Cluster Profile
Khurja Potteries

teri

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development
and Cooperation SDC

Certificate of originality

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

Suggested format for citation

TERI. 2015
Cluster Profile Report – Khurja potteries
New Delhi: The Energy and Resources Institute 8 pp.
[Project Report No. 2014IE15]

Disclaimer

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
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi-110 003
India

For more information

Project Monitoring Cell
T E R I
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003
India

Tel. 2468 2100 or 2468 2111
E-mail pmc@teri.res.in
Fax 2468 2144 or 2468 2145
Web www.teriin.org
India +91 • Delhi (0)11

Contents

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 thankful to Central Glass & Ceramic Research Institute, Khurja for providing support and information related to pottery units in Khurja cluster. TERI extends its sincere thanks to Mr L K Sharma, Scientist in Charge for organizing field visits and interactions with pottery units 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.

Khurja potteries

Overview of cluster

The Khurja pottery cluster is one of the oldest pottery clusters in the country. It came into existence during the Mughal rule in the Northern India when there was a demand for earthenware in Mughal period. Khurja cluster is located at a distance of about 100 kilometers from Delhi. A majority of the units are located around Khurja town.

Product types and production capacities

At present there are about 400 small-scale units in the cluster engaged in production of various types of ceramic products. The pottery units are engaged in the manufacture of a variety of ceramic products like crockery, insulators, electrical items, bone china wares, sanitary and decorative items. The break-up of pottery units based on products is shown in table.

Type of products from Khurja pottery cluster

Product	Number of units
Stoneware crockery	150
Electric kitkat	80
Art-ware	60
Insulators	15
Bone china	15
Decorative items	14
Laboratory-ware	5
Technical ceramics	4
Refractories	3
Grinding balls	2
Ceramic External Decorative	2
Dependent potters	50
Total	400

Energy scenario in the cluster

The pottery units in Khurja cluster was initially using coal for firing in downdraft kilns. With no downdraft kilns in operation at present, coal is no longer used as fuel in the cluster. The cluster extensive uses Light Diesel Oil (LDO) and Rubber Process Oil (RPO) for firing kilns. Few units use piped Natural Gas (NG) as well.

Electricity requirements at cluster level are mainly met through grid – Uttar Pradesh Power Transmission Corporation Limited (UPPTCL). Estimation of energy consumption indicates that thermal energy accounts for 80-85% and electrical energy accounts for 15-20% of total energy consumption. The details of major energy sources and tariffs are shown in table.

Prices of major energy sources

Energy type	Price
Light Diesel Oil	Rs 55,000 per kilo litre
Rubber Process Oil	Rs 32,000 per kilo litre
Electricity	Energy charge : Rs 6.50 per kWh

Production process

Ceramic manufacturing process broadly consists of mould preparation, body material preparation, shaping, drying and firing. The general manufacturing process of ceramic products is described below.

(i) Mould preparation and curing

Most of the ceramic products are shaped using dies. Mould is used in slip casting during forming process for pottery-wares. Moulds are either made of Plaster of Paris (POP) or polymers. Pre-shaped pattern is used to prepare green moulds which are strengthened through controlled heating and drying in kiln. The curing and strengthening cycle for a batch of green mould is around 72 hour.

(ii) Body material preparation

Batch preparation is the first step towards shaping of any ceramic product. Batches of coarser size raw materials are reduced to desired mixture of target size through series of operation like crushing, grinding, sieving and magnetic separation following either wet or dry body preparation methods to produce final body mix or slip. The final slip of desired particle size is screened to remove unwanted particulate matters and kept in agitating tank with addition of required de-flocculants to avoid sedimentation of dense slurry. The material is then passed through filter press to get rid of soluble salts and excess water to make a plastic body mix. Based on requirements, the moisture content of the body-mix is reduced before pugging or directly fed into a pan or pug mill for de-aeration. The de-aerated body mass is transferred to casting areas.

In case of dry body preparation, the raw material is dry milled in a hammer mill or a pendular type of mill. The mixture is then made wet to 7-12% on a dry weight basis. The granulated material is dried in a spray dryer to obtain dried mass of 5-6% moisture content. In wet body preparation, the raw material is wet milled in a ball mill by mixing with water to have a moisture content of 42-50% on a dry basis. Granulation subsequently takes place using a spray drying process and the granulated material is dried to a moisture content of 5-6%. The final moisture content of body mixture is decided as per the forming process requirement. It may be 6-8% for dry process and 30-40 % for plastic/wet process.

