foundries in past decade have started using induction furnace for producing ductile iron and steel castings. Foundry units are located around city, mailnly at: Liluah, Salkia, Benaras road, Belgachia, Dasnagarn, Balitikuri, Jangalpur and Santragachi. Total annual turnover of foundries is Rs 1,350 crores, out of which 60% is coming from exports. The cluster is known for exporting sanitary castings to several countries in five continents. Over 90% of casting produced in the cluster is cast iron, under 10% of total production is ductile iron and steel castings. Major foundries in cluster include Kiswok Industries, Calcutta Ferrous, Bharat Engineering Works, Crescent Foundry, Shree Uma Foundry.

Product types and production capacities

The total annual production from 320 foundries in the cluster is about 750,000 tonnes of castings. About 90% of foundries use cupola and remaining 10% use induction furnace for melting. Foundries cater to following sectors: sanitary casting, machinery bodies, counter weights, pump and valve bodies, jute mill spares, railway, defence and mining, etc. The cluster procures raw material from different parts of India, limestone from Bhutan and Dubai.

Raw material suppliers

Raw material	Supplier
Pig iron and scrap	TISCO, IISCO, DSP, BSP, Usha
Coke	Anuradha (Dhanbad coke)
Limestone	Bharat Mineral
Alloys	Tata Chemicals

Raw materials

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

Category A : 50 tonne per month
Category B : 100 tonne per month
Category C : 500 tonne per month
Category D : 1000 tonne per month

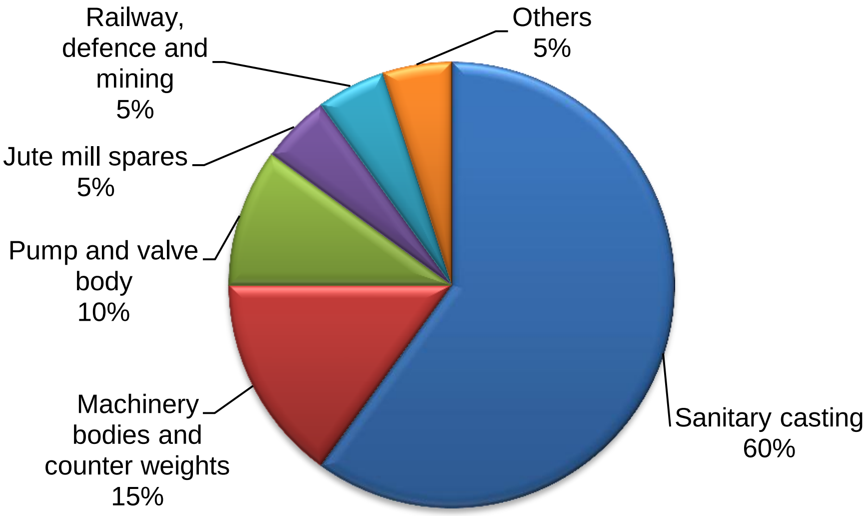
Categorization of foundries

Type	Production (tonne/month)	Employment (Nos.)	Turnover (Rs crore/year)
Category A	50	15	1.0
Category B	100	50	2.0
Category C	500	75	10.0
Category D	1000	200	25.0

Some of the castings produced in the cluster are shown in the figure.

Major castings produced in cluster

A majority units fall under category B; category A and C have only nine and eight units respectively. The total production of castings in the cluster is about 2,500 tonnes per day (about 0.75 million tonnes per annum). A very few units are operating round-the-clock (three shifts), majority of units are under-utilizing the facility and run at average capacity utilization less than 60%. The major products from the cluster include valves & pumps, earth moving & mining, machine tools, railways and automobile and are shown in figure.



Product share from Howrah cluster

Energy scenario in the cluster

Coke and electricity are the major sources of energy for the foundries. Coke is supplied by a number of distributors who in turn procure it mainly from Dhanbad or other areas in country. Electricity to foundries is supplied by either West Bengal State Electricity Distribution Company (WBSEDCL) or The Calcutta Electric Supply Corporation (CESC) depending on th location. The foundries typically have low-tension connection at 440 V voltage, few foundries which use induction furnace for melting have high-tension connection at 11 kV or 33 kV. 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 and is procured from local market. The details of major energy sources and tariffs are shown in table.

