

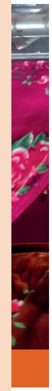
ENERGY PROFILE

PANIPAT TEXTILE CLUSTER

The Energy and Resources Institute

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA



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Suggested format for citation

TERI. 2016
Energy Profile: Panipat Textile Cluster
New Delhi: The Energy and Resources Institute; 24 pp.
[Project Report No. 2015IE18]

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This document is an output of a research exercise undertaken by TERI supported by the Shakti Sustainable Energy Foundation (SSEF) for the benefit of MSME sector. While every effort has been made to avoid any mistakes or omissions, TERI and SSEF would not be in any way liable to any persons/organizations by reason of any mistake/omission in the publication.

Published by

TERI Press
The Energy and Resources Institute
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi-110 003
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Acknowledgements

TERI places on record its sincere thanks to the Shakti Sustainable Energy Foundation (SSEF) for supporting the project on profiling of energy intensive micro, small, and medium enterprise (MSME) clusters in India.

TERI team is indebted to MSME-Development Institute (DI), Karnal (Haryana); Haryana Chamber of Commerce and Industries (HCCI); Panipat Dyers Association; Haryana Carpet Manufacturers Association (HCMA); and National Small Industries Corporation for providing support and information related to textile units in Panipat cluster. TERI extends its sincere thanks to Mr D K Tyagi, Assistant Director, MSME-DI, Karnal, for organizing field visits and interactions with unit members during the study for the preparation of this cluster profile report. TERI also places on record the support provided by Mr Pritam Singh Sachdeva, President, HCCI; Mr Bhim Rana, President, Panipat Dyers Association; and Mr Anil Mittal, General Secretary, HCMA, during the study.

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.

Panipat Textile Cluster

Overview of cluster

Panipat, a city located in the state of Haryana, is an important industrial location in India. The industrial activities in the cluster started after the partition of India and Pakistan, when the weaver's community displaced from Pakistan was facilitated to settle in Panipat. Further, the carpet business evolved as a result of yarn dyeing of woollens in 1970s and 80s. At the same time, power looms were introduced to make bed covers, curtains, and other upholstery clothes. By 1990, many industries started manufacturing blankets. The business of blankets expanded very fast, and in due course, Panipat became famous for blanket market. Panipat accounts for about three-fourth of total blankets produced in the country.

The textile units are involved in manufacturing of cotton *durries*, carpets (woollen, cotton based and synthetic); furnishings (bed covers, cushion covers, mats, etc.), woollen blankets, and cotton and woollen yarns. A majority of the manufacturers are concentrated in industrial areas in Haryana Urban Development Authorities (HUDA) in Sector 25 (I & II) and Sector 29 (I & II) and Panipat industrial area. The other enterprises including job work units are primarily located in and around Panipat Town.

Some of the leading manufacturers and exporters of home furnishing in the cluster include Abhishek Industries Ltd. (Trident Group), Palliwal Exports, Abhiasmi International Pvt. Ltd, SPJ Textiles Pvt. Ltd (formerly called Flora International), Ravera Textiles, Golden Terry Towel Pvt. Ltd, Aggarsain Spinners Ltd, Anand International, Shivam Exports, Sachdeva Home Furnishing Pvt. Ltd, Vardhman Creations, and Om Overseas.

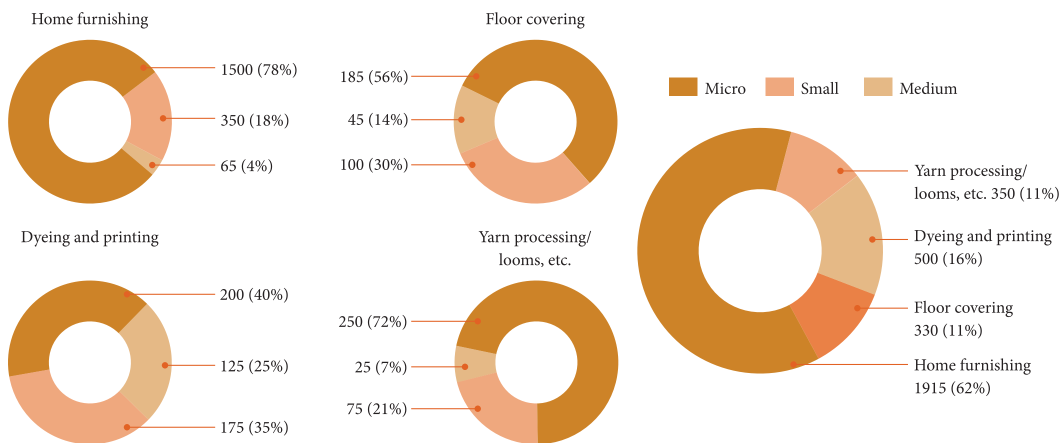
Product, market, and production capacities

