MANUAL ON ENERGY CONSERVATION MEASURES IN TEXTILE CLUSTER TIRUPUR

ENERGY IS LIFE
BEE
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Bureau of Energy Efficiency (BEE)

Ministry of Power, Government of India

WINROCK INTERNATIONAL INDIA

Prepared by

Winrock International India

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About BEE SME Program

Worldwide, the Micro, Small and Medium Enterprises (MSMEs) have been accepted as engines of economic growth to promote and accelerate equitable development. The major advantage of this sector is its enormous employment potential at significantly low capital involvement. This can be established from the simple fact that the MSMEs constitute over 90% of total enterprises in most economies and are credited with generating the highest rates of employment growth and also account for a major share of industrial production and exports. In Indian context, MSMEs play a pivotal role in the overall industrial economy. In recent years, the sector has consistently registered higher growth rate as compared to the overall industrial sector. With its agility and dynamism, the sector has shown admirable innovativeness and adaptability to survive the recent economic downturn and recession.

As per available statistics (the 4th Census of MSME Sector), this sector employs an estimated 59.7 million people spread over 26.1 million enterprises. It is estimated that in terms of value, MSMEs have a 40% share in total industrial output at a huge volume of producing over 8,000 value-added products. At the same time, MSMEs contribute nearly 35% share in direct export and 45% share in the overall export from the country. SMEs exist in almost all major sectors in the Indian industry such as Food Processing, Agricultural Inputs, Chemicals & Pharmaceuticals, Electrical & Electronics, Medical & Surgical Equipment, Textiles and Garments, Gems and Jewellery, Leather and Leather Goods, Meat Products, Bioengineering, Sports goods, Plastics Products, and Computer Software.

However, despite the significant contributions made towards various aspects of the nation's socio-economic scenario, this sector too faces several critical issues that require immediate attention. One such factor that falls in the ambit of this publication is the prevalence of age-old technologies across the sectors and inherent inefficiencies associated with resource utilization, including, energy. The National Mission for Enhanced Energy Efficiency in Industry under the National Action Plan for Climate Change (released by Government of India on June 30, 2008) has emphasized the need for improving Energy Efficiency (EE) in the manufacturing sector. A number of sector-specific studies have also unanimously confirmed that energy intensity in the industry can be reduced with the widespread adoption of proven and commercially available technologies which will improve EE and produce global benefits from reduced Green House Gas (GHGs) emissions.

As a result of increasing awareness towards efficient usage of energy and other resources, there has been a visible reduction in energy intensity in comprehensive Indian industrial sector. However, focusing the observation on the MSME sector reveals that the energy intensity per unit of production is much higher than that of the organized large-scale sector. Since energy cost is a significant contributor to the overall production cost of SMEs due to high and rising energy costs in current scenarios, it is required to increase the EE levels in order to ensure the sustenance of SMEs. One of the ways to reduce the inefficiencies is by replacing the conventional/old/obsolete technology with feasible and adaptable energy efficient technologies. This would not only contribute towards reduction in production cost, but would also improve the quality and productivity of MSME products. However, while knowing the way out, there are still numerous barriers (as listed below) and market failures that have prevented widespread adoption of new energy efficient technologies.

The key barriers in promotion and adoption of EE technologies in Indian SME sector are:

- Lack of awareness and capability on the part of SMEs to take up energy conservation activities
- Lack of scientific approach on monitoring and verification of performance assessment of installed equipments and utilities.
- Non availability of benchmark data for various equipments/process
- Low credibility of the service providers such as equipment suppliers and their technologies

- The SME owners are more concerned on production and quality rather than energy efficiency and conservation
- The key technical personnel employed in the SME units are based on their past experience in similar industries rather than technically qualified personnel and hence, they are not aware of the latest technologies or measures which improve energy efficiency
- Lower priority to invest in improving efficiency than in expansion (this may be due to lack of knowledge on cost benefit)

Majority of SMEs are typically run by entrepreneurs and are leanly staffed with trained technical and managerial persons to deploy and capture energy efficiency practice to reduce manufacturing cost and increase competitive edge. Therefore, it will be useful to build energy efficiency awareness in the SMEs by funding/subsidizing need based studies in large number units in the SMEs and giving energy conservation recommendations including short term energy conservation opportunities, retrofit/replacement options and technology up-gradation opportunities.

In this context, the Bureau of Energy Efficiency (BEE) has laid adequate emphasis on the SME sector as presented in the Working Group on Power for 11th Five-Year Plan (2007-2012)-Sub-Group 5. Consequently, the BEE has initiated the Energy Efficiency Improvement Program in 25 SME clusters in India.

1.1 Program objectives

The BEE SME Program is aimed to improve Energy Efficiency in SME sector by technological interventions in the various clusters of India. The EE in SMEs is intended to be enhanced by helping these industries in the 29 energy intensive SME clusters of India by:

- Technology interventions
- Sustaining the steps for successful implementation of EE measures and projects in clusters
- Capacity building for improved financial planning for SME entrepreneurs.

The Program also aims at creating a platform for:

- Dissemination of the best practices and the best available technologies available in the market for energy efficiency and conservation
- To create awareness in the clusters
- To demonstrate the new technology interventions/ projects to stimulate adoption of similar technology/ projects in the clusters.

The BEE SME program has been designed in such a way so as to address the specific needs of the industries in the SME sector for EE improvement and to overcome the common barriers in way of implementation of EE technologies in cluster through knowledge sharing, capacity building, and development of innovative financing mechanisms. Major activities in the BEE SME program are listed below:

- Energy use and technology studies
- Capacity building of stake holders in cluster for building EE projects
- Implementation of energy efficiency measures
- Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The brief objective of each of these activities is presented below:

❖ Energy use and technology studies

An in-depth assessment of the various production processes, energy consumption pattern, technology employed and possible energy conservation potential and operational practices in cluster by means of conducting detailed energy audits and technological gap assessment studies in a cluster is presented herewith. The energy audit study includes analysis of the overall energy consumption pattern, study of production process, identification of energy intensive steps/sub-processes and associated technology gap assessment for the individual units. The study also focuses on identifying the Best Operating Practices and the EE measures already implemented in the units.

❖ Capacity building of stakeholders

The aim of this activity is capacity building of the enrolled Local Service Provider (LSPs) to equip them with the capability to carry on the implementation of the EE technology projects in cluster on a sustainable basis. The needs of the LSPs will be identified as a preparatory exercise to this activity, as to what they expect from the BEE Program in terms of technical and managerial capacity building.

❖ Implementation of EE measures

To implement the EE and technology up-gradation projects in the clusters, technology specific Detailed Project Reports (DPRs) for five different technologies for three scales of operation will be prepared. The DPRs will primarily address the following:

- ❒ Comparison of existing technology with feasible and available EE technology
- ❒ Energy, economic, environmental and social benefits of proposed technology as compared to conventional technology
- ❒ Details of technology and service providers of proposed technology
- ❒ Availability of proposed technology in local market
- ❒ Action plan for implementation of identified energy conservation measures
- ❒ Detailed financial feasibility analysis of proposed technology

❖ Facilitation of innovative financing mechanisms

Research and develop innovative and effective financing mechanisms for easy financing of EE measures in the SME units in the cluster. The easy financing involves following three aspects:

- ❒ Ease in financing procedure
- ❒ Availability of finance on comparatively easy terms and relaxed interest rates
- ❒ Compatibility and availing various other Central/ State Governments' incentive schemes such as CLCSS, TUFF etc.

1.2 Expected project outcome

Expected project outcomes of BEE SME program in clusters are:

❖ Energy Use and Technology Analysis

The outcome of the activity will include identification of the EE measures, potential of renewable energy usage, fuel switching, feasibility analysis of various options, and cost benefit analysis of various energy conservation measures including evaluation of financial returns in form of payback period, IRR and cash flows. The cost liability of each measure, including the capital and operational cost will also be indicated.

The identified EE measures will be categorized as per the following types:

- ❒ Simple housekeeping measures/ low cost measures
- ❒ Capital intensive technologies requiring major investment.

The sources of technology for each of the suitable low cost and high cost measures, including international suppliers as well as LSPs / technology suppliers, in required numbers shall be identified. It is envisaged to create a knowledge bank of detailed company profile and CVs of key personnel of these technology sources. The knowledge bank will also include the capability statements of each of these sources.

The EE measures identified in the energy audit study will be prioritized as per their energy saving potential and financial feasibility. The inventorization survey would establish details like the cluster location, details of units, production capacity, technologies employed, product range, energy conservation potential along with possible identified EE measures and respective technology suppliers.

The specific outcomes of this activity will be as follows:

- ❒ Determination of energy usage and energy consumption pattern
- ❒ Identification of EE measures for the units in cluster
- ❒ Development and preparation of case studies for already implemented EE measures and Best Operating Practices in the units
- ❒ Evaluation of technical & financial feasibility of EE measures in terms of payback period, IRR and cash flows
- ❒ Enlisting of LSPs for capacity building and training including creation of knowledge bank of such technology suppliers
- ❒ Capacity building modules for LSPs
- ❒ Development and preparation of cluster manuals consisting of cluster details and EE measures identified in cluster.

❖ Implementation of EE measures

The aim of this activity is development and finalization of bankable DPRs for each of the EE projects which would be presented before the SME units for facilitation of institutional financing for undertaking the EE projects in their respective units.

The activity will ensure that there is close match between the proposed EE projects and the specific expertise of the LSPs. These DPRs will be prepared for EE, renewable energy, fuel switching and other possible proposed measures during course of previous activities. Each DPR will include the technology assessment, financial assessment, economic assessment, and sustainability assessment of the EE project for which it has been developed. The technology assessment will include the details of the design of equipment/ technology along with the calculation of energy savings. The design details of the technology for EE project will include detailed engineering drawing for the most commonly prevalent operational scale, required civil and structural work, system modification and included instrumentation and various line diagrams. The LSPs will be required to report the progress of the implementation of each such project to BEE PMC. Such implementation activities can be undertaken by the LSPs either solely or as a group of several LSPs.

❖ Capacity Building of LSP's and Bankers

The outcome of this activity would be training and capacity building of LSPs so as to equip them with necessary capacity to undertake the implementation of proposed EE projects as per the DPRs. Various training programs, training modules and literature are proposed to be used for the said activity. However, first it is important to ascertain the needs of the LSPs engaged, as in what they expect from the program in terms of technical and managerial capacity building. Another outcome of this activity will be enhanced capacity of banking officers in the lead banks in the cluster for technological and financial feasibility analysis of EE projects that are proposed by the SME units in the cluster. This activity is intended to help bankers in understanding the importance of financing energy efficiency projects, type and size of projects and ways and means to tap huge potential in this area. Different financing models would be explained through the case studies to expose the bankers on the financial viability of energy efficiency projects and how it would expand their own business in today's competitive environment.

❖ Concluding workshop

The outcome of this activity will be the assessment of the impact of the project as well as development of a roadmap for future activities. The workshop will be conducted for the representatives of the local industrial units, industry associations, LSPs and other stakeholders so that the experiences gained during the course of project activities including implementation activities of EE project can be shared. All the stakeholders in the project will share their experience relating to projects undertaken by them as per their respective roles. Efforts from industrial units as well as LSPs to quantify energy savings thus achieved would be encouraged. This would lead to development of a roadmap for implementing similar programs in other clusters with greater efficiency and reach.

1.3 Identified clusters under the program and target cluster for implementation

29 most energy intensive MSME clusters across different end-use sectors have been identified to implement the BEE SME program for EE improvement. The details of industrial sector and identified cluster are provided in Table 1 below:

Table 1.1: List of clusters identified for BEE SME Program

Cluster Name	Location
Oil Milling	Alwar, Rajasthan
Machine Tools	Bangalore, Karnataka
Ice Making	Bhimavaram, Andhra Pradesh
Brass	Bhubaneswar, Orissa
Sea food processing	Kochi, Kerala
Refractories	East &West Godavari, Andhra Pradesh
Rice Milling	Ganjam, Orissa
Dairy	Gujarat
Galvanizing	Howrah, West Bengal
Brass& Aluminum	Jagadhari, Haryana
Limestone	Jodhpur, Rajasthan
Tea processing	Jorhat, Assam
Foundry	Batala, Jalandhar and Ludhiana, Punjab
Paper	Muzzafarnagar, Uttar Pradesh
Sponge iron	Orissa
Chemicals& Dyes	Vapi, Gujarat
Brick	Varanasi, Uttar Pradesh
Rice Milling	Vellore, Tamil Nadu
Chemical	Ahmedabad, Gujarat
Brass	Jamnagar, Gujarat
Textile	Pali, Rajasthan
Textile	Surat, Gujarat
Tiles	Morbi, Gujarat
Textile	Solapur, Maharashtra
Rice Milling	Warangal, Andhra Pradesh
Tiles cluster	Mangalore, Kerala
Textile	Tirupur, Tamil Nadu
Coir	Alleppey, Kerala
Glass	Firozabad, Uttar Pradesh

As a part of BEE SME program, one of the clusters identified was the Tirupur Textiles cluster. It was proposed to carry out energy use and technology audit studies in 75 units in the Tirupur Textiles cluster covering all types and sizes of the industries to understand and give valuable insight into the process of developing energy efficiency solutions relevant to the SME industries in the Tirupur Textile cluster.