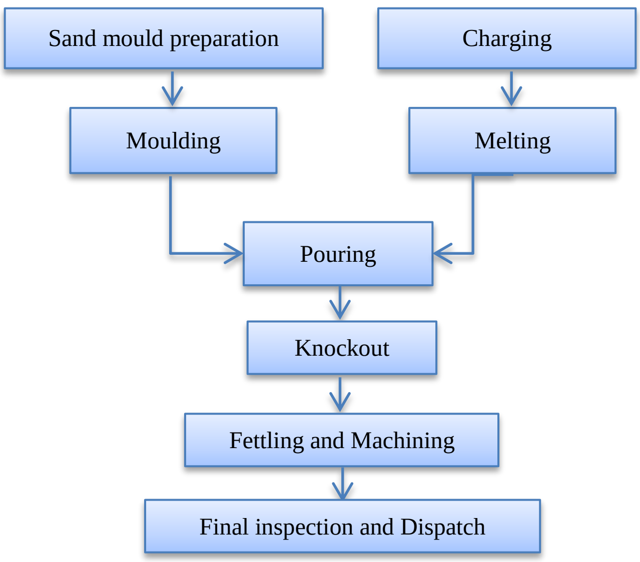
Prices of major energy sources

Raw material	Remarks	Price
Electricity	LT Connection	Energy charge : Rs 6.67 per kWh Demand charge: Rs 30 per kVA per month
	HT Connection	Energy charge : Rs 6.86 per kWh Demand charge: Rs 320 per kVA per month
Coke	High ash (~28%)	Rs 11,000 - 12,500 per tonne
	Low ash (~12%)	Rs 17,000 - 18,500 per tonne

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

1. **Mould sand preparation**. Fresh sand is mixed with bentonite and other additives and mixed in muller to make green sand. Plants in general use sand mixers and sievers for mould sand preparation, about 10-15 plants have complete automated sand handling plant equipped with sand cooler system. Typical category A and B foundry units have 250 – 350 kg capacity sand mixers, other category foundries have bigger sand mixers, with typical size of about 500 – 800 kg capacity.
2. **Moulding.** The mould sand is pressed manually or by pneumatic machines on the pattern to make the mould. The mould is divided into two sections - the upper half (cope) and the bottom half (drag), which meet along a parting line. Both mould halves are enclosed 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[4]. The sand can be packed manually, but moulding machines that use pressure to pack the sand are also commonly used. Majority (about 70%) of the units use hand moulding technique, remaining use pneumatic moulding lines, about 10 units have high pressure moulding lines (HPML) installed.
3. **Charging.** The raw material such as pig iron, scrap, foundry returns and other alloys are weighted and charged in the cupola furnace for melting. About 75% of the foundry units use manual charging technique remaining use mechanical charging method.
4. **Melting.** The metal charge is melted in cupola furnace. Initial chill metal is pigged and is about 5% of melting rate of cupola. The operator visually verifies the molten metal temperature. Once verified the pouring begins. Charging of metal and coke keeps progressing in systematic manner.



5. **Pouring.** After melting, the molten metal is transferred and poured into the moulds using ladles operated either manually. In induction furnace based foundry the molten metal is poured 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.

Technologies employed

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

(i) Melting furnace

A majority of the foundry units melt raw materials using cupola furnace. Majority of units are using divided blast cupola for melting, with a few exceptions that are still running single blast cupola. About 75% of cupolas are over a decade old, the blower motor are re-winded multiple times. The specific energy consumption of cupola for melting varies in range of 80 – 150 kg coke per tonne for molten metal. In terms of coke to metal ratio, it translates into 1:12 to 1:7 and talking in terms of percentage of coke the figures are 15%. All the figures are on charging coke basis (i.e. total coke used during a batch except bed coke).

Cupola

(ii) Moulding and core preparation

Mould preparation 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). About 10 units use ‘high pressure moulding lines’ (HPML).

(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

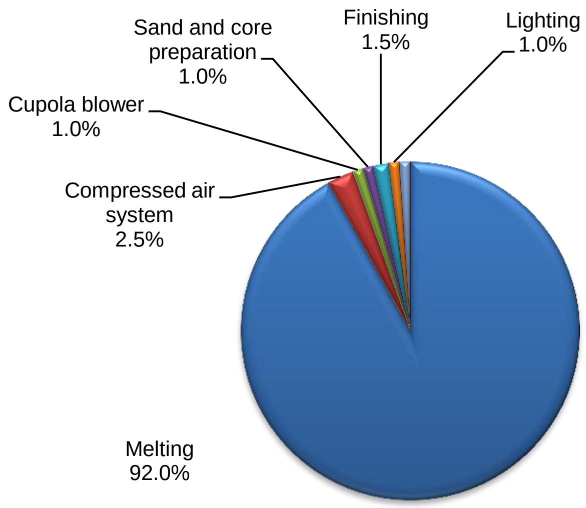
Air compressors: Typical majority of category A and B foundries do not use compressed air system. All of the category C and D foundries use air compressors. Foundry utilizes compressed air in number of process applications which includes mould preparation, pneumatic fettling and application of cleaning 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 based foundries 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 namely coke and electricity. Melting accounts for a major share of about 80-95% of total energy consumed in a foundry unit. The other important energy consuming areas include moulding, core, sand preparation and finishing. The share of energy usage in a typical 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 cupola for melting varies in range of 80 – 150 kg coke per tonne for molten metal. In terms of coke to metal ratio, it translates into 1:12 to 1:7 and talking in terms of percentage of coke the figures are 15%. All the figures are on charging coke basis (i.e. total coke used during a batch except bed coke). Typical energy consumption of a unit is given in table.