The raw materials for home furnishing industries are sourced mainly from spinning mills and power loom industries. Procurement of raw material is one of the great concerns of the production processes adopted for home furnishing material to maintain the best quality standards of final product. Home furnishing and carpet manufacturing units are mainly exporting to both developing and developed countries whereas spinning/yarn, processing/dyeing/printing units are processing the intermediate yarn/grey for final product manufacturers. A few manufacturers also have local market and supply chain system under various reputed brands in India.

The major products include floor coverings product, such as durries, woollen carpets, cotton, and synthetic carpet, home furnishings material (bed covers, cushion covers, mats, etc.), fabric blankets, etc. Cotton and woollen yarns produced in the Panipat cluster are utilized by home furnishing and carpet industries located in and around Panipat as well as other cities.

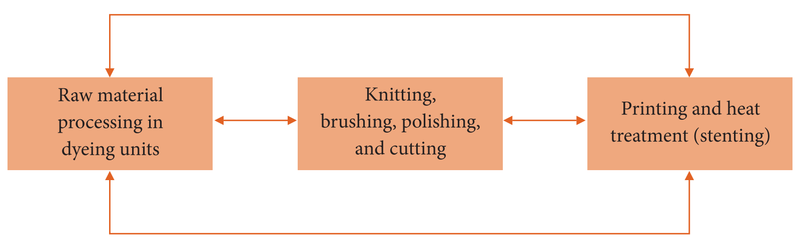
There are about 3,095 micro, small, and medium enterprises (MSMEs) in the Panipat textile cluster with more than 60% of the industries are involved in home furnishing. About 65% of the units fall under micro category. There are about 200 textile machinery units in the cluster. The breakup of textile units operating in the cluster is given in the following table. Classification of the textile units in Panipat is based on product manufacturing, and investment towards plant and machinery is shown in the figure below.

Category	Micro	Small	Medium	Total
Home furnishing	1,500	350	65	1,915
Floor covering	185	100	45	330
Dyeing and printing	175	200	125	500
Yarn processing/looms	250	75	25	350
Total	**2,110**	**725**	**260**	**3,095**



Classification of units in Panipat textile cluster

The estimated annual production of the cluster is valued to be ₹950 crore. Carpet industries and home furnishing units require raw material, such as yarn and threads and services such as dying and printing, which is catered by local units. The linkage between units in home furnishing segment is shown in the following figure. The major share of production in textile industries in Panipat is home furnishing product (62%), such as bed sheet, *durree*, and blanket (polar, cotton, and woollen). Most of the power looms and yarn-processing units are operating to cater to the raw material requirements of home furnishing industries and floor covering industries. There are some integrated units with power loom, yarn processing, dying, and printing facilities. While large industries and export house are selling their products with their brand names, some of the small units are manufacturing products for large brands, such as Bombay Dyeing, Future Group, etc.



Linkage of units in home furnishing

Production process

The main processes for dyeing and printing process of raw and intermediate materials in home furnishing units are discussed below:

Raw material preparation

Raw material preparation includes various processes including pre-treatment of grey. In fabric pre-treatment, grey materials (thread or fabric) are pre-treated in open width or rope form.

Scouring: Yarns/fabrics carry dirt, natural waxes or oils, or have been treated with size or lubricants used in spinning, weaving, or knitting. The presence of these materials can change the desired results of dyeing process. The level of scouring adopted in the process is dependent on type of fibre and its condition.

Bleaching: Bleaching is a chemical treatment process required to remove natural coloured impurities present in the material from the sources. Fabric in its natural form contains many minerals, proteins, colouring matters, etc. The sources of natural colour are organic compounds with conjugated double bonds. During the chemical bleaching process, discoloration takes place by breaking the chromosphere, most likely the one or more double bonds with in this conjugated system. The product appears whiter after bleaching process.

