

ENERGY PROFILE

YAMUNA NAGAR PLYWOOD INDUSTRY CLUSTER

The Energy and Resources Institute

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA



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Yamuna Nagar Plywood Industry Cluster

Overview of cluster

Yamunanagar is one of the important cities in Haryana located about 123 km from Delhi and about 130 km from Chandigarh. The city has emerged as an important industrial destination in Haryana despite its isolated location from the rest of the state. Different types of industries, such as sugar machinery, paper machinery, and equipment for petrochemical plants, are located in Yamunanagar. In addition, the city has provided space for a number of metal and utensil industries. One of India's largest railway carriage and wagon repair workshops are also located in Yamuna Nagar. It also has a large number of plywood industries. Apart from different small and medium industries, a number of large industries like Shri Gopal Paper Mills and Saraswati Sugar Mills (the biggest in Asia) are also located in Yamuna Nagar.

Yamunanagar plywood cluster
Source: Googlemaps

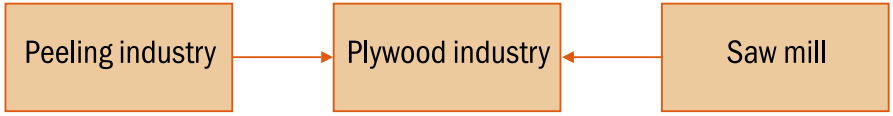
Product, market, and production capacities

The large number of plywood industries in Yamunanagar may be attributed to ease of accessibility of primary raw materials i.e. poplar tree used in making plywood. The cluster produces a variety of plywood products that include block board, decorative plywood, chequered plywood, flush door, mould door, marine plywood, flexi ply, film face ply, densified film face ply, laminated veneered lumber, etc. Plywood produced in Yamunanagar is used extensively in different parts of the country. Interestingly, about 50% of plywood used in India is produced in Yamunanagar. The cluster comprises the plywood industry, peeling industry, and saw mills. The categorization, number of units and average production capacities of units in plywood cluster is shown in the following table.

Categorization of units and estimated production

Type of unit	Production capacity	Number of units
Plywood industry	10,000 square feet per day	300
Peeling industry	3,500 square feet per day	356
Saw mill	1.5 tonne per day	40
Total		**696**

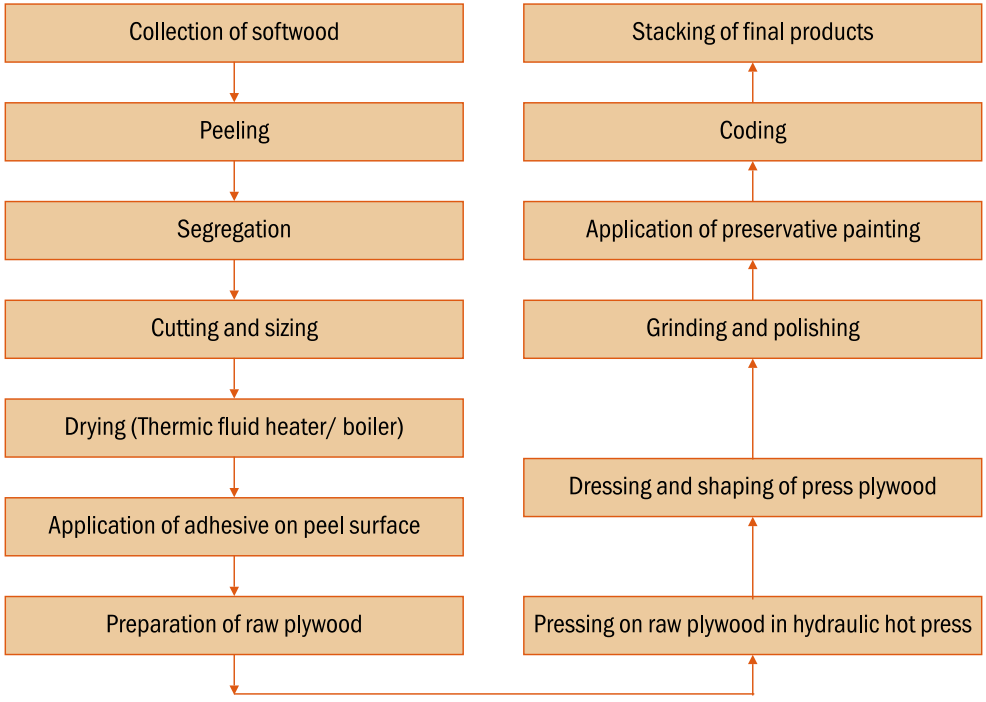
The total production of plywood products in the cluster is estimated to be 3 million ft^2 per day. The "support industries" of plywood industries which do not have integrated facilities are the following. The peeling industries supply wood sheets for plywood manufacturing produce about 1.25 million ft^2 per day. The saw mills are involved in cutting wood to produce planks which are generally supplied to plywood industries wherein the facility is unavailable. The estimated production of planks in the saw mills is about 60 tonne per day (tpd).