Typical energy consumption in cupola based foundry units

Production – saleable castings (tonne/yr)	Electricity (kWh/yr)	Coke (tonne/yr)	Diesel (kL/yr)	Total energy (toe/yr)	Annual energy bill (million INR)
600	6,000	80	1	55	1.0
1200	35,000	150	2	105	2.1
6000	100,000	950	10	660	14.0
12000	700,000	1700	20	1,230	27.0

(ii) Cluster level consumption

The total energy consumption of foundry unit in the cluster is estimated to be 73,760 tonnes of oil equivalent as shown in the table. Thermal energy accounts for about 97% of total energy consumption in the cluster.

Energy consumption of the Howrah foundry cluster (2015-16)

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2/yr)	Annual energy bill (million INR)
Electricity	23.5 million kWh	2,010	23,030	190
Thermal				
- **Coke**	108,500 tonne	71,750	320,447	1450
- **Diesel**	1,250 kilo litre			
	Total	**73,760**		**1,640**

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 existing conventional cupola with divided blast cupola

For cupola based foundries, replacement of conventionally designed cupolas with an energy efficient divided blast cupola (DBC) is the major option. The existing modified divided blast cupolas have coke consumption of about 110 – 130 kg per tonne of liquid metal. With proposed energy efficient DBC the coke consumption is expected to be about 80 kg per tonne of liquid melt. The investment for a new DBC is expected to pay back within one year on account of coke saving alone. The saving can be achieved around 25-30%.

Divided blast cupola

(ii) Replacement of inefficient blower with proper design blower

The cupola are equipped with blower of 30-100 hp, but the blower are of local make and are not properly designed. Morover the blower motors are over a decade old and re-winded more than once. The blower selection should be done according to inner diameter of cupola. The blower should be of proper flow rate and discharge pressure. By replacing blower with proper blower, coke saving of around 3% can be achieved.

(iii) Reduction in rejections through process control

A large number of foundries have high rejection level (5 – 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) Best operating practices for cupola melting

Efficient operation of cupola furnace depends mainly on adoption of best operating practices (BOP) in each steps of metal melting in cupola furnace. The foundries do not use any standard operating practices and has lot of irregularities. The units and cluster does not have any testing facility. By improving operating practices in cupola a foundry can achieve about 5% coke saving.

(v) 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 (4-5% 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.

(vi) 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.

(vii) Replacement of inefficient lighting with energy efficient lighting

The foundry units were still using mercury vapour lamp (MVL) of 250 – 400 W for lighting. Some were using 85 W CFLs. The office lighting is typically done using florescent tube lights of 40 W (FTL T12). This can be replaced by FTL T5 of 28 W rating. Replacing MVL with induction lamp and T12 with T5 can lead to energy saving of around 40%.

(viii) 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.

(ix) Arresting the compressed air leakage

Compressed air is an expensive utility in a plant. However, in most cases, air leakages in piping system are quite high (above 20%) and 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.

(x) 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%.

Major stakeholders

There are two major industry associations related to the foundry industry in Howrah, Indian Foundry Association and Howrah foundry Association. The major industry associations are the following:

- *IFA (Indian Foundry Association)*: The IFA is a national association, affiliated to the Indian Chamber of Commerce having a total membership of about 500 foundries across the country.
- *HFA (Howrah Foundry Association)*: The HFA is the state level association for foundries. Most of micro and small scale cupola foundries are member of HFA.

The 'District Industries Centre' (DIC), Howrah provides several incentives to MSMEs like the 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.

The MSME Development Institute (DI), Kolkata provides assistance for the promotion and Development of Micro, Small and Medium Scale Industries. They also implement various central and state government schemes for MSMEs including Credit Linked Capital Subsidy Scheme (CLCSS) and Technology Upgradation Scheme (TEQUP) for technology and quality upgradation.

Cluster development activities

West Bengal Industrial Development Corporation (WBIDC) along with IFA, realizing the needs for modernization, renovation and expansion of foundries at Howrah are setting up a Foundry Park near vicinity of Howrah foundry cluster. The foundry park is being built 924 acres of land. Phase-1 of the park (600 acres) is expected to be ready by end of 2016. In phase one about 100 foundries with a production of 300,000 tonnes of casting annually is anticipated. It is also envisaged to provide direct employment to about 10,000 people and indirect employment to 30,000 people. The park will be equipped with tool-room, R&D centre cum testing laboratory, library, marketing cum management up-gradation centre and an Industrial Training Institutes (ITI).

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

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Swiss Agency for Development and Cooperation 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