Dyeing

Dyeing is the process of imparting colours to fabric or yarn using a dye (pigments-based colour). In this process, dye is applied to the substrate in a uniform manner to obtain an even shade with a performance and fastness appropriate to its final use. The machinery used in the process is mainly tankie dyeing and cabinet dyeing machines; however, a few units use jet dyeing machines. Cabinet machines are designed to have liquor flow parallel to the yarn and they work with low liquor ratios to reduce thermal energy consumption and save water and chemicals.

In the dyeing process, water chamber of the machines is filled with measured quantity of water at required temperature and the fabric is loaded. The temperature of the liquid is raised by addition of steam (direct or indirect). When the temperature of water reaches desired level (90–130°C), necessary colours and chemicals are added. The water is completely drained off after the process is completed. A few plants are recycling the water for cleaning purpose. After dyeing, the fabric is unloaded from the machine and taken to the folding and rolling machines for improving the width of cloth, which gets shrunk during the washing and dyeing process.

Cabinet dyeing machine

Printing

The most commonly available technologies for printing process are flatbed printing, rotary printing, and hand print. Hand printing is the oldest and conventional method for printing fabric; Flatbed printing, a second generation technology, is most commonly used in Panipat cluster. Flatbed printing has provision for printing 10 to 14 colours simultaneously. The colour print paste prepared is fed onto the screens from where it is transferred to the fabric. The fabric after print paste transfer is passed through a drying chamber at 145°C. The dried and printed fabric is taken for further processing.


Printing – flatbed

Colour fixing, drying, and finishing

After printing, aging process will be performed to fix colour on fabric or yarn. Under this process, the material must be kept in a steam chamber and its duration depends on colour and fabric. Drying process is carried out in loop machine wherein temperature of 110–120°C for better colour setting is maintained. The printed fabric is then washed in a series of normal water and hot water in the presence of chemicals for colour setting. After completion of the washing process, the printed and washed fabric is subjected to heat setting process in stenter machines and sent for pressing and finishing. Heat setting is carried out on fabrics made of manmade fibres or blends of them with natural fibres to relax tensions in the textile fibres due to upstream fabric or yarn processing and to improve the dimensional stability of textiles. Heat setting is carried out continuously in stenters at temperatures 150–220°C. The stenter chambers have heating coils wherein hot air generated from thermic fluid heater is circulated. A few more additional steps involved in home furnishing process include brushing, polishing, fabric raising, and embossing.

Fabric brushing or surface raising

Some fabrics such as velvet have naturally raised (fuzzy) surface, which is referred to as the nap. In the finishing process, after the cloth is woven, it goes through processes such as washing, filling, raising, and trimming the nap. There are several ways to 'raise the nap', most of which involve wire brushes such as raising cards and involve special brushing machines to get the best finish. During raising, the fabric surface is treated with sharp teeth to lift the surface fibres, thereby imparting hairiness, softness, and warmth. Flannelette is a well-known example of this type of material. This process is primarily adopted in polar blanket manufacturing units as fabric brushing, or surface raising in blanket is an effective way to increase the ability of the fabric to retain heat or provide a thermal barrier.