Linkages in plywood manufacturing

Production process

The manufacturing of plywood includes a number of activities such as preparatory work on log, peeling, reeling & clipping, drying, gluing, assembly, pressing, trimming, sanding, and finishing. A simplified process flow diagram of an integrated plywood unit is shown below. The different steps followed in plywood manufacturing are explained further ahead.



Process flow diagram of plywood manufacturing

Peeling and segregation

The raw material is wood, generally poplar tree in Yamuna Nagar. In storage yard, logs are sorted and stored according to type, size, and end use application, etc. Each mill stockpiles sufficient quantities of raw material to ensure continuous operation of the saw mill. Transportation and handling of logs are generally done using overhead cranes within the units. Peeling or debarking of logs is done using mechanical debarkers, generally at the mill site. The purpose of peeling is to remove the outer bark of the tree, without substantially damaging the available wood. Further, debarking helps in safeguarding of saws and other equipment from undue wear and damages.

Cutting, sizing, sorting, and grading

After peeling, wood logs are cut to appropriate lengths as per requirement of the unit. The logs are cut to the longest permissible straight length, using a cut-off saw to ensure optimum production and minimize wastage. The pattern of cut is generally decided based on dimensions and conditions of the log as well as market requirements. Band saw or circular saw is used for sawing of log. A second saw is also mounted vertically above this for sawing large diameter logs. A log carriage conveys the log through the head saw on which the log is clamped and turned to achieve the best sawing pattern.

In resaw, further breakdown of slabs, flitches, and cants takes place. Thick slabs are sawn into planks, while flitches and cants are sawn into planks and boards. The rough round edges of pieces coming out are removed using a circular saw or chipper edger to produce standardized widths as per requirements. After this, the lumber is cut to standardized lengths, edges squared, and defects removed in trimming saws. The sawn and trimmed timber is sorted and graded based on various parameters, such as thickness, width, length, quality, grade, type of wood, market requirements, etc. This is either done manually or by using mechanized sorters. Grading is an important activity that would ensure segregation of lumber according to quality, grain direction, presence of defects, etc.

Drying

Drying involves removal of moisture from timber and provides dimensional stability, strength, and colour improvements. Mechanical drying enables faster drying operation and hence, is the most preferred option in industries. Generally, the cluster uses mainly boiler while some units use thermic fluid heater (TFH) for drying. In the boiler, steam is generated which is further used for drying. In TFH, thermic fluid is circulated to enable heat transfer. In the plywood manufacturing process, drying is carried out for two intermediate products separately. The first one involves drying of sized wood planks which is done in 'seasoning chambers' which is an extensive and time-consuming process.

The wood planks have moisture levels of about 50% and are reduced down to 3 to 5% in the seasoning chamber. In order to reduce moisture in the seasoning chamber, continuous heating takes place for about 5 to 6 days, till the temperature of the seasoning chamber reaches 1250C. The second type of drying is carried out for the peeled wood sheets. The sized sheets are rolled through the drying chamber; the rolling timing is arranged in such a way that wood sheets are kept inside the chamber for 15 minutes. The initial moisture of about 50% is reduced to 3 to 5% in these rolling chambers.