(iii) Shaping

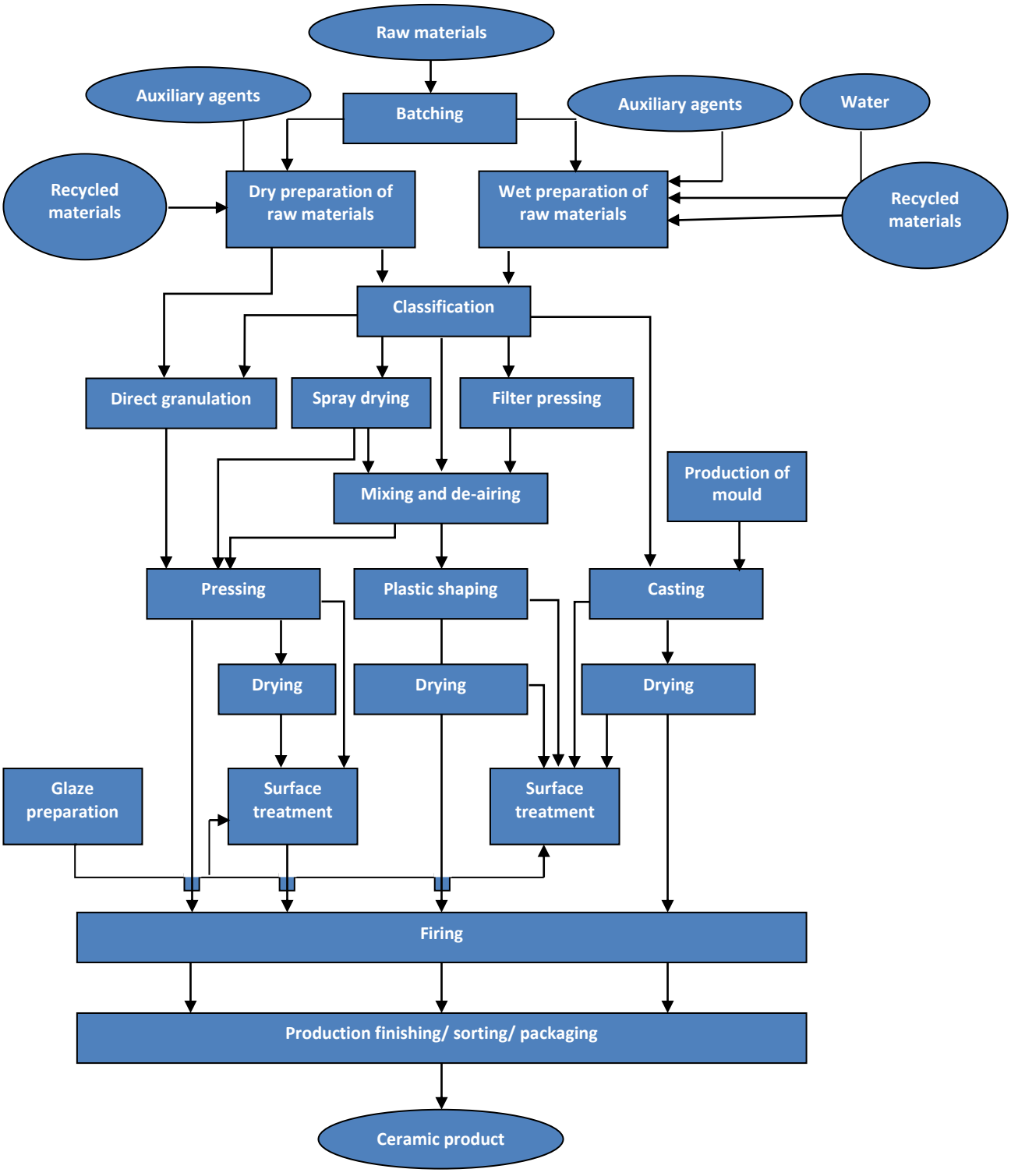
Depending upon the target product, one of the shaping processes out of (i) pressing, (ii) extrusion, (iii) moulding, (iv) slip casting, (v) tape casting (thickness 0.25-1mm) and (v) fusion casting is undertaken. Mostly hydraulic presses are used in the ceramic industry. It is suitable for wider product variations like glazed, unglazed, single fired, double fired, small size and large size as the required high pressure can be controlled quite easily. In wet shaping, slip casting is undertaken wherein clay mixture/ body mass supplied through overhead belt conveyor and poured into the mould under manual supervision. The cycle time in wet shaping for typical pottery-ware is 6 about hour covering pouring to de-moulding activities. Normally, 5-6% rejection in wet shaping is observed, which is mostly recycled in the process after suitably modified.