Surface raising

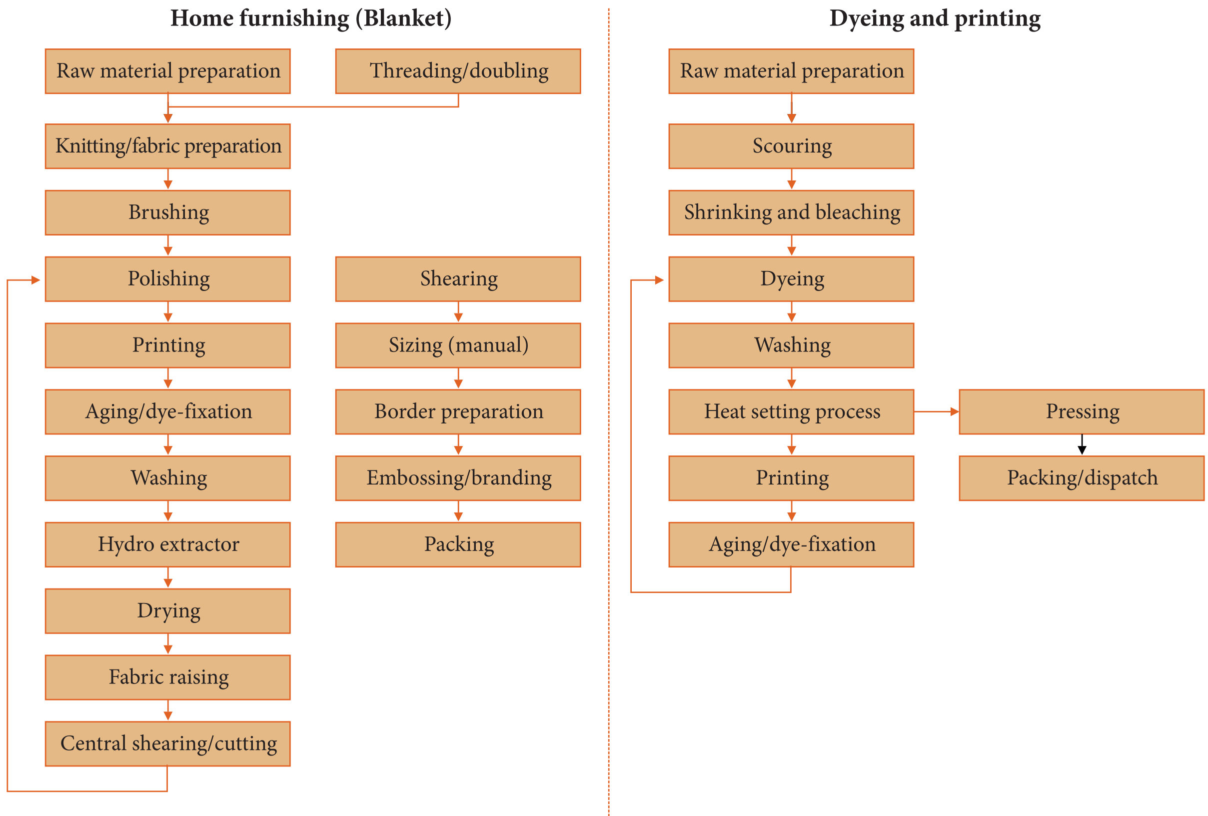
Polishing

Polishing is a finishing process that enhances fabric quality by decreasing pilling trend and woolliness of knitted fabrics. This process removes bulging fibres and slubs from knitted fabrics, significantly reduces pilling, softens fabric hand, and provides a smooth fabric appearance. In Panipat cluster, most of the polar/fleece blanket manufacturing units use double rollers polishing machine having a heating


Polishing

power up to 90 kW and handle fabric width up to 2.5 metres. Polishing is one of the major energy-consuming processes in the home furnishing units.

The detailed process flow diagram of dyeing and printing units and home furnishing units (fleece/polar blanket) is given in following sections.



Technologies employed

Some of the major equipment used in the textile cluster are described below.

Thermic fluid heaters

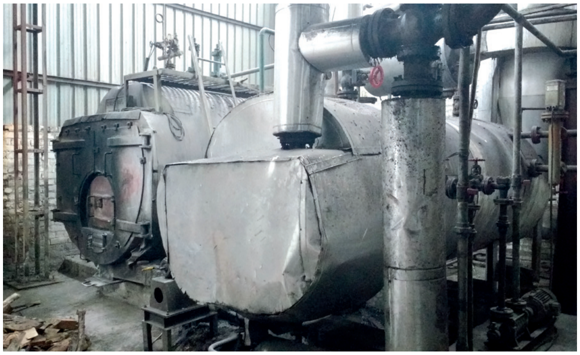
The medium-scale textile units having combined facilities for dyeing, printing, and manufacturing of home furnishing product has thermic fluid heaters. The installed capacity of thermic fluid heater in the cluster is 5–25 lakh kcal per hour. These solid fuel-fired (pet coke is most common fuel used) thermic fluid heaters are provided with constant speed thermic fluid circulation pump. Most of the

Thermic fluid heater

thermic fluid heaters have manual fuel charging mechanism; however, some progressive units have also installed screw feeding mechanism. Primarily, thermic fluid is being used in printing and stenter facility. Thermic fluid is also used to generate the steam to cater intermittent steam requirement of the process.

