



PROMOTING ENERGY EFFICIENCY IN FOUNDRY INDUSTRY BY STRENGTHENING BUSINESS DEVELOPMENT SERVICES

A case study in Rajkot Engineering Cluster

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SIDBI is implementing a multi-agency/ multi activity project (SMEFDP) for MSMEs. While SIDBI has been assigned the reasonability of implementing the project, the Department of Financial Services, Ministry of Finance, Government of India is the nodal agency for the same. The World Bank, Department for International Development (DFID) UK, KfW Germany and GTZ Germany are the international partners in the project.

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Introduction

Micro, small and medium enterprises (MSMEs) play a very significant role in India's economy in terms of industrial production as well as employment generation. At the same time, many MSMEs continue to face barriers to their growth such as lack of awareness on or access to clean energy efficient technologies and operating practices; paucity of technical, management and marketing capacities; difficulties in accessing bank finance and R&D facilities; and so on. These barriers must be addressed and overcome in order to enable Indian MSMEs to face the challenges of an increasingly competitive globalized environment.

Towards this, the Small Industries Development Bank of India (SIDBI) is implementing a World Bank-led multi-agency/multi-activity project titled 'Small and Medium Enterprises Financing & Development Project' (SMEFDP). The aim of SMEFDP is to establish and strengthen business development services (BDS) at the cluster level in order to provide MSMEs with the technological, management and marketing support services they require for improving their productivity and profitability. The Energy and Resources Institute (TERI) has executed the project in two important engineering clusters: (1) Rajkot, in Gujarat, and (2) Mohali–Panchkula–Chandigarh, in Punjab/Haryana.

In the Rajkot cluster, TERI has focused on two important industrial segments: (1) foundries and (2) pump set manufacturers. This case study highlights TERI's work in the foundry segment: expressly, the promotion of an energy efficient melting furnace technology called the divided blast cupola (DBC). It provides a brief and simple account of how TERI has successfully identified and strengthened the capabilities of local fabricators to promote and sustain the uptake of the DBC among foundries in the cluster.

Backdrop

The Rajkot engineering cluster has about 500 foundries ranging in size from micro to large scale. Most of the foundries in Rajkot produce grey iron castings for the manufacturers of automobiles, pump sets and machine tools; a number of foundries also produce high-value (precision) castings (Figure 1). A number of Rajkot foundries export their products to countries in Europe, the Middle East and Southeast Asia. The majority of Rajkot foundries use conventional coke-based cupola furnaces or induction furnaces to melt metal (Figure 2).

In general, the melting process consumes the maximum amount of energy in a foundry. Hence, foundries can cut costs by reducing energy (fuel) consumption during the melting process. This can be done by replacing the conventional cupola with the energy efficient divided blast cupola (DBC), or by reducing heat losses in the induction furnace.

Figure 1 Precision castings made by Gautam Technocast

Figure 2 (a) Conventional cupola
(b) Induction furnace

FOUNDRY AND ENERGY USAGE

A foundry makes iron castings by processing a variety of iron-containing materials such as pig iron and cast iron scrap. These materials are melted in a furnace to make molten iron, which is then poured into moulds to make castings of desired shapes. The castings form the primary components for a vast range of engineering industries.

Foundries use two main kinds of melting furnaces. One is the coke-based melting furnace, called cupola. The other is the induction furnace, which uses electricity.

The steady growth in India's economy—particularly in sectors like infrastructure and automobiles—offers opportunities as well as challenges for the Indian foundry industry in general and the Rajkot foundries in particular. In order to be able to meet the increasing demand for high-value castings and overcome competition from new players, the foundries must quickly find ways to cut process costs and improve their product quality. The need for foundries to cut costs has become particularly acute in recent years, with frequent hikes in the prices of all key foundry inputs like pig iron and coke.

In this backdrop, TERI intervened in the cluster to provide foundries with a technology-based solution that would enable them to cut costs and improve product quality. In order to ensure that the improved technology is completely absorbed at cluster level, TERI focused on enhancing the technological capacities of the cluster by identifying and strengthening the capabilities of cluster-level BDS providers in fabricating and commissioning DBCs.

