

ENERGY PROFILE

RAJKOT AUTO COMPONENTS CLUSTER

The Energy and Resources Institute

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

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Certificate of originality

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Abbreviations

Abbreviation	Full form
APFC	Automatic Power Factor Controller
CMTI	Central Manufacturing Technology Institute
CNC	Computer Numerical Centre
DG	Diesel Generator
DIC	District Industries Centre
EE	Energy Efficient
GDP	Gross Domestic Product
GIDC	Gujarat Industrial Development Corporation
GLIA	G.I.D.C (Lodhika) Industrial Association
hp	Horsepower
HT	Heat Treatment
IIF	Institute of Indian Foundrymen
kWh	kilowatt-hour
MSME	Micro Small and Medium Enterprises
NSIC	National Small Industries Corporation
OEM	Original Equipment Manufacturer
PGVCL	Paschim Gujarat Vij Company Ltd
REA	Rajkot Engineering Association
SPM	Special Purpose Machine
SSEF	The Shakti Sustainable Energy Foundation
VFD	Variable Frequency Drive
VMC	Vertical Machining Center

Acknowledgements

Shakti Sustainable Energy Foundation (SSEF) works to strengthen India's energy security of India by aiding the design and implementation of policies that support renewable energy, energy efficiency, and sustainable transport solutions. TERI places on record its sincere thanks to SSEF for supporting the project on Advancing Energy Efficiency in the Micro, Small and Medium Enterprise (MSME) sector in India.

TERI team is thankful to Rajkot Engineering Association (REA) and Institute of Indian Foundrymen (IIF)—Rajkot Chapter for providing support and information related to auto components manufacturing units in Rajkot cluster. TERI extends its sincere thanks to Mr Paresh Vasani, President, REA, for organizing field visits and interactions with unit members during the preparation of this cluster profile report. TERI would also thank Mr Rajesh Tanti, Chairman, IIF Rajkot Chapter and Mr Naresh Sheth, Secretary, IIF Rajkot Chapter.

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.

Rajkot Auto Components Cluster

Overview of cluster

Rajkot is located south-west of Ahmedabad in the state of Gujarat. Rajkot is a prominent engineering cluster in India. A large number of micro, small and medium enterprises (MSMEs) manufacturing auto components are located in industrial estates around the city. The auto components manufacturing units in Rajkot cater to a number of original equipment's Manufacturers (OEMs) and also service the after-market sales market. The auto components sector is a major contributor to the manufacturing sector. The sector contributes almost 7 percent to India's gross domestic product (GDP) and employs as many as 25 million people. The auto component industry registered a turnover of USD 43.5 billion in the financial year (FY) 2017-2018. The auto components sector has been observing robust growth. India is expected to become the fourth largest automobile producer globally by 2020 after China, USA, and Japan. The auto components industry is expected to become the third largest in the world by 2025.

Location of Rajkot and Ahmedabad (Source: Google Map)

The cluster has about 160 auto components manufacturing units located in industrial estates such as Shapar-Veraval, Samrat Industrial Estate, Aji GIDC, Metoda GIDC, Vavdi manufactures and Mavdi Plot.

Products, market and production capacities

The Rajkot auto components cluster manufacturers a variety of auto components. Steel is one of the major raw materials used by the auto components manufacturing units. Different types of steel like mild steel, carbon steel, alloy steel, stainless steel, super alloys, and special steel are used as forgings, castings, commercial round bars, bright bars, and so on. Common grades of steel used by the units are ASTM/ASME SA 182 F, 304, 304L, 304H, 309H, 310H, 316, 316H, 316L, 316 LN, 317, 317L, 321, 321H, 347, 347H. Most of these raw materials are available locally or sourced from domestic producers like Essar Steel (Hazira, Gujarat) and Jindal Steel and Power (Angul, Odisha).

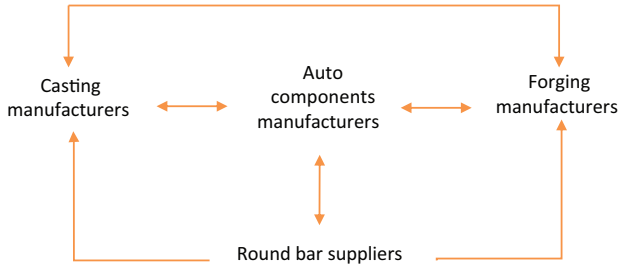
Major products manufactured by auto component units include crankshafts, connecting rods, kingpins, tappet valve, cylinder liners, differential case, gear shifter shaft and rocker arm, cam shaft, valve guides, pistons and rings, etc. There is large variation in production and installed capacity of the industries in the cluster. Production is recorded in million pieces manufactured/annum. It is estimated that the cluster produces about 210 million pieces of auto components per annum.