Steam boilers

The most common capacity of the boiler in the cluster is 1.5 tonne per hour (tph) used mainly by micro and small enterprises. Most of the boilers are three pass, solid fuel fired boilers. Few smaller units use single pass boiler, which exhibit higher heat losses and poor quality of steam. Micro and small units use biomass (wood, upla) as fuel in boilers; medium size units are using wood and pet coke as fuel. The boilers are operated at 6.5–10 kg/cm^2 drum pressure whereas the end use steam pressure requirement is 3.5–4 kg/cm^2. Some of the boilers have economizer to recover the heat from waste flue gases.



Solid fuel fired boiler and thermic fluid based steam generator

Few unit also using thermic fluid to generate hot water as well as steam at 3.5–4.0 kg/cm^2 pressure to cater to the intermittent steam requirement of the process. There is no monitoring and control system provided for monitoring key operating parameters of boilers such as flue gas temperature, steam pressure at utilization end, and air to fuel ratio controllers.

Power looms

The most common power looms used in the cluster are shuttle looms with an installed motor capacity of 1 hp. The production capacity of these looms is about 2 metre fabric (90 inch width) per hour. The average operation per loom is about 9–10 hours per day in cluster. The major problems being faced by the units include: (i) use of shuttle loom, which is old technology and (ii) poor skills of labour. Upgradation of existing shuttle looms is pre-requisite as low level of finished products brings in greater competition from other countries like China, which offers finer products at cheaper prices. Some of the units have converted to rapier loom having motor capacity up to 3 hp. Almost all the shuttle-less looms used in Panipat are imported second hand looms.

Polishers

Majority of units follow manual assembly process. Selected units have invested in low cost automation to improve assembly accuracy and precision. The time taken for assembly reduces considerably with automation thereby improving production efficiency.

Stenters

The stenter installed in home furnishing units consist of 6-8 chambers. Some large units in the cluster also have

12 chamber stenters. Most of the units (new and old installation) have stenters fitted with three-way valve (hot oil will bypass heat exchanger upon attaining set temperature) to maintain the temperature of stenter chambers. Conventional local-made blowers are installed with dual-speed motors (standard efficiency motors) and speed of fan is independent (having no closed loop control) of chamber temperature. The insulation level of the stenter chamber is poor.

Stenter

Air compressor

Compressed air is used for pneumatic operation in process machinery, such as stenter, polishing, cleaning, and packing. Home furnishing units use reciprocating as well as screw type air compressors. The connected load of an air compressor size ranges from 5 hp to 60 hp. The pressure requirement for the majority of applications is below 5.5 kg per cm^2 (bar). Capacity of most of the compressors is more than the requirement, which is leading to unload power losses. Air quality control (e.g., auto drain valve) system and improvement system (e.g., dryer) are also not used by most of the units.

Energy scenario in the cluster

The prices of major energy sources, such as electricity, pet coke, wood/ biomass and high speed diesel (HSD) are shown in table.

Prices 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 (up to 50 kW)	Demand Charges: ₹185 per kW Energy Charges: @up to 10 kW—₹5.95 per kVAh @10–20 kW—₹6.25 per kVAh @20–50 kW—₹6.00 per kVAh
Pet coke	Distributors	₹8,000–8,500 per tonne (price subjected to market fluctuations)
Wood/ biomass	Local Market	₹2,200–3,000 per tonne (seasonal variation with respect to moisture content)
HSD	Distributors	₹50 per litre (price subjected to market fluctuations)

Source: Field survey and interaction with unit entrepreneurs

Energy consumption

The overall energy consumption of cluster is estimated to be 305,950 tonne of oil equivalent (toe) per annum leading to carbon emissions of 383,470 tonnes of CO_2. The overall energy bill of cluster is estimated to be ₹3,950 million, which is about 8% of cluster turnover.