Context

TERI has been engaged in promoting the energy efficient DBC among foundry units in India as part of a larger country-wide initiative supported by Swiss Agency for Development and Cooperation (SDC) to promote energy efficient technologies in the Indian MSME sector. TERI introduced the DBC technology in Rajkot in 2002, and has since then been working with several individual foundry units in partnership with the Institute of Indian Foundrymen (IIF), Rajkot.

DIVIDED BLAST CUPOLA (DBC) AND ITS BENEFITS

The divided blast cupola (DBC) is an energy efficient coke-based melting furnace. TERI first demonstrated the DBC in the Howrah foundry cluster in 1998 with the support of SDC. The DBC typically saves 20–30% of the coke consumed by a conventional cupola, thereby reducing fuel expenses and increasing profits. It also produces molten metal at temperatures 50°–100° C higher than in the conventional cupola; this enables production of better quality castings and also reduces the volume of 'rejects'—further adding to productivity and profitability. Although the capital cost of a DBC is higher than that of a conventional cupola, it offers an attractive payback on investment (often, within a year) due to savings in coke.

Studies indicate that electrical melting by using an induction furnace costs nearly twice as much as coke-based melting using the DBC. Hence, the DBC can provide a cost-effective technological option for the electrical induction furnace as well; particularly in a scenario when power is becoming increasingly costly.

The first to take up the energy efficient technology promoted by TERI was Shining Engineers & Founders (Pvt) Ltd; in 2003 it adopted two DBCs (Figure 3). The very next year another progressive foundry group,

Figure 3 DBC commissioned in 2003 at Shining Engineers & Founders, Rajkot

Prashant Castings, adopted two DBCs. Encouraged by the results, these two foundry groups acquired additional DBCs: currently, Shining Engineers & Founders (Pvt) Ltd has six DBCs while Prashant Castings has seven DBCs of TERI design. Other foundries in Rajkot took the cue from these two leading foundry groups and proceeded to adopt DBCs. By 2008–09, a total of 29 DBCs were in operation in various foundries in the cluster (Table 1).

Intervention

Approach and target

The diagnostic study by the TERI–SIDBI project in 2008–09 indicated a growing interest in the DBC technology among Rajkot foundry owners, particularly in an environment of rising coke and electricity prices. While there was already widespread awareness among foundry owners in the cluster on the DBC and the benefits it offered in terms of energy savings and attractive payback on investment, the diagnostic study suggested that there was a good opportunity to spur the uptake of DBCs in the cluster by strengthening the number as well as capabilities of fabricators in executing orders for DBCs.

In essence, the foundations for up-scaling of the DBC in the Rajkot cluster were laid by the SDC-supported project through enhancing technological capacity on the 'demand' side (i.e. among foundry entrepreneurs). The SIDBI-supported project aimed to promote and sustain the uptake of the DBC by enhancing technological capacity on the 'supply' side, i.e. among cupola fabricators (Figure 4). Specifically, the project aimed at facilitating the adoption of DBCs by strengthening the capabilities of BDS providers, i.e. cupola fabricators, in fabricating and commissioning DBCs.

Table 1 List of Rajkot foundries which had adopted DBCs between 2003–09

S.no.	Foundry name	No. of DBCs
1	Shining Engineers & Founders (Pvt) Ltd	6
2	Prashant Castings (P) Ltd	7
3	Mahadev Manufacturers	1
4	New Ramesh Industries	2
5	Meghdoot Foundry	1
6	Vishal Foundry	2
7	Sita Foundry	1
8	Real Cast	1
9	Prabhukrupa Industries	1
10	Iswarkrupa Moulding Works	1
11	Sardar Castings	1
12	Patel Engineering	1
13	Radhika Industries	1
14	Aai Shree Kodiar Foundry	1
15	Rainbow Industries	1
16	Bajarang Metal	1
	Total DBCs	29

Activities

The project activities followed four parallel paths:

- Generate awareness among cupola fabricators in Rajkot on the DBC technology, present it as a lucrative business opportunity for them, and identify those interested in acquiring expertise in fabricating DBCs
- Train the interested fabricators in interpreting design drawings for the DBC and in fabrication of DBCs according to the prescribed quality norms
- Generate awareness among foundry entrepreneurs on the availability of these (freshly) trained DBC fabricators
- Provide furnace operators, supervisors and other factory-floor workers with hands-on training in DBC operation during and after commissioning of DBCs.