Based on the quantum of production, the auto components industries in Rajkot may be categorized as follows:

Categorization of auto components manufacturing units in Rajkot cluster

Category	Number of units	Production (million pieces/annum)
Micro	80	18
Small	65	85
Medium	15	107
Total	**160**	**210**

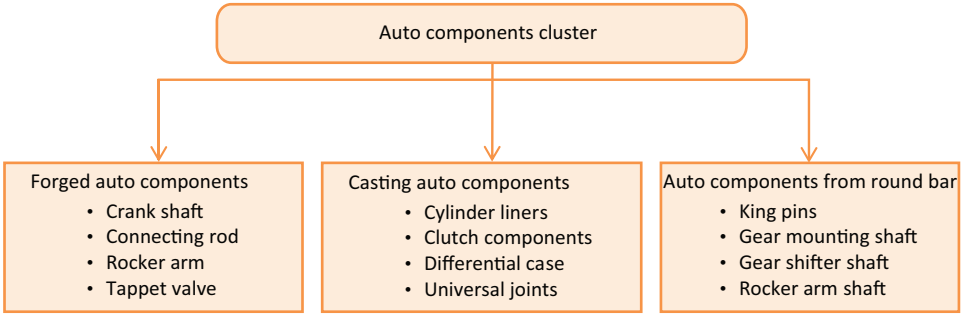
Casting and forged parts required for auto components manufacturing are generally sourced from foundries and forging units. Some auto components are manufactured directly from round bars by machining. The linkage between auto components and associated industries is shown in the figure below:



Linkages between industries

Product categories

Different auto components manufactured in the cluster are illustrated below:



Rocker Arm

Gear shifter shaft

Rocker arm shaft

Connecting rod

Crank shaft

Differential case

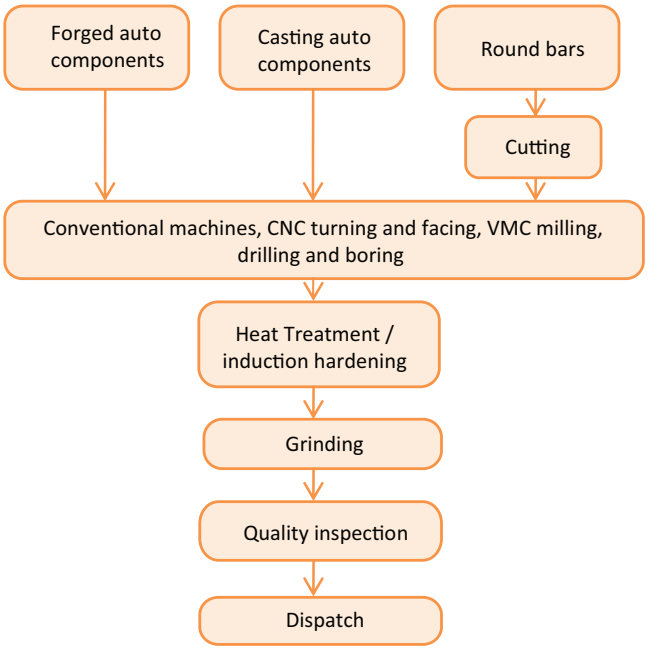
King pins

Production process

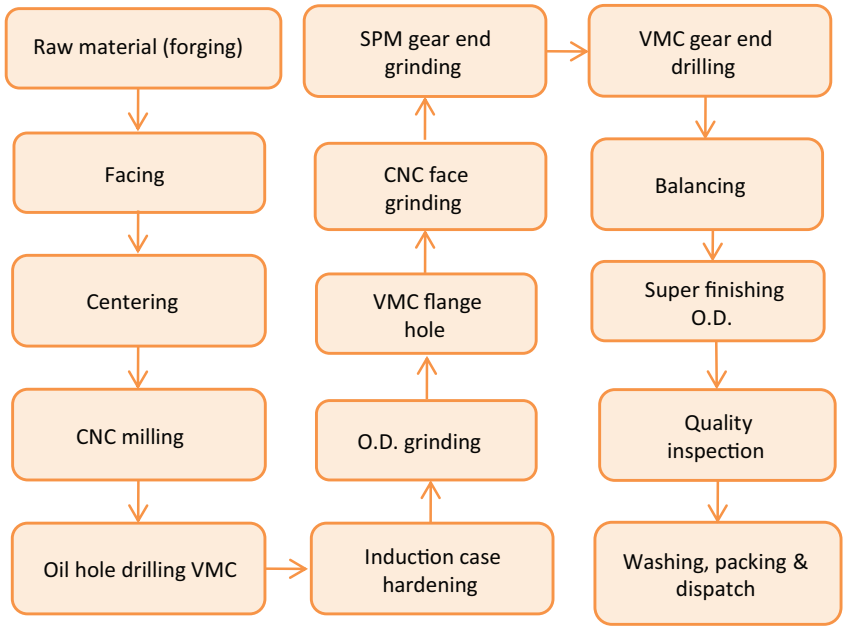
The production process for auto components manufacturing varies for different products. Most auto component manufacturers use basic manufacturing operations like turning, facing, milling, drilling, boring, hardening, grinding, and so on.

The manufacturing operations are carried by a combination of different machines, such as conventional lathe machines, SPMs, CNC machines and VMC machine. Most auto components manufacturers outsource the heat treatment operation. Some of the units carrying out case hardening operation in-house use induction hardening machines. Finally, the inner/outer diameters of the auto components are adjusted by grinding after which they are inspected for quality and dispatch. The generic process flow chart for production of auto components is depicted in the figure.

The production processes for few typical auto components are detailed in following section.



Typical process flow of auto components manufacturing



Process flow for crank shaft manufacturing

Crank shaft manufacturing process

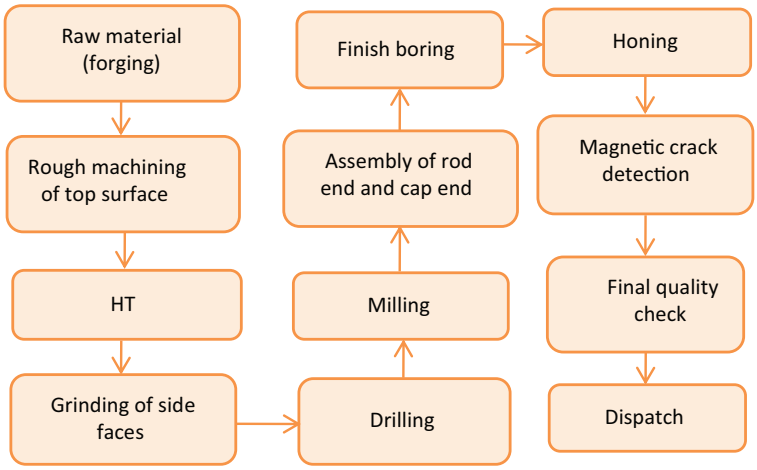
The basic raw material, unfinished forged crank shaft, is procured from forging units. Machining of the forged crank shaft is done as per required specifications. The major machining operations are facing and centering, followed by CNC milling, oil hole drilling by VMC, induction case hardening, of shaft bearing diameter, outer diameter grinding, operations on VMC, CNC face grinding, SPM gear end grinding, and VMC gear end drilling operation. The crankshaft is checked for balancing on a balancing machine and then a final super finishing of outer diameter is undertaken. Finally, all the dimensions of the crankshaft are inspected for quality, and the final product is washed, packed, and dispatched.

Connecting rod manufacturing process

The basic raw material, unfinished forged connecting rod, is procured from forging suppliers. The first operation is deburing of raw material, followed by rough machining of top surface, heat treatment for hardening (usually out sourced), grinding of side faces, drilling and milling on CNC machines, assembly of both rod end and cap end by bolting, finish boring, and honing of internal bore diameter to achieve the finish bore dimensions. The connecting rod is checked for crack detection and dimensions before packing for dispatch.

Technologies employed

The use of outdated and outmoded technologies is a major challenge in the cluster. Presently, most of the units use conventional lathe machines for turning and facing. Some of the major processes/equipments used in auto components manufacturing units are described below.



Process flow for connecting rod manufacturing

Cutting band saw

Band saws are used in most of the units where auto components are manufactured from round/bright bars. As per the job, suitable lengths of bars are adjusted on clamps of the band saw and cut.

Band saw

Machining by conventional lathes, SPMs, CNC and VMC machines

In most of the auto components manufacturing units, conventional lathes are used for rough machining like turning and facing. For specific machining, SPMs are used as per design requirement. For jobs requiring precise accuracy work, CNC turning/ milling and VMC boring/drilling are done. Compared to conventional machining, the productivity is improved using SPMs and CNC/VMC machines as cycle time of each job is reduced considerably.

VMC

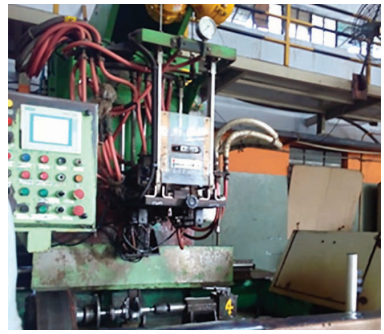
CNC

SPM

Conventional milling machine

Induction hardening machine for case hardening

Auto components like crankshafts require case hardening upto a depth of 2 mm. To achieve this, case hardening of the outer diameter is done by induction hardening machines. About 100 kW/ 150 kW induction hardening machines are used and the cycle time of each job is between 10-15 seconds.

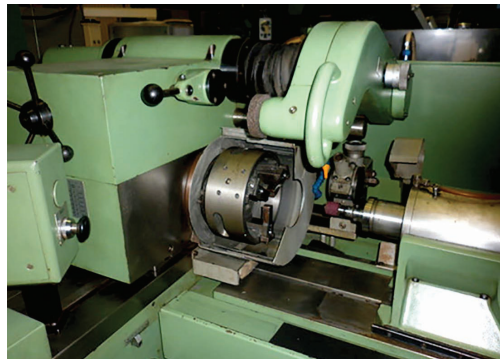


Induction hardening machine

External and internal grinding machines

The grinding operation is primarily a fine finishing/super finishing operation for auto components. Grinding is usually undertaken after case hardening/heat treatment of the auto components. To achieve the required tolerances, external grinding of the outer shaft diameter and internal grinding of the bore diameter is required. After grinding the external and internal bore diameters, of the auto components are measured for quality inspection.

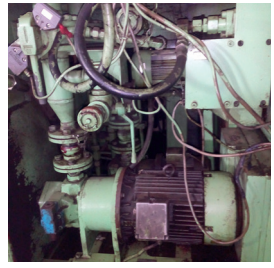
External grinding machine



Internal grinding machine

Hydraulic power packs

Most of the SPMs used in auto components units use hydraulic power packs. These power packs consists of positive displacement pumps mounted on hydraulic oil tank. The hydraulic pumps use induction motors as prime movers.



Hydraulic power pack

Air compressor

Compressed air is used for pneumatic actuation of the different machines like CNC and VMC. Compressed air is also used in these machines for tool gripping and for blowing the burrs/chips. The connected load of the air compressor range from 7.5 kW for a small and micro scale unit to 30 kW for a medium scale unit. The pressure requirement for the majority of applications is below 6.0 kg/cm^2. Both reciprocating as well as screw compressors are used.

Reciprocating compressor

Screw compressor

Energy scenario in the cluster

Electricity is the major source of energy used in auto component manufacturing. Electricity is supplied by Paschim Gujarat Vij Company Ltd (PGVCL). The power outage is very minimal in the cluster, and hence, DG sets are not used. The details of major energy sources and tariffs are given in the following table.

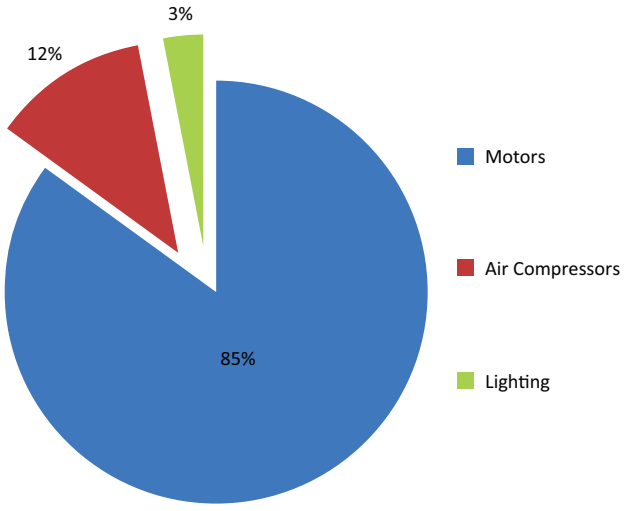
Prices of major energy sources

Source	Remarks	Price
Electricity	High tension connection	₹8.5 per kWh (inclusive of energy, demand charges, other penalty/rebate and electricity duty)
	Low tension connection	₹9.0 per kWh (inclusive of energy, demand charges and electricity duty)

Energy consumption

Unit level consumption

Electricity is used to run all machinery. Most of the units in the cluster have LT connections with exception of a few selected large units. The major energy consuming area in auto components manufacturing is electric motors. Motors are used in various applications in lathes, SPMs, VMCs, CNCs, drilling machines, cranes, etc. Machining and crane motors account for about 85% of the total energy consumption, followed by air compressors (12%) and lighting (3%). The share of energy usage in a typical micro, small and medium auto component manufacturers is given in the figure.



Share of energy use in manufacturing auto components

The specific energy consumption (SEC) of auto component units vary considerably depending on the type of auto components being manufactured. Typical energy consumptions, based on manufacturing capacity, are given in the following table.

Unit level energy consumption of auto components manufacturers

Typical unit level	Electricity	Total energy	Total CO_2 emissions	Annual energy bill (million INR)
	(kWh/yr)	(toe/year)	(tonne CO_2/year)	
Micro	41,000	3.5	34	0.3
Small	181,285	16	149	1.3
Medium	1,003,608	86.3	823	7.1

Cluster level consumption

The overall energy consumption of the cluster is about 2,590 tonnes of oil equivalent (toe) per annum which is equivalent to carbon emissions of 24,682 tonnes of CO_2. The overall energy bill of cluster is Rs 216 million, which translates to about 2% – 3% of cluster turnover. The energy consumption of the cluster is given in the table.

Energy consumption of auto components manufacturing cluster (2017–18)

Energy type	Annual consumption (million kWh)	Equivalent energy (toe)	Equivalent emissions (tonne CO_2)	Annual energy bill (million INR)
Electricity	30.1	2,590	24,682	216
Total		**2,590**	**24,682**	**216**

Potential energy efficient technologies

Some of the major energy efficient (EE) technologies relevant for the auto components manufacturing units in the cluster are discussed below.

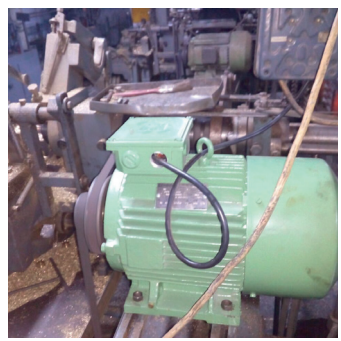
Maintaining unity power factor by using APFC

Most of the units are unable to maintain unity power factor at the plant levels leading to increase in demand and penalty. Use of automatic power factor controller (APFC) will help the plants to maintain unity power factor, save kVA demand, and prevent penalties. Improving power factor also helps to reduce I^2R losses leading to energy savings.

Energy efficient IE3 motors

All the units in the cluster use electrical motors as prime mover. The ratings of these motors vary from 0.5 hp to 5 hp depending on the

Low efficiency motor



IE3 motor

capacity of the machine and operations to be performed. Most of these motors operate on low loads except during cutting or drilling operation. The power factor of these motors are also generally lower than 0.87. Due to presence of significant variable and jerk loading pattern in the machines, failure rates of motors are high. Further, no-load losses of these motors are high, which increase the overall energy consumption. There is a lack of awareness among MSMEs about efficiency standards of motors. Most of the units use low-efficiency standard motors. There is a significant potential to save energy by replacing the low-efficiency motors with energy efficient IE3 motors. Depending on the operating period of the machines, payback period for EE motors can vary between 10 months to 2 years. Typically, energy saving of 3% can be achieved by replacement of old IE2 motor with IE3 motor and savings upto 7% can be achieved on replacement of old IE1 motor with IE3 motor.

Air compressor

Huge energy savings can be realized by improving the energy efficiency of the air compressor and reducing demand of compressed air in the plants. Demand can be reduced by reducing end uses and repairing air leaks. Blow-off nozzles should be upgraded to high-efficiency engineered nozzles or replaced with a low-pressure electric blower. Some of the specific areas of energy savings in compressed air systems are elaborated below:

Retrofitting air compressor with variable frequency drive

During normal operation, most screw air compressors operate on unload position for more than half the time. Installation of variable frequency drive (VFD) to such compressors minimises the unload power consumption resulting in energy savings of 20% to 35%. Investment in a VFD costs between ₹ 0.50–3 lakh depending on size of the air compressor. The investment payback is between 6 months to 1.5 year.

Arresting compressed air leakages

Compressed air is an expensive utility. However, in most plants, air leakages are quite high (more than 20%). The compressed air leakages could be reduced to 5% with better maintenance practices. Significant energy savings with no or minimum investment can be achieved simply by controlling the compressed air leakages.

Reduction in pressure setting of air compressor

Reciprocating compressor (in smaller units)

Screw compressor with VFD (in larger units)

The set pressure of air compressors are often kept much higher than the air pressure requirement at the usage point in the plant, leading to energy wastages. Reducing the generation pressure by 1 bar leads to energy saving of 6%.

Application of VFD in electric motors

Motor-driven systems are often oversized and inefficiently controlled. Energy savings in the range of 8% – 20% can realised by application of VFDs in electric motors.

VFDs installed in motors

Lighting

T-12 tube lights (of 52 W including choke) and halogen lamps (150W and 250W) are generally used by auto component units in the cluster. These inefficient lightings can be replaced with energy efficient LED lighting (LED tube lights of 10W and 20W) and magnetic induction lamps (80 W 100 W and 150 W) which would provide better illumination and energy savings. Since a large number of lamps are used in the units, the existing lighting may be replaced with EE lighting in a phased manner.

T-12 tube light

LED tube light

Magnetic induction lamp

Major cluster actors and cluster development activities

Industry associations

There are several industry associations in the Rajkot auto components manufacturing cluster. The major industry associations that are active in the cluster are briefed below.

Rajkot Engineering Association

Rajkot Engineering Association (REA) is the apex industry association for engineering industry in Rajkot and has membership of over 1,600 industrial units. The association was incorporated in 1963 with the objective of providing support to members on promotion and development of its manufacturing activities.

The Institute of Indian Foundrymen, Rajkot Chapter

The Rajkot Chapter of Institute of Indian Foundrymen (IIF) is one of the most vibrant chapters in the Western Region. The chapter organizes meetings on monthly basis and discusses new initiatives to be taken and other activities such as participation in various exhibitions, technology upgradation, seminars, and workshops. IIF has started implementing lean manufacturing by forming lean cluster of few foundries.

Other associations

The other industry associations in the cluster are GIDC (Lodhika) Industrial Association (GLIA), AJI (GIDC) Industries Association, and Shapar-Veraval Industrial Association.

Government support institutions

The District Industries Centre (DIC), Rajkot, provides several incentives to MSMEs such as capital investment subsidy, interest subsidy, venture capital, quality certification, energy and water audits subsidy, and so on. DIC is also active in creating awareness among industries about trade information, import–export regulations, and financial rules and regulations for MSMEs. The other support institutions in the cluster include Central Manufacturing Technology Institute (CMTI) and National Small Industries Corporation (NSIC).

Cluster development activities

The major cluster development activity on going in the Rajkot auto components manufacturing cluster is the implementation of lean manufacturing competitive scheme of the Ministry of MSME by some of the units.

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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 SSEF

Shakti Sustainable Energy Foundation established in 2009, is a section-25 not-for-profit company that works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage renewable energy, energy efficiency and sustainable transport solutions. Based on both energy savings and carbon mitigation potential, Shakti focuses on four broad sectors: Power, Transport, Energy Efficiency and Climate Policy. Shakti act as a systems integrator, bringing together key stakeholders including government, civil society and business in strategic ways, to enable clean energy policies in these sectors.

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 of SAMEEEKSHA platform are (1) Swiss Agency for Development and Cooperation (2) Bureau of Energy Efficiency (3) Ministry of MSME, Government of India (4) Shakti Sustainable Energy Foundation, and (5) The Energy and Resources Institute.

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

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