Energy consumption of the Panipat textile cluster (2014–15)

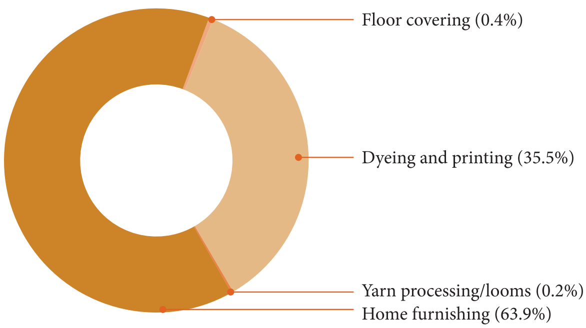
Production category	Electrical energy Million kWh/year	Thermal energy toe/year	Total energy (toe/year)	Total CO_2 emissions (t CO_2/year)	Annual energy bill (million INR)
Home furnishing	48	191,252	195,360	237,051	2,468
Floor covering	16	-	1,362	14,096	133
Dyeing and printing	14	107,366	108,536	125,164	1,279
Yarn processing/looms	8	-	692	7,159	70
Total	85	298,618	305,950	383,470	3,950

Source: Field survey and interaction with unit entrepreneurs

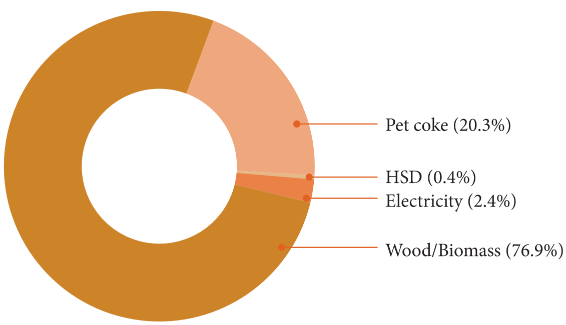
The home furnishing units consumes about 64% of the total energy consumption of the cluster, which is mainly due to use of the thermal energy in aging, washing, and printing as well as electrical heating system in polishing section.

The thermal energy accounts for about 97% of total energy consumption in the cluster. Higher thermal energy consumption may be attributed to factors such as large heating requirement during the dyeing, printing, aging, and drying process. The share of the grid electricity and backup power generation is less than 3%.

The share of biomass in total energy use at cluster level is about 77%, mainly by micro and smaller units. Petcoke, primarily used by larger units accounts for about 20% of total energy consumption.



Share of energy consumption by textile units



Fuel-wise share in energy consumption

Potential energy efficient technologies

Some of the major energy efficient technologies for the pump set units in the cluster are discussed below.

Energy efficiency in boilers/thermic fluid heaters

The heating loads of dyeing and home furnishing units are quite significant. Most of the units use boilers and thermic fluid heaters of sub-standard design. There is no control and automation available to maintain the air to fuel ratio. Waste heat recovery (WHR) options to recover the heat from hot flue gases are also not available. The flue gas temperature in thermic fluid heaters (at stake end) was observed to be in the range of 300–410°C, which is quite high and can be recovered. Similarly, boilers installed in micro and small units do not have WHR option. Some of the units also use single pass boiler, leading to loss of wet steam as well as high dry flue gas.

Existing boilers and thermic fluid heaters may be retrofitted with control and automation to maintain optimum air to fuel ratio and to monitor temperature of flue gases regularly for periodic maintenance of the system. The units may also maintain proper record (logbook) for key operating parameters, such as steam pressure, steam generation, fuel consumption, water properties, and blowdown.

Some of the recommended features for the boiler and thermic fluid heaters are the following:

» Three-pass construction of boiler consisting of furnace section as first pass and number of convective tubular pass.

» Appropriate size of smoke tube ensures smooth passage of flue gases and prevent choking, clinkering at the tube ends in solid fuel-fired boilers. This will also make periodic maintenance/cleaning easy.

» Air to fuel ratio controller with closed loop control mechanism (installation of variable frequency drive [VFD] for Induced Draft [ID] fans and Forced Draft [FD] fans) with flue gas parameters (O_2 level and temperature).

» Variable control option in induced draft fan to optimize gas velocities for minimum pressure drop on gas side and most effective heat transfer.

» Appropriate selection of refractory (based on furnace temperature) and surface insulation material.