The project established its cluster office in the premises of Rajkot Engineering Association (REA) in Rajkot. This proximity to the leading industries association helped the project's cluster team in coordinating its activities with REA, and in remaining closely engaged with foundry entrepreneurs and

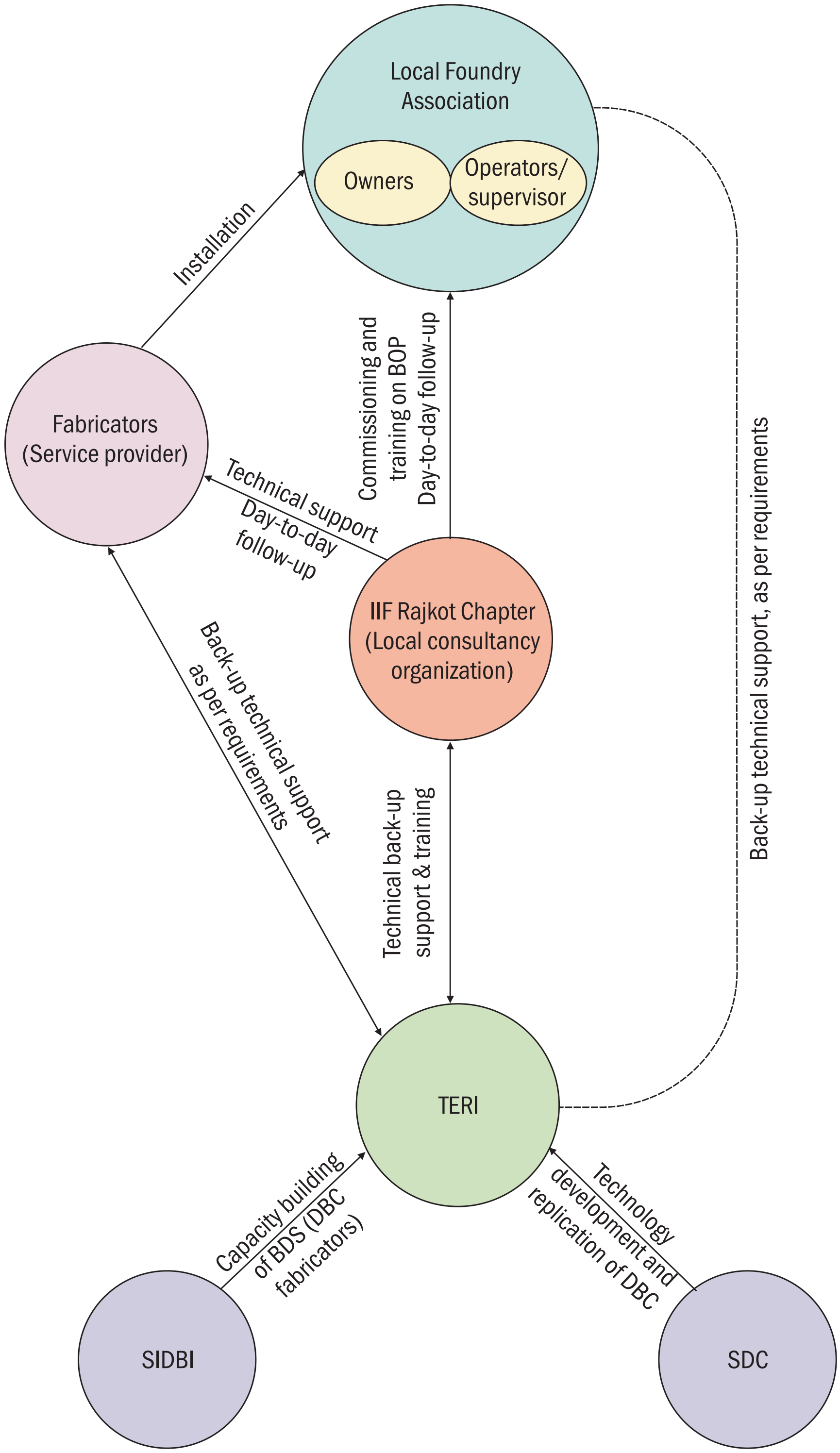

Figure 4 Strategy adopted by project in Rajkot cluster

THE FABRICATOR'S ROLE

The fabricator plays a key, though often understated role in supporting manufacturing industries—including foundries. In simple terms, a fabricator works on raw materials such as iron and steel in order to make them into equipment, machines and structures of specified designs, which are then used by an industrial unit to manufacture its products. Thus, a fabricator must be able to interpret engineering (design) drawings; accurately cut and shape metal plates into the required shapes; and then join/weld them together to assemble the structures/equipment specified in the drawings. Typically, a fabricator's workshop has a variety of machines and tools for cutting, bending and shaping metals—like lathes, millers, grinders, gas cutters, arc welders, and so on.

In the context of foundries, a fabricator not only makes cupolas for melting metal but also a whole range of related machinery/equipment like overhead cranes and other lifting and charging equipment, sand mixers, moulding machines, ladles for pouring molten metal, and so on (Figure 5).

Figure 5 View of fabricator's workshop – Geeta Engineering; Mr Raja Kannu (L) with Mr Bharat Davda of TERI cluster team (R); pneumatic moulding machine in background

other industry stakeholders throughout the project tenure.

During 2009–10 the project interacted extensively with the local fabricators in the Rajkot cluster, both through awareness generation meets and through visits to the fabricators' workshops for one-on-one dialogues. The aim was to create awareness on the DBC and awaken interest in DBC technology on the part of the fabricators. At the same time, during its periodic interactions with the local foundry industry through workshops, seminars, etc., the project kept the local foundry entrepreneurs informed on its ongoing efforts to create a pool of fabricators trained in and capable of fabricating TERI-design DBCs.