(iv) Drying

The green products are stacked on the kiln car in a stack of 3 feet height and dried in place using hot waste gases from the kiln. The temperature and duration depend on product batch to be dried. The green tiles are dried for 20 hours at about 250-300˚C and allowed to cool down to room temperature naturally. The ceramic products are screened through on-line sorting followed by hammer test, brushing and water spraying before glazing application. Some of the green ceramic products dried either in open sun or at room temperature before taken to next process step like glazing and sintering.

(v) Firing

Firing is the process by which ceramics are thermally consolidated into a dense, cohesive body composed of fine, uniform grains. This process also is referred to as sintering or densification. Ceramics are generally fired at 50-75% of the absolute melting temperature of the body material. Kilns used in firing may be intermittent or continuous types.



Typical process flow diagram of ceramic products

Technologies employed

Traditionally, Khurja pottery cluster was using downdraft kilns which were mainly using coal as fuel. However, there were number of issues related to operation of downdraft kilns which included (1) higher Specific Energy Consumption (SEC), (2) Lower yield and (3) Poor Environmental Performance. Over the years, majority of downdraft kilns have been replaced with tunnel kilns and shuttle kilns. At present about 5 downdraft kilns operating in the cluster (table)

These kilns use LDO as the main fuel for firing of ceramic products. With the availability of piped Natural Gas, about 10 pottery units have switched over to NG firing. Approximately 15 to 17 days are required from raw material preparation to final product. Some of the major processes/equipment used in the cluster are described below.

Types of kilns in Khurja cluster

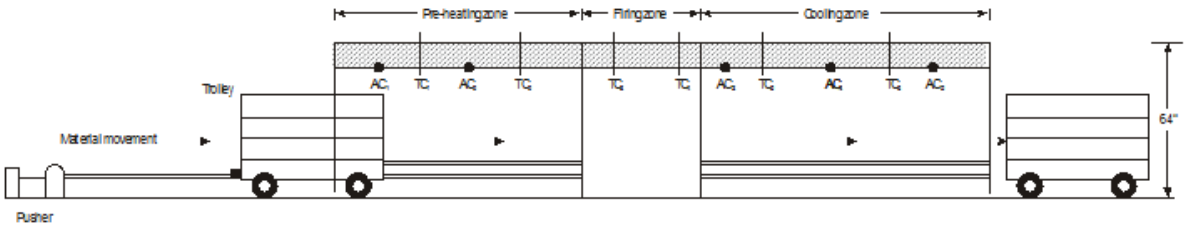
Type of kiln	Number of kilns
Tunnel kiln	91
Shuttle kiln	60
Downdraft kiln	5
Total	156

(i) Tunnel kiln

Tunnel kilns are continuous type kilns which are used for firing of various ceramic products. A majority of tunnel kilns used in the cluster are oil fired; about 10 tunnel kilns in the cluster have started using NG. The capacity of tunnel kilns varies between 2 tonne per day (tpd) to 9 tpd. A typical tunnel kiln has three different zones, namely, preheating, firing and cooling zones.