Cost-benefit analysis in boiler and thermic fluid heaters

Energy saving measure	Existing scenario	Proposed scenario	Energy saving potential (%)	Simple payback period
Installation of energy efficient boiler	Single pass boiler of efficiency 48–60%	Three pass boiler WHR mechanism	15–27	up to 18 months
Installation of economizer in boilers	Flue gas temperature: 220–310°C Boiler feed water temperature: 30–35°C	Economizer for preheating of boiler feed water Feed water temperature: 75°C	5–8	up to 8 months
Installation of air preheaters in thermic fluid heaters	Flue gas temperature: 300–410°C Combustion air temperature: 30–35°C	Air preheater for preheating of combustion air combustion air temperature: 110°C	4–9	up to 11 months
Air to fuel ratio controller	Estimated excess air: 110–160 (based on design) No control on combustion air	Air to fuel ratio controller with closed loop feedback of flue gas parameters	8–14	8–12 months
Use of appropriate surface insulation	Non-insulated surfaces Surface temperature with insulation: 80–110°C Ambient temperature: 30°C	Use of appropriate insulation at front and back face	1.5–2	up to 3 months

Energy efficiency in Stenters

Stenters installed in the home furnishing units are mainly 6 to 8 chamber systems. Some large units also having 12 chamber stenters in the cluster. Most of the units (new and old installation) have stenters fitted with three-way valve (hot oil will bypass the heat exchanger after attaining the set temperature) to maintain the temperature of the stenter chambers. In the existing scenario, even after meeting the chamber temperature thermic fluid is circulating to the rated volume, which leads to loss of electricity in pumping as well as heat loss during the circulation. The temperature difference at inlet and outlet was very low than the design value. To avoid the losses due to idle circulation of hot fluid media and optimum capacity utilization, the circulation pump may be retrofitted with two-way valves with VFD.

Blowers (i.e., chamber air circulation fans) are installed with dual speed motors (standard efficiency motors) and speed of fan is independent (having no closed loop control) of chamber temperature. Installation of VFD in stenter fans will enable auto feedback modulation system, resulting in significant amount of energy saving. Speed regulation is also used to ensure air jet velocity by modulating speed of first section to rapid heating of fabric and then modulating speed second chamber/section and third chamber. Use of energy efficient fans may also give additional saving up to 5–7 % in electricity consumption of stenters.

Cost-benefit analysis in Stenter system

Energy saving measure	Existing scenario	Proposed scenario	Energy saving potential (%)	Simple payback period
Installation of two-way valve at utilization end and VFD on thermic fluid circulation pump	Three-way valve Fix volume circulation of thermic fluid pump Idle operation during no-operation of stenters	Two-way valve with temperature feedback control Variable flow of thermic fluid	15–20 (pumping power) 2–3 (heat)	Up to 18 months
Use of VFD on chamber air circulation fans	Constant speed operation without feedback of chamber temperature	Closed-loop speed control with chamber temperature	15–20	up to 9 months
Use of energy efficient air circulation fans	Design efficiency: up to 65%	Design efficiency: up to 80%	5–9	up to 12 months

Compressed air system

Compressed air is a continuous operating utility in home furnishing units. It is one of the high energy intensive utilities in any process industries. Different factors accounting for performance of compressed air system include air intake temperature, generation pressure, capacity utilization, type of technology used, compressed air distribution network, etc.

In Panipat textile cluster, the maximum pressure requirement at utilization end is 5.5 bar; whereas, the set generation pressure was observed to be 7.5–10 bar. As a thumb rule, 1 bar of increased air pressure leads to 7% additional consumption of electricity. For optimum utilization of compressed air, it is preferred to keep the load pressure of compressed air at about 1 bar above the pressure requirement at the point of utilization.

The temperature of intake air of compressors was observed to be 8–10°C higher than ambient temperature that are kept in boiler/thermic fluid heater area or close to stenter. An increase in intake air temperature of about 4°C will increase the electricity consumption by 1%. Hence, the intake air of compressor must be taken from a clean, cool location as pressure drop across the intake air filter will reduce the pressure at the air end inlet and increasing the compression ratios.

Apart from operating practices, the capacity utilization of most of the screw compressors was in the range of 45–65%. As most of the compressors are constant speed compressor with load/unload option, huge losses of electricity was observed due to unload operations. Use of the VFD enabled air compressors or retrofit of VFD in existing screw type air compressor will lead to reduction in unload hours and electricity consumption as shown in the table below.