Consequent to the project efforts, four fabricators evinced interest in obtaining training on fabrication of DBCs:

1 Mr Mahendrabhai Parmar (Shree Ambika Industries)

PORTRAIT OF A FABRICATOR

Mr Chandubhai Mistry, fabricator trained under the project, comes from a rural background. He studied in a Gujarati medium school in Rajkot, but dropped out in Class 5 to seek work and augment family income. He traveled to Mumbai where he did all kinds of jobs, progressing from menial tasks to working as a fitter/mechanic in small workshops. He returned to Rajkot to take up assembly of oil engines, and in due course set up his own workshops and switched to the fabrication and manufacture of all kinds of equipment and machinery related to the foundry and pump set industries (Figure 6).

He is quite vehement in voicing his approval of the DBC. *"It is a good furnace, not only for the foundry owner but also for the workers. It saves fuel, it is easy to operate, and it gives out much less smoke."*

Figure 6 Bhavani Fabrication Works

2 Mr Raja Kannu (Geeta Engineering)
3 Mr Harkishen V Maru (Vasant Engineering Works)
4 Mr Chandubhai Mistry (Devkrupa Industries, now renamed Momai Industries, and Bhavani Fabrication Works)

Thereafter, the project conducted a training program for these four fabricators through which they learned to interpret the design drawings for the DBC, as well as to fabricate and assemble its different components according to the stringent norms laid down in the drawings.

Replications

The first success for the project came in mid-2010, when a local foundry, Steelcon Metal Cast, placed an order with Mr Chandubhai Mistry for fabrication of a 21-inch DBC. This foundry specializes in producing castings for induction motor bodies, pump parts, automotive hubs, valve components, etc. Many of its products are exported. Earlier, the foundry was using a conventional coke-fired cupola for melting metal, which gave rise to problems such as inconsistency in the grade of metal. The foundry entrepreneur decided to adopt a DBC instead for three key reasons.