Application of adhesive

Adhesive is applied on peeled surfaces and plies are kept for preparation of raw plywood. The purpose of application of adhesive is to ensure that the plies are bound together to strengthen the plywood and stick to peeled wood surfaces.

Hot pressing of raw plywood

The raw plywood is sent to a hot press in which it is subjected to heat and pressure. The main objectives of hot pressing include—(1) pressing glue into a thin layer, and (2) activating thermosetting resins. A temperature of about 107–165 °C is maintained in the hot press. The press times generally range from 2 to 7 minutes. The time and temperature varies and is dependent on the type of wood used, resin/glue, and press design.

Dressing, shaping, and sanding

The hot pressed plywood is sent to the shaping section so as to provide suitable shapes as required by the customer. The deformed edges are sized in order to give the plywood a definite rectangular structure. Once the plywood is dressed and shaped properly, the sanding of the top and bottom surface is carried out which results in a better finish of the product.

Grinding, polishing, and preservative coating

After polishing, the plywood is sent to the grinding and polishing section to provide better finishing. In addition, a preservative coating is also applied to strengthen the life of plywood.

Coding and stacking of final products

The final finished plywood is stacked and coded and the final products are stacked for despatch.

Technologies employed

Some of the major equipment used in plywood cluster are described as follows:

Steam boilers

Boilers are used in plywood units to supply steam for drying. The boilers are manually fired and generally do not have any control systems. The most common capacity of the boiler in the cluster is 3 tonne per hour (tph). The fuel for boilers is generally not procured from outside; rather it is available at the unit only. The boilers use only the wood wastes generated in different processes in plywood manufacturing. The boilers are pressure controlled for their operation. The steam pressure generated in the boiler is 100–130 psi

Wood waste fired boiler

with a cut-off done at 130 psi. The approximate temperature of steam produced in different mills is about 130OC. The present efficiency of the boilers is generally low at about 55%. A majority of the boilers do not have economisers (feedwater preheaters) or other waste heat recovery (WHR) systems to recover heat from flue gases and enhance their thermal efficiency levels. The sensible heat in condensate from process areas is not generally recovered.

Thermic fluid heaters

Some of the plywood units use thermic fluid heaters (TFH) in place of boilers for drying purposes. TFHs are closed loop systems wherein heat from combustion of fuel is transferred to thermic fluids that have the capacity to carry a large quantum of heat. The hot thermic fluid exchanges heat in dryers, thereby losing heat and flows back to the heating section. They are provided with constant speed thermic fluid circulation pump. Thermic fluid heaters generally have a manual fuel charging system and use wood wastes generated in process sections as fuel.

Dryers

The plywood units in the cluster use two different types of drying system. Seasonal chambers are used for drying of wood planks whereas impregnators or stenters have been installed for drying wood sheets in the units.

Seasoning chambers

Seasoning chambers are used for drying of sized wood planks. Steam from boiler is supplied as heat source which transfers heat through radiators. Each seasoning chamber is provided with 3 to 5 circulating fans (about 3–5 HP motors) as per chamber size for circulation of hot air. Drying of wood planks in seasoning chambers takes about 5–7 days for reducing moisture from 50% level to 3%.

Impregnator (Stenters)

Impregnators or stenters are straight chambers of about 25 to 30 feet in length. Steam is supplied to radiators installed on both the sides of the chambers. Circulation fans have been provided for circulating hot air inside chambers. The sized sheets are rolled into hot chambers within an initial moisture level of about 50% which then reduces up to 3 to 5%. Each sheet passes through the hot chamber for about 15 minutes. The drying periods are adjusted (increased or decreased) by adjusting the speed (rpm) of drives through gears.

Hot press

In hydraulic or hot presses, a stack of movable plates are provided with hydraulic lifts. High pressure steam is passed between plates for maintaining the required temperature. The stack of wood sheet and sandwiched wood planks are placed over these hot plates which are then pressed with hydraulic lifts, while high pressure steam is passed between plates simultaneously for raising temperature of the product to the desired level. This condition is maintained for about 8–15 minutes as per size of the product. The adhesive applied in between the wood sheets and planks is strongly bound with each other and forms plywood of desired strength.