Cost-benefit in air compressor

Energy saving measure	Existing scenario	Proposed scenario	Energy saving potential (%)	Payback period
Optimum setting of compressed air generation pressure	Set pressure: 7.5–10 bar End user pressure requirements: 5.5 bar (max.)	Set Pressure: 6.5–7.0 bar End user pressure requirements: 5.5 bar (max.)	10–17	Immediate
Air compressor intake air temperature should be close to ambient temperature	Intake air temperature: 38–40°C Ambient temperature: 30°C	Intake air temperature: 30–32oC Ambient temperature: 30oC	1.5–2	up to 3 months
Installation of VFD on existing screw compressor to avoid unload operation/ installation of VFD enabled air compressor	Capacity utilization: 45-65% Unload period: 35–55%	Unload period is nil	15–25	up to 12 months

Waste heat recovery from dyeing process

Dyeing process requires water temperature at about 90–130°C depending on fabric and colour requirements. After completion of dyeing process, hot liquor (90–95°C) is generally drained out, having significant amount of sensible heat that can be recovered using a heat exchanger (HX). This recovered hot water can be used for: (i) generating hot water required for next batch (in indirect steam injection system) or as feed water in boiler. The cost benefit analysis of waste heat recovery system (WHR) from hot liquor of dyeing process is shown in the table below.

Cost-benefit analysis of WHR system

Energy saving measure	Existing scenario	Proposed scenario	Energy saving potential (%)	Payback period
Waste heat recovery from dyeing process	Hot liquid temperature: 90–95°C	Recovery through heat exchanger	5–7	up to 8 months
	No reuses application	Hot water temperature: up to 65°C Boiler efficiency: 85%		

Installation of condensate recovery system

The steam is used directly and indirectly in textile processes in Panipat cluster. The condensate at indirect steam utilization end is not recovered in a majority of micro and small units. Medium scale units have condensate recovery system but there is a mixing with other liquors generated from the processes thereby making it difficult for use in boilers.

Even in units practicing condensate recovery, the condensate from drums/dryers is stored in a tank and pumped to feedwater tank once it becomes full. Since transfer of condensate is intermittent, there is considerable temperature fall (90°C to 45–50°C) at the collection tank. Use of steam traps in textile units is also not a common practice; a few units use thermodynamic type steam traps, which cannot handle high volume condensate.

To ensure condensate recovery and heat gain from the return water, pressured powered pump may be installed for pumping back the condensate continuously to boiler feedwater tank thereby ensuring recovery at maximum possible temperatures.

Cost-benefit analysis of condensate recovery system

Energy saving measure	Existing scenario	Proposed scenario	Energy saving potential	Payback period
Condensate recovery from indirect steam use application	Condensate not being recovered Condensate is having impurities Condensate temperature is down by 30–40°C during transfer	Installation of pressured powered pump	5-8 %	up to 10 months

Major cluster actors and cluster development activities

There are several industry associations in Panipat textile cluster. The major industry associations, related to textile industry include: (i) Haryana Chamber of Commerce and Industries (HCCI), (2) Panipat Dyers Association, and (iii) Haryana Carpet Manufacturers Association (HCMA). Other major cluster actors include District Industries Centre (DIC) and National Small Industries Corporation (NSIC).

Panipat home furnishing cluster has been taken under Micro and Small Enterprises—Cluster Development Programme (MSE-CDP) scheme for establishment of Textile Designing on Auto Cad and Testing Laboratory for colour fastening, yarn testing, etc. The cluster coordination committee has taken approval of detailed project report (DPR) from the office of Development Commissioner, MSMEs, New Delhi. The Industries Associations also has requested for allotment of Land to Government of Haryana.

Abbreviations

Abbreviation	Full form
Cfm	cubic feet per minute
DI	Development Institute
DIC	District Industries Centre
HCCI	Haryana Chamber of Commerce & Industry
HCMA	Haryana Carpet Manufacturers Association
HT	High Tension
HUDA	Haryana Urban Development Authority
IIF	Institute of Indian Foundrymen
kL	Kilolitre
kWh	kilowatt-hour
Lit	Litre
LT	Low Tension
MSE-CDP	Micro & Small Enterprises - Cluster Development Programme
MSME	Micro, Small, and Medium Enterprises
NSIC	National Small Industries Corporation
OEM	Original Equipment Supplier
PDB	Power Distribution Board
SEC	Specific Energy Consumption
SPC	Specific Power Consumption
SPV	Special Purpose Vehicle
SSEF	Shakti Sustainable Energy Foundation
t	tonne
toe	tonne of oil equivalent
VFD	Variable Frequency Drive

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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SHAKTI
SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA