

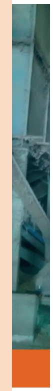

ENERGY PROFILE

RED HILLS RICE MILL CLUSTER

teri
The Energy and Resources Institute

SHAKTI
SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA



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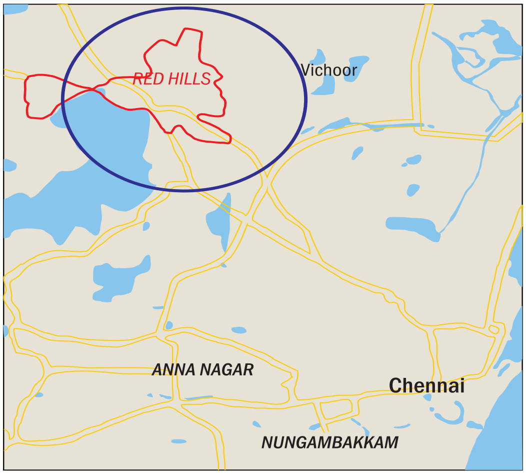
TERI team is indebted to Red Hills Rice Millers, Paddy and Rice Merchants' Association, for providing support and information related to rice mills in Red Hills cluster. TERI extends its sincere thanks to Mr D Tulasingham (President, Tamil Nadu Rice Mill Federation), Mr N M Duraisamy (President, Rice Merchants' Association), Mr G Gobi (Secretary, Rice Merchants' Association), and Mr P Murali (Proprietor, Murali Modern Rice Mill) for preparation of this cluster profile report. TERI extends special thanks to Mr Jayapal (Vice-President, Rice Merchants' Association) for close coordination with the team, organizing visits to industries, and providing data and inputs during field visits.

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.

Red Hills Rice Mill Cluster

Overview of cluster

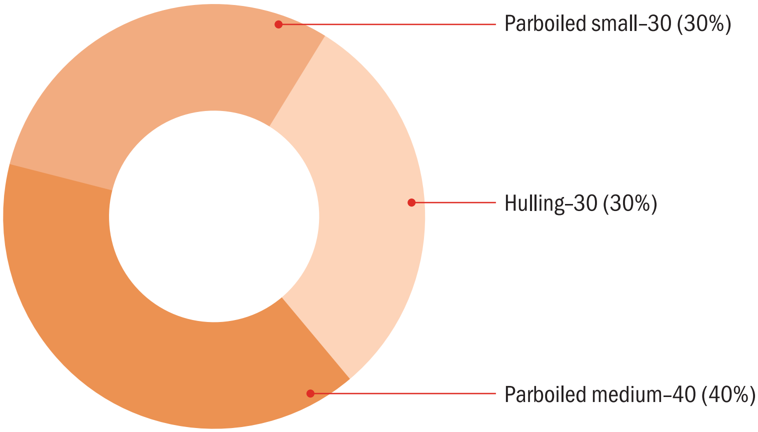
The Red Hills cluster is located north-west of Chennai in Thiruvallur district, Tamil Nadu. Red Hills is known for paddy-related business and generates significant employment opportunities. The cluster has close to 200 rice mills. Due to market-related issues, about 100 rice mills have closed down in the recent past. With urbanization, the industrial area of Red Hills has been surrounded by more residential area at present. This has also led to certain environmental issues related to particulate emissions from boilers used in rice mills and the industry has installed different pollution control systems to comply environmental standards.



Red Hills Rice Mill Cluster

Product, market and production capacities

The major raw material used in rice mills in Red Hills rice mill cluster is paddy mainly procured from local market. The cluster processes about 429,000 tonnes of paddy producing about 279,000 tonnes of rice comprising both par-boiled rice and raw rice. The production of parboiled rice is about 69% from the cluster and rest 31% of raw rice is produced from hulling units. These hulling units process paddy to supply the state government. The average yield ratio of the local paddy is about 65% which however varies based on the quality of grains and contaminants present in raw paddy.



Distribution of rice mills

There are about 100 rice mills operating in Red Hills cluster. Majority of these mills falls under Micro, Small, and Medium Enterprises (MSME) as defined by the Ministry of MSME. About 70 rice mills are engaged in production of par boiled rice. About 30 hulling units (i.e., units engaged only in removal of husk and polishing activities) produce only raw rice that provides supply to government programmes. It was informed by cluster industry association that around 100 rice mills of different production capacity have closed down in the recent past. Apart from rice, the important by-products from rice mills include husk (22%) and bran (8%). Husk in par-boiled rice mills is used in-house as boiler fuel and bran is sold out for further processing.

The installed capacity of rice mills in the cluster is about 3 tonnes per hour (tph) of paddy processing. The major difference is that modern rice mills operate round the clock for about 25 days per month (300 days per year) and other parboiled units for about 12 hours per day (180 days). The hulling units operate round the clock for about three months and are engaged in production of only raw rice.

Categorization of rice mills and estimated production

Category	Installed capacity (tph)	Number of units[1]	Operating hours per year	Paddy processed	
				Tonnes/year	Share (%)
Parboiled rice mill—Medium	4	40	7,200	6,000	49
Parboiled rice mill—Small	3	30	2,160	1,800	15
Hulling unit2	3	30	2,160	4,5002	37
	Total	**100**		**12,300**	

[1] About 100 mills have been closed in recent past as indicated by local industry association

[2] Raw rice only

Production process

The raw material—paddy—undergoes various processes before reaching rice yard for bagging. The complete paddy processing to produce parboiled rice could be grouped into following major steps:

- Paddy preparation: Various contaminants namely rice straw, dust, stone, sand, and seedless paddy is removed from paddy using air blower and series of vibrating screen with different size cut off. Cleaning of raw paddy equivalent to one batch capacity takes around two hours. Generally, cleaned paddy after preparation is stored in vertical silos prior to onward processing of soaking and steaming.

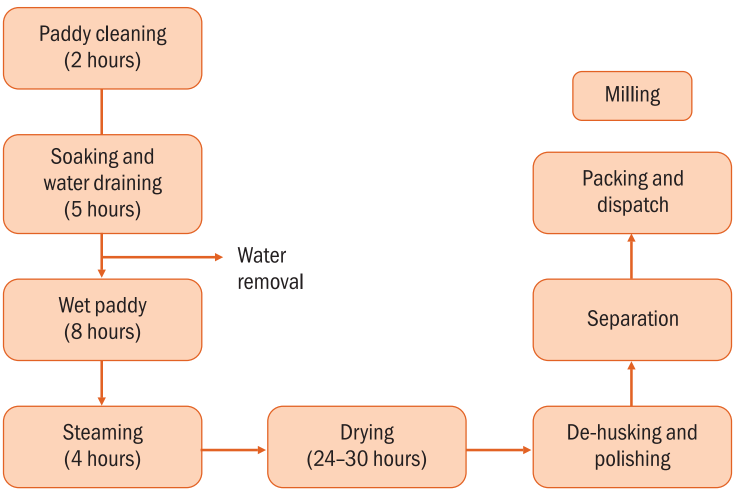
- Soaking: Cleaned paddy is transferred with the help of conveyor belt from storage silos to mild steel soaking pit. Normally, there are two soaking pit, each one having holding capacity of about 8 tonnes of cleaned paddy. Paddy is soaked in raw water at room temperature for about 4 hours. The water is drained out under gravity after soaking is completed. Though most of the units have effluent treatment plants (ETP), normally the drained water is directly dispatched to sewage without any treatment. The process of draining water takes about one hour for one complete batch of soaked paddy. The soaked paddy is left as it is in soaking bin for about eight hours after draining of water. The entire soaking cycle takes about 13 to 14 hours for one batch.

- Steaming: The soaked paddy is heated using steam from in-house boiler in parboil rice manufacturing process. In case of raw rice, steaming operation is not required. During steaming stage, two steaming vessels are operated alternately for steaming 600–700 kg of soaked paddy in a batch for about 10 minutes until steam starts coming out from the vessel indicating it has reached the top surface of the steaming bowl and steaming is completed. Soaked paddy from soaking bin is transferred to steaming vessel by gravity, and the entire batch of soaked paddy from two bins takes around four hours for complete steaming.

- Drying: Steamed paddy is dried either on open concrete floor in sun light or by indirect heat transfer in hot air dryer system. In case of hot air dryer, hot air is generated in a steam-based heat exchanger with automatic temperature controller to maintain hot air temperature as per set value. Steamed paddy with around 32% of moisture is first transferred to port dryer where moisture is reduced to 22%. Partially dried paddy is then transferred to second dryer for final moisture reduction to the level of 13–14%. The complete drying cycle takes about 30 hours. Dried paddy is stored in silos before being transferred to milling section.