Tunnel kiln

The kiln has two ends viz. loading and unloading. The green wares are stacked on trolleys, and moved on rails inside the kiln. The speed of the trolleys inside the kiln is controlled with the help of an electrically operated pusher. The pushing time is adjusted to provide the required residence time for the type of products being fired in the kiln. For loading the greens and unloading the fired products, a side rail is provided parallel to the kiln. The proximity of the side rails to the kiln walls also helps in drying of the greens before they are fed in the furnace. Some units have covered the area between firing zone and side rail area that would act as 'Drying Chamber'. A temperature of 1050-1200 ºC is maintained in the firing zone based on the type of products such as crockery or insulators. Upon completion of soaking, trolleys are pushed towards cooling zone, wherein the products are cooled before taken out from unloading end.



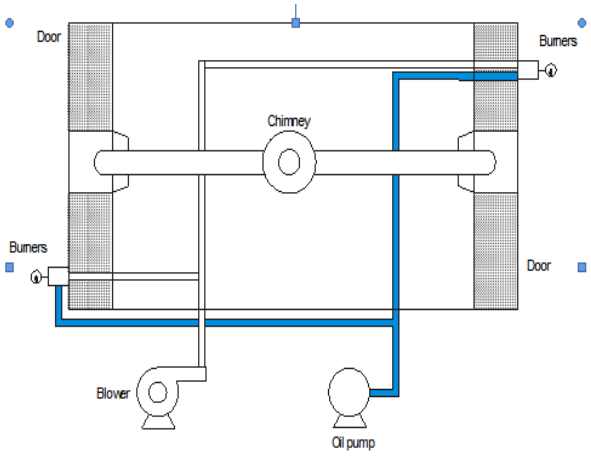
AC: Air curtain
TC: Thermocouple

Schematic of tunnel kiln

(ii) Shuttle kilns

Shuttle kilns are batch operated kilns. These kilns are suitable for non-uniform ceramic products such as decorative items. Shuttle kilns are oil fired. There are four burners with two burners on The greens are loaded inside the furnace and closed down. These materials are heated slowly and gradually to a temperature of about 1240 ºC, which generally takes about 36 hours. The products are soaked at the maximum temperature for about 2 hours to enable effective firing of glazed products.

Shuttle kiln

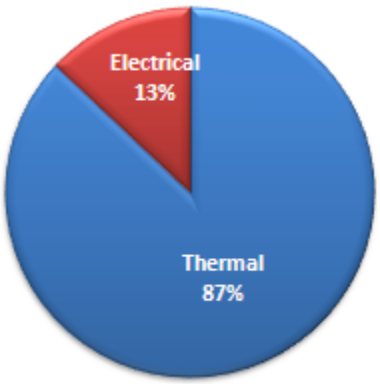


Schematic of tunnel kiln

After soaking of the products is complete, the fuel supply to the burners is cut off and only cooling air is supplied to the kiln. The accelerated cooling through air blowers is done to maintain a cooling temperature gradient for the wares. Forced cooling through air blower is carried out till the kiln temperature has dropped to about 200 ºC, after which the blower is stopped and the doors are opened for natural cooling of the products. The kiln does not have any waste heat recovery system to recover waste heat available in flue gases.

Energy consumption

The pottery units in Khurja use LDO, Processed Rubber Oil (RPO), NG and electricity. Thermal energy accounts for about 80-85% share and electrical energy 15-20% share of total energy consumption in a pottery unit. Energy costs are estimated to be 25-40% in overall production costs. RPO is being increasingly used by pottery units in the cluster, which may be mainly attributed to lower costs as compared to LDO. However, the issues related to use of RPO in existing burner setup include higher unburnts in flue gases and frequent maintenance of burner.



Energy consumption share

(i) Unit level consumption

The specific energy consumption (SEC) of pottery units are quite high, as significant quantity of dead-weight is also heated and cooled along with the products. The average SEC of tunnel kiln was estimated to be 4.3 MJ per kg product (1030 kcal/kg) and of shuttle kiln was 15.7 MJ per kg product (3748 kcal/kg). The SECs of shuttle kilns are quite high (about 3.6 times of tunnel kilns) which may be attributed to factors such as batch operation and absence of any waste heat recovery system and temperature monitoring & control system.

Typical energy consumption in tunnel and shuttle kilns

Kiln	Thermal energy (toe/yr)	Electricity (kWh/yr)	Total energy (toe/yr/unit)
Tunnel kiln			
• 4.0-4.5 tpd	137	221,554	156
• 6.0-6.5 tpd	179	369,228	211
• 9 tpd	248	461,544	288
Shuttle kiln	64	110,772	73

(ii) Cluster level consumption

The total annual energy consumption at cluster level is estimated to be 18,442 toe. The break-up energy consumption based on different energy sources is shown in table.