- The periodic awareness meets on the DBC organized by the project, as well as the feedback he got from other foundry entrepreneurs who were already operating DBCs, convinced him that a DBC could produce melt that was comparable in quality and consistency to that produced by an induction furnace.
- The DBC offered an attractive payback on investment.
- Installing an induction furnace entailed considerable delay as well as expenditure.

"*Production cannot stop*!" explains Mr Kotecha, proprietor of Steelcon Metal Cast. "*Going in for an induction furnace meant waiting a long time for power connection; something I just could not afford to do. Also, I would have had to invest a lot of money in setting up the induction furnace system—over 50 lakh rupees towards registration etc. with the state electricity board, and at least another 25 lakh rupees for setting up the necessary infrastructure within my factory. And then, the recurring expenditure is very high in electrical melting…as power costs Rs 5.50 per unit! After weighing all these factors, I opted for a DBC…and I am happy with my decision.*" (Figure 7)

Figure 7 21-inch DBC at Steelcon Metal Cast

BDS PROVIDER SHOWS HIS METTLE

The 21-inch DBC at Steelcon Metal Cast —the first to be adopted under the TERI–SIDBI project—was designed, fabricated and commissioned by Mr Chandubhai Mistry, BDS provider trained by the project. The DBC performance has been monitored following its installation, and the results clearly show its benefits in terms of better melting rate and lower coke consumption:

- Melting rate: 2.25 to 2.7 tonnes per hour
- Coke to metal ratio: 1:13 (indicating that coke consumption has been reduced by nearly 35% compared to conventional cupola)

The new DBC cost around Rs 6.65 lakhs, compared to Rs 4 lakhs for the conventional cupola at that time. Due to its higher energy efficiency, the DBC saves around Rs 850 per tonne of liquid metal produced—giving a simple payback on its cost within six months.

The Steelcon Metal Cast DBC brought benefits for Mr Chandhubhai too: he not only earned a substantial fee for executing this project, but established his reputation among the foundry entrepreneurs in Rajkot as a fabricator trained by TERI and capable of executing an order for a DBC from its design to commissioning.

In subsequent months, a number of other foundries in Rajkot decided to adopt DBCs. As of end-September 2011, five DBCs have already been commissioned; another five are in various stages of design/fabrication/installation, and are expected to be commissioned before the end of 2011 (Figures 8, 9).

Figure 8 New 21-inch DBC installed at Gautam Technocast

The furnace operators were given hands-on training in DBC operation during commissioning of the first few furnaces. The project also conducted a comprehensive training session for furnace operators, supervisors, and charge-hands in order to further strengthen their capacities in optimal operation of the DBCs (Figure 11). The training covered pre-commissioning checks, preparation of bottom sand and bed coke, charging, cupola lighting-up, drawing of melt and cupola shutdown. Emphasis was placed on weighing of charge and maintaining a record of each production run.

Figure 9 New 18-inch DBC under installation at Die Cast

Entrepreneurs' perspectives

All the entrepreneurs who have opted for the DBC under the project cite two common reasons for their decision: (1) the DBC offers significant coke savings and better metal quality compared to their existing conventional cupolas, and (2) it is far more cost-effective than the electrical induction furnace. The entrepreneurs also provide insights into other factors that have impacted the foundry industry, and that have had a bearing on their decision to adopt the DBC.

"*The prices of raw material have risen drastically in recent times—yet we cannot afford to pass on the burden of these increased costs to our clientele*," says Mr Praful D Dhami, Director, Gautam Technocast, a leading foundry in Rajkot which produces high-value

CARBO TECH: GROWTH OF AN ENTREPRENEUR

Mr Karamshi Bhai Patel has commissioned a 33-inch DBC in his recently opened foundry, Carbo Tech. Mr Patel started his career nearly two decades ago by doing job work for foundries in Rajkot—he would collect castings from various foundries and smoothen their rough edges with the help of a planning machine at his small workshop. Over the years, he acquired knowledge and expertise in various aspects of foundry operation, and with diligent planning he has today acquired the largest DBC promoted under the project. He is using it to produce castings (mainly for lathe beds) ranging in weight from 350 kg to 4 tonnes (Figure 10).

Figure 10 33-inch DBC commissioned at Carbo Tech: (a) Drawing molten metal from DBC; (b) Pouring metal into moulds; (c) Heavy lathe bed castings

Figure 11 Classroom training session on DBC for furnace operators, supervisors etc.

castings for the automobile industry. "*This is because there is fierce competition in the industry, especially among new players, to get a foot into the growing automobile industry market*." In this scenario, he sees the DBC as a good option to save coke while improving productivity and retaining product quality. He has already commissioned a 21-inch DBC; a second 21-inch DBC is expected to be commissioned shortly.

Mr Ramnik Kotecha, proprietor, Steel Forge and R K Ganga, has placed an order for two new 18-inch DBCs to replace his existing twin conventional cupolas, as part of a comprehensive project being financed by SIDBI (Figure 12). His products are exported to Middle East and South-East Asian countries. He has opted for DBCs rather than induction furnaces because the former not only offer lower capital cost and attractive payback, but because they assure him of consistency in metal quality—a must for his overseas clientele. He too points to the fact that policies that affect the prices of coke and pig iron have a direct impact on the foundry industry.

Mr Sanjay Soni, proprietor of Parv Metal, notes that the DBC not only saves fuel costs due to its higher energy efficiency, but offers other benefits by producing melt at higher temperature. "*The*

Figure 12 Steel Forge; (a) view of new project site (b) view of conventional cupolas

Figure 13 27-inch DBC at Parv Metal

higher tapping temperature provides advantages while pouring the metal into moulds— the quality of metal stays consistent because it is hotter, and I get more time for pouring operations. This helps in reducing the percentage of rejects, which in turn translates into better productivity." He has adopted a 27-inch DBC in place of the conventional cupola in one of his units, Bhumi Metal Processing Company (Figure 13).

Mr Nilesh Patel and Mr Pankaj Patel of Shivanand Castings underline the point that a foundry cannot afford to interrupt or halt production for long, and that this factor plays a crucial role in deciding whether and when to replace an existing melting furnace by a new one. "*We were operating two conventional cupolas. We decided to replace one by a DBC—but we had to plan the switchover process very carefully, as both our cupolas were being used continuously*." Installation of the new DBC required dismantling of one of their existing cupolas and strengthening the masonry work at its base. When the DBC was ready for installing, they shut down one cupola and increased the throughput of the other (to minimize disruption in production) till the DBC was successfully commissioned. "*We had to plan every aspect of the switchover months beforehand—production schedules in both cupolas, materials, costs, logistics, time, and so on*." (Figure 14)

BDS providers' perspectives

It is interesting to note that Mr Chandubhai Mistry has been the most successful BDS provider under the project; he has taken on fabrication of most of the DBCs set up under the project. However, this does not in any way reflect adversely on the capabilities of the other three BDS providers. Rather, it only emphasizes the fact that, just as foundry entrepreneurs must necessarily weigh orders on hand and the costs of stopping/interrupting production while adopting a DBC, so too fabricators

Figure 14 24-inch DBC at Shivanand Castings: (a) Mr Nilesh and Pankaj Patel with cupola; (b) view of casting products

must weigh their orders on hand and work in progress before taking on the job of fabricating and commissioning a DBC. It is important to recognize that fabricating a DBC takes several months; hence, taking on such a task might imply putting other work on hold. Mr Chandubhai has taken a considered decision to execute orders for DBCs; likewise, the others have—at least so far—taken equally considered decisions *not* to execute orders for DBCs.