- Milling: Rice is produced along with by-products such as husk and bran. Husk is the primary by-product in rice milling, which is around 22% in Red Hills cluster and a major quantity of husk is used as fuel in boiler. Another, high premium by-product, bran has about 60% of nutrients in rice kernel, is sold out. Rice bran accounts for about 8% of total weight of paddy. In the milling section, dried paddy passes through screening, de-husking, separation, cone polishing, separation and grading, silky polishing, etc., depending upon the existing facilities in the rice milling plant before its transferred to bagging yard either for manual or automatic bagging of final polished rice. Milling section consists of various motive loads connected to operate either single drive or multiple drive with common shaft using different pulley and belt transmission. The electrical load in milling section varies in the range of 3–4 kWh per bag of raw paddy for 75 kg. Generally, electrical power consumption in rice milling process varies in the range of 6.5–7 kWh per 75 kg of raw paddy.

The hulling units do not require both raw water soaking and steaming in their process. The paddy, after preparation, is sent for direct milling.



Parboiled rice milling process

Technologies employed

The processing of paddy into parboiled rice involves the following equipment for processing of paddy:

Boiler

Boiler is used for generation of steam required for parboiling. Steam is generated at a pressure of about 10 kg/cm^2 (g). Condensate steam from dryer section is generally recovered and sent back to boiler as feed water, thereby utilizing sensible heat in condensed water. Husk firing leads to significant generation of suspended particulates, and hence, pollution control systems such as cyclones are used for trapping suspended particulates. Few units have installed large chambers through which flue gas is passed. While particulates are trapped and collected from bottom of chamber, the water kept at tank above the chamber gets preheated in the process. A majority of the boilers do not have any waste heat recovery system for preheating boiler feedwater. A forced draught fan is used both for combustion air as well as husk feeding simultaneously. Apart from pressure gauge, the rice mills do not use any instrumentation to monitor the operating parameters of steam generating boiler and distribution system. A very few units also started using boilers of about 700 kg/hr capacity used only for steaming. Drying of steamed paddy is done separately using hot air generator.


Rice husk-fired boiler


Pollution control cum water preheating system


Baby boiler (used only for paddy steaming)

Steaming bowl

Upon completion of raw water quenching at ambient temperatures and after a gap of about 8 to 10 hours, paddy is loaded into steaming bowls in batches through gravity. Steam is directly injected at bottom of bowls by opening the valve till it starts coming out from top. The entire steaming cycle for one full batch of soaked paddy after quenching is completed in about four hours. The duration of steam is based on type of paddy being used. The condensed steam is drained out.


Steaming bowl

Dryer

In conventional rice mills, paddy is sent for sun drying, which is time and labour intensive. Also, sun drying is not a suitable option during rainy season. However, in modern rice mills, the steamed paddy is dried separately in a dryer section, which helps in overcoming the problems faced by traditional rice mills and supports continuous operation.

The steamed paddy is moved to the top of dryer channel arrangement with the help of a bucket elevator system for repeated circulation in a counter flow arrangement to ensure complete drying. The bucket elevators are made of mild steel in old mills and the potential alternative is plastic bucket elevator, which would reduce the energy consumption to a significant extent. The dryer comprises an indirect heat exchanger in which steam at 10 kg/cm^2 (g) pressure (at about 180°C) is used to exchange heat with ambient air to generate hot air that in turn removes moisture from steamed paddy. Steam traps are used to remove condensate formed in steam lines.


Steam dryer

Milling section

The dried paddy is shifted to milling section and stored in silos before converting the paddy into rice. The milling section comprises the following areas:

» Destoning: In this pre-cleaning area, the carry-over along with paddy, such as stones, are removed in a vibrating platform having sieves.

» De-husking: Husk is removed from paddy producing brown rice. Husk is used as fuel in boiler for steam generation.

» Whitening and polishing: De-husking produces brown rice, which comprises a brown layer called bran. The bran is removed from the brown rice in polishing area to produce white rice. Bran is a by-product rich in protein content and can be used for producing rice bran oil and poultry products.

Some of the utilities used in rice mills include pumps for water pumping, material conveying system, and compressors for meeting compressed air requirement.

Energy scenario in the cluster

The rice mills mainly use husk produced during processing of paddy for meeting thermal loads. Few units use wood as well along with rice husk. Electricity is sourced from grid for operating electrical loads in the mill. Grid electricity is supplied by Tamil Nadu Generation and Distribution Corporation (TANGEDCO). The details of major energy sources and tariffs are shown in the table below.

Prices of major energy sources

Source	Remarks	Price
Electricity	High Tension connection (HT)	₹8.00 per kWh (inclusive of energy, demand charges, other penalty/rebate and electricity duty)
	Low Tension connection (LT)	₹5.00 per kWh (inclusive of energy, demand charges, and electricity duty)
Rice husk	By-product	Nil (Selling price of excess husk: ₹ 2,000 per tonne)
Wood	Local market	₹4,000 per tonne

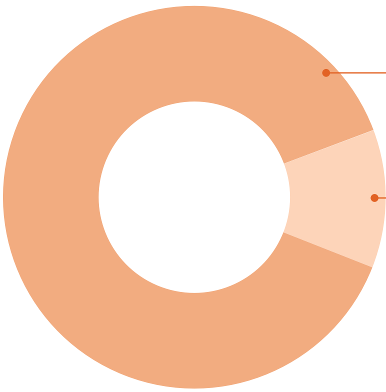
Energy consumption

The major energy forms used by parboiled rice mills in Red Hills cluster include husk and electricity. Few units also use wood in order to address local environmental concerns. Electricity from grid is used for different motive loads in the processing sections, water pumping, and blowers. Thermal energy in the form of steam is used for soaking of paddy and subsequent drying. Husk, a by-product in paddy processing, is used as the fuel in boiler for generating steam. About 22% of husk is produced while processing paddy. Almost 85% of husk is used in-house for steam generation and the balance 15% is sold out. Generally, steam at 10 kg/cm^2 pressure is used in parboiling section. The average capacity of boilers used in rice mills is about 2.5 tph. Steam is used mainly for following purposes in a rice mill:

- Soaking using steam by direct injection in steaming bowls
- Dryers for generation of hot air in heat exchangers for drying of wet paddy after completion of steaming process

Unit level consumption

The unit-level energy consumption in a rice mill includes rice husk and electricity. Some of the units use wood along with husk to reduce level of particulate emissions from boilers. Internally generated rice husk/wood constitutes about 88 % of total energy requirement in a parboiled unit; about only 12% of energy is met through electricity. However, in a hulling unit, in which only removal of husk and polishing activities are carried out, 100% of energy is accounted by electricity.



Energy share in a parboiled Rice Mill

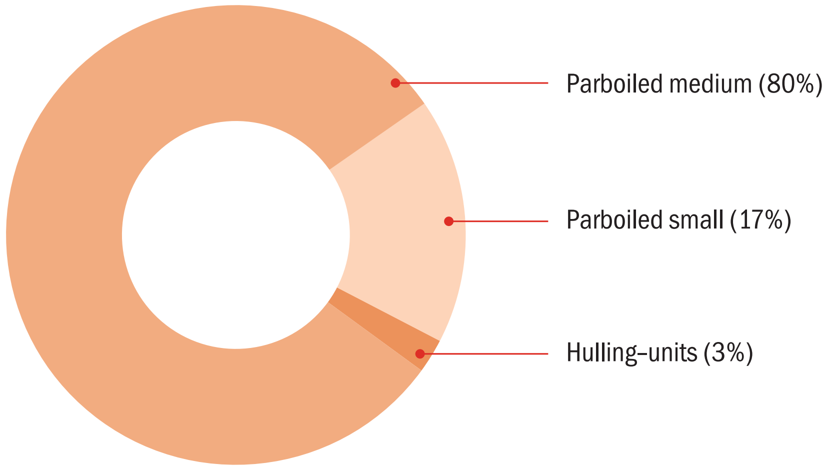
In a parboiled unit, paddy steaming and dryer sections account for major thermal energy consumption. The average 'specific energy consumption' (SEC) of parboiled units in the cluster is 0.061–0.064 per tonnes the SEC of a hulling unit is estimated to be 40 kWh per tonne of rice processing production (equivalent to 0.003 toe per tonne). The typical energy consumption of different capacities of rice mills are shown in the table below.

Typical energy consumption of typical rice mills

Type of unit	Husk/wood (tpy)	Electricity (kWh/year)	Total energy (toe/year)	Total CO_2 emissions (t CO_2/year)	Annual energy bill (million INR)
Parboiled—Medium	1,122	545,460	384	53	5.2
Parboiled—Small	101	109,092	110	11	1.3
Hulling unit	–	180,000	15	18	1.0

Cluster-level consumption

The overall energy consumption of the cluster is estimated to be 19,118 toe. The estimated 'greenhouse gas' (GHG) emissions from rice mills at cluster level is 2,988 tonnes of CO_2. The overall energy bill of cluster is estimated to be ₹260 million. Husk is a by-product from paddy processing and hence selling price of husk from rice mills is considered for estimating energy bill. Few units also use wood partially along with rice husk.



Distribution of Rice Mill

Energy consumption of the Red Hills rice mill cluster (2014–15)

Energy type	Annual consumption	Equivalent energy (toe)	Equivalent CO_2 emissions (t CO_2)	Annual energy bill (million INR)
Husk/wood	54,990 tonne	16,497	–	110
Electricity	30.5 million kWh	2,621	2,988	168
	Total	**19,118**	**2,988**	**278**

Potential energy efficient technologies

Rice mills mainly engaged in production of parboiled rice offer significant scope for energy efficiency improvements both in thermal and electrical areas. These options are discussed below.

Economizer and condensate recovery system for boilers

A majority of rice mills in Red Mills cluster do not recover condensate at higher temperatures or have locally designed feedwater heating system (e.g., dust collecting chamber with water tank at top) in boilers. Although condensate is recovered in some of the units mainly from dryer section, the sensible heat is lost during recovery. For example, an economizer put in a boiler will utilize the waste heat in flue gases and use it for preheating of feedwater. As a thumb rule, about 6°C preheating of feed water would result in an energy saving of 1%. Considering the feedwater to boiler is preheated up to 90°C, through preheating in economizer and improving condensate recovery, it would lead to about 10% saving in fuel. About 75 rice mills belonging to small and medium type can benefit by adopting economizer and condensate recovery in boiler. The envisaged energy saving is 5,500 tonnes per year of husk (equivalent to 1,650 toe). The equivalent monetary value of husk saved is ₹11 million.

Cost-benefit analysis of economizer and condensate recovery system

Particular	Unit	Value
Present husk consumption in boiler	tpy	1,120
Husk saving	tpy	112
Monetary saving	₹(lakh)/year	2.2
Investment	₹(lakh)	1.0
Simple payback period	Month	5

Hot air generator for paddy drying

Rice mills use steam-based dryer system for drying of steamed paddy before milling process. Dryers are generally operated continuously and estimates have shown that about 80% of steam is used in dryers. Use of steam for generation of hot air in heat exchangers is an inefficient process. Hot air can be directly generated in husk fired hot air generators (HAG) with heat exchangers that would help in improving overall efficiency of dryer system. It is envisaged that 28–30% of husk can be saved with HAG system. By eliminating use of steam for paddy drying, steam load of the plant will come down substantially. The plant would require boiler size of up to 1 tph to meet steam demands for parboiling purpose only.

Cost-benefit analysis for hot air generator

Particular	Unit	Medium mill
Present husk consumption in boiler	tpy	1,120
Husk consumption for drying	tpy	900
Husk saving with hot air generator	%	28
	tpy	250
Monetary saving	₹(lakh)/year	5.0
Investment	₹(lakh)	5.5
Simple payback period	Year	~1

Optimization of air supply and reduction of unburnts

A majority of boilers in Red Hills rice mills are not equipped with control system to regulate combustion air supply with respect to husk feed rates. It was observed that the level of unburnts in bottom ash was quite high. It was further reported by rice mill units that black smoke was observed in flue gases. These indicate that optimum level of excess air is not maintained or/and proper mixing of combustion air with husk is not taking place. It is suggested that rice mills in the cluster install auto/semi-auto control systems for optimizing air supply with respect to husk feed in boiler. By optimization and ensuring complete combustion, formation of unburnts can be reduced to a large extent. Further, the units must also undertake periodical monitoring/testing of flue gases to check the level of excess air supplied to boiler.

Cost-benefit analysis for combustion air optimization

Particular	Unit	Value
Present husk consumption in boiler	tpy	1,120
Husk saving	tpy	60
Monetary saving	₹(lakh)/year	2.2
Investment	₹(lakh)	0.7
Simple payback period	month	7

Biomass gasifiers for power generation

The excess rice husk after steam generation in boilers as well that saved with other energy efficiency measures can further be used in a biomass gasifier for power generation. The husk is used to generate producer gas, which is rich in carbon monoxide (CO) and hydrogen (H_2). This gas can be effectively utilized in internal combustion engines to replace diesel completely or partially, which is used for power generation. The option of power generation would help in utilizing husk effectively instead of selling the same at lower costs. In a medium size rice mill, close to 330 tonne per year of husk may be available that includes savings with adoption of energy efficiency measures. The estimated capacity of biomass gasifier is 30 kW.

Cost-benefit analysis of biomass gasifier

Particular	Unit	Medium mill
Husk available for power generation	tpy	330
Proposed capacity of gasifier	kW	30
Estimated power generation	kWh/day	500
Cost saving with power generation	₹/day	2,770
Cost for diesel	₹/day	1,110
Monetary saving	₹(lakh)/year	499,000
Investment	₹(lakh)	390,000
Simple payback period	Month	10

Solar water heater

Both small and medium rice mills in the cluster provide significant scope for adoption of solar water heaters that can be used for generation of hot water at about 60–70°C. Hot water is required in soaking of paddy in steam bowls. Apart from soaking process, the hot water can also be used as boiler feedwater that would help in fuel saving. The estimated energy saving potential is 700 tonnes per year of husk (equivalent to 220 toe). The equivalent monetary saving is ₹1.5 million.

Others

A significant reduction in energy losses is possible in areas such as steam distribution including insulation and steam traps, steaming bowl, and paddy dryer. Further, it may be noted that the level of reuse of water from different processes in rice mills is very low, which has a potential for improvement. On electrical side, pumping of (cold and hot) water and drives constitute important energy consuming areas that have potential for energy efficiency improvements. Further, monitoring and control of operating parameters in different process sections, for example, temperature monitoring in hot water preparation area would help in operating the mill close to design level.

Major cluster actors and cluster development activities

Major stakeholders

The major stakeholder of the rice mills is Red Hills Rice Millers, Paddy and Rice Merchants' Association. The industry associations are generally engaged with the government on policy- and regulatory-related issues. They have very little experience and activities related to technology issues in the cluster; however, the associations have shown keen interest towards technology upgradation of rice mills including 'renewable energy' applications, such as solar water heater and biomass gasifier system. Other important stakeholders in rice mills are MSME-Development Institute (DI), District Industries Centre (DIC) and Public Distribution System of the state government.

Cluster development activities

There are no major cluster development activities at cluster level. With the cluster exhibiting significant potential for energy saving, there exists opportunities for cluster level programmes focusing on energy efficiency.

Abbreviations

Abbreviation	Full form
DI	Development Institute
DIC	District Industries Centre
ETP	Effluent Treatment Plant
HAG	Hot Air Generator
HT	High Tension
kWh	kilowatt-hour
Lit	Litre
LT	Low Tension
MSME	Micro Small and Medium Enterprises
SEC	Specific Energy Consumption
t	tonne
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
toe	tonnes of oil equivalent
tph	tonnes per hour
tpy	tonnes per year

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 (SSEF), established in 2009, is a section-25 not-for-profit company, which aids design and implementation of clean energy policies that support promotion of air quality, energy efficiency, energy access, renewable energy and sustainable transportation solutions. The energy choices that India makes in the coming years will be of profound importance. Meaningful policy action on India's energy challenges will strengthen national security, stimulate economic and social development, and keep the environment clean.

Apart from this, SSEF actively partners with industry and key industry associations on subsector specific interventions towards energy conservation and improvements in industrial energy efficiency.

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: (i) Swiss Agency for Development and Cooperation: (ii) Bureau of Energy Efficiency: (iii) Ministry of MSME, Government of India and: (iv) 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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