Energy consumption of the Khurja pottery cluster (2015)

Energy type	Annual consumption	Equivalent energy (toe)	Annual energy bill (million INR)
LDO/RPO	19,032 kL	14,602	82.0
Natural Gas	1.5 million m^3	1,455	6.0
Electricity	27.7 Million kWh	2,385	18.0
	Total	**16,192**	**106.0**

Energy saving opportunities and potential

The total potential energy saving at cluster level is estimated to be 1339 toe per year. Some of the major energy-saving opportunities in the pottery units in the cluster are discussed below.

(i) Use of low thermal mass cart

The weight reduction of the kiln carts provides significant amount of energy savings in tunnel kiln. Low thermal mass materials are now being used for kiln car construction, which reduces the weight of the kiln car considerably. The following modifications can be incorporated to reduce the weight of the kiln cars:

- Replacement of refractory bricks with the hollow ceramic coated pipes at the supporting pillars for holding the racks
- Use of ceramic fibre blankets at the base of the car instead of refractory brick base
- Use of cordierite (hollow) blocks to hold the raw-wares/ nano material instead of solid refractory mass

Reducing the dead weight by about 30%, heat losses from kilns can be reduced substantially. The envisaged fuel saving with dead weight reduction of trolleys is about 3% of total heat input equivalent to 482 toe per year.

(ii) Kiln automation

The existing tunnel kilns and shuttle kilns are controlled manually. This leads to deviations in various operating parameters and hence energy losses. Kiln automation can lead to an energy saving of about 3% equivalent to an annual saving of 482 toe.

(iii) Waste heat recovery in shuttle kilns

Shuttle kiln is a batch type kiln wherein the products are kept inside the kilns wherein they are slowly preheated, fired, soaked and cooled at the same location. The temperature of flue gases also increases gradually over the firing cycle, with the highest temperature reaching about 900-1000 ºC. By incorporating a Waste Heat Recovery (WHR) system, the combustion air at ambient temperature can be preheated from 100-350 ºC depending on flue gas temperatures. An average energy saving potential of 7% exists with air preheating system, equivalent to an annual energy saving of 268 toe.

(iv) Energy efficient motors

Almost all the units in the cluster use locally procured motors and rewinding of more than two times is not very uncommon, leading to inefficiency in various activities in raw material preparation. For every rewinding, there is an energy loss of about 2%, and hence it is recommended to replace the motors if rewound more than two times with Energy Efficient (EE) motors. The envisaged energy saving is about 5% of energy consumption in motors equivalent to 107 toe annually.

(v) Others

Energy efficiency lighting is another option that can be adopted by the pottery units. Apart from this, a large number of industries quite frequently face problems related to voltage fluctuations. This would lead to repair and failure of equipment at unit level. The units can install voltage stabilizers to avoid recurring problems of voltage fluctuations.

Major stakeholders

The major stakeholders in Khurja pottery cluster include the following.

- *Industry associations:* The important industry association at cluster level is Khurja Pottery Manufacturers Association (KPMA). It is well represented by a large number of potteries using tunnel and shuttle kilns. Other industry associations include Khurja Pottery Raw Materials Association (KPRMA) and Khurja Kutir Udyog Associations (KKUA).
- *Central Glass and Ceramics Research Institute (CGCRI)*: The CGCRI, a unit of CSIR, Government of India is located within the cluster. CGCRI is equipped with a laboratory for raw material preparation and kiln firing. It conducts regular training program on skill upgradation.
- *Indian Ceramic Society (Western Uttar Pradesh Chapter)*: The Indian Ceramic Society (Western Uttar Pradesh Chapter) is located in CGCRI and is involved in conducing workshops and conferences relevant for ceramic industries in the region.

Cluster development activities

Khurja pottery cluster is one of the focus clusters in a UNIDO supported study on "Promoting energy efficiency and renewable energy in selected MSME clusters in India". UNIDO is working closely with CGCRI in implementation of the project in the cluster.

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

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

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