Mr Chandubhai Mistry explains that it takes 3–4 months for him to execute an order for a DBC, from fabrication of the cupola to its installation and commissioning. In comparison, a conventional cupola takes only 1½–2 months to fabricate and commission. He also had to invest in new machinery (such as heavy duty lathe, drilling machine, arc welding machine and gas cutter) in order to be able to do the work required in fabricating DBCs. "*The DBC is a 'heavy' job; it requires much more raw material, mainly cast iron (CI) plates, than the conventional cupola. We also have to take much more care in getting the dimensions and specifications correct…down to the last screw.*" (Figure 15)

Mr Chandubhai is happy with the profits he makes by executing orders for DBCs. Typically, he

Figure 15 Momai Industries: (a) Heavy duty lathe in workshop; (b) Newly fabricated DBC components; (c) Mr Chandubhai with tuyeres for DBC

charges foundry entrepreneurs according to the weight of cast iron (CI) plates needed for cupola fabrication work. He charges around Rs 75 per kg for the conventional cupola, and Rs 85 per kg for the DBC. According to him, the weight of CI plates needed for the DBC ranges from 9 tonnes to 27 tonnes depending on the size (internal diameter) of the DBC.

Taking stock

Table 2 lists the 10 DBCs that have been fabricated and commissioned by BDS providers, or that are in the pipeline, as of end-September 2011 under the project.

The project has thus achieved its target of facilitating the replication of 10 DBCs through strengthening the capacities of BDS providers in fabrication and commissioning of this energy efficient cupola model.

Four BDS providers have been trained in fabricating and commissioning DBCs under the project. The cluster-level capacities for fabricating DBCs have thus been enhanced under the project. The trained BDS providers are expected to support replications of the DBC in the Rajkot cluster beyond the project term.

Table 2 Ongoing and completed DBC replications in Rajkot during 2010–11

S. no.	Foundry	No. of DBCs
1	Steelcon Metal Cast	1
2	Gautam Technocast	2 (1 new)
3	Parv Metal Processing Co. Group (unit: Bhumi Metal Processing Co.)	1
4	Shivanand Castings	1
5	Carbo Tech	1
6	Die Cast	1 (new)
7	Steel Forge/R K Ganga	2 (new project)
8	Patel Foundry	1 (new)
		10

The foundries that have adopted DBCs during the project term are benefiting in terms of coke savings, quick payback on investment, and improved productivity and quality of castings. The furnace operators and other shop-floor personnel have benefited in terms of easy operability of the DBC and reduced pollution.

The TERI-designed DBC is now firmly entrenched in the Rajkot cluster, and the technology is expected to disseminate on its own momentum.

The Energy and Resources Institute

TERI (The Energy and Resources Institute), a dynamic and flexible organization with a global vision and a local focus, was established in 1974. A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy requirements to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across continents to helping conserve forests; from advancing solutions to the growing urban transport and air pollution to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. To this end, TERI has established regional centres in Bangalore (Karnataka), Panaji (Goa), Guwahati (Assam), Supi (Uttarakhand) and Mumbai (Maharashtra). It has set up affiliate institutes: TERI–NA (The Energy and Resources Institute, North America) in Washington, DC, USA and TERI–Europe, London, UK; and it also has a presence in Japan, Malaysia, the UAE, and Africa.

Small Industries Development Bank of India

SIDBI (Small Industries Development Bank of India) was established in 1990 as the principal financial institution for financing, promotion and development of industries in the small scale sector and to coordinate the functions of other institutions engaged in similar activities.

Mission

"To empower the Micro, Small and Medium Enterprises (MSME) sector with a view to contributing to the process of economic growth, employment generation and balanced regional development."

SIDBI has been supporting the MSME sector with various innovative schemes and special products in the areas of cleaner production and energy efficiency with the support of various Indian and international institutions. While finance is the basic need of the MSMEs, they also require different non-credit facilities such as equity capital, credit rating, technology transfer and upgradation, etc. To cater to these needs, SIDBI has set-up various subsidiaries / associates such as:

- SIDBI Venture Capital Ltd. (SVCL), an asset management company
- Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) to provide credit guarantee support to collateral free / third-party guarantee free loans
- SME Rating Agency of India Ltd. (SMERA), an MSME dedicated third-party rating agency
- India SME Technology Services Limited (ISTSL), a platform for MSMEs to tap opportunities at the global level for acquisition of modern technologies
- India SME Asset Reconstruction Company ltd (ISARC), the country's first MSME focused Asset Reconstruction Company