Hot press

Energy scenario in the cluster

Sawdust and electricity are the main energy forms used in the cluster. Sawdust contributes for major energy source used to meet thermal energy requirements of plywood industries. Sawdust is a by-product of the plywood manufacturing process in the unit. Electricity is mainly sourced from the grid supplied by Uttar Haryana Bijli Vitran Nigam (UHBVN) Limited. The prices of major energy sources are shown in the table below.

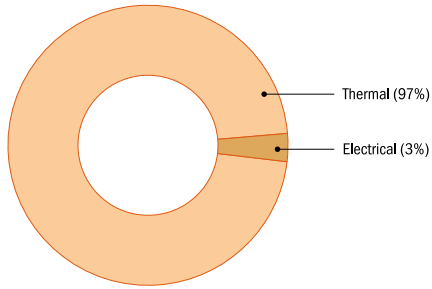
Price of major energy sources

Source	Remarks	Price
Electricity	HT Industry (above 50 kW)	Demand Charges: ₹170 per kVA Energy Charges: @11 kV—₹6.15 per kVAh @33 kV—₹6.05 per kVAh @66/132 kV—5.95 per kVAh
	LT Industry - (upto 50 kW)	Demand Charges: ₹185 per kW Energy Charges: @ upto 10 kW—₹5.95 per kVAh @10–20 kW—₹6.25 per kVAh @20–50 kW—6.00 per kVAh
Sawdust	By-product in plywood industries	₹2,000 considering selling price

Energy consumption

Unit level consumption

Plywood units use sawdust which is a by-product of the plywood manufacturing process for generation of steam in boilers. Electricity is used for various operations like peeling, reeling, clipping, trimming, etc. About 97% of the energy used in plywood manufacturing is thermal supplied by sawdust as shown in the figure. Peeling units and saw mill units in the cluster use only electricity for their operations.



Share of unit level energy consumption

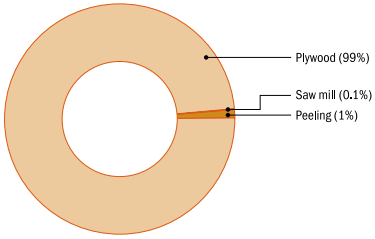
Typical energy consumption of industries in plywood cluster

Type of unit	Electricity (kWh/yr)	Sawdust (tpy)	Total energy (toe/yr)	Total CO_2 emissions (t CO_2/yr)	Annual energy bill (million INR)
Plywood	1,71,160	1382	457.0	16.8	4.3
Peeling	50,281	–	4.3	4.9	0.5
Saw mill	48,384	–	4.2	4.7	0.4

Cluster level consumption

The overall energy consumption of the cluster is estimated to be 1,38,793 tonne of oil equivalent (toe) per annum. The equivalent carbon emissions are 6,976 tonnes of carbon dioxide (CO2) mainly due to the consumption of

electricity. The integrated plywood units account for about 99% of total energy consumption in the cluster, as thermal energy accounts for major energy supply. The fuel used in the boiler is sawdust which is considered carbon neutral. The overall energy bill of cluster is estimated to be ₹1,488 million.



Energy share by different industries

Energy consumption of Yamuna Nagar plywood cluster

Energy type	Annual consumption	Equivalent energy (toe)	Equivalent CO2 emissions (t CO2)	Annual energy bill (million INR)
Electricity	71.2 million kWh	6,121	6,976	659
Thermal (Sawdust)	4,14,600 tonne	1,32,672	–	829
	Total	**1,38,793**	**6,976**	**1,488**

Potential energy efficient technologies

Some of the major energy efficient technologies suitable for plywood manufacturing units in the cluster are discussed below.

Hot air generator

At present, the level of steam used for removal of moisture in wood from a level of 50% down to 3%. The present rate of moisture removal is estimated to be 75 kg/hr. The moisture removal rate can be enhanced with use of 'hot air generator' (HAG) which can be fired with sawdust which is a by-product in plywood production process. With use of HAG, it is envisaged that the moisture removal will increase to about 110 kg/hr, which is about 45% increase as compared to existing level. Replacement of steam based heating with HAG based system would lead to saving of both sawdust and electricity consumptions. In a typical plywood manufacturing unit, the potential monetary saving is estimated to be ₹8,21,000 per year.

Energy and monetary savings with hot air generator

Particular	Unit	Value
Capacity of drying	tonne	25
Initial moisture level	%	50
Final moisture level	%	3
Existing moisture removal rate	kg/hr	75
Envisaged moisture removal rate with HAG	Kg/hr	110
Reduction in sawdust consumption	%	20
Reduction in electricity consumption	%	15
Monetary saving	Rs/yr	8,21,000

Combustion control in boilers

A majority of boilers used in the cluster are not equipped with control system to regulate combustion air supply based on fuel i.e. sawdust feeding. Non-control of combustion leads to very high or low levels of combustion air supply, leading to high level of excess air in flue gases (and hence high flue gas heat losses) or unburnts in ash from boilers. Combustion control enables proper mixing of air with fuel, leading to complete combustion, thereby releasing maximum possible heat.

Auto/semi-auto control systems would help in optimizing air supply with respect to sawdust feed in boiler. By optimization and ensuring complete combustion, unburnt formation or high flue gas losses from boiler may be minimized. Further, the plywood industries must also undertake periodical monitoring/testing of flue gases to check the level of excess air supply to boilers. About 5% energy saving potential exists with combustion air optimisation. Typical cost benefit analysis shows that it offers attractive payback period.

Cost-benefit analysis for combustion air optimization

Particular	Unit	Value
Present sawdust consumption in boiler	tpy	1382
Sawdust saving	%	5
	tpy	69
Monetary saving	₹ lakh/yr	1.4
Investment	₹ lakh	0.7
Simple payback period	month	6

Enhance condensate recovery with pressure power pumps

The level of condensate recovery and its sensible heat is low in a large number of plywood industries. Pressure power pumps may be installed to enhance condensate recovery along with sensible heat. According to the envisaged energy saving, about 6% of sawdust may be saved by enhancing condensate recovery from process sections.

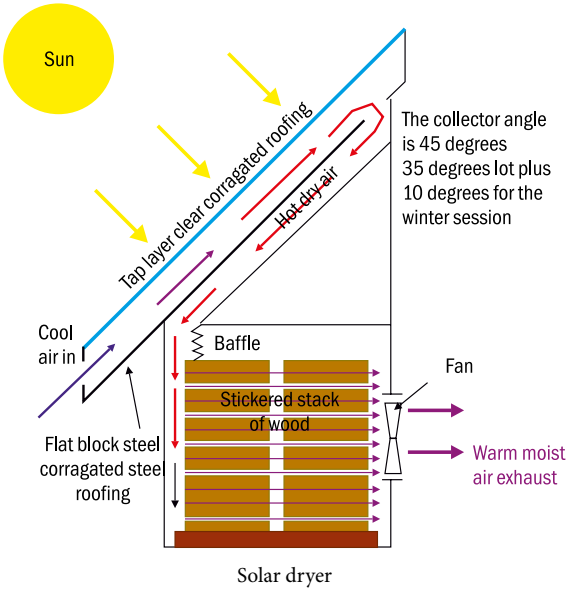
Savings with enhanced condensate recovery

Particular	Unit	Value
Present sawdust consumption in boiler	tpy	1382
Sawdust saving	%	6
	tpy	83
Monetary saving	₹ lakh/yr	1.7

Enhancing drying by solar dryers

The level of moisture in sized wood planks is close to 50%. The plywood industries in the clusters use hot chambers for drying of wood planks as they are cheaper, provide ease of operation, flexible applications, etc. However, these systems are associated with longer drying periods.

In general operating practices, the units initially store planks which are subsequently transferred to hot chambers for drying. Instead of just storing wooden planks, a solar air heating system, based on flat plate collectors, can be installed that can lead to pre-moisture removal up to 15 to 20%. This process may take about 1 to 2 days depending on climatic conditions. Pre-moisture removal would help in significant saving of sawdust, apart from improving quality of end products.



Solar dryer

Source: http://www.forestryforum.com/board/index.php?topic=57848.20

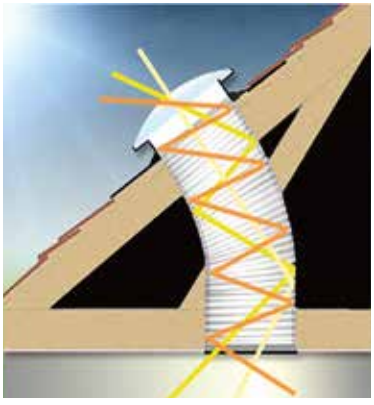
Savings with solar drying system

Particular	Unit	Value
Initial moisture content	%	50
Final moisture content	%	35
Sawdust saving with solar drying	tpy	63
Monetary saving	Rs/yr	1,26,692

Maximizing use of daylight with solar tube lights

Most of the plywood and associated industries operate during day time. However, the usage of day lighting inside the plant is quite low. The plywood units generally use compact fluorescent lamps (CFL), T12, and T8 lamps for illumination purposes.

One of the recent and most efficient systems is solar light tubes. Solar tube lights can provide a light output of 14,215 lumen without using electricity. A solar tube consists of a hemispherical dome at roof level that allows efficient collection of sunlight for different angles of sun. The sunlight gets reflected in the mirror finished tube and gets directed to anti-glare lenses installed in the room area. The light intensity of such systems varies with climatic conditions and orientation of the sun angle throughout the day.



Solar tube light

http://www.solatube.com/

Others

Other energy saving measures include the use of energy efficient motors like IE3 and IE4, power factor improvement, etc.

Major cluster actors and cluster development activities

Yamuna Nagar Plywood Association

Yamuna Nagar Plywood Association, with over 200 members, is the apex industry association of plywood units in Yamuna Nagar. The association address the issues related to the welfare and grievance redressal of their member industries.

District Industries Centre

The District Industries Centre (DIC), Yamuna Nagar, provides several incentives to MSMEs such as capital investment subsidy, interest subsidy, venture capital, quality certification, energy, water audits, etc. DIC is quite active in creating awareness on existing MSME schemes, trade information, and financial rules & regulations for MSMEs.

Cluster development activities

Yamuna Nagar Plywood Cluster has been taken under Micro & Small Enterprises - Cluster Development Programme (MSE-CDP) scheme for establishment of 'Common Facility Centre' for face veneer peeling, urea formaldehyde resin for veneer bonding, alternative product from waste scrap, high density plywood making press, etc., which will benefit the units by way of improving the quality of the products, product differentiation, production cost reduction, etc. A Special Purpose Vehicle (SPV) named 'Yamuna Nagar Plywood Cluster Pvt Ltd', comprising 25 members, has been constituted for this purpose. The Detailed Project Report (DPR) for the project has been approved and the SPV has been granted in-principle approval to set up the CFC by the office of Development Commissioner, MSME (DC-MSME), New Delhi. The land for establishment of CFC has already been allotted by Haryana State Industrial & Infrastructure Development Corporation Limited (HSIIDC) in Yamuna Nagar.

Abbreviations

Abbreviation	Full form
CFL	Compact Fluorescent Lamp
DC-MSME	Development Commissioner, MSME
DIC	District Industries Centre
DPR	Detailed Project Report
HAG	Hot Air Generator
HSIIDC	Haryana State Industrial & Infrastructure Development Corporation Limited
HT	High Tension
kL	Kilolitre
kWh	kilowatt-hour
Lit	Litre
LT	Low Tension
MSE-CDP	Micro & Small Enterprises - Cluster Development Programme
MSME	Micro Small and Medium Enterprises
SEC	Specific Energy Consumption
SPV	Special Purpose Vehicle
t	tonne
TFH	Thermic Fluid Heater
toe	tonne of oil equivalent
UHBVN	Uttar Haryana Bijli Vitran Nigam
VFD	Variable Frequency Drive
WHR	Waste Heat Recovery

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 sub-sector 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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