CHAPTER 2

About Tirupur Textile Cluster

2.1 Overview of Tirupur Textile Cluster

Tirupur used to be a centre for cotton trading a few decades ago. Over the years, a few small units were established to manufacture underwear / vest (banians). It was said that the water in Tirupur was of such good quality that the banians made here were the whitest of them all. The fact that the town was located so close to Coimbatore, which was an established textile manufacturing and trading centre, ensured that adequate skills were available. This business grew steadily. It was only in the early 1980s that some enterprising businessmen got the idea that the same facilities could be used to manufacture colour T-shirts, which had become a rage all over the world.

Tirupur is a relatively medium sized town in the Coimbatore district of Tamil Nadu. It has a resident population of around 19,17,000. An additional 300,000 people come in from nearby towns to work in Tirupur's booming textile industry. The entire town's economic activity is centered on the manufacture of cotton knitwear: for use as banians and underwear (catering domestic and International market), and for use as T-shirts (mostly exported). Recently, very few industries started producing winter wears.

The Tirupur knitwear industry's exports are directed to customers in the following percentages: 10% to departmental stores, 60% to importers, 10% to catalogue stores, 5% to retailers, and 5% to established consumer brands. Among major customers of Tirupur's exports are Kitaso, Savanbee, Texman, Marine Prod, Norwigs Clipper, Green Knitwear, Roy atsan, Lotto, Arrow, Roytex, Wal-Mart, KDAB, Auchan, Primark, Ether Austin, Clothesline, Norpo-Tex, Dan- Do, V&D Alians Dominos, Oneil and Wibra.

The local market for ready made garments still has great scope for development. After the emergence of export based garment production, retailers all over India started marketing garments with small faults, garments rejected by the buyers, and excess quantity of garments. Recently, big brand companies are marketing garments in major metropolitan cities in India and most of the garments are produced in India.

In the past few years, however, over 500 units have taken up to modernization of their production processes with fresh investments. About 800 new knitting machines have been imported from abroad. According to the Association, soft flowing dyeing machines, compacting machines for minimizing residual shrinkage, dyeing machines, computerized colour matching systems, computer embroidery, and stenter machines for removing deformity in knitwear are some of the many new machines that have been bought by the industry.

2.1.1 Description of supply chain / production network

Garment production can be split up into the following steps:

- Yarn manufacturing / spinning mills - Threads are manufactured from cotton
- Knitting process - Machines convert the threads in garment cloth rolls
- Dyeing and bleaching process - In this process, clothes are bleached first as white garments and then colored using dyeing process
- Compacting and calendaring process - In this process, clothes are dried and straightened
- Cutting the cloth - by hand or machine
- Stitching process - Clothes are cut and stitched as garments
- Fabric printing - If required logos and slogans are printed in the screen printing process
- Embroidery process - Embroidery designs are made in clothes if required by the design
- Labeling process - Labels of each brand are stitched in the clothes

- Checking process - Garments are checked for any faults like small holes, scratches, imperfect colour, stitching errors etc.
- Ironing process - In this process, garments are ironed
- Packing and shipment - All garments are uniformly arranged and each piece is packed in a polythene covers and then packed in cardboard boxes. Finally loaded in containers and shipment.

There are an estimated 3,200 small and medium units in the town, which specialize in different aspects of the production process such as dyeing, compacting, knitting, computer embroidery, bleaching, and stitching and finishing. There are a few integrated manufacturing units in Tirupur, with all the activities under one roof. The absence of many large integrated units is partly due to the current government policy and the regulatory framework, which encourages the small-scale sector.

A large majority of units in Tirupur operate on job work basis. The exporters take up job work for brand marketers in developed countries and do not sell their own brands and the exporters are key players in Tirupur Textile industry. The exporters provide design and the fabric is processed in various units from raw material to finished product and the amount is paid based on the quantity, quality, and design for each process step separately. Often, the exporter will buy the yarn and have the material processed by any of the jobbers in the town. The exporters may also have processing facilities.

2.1.2 Products Manufactured

Early in the 80's, export of knitwear, mainly basic T-shirts were made in small quantities. Exports of other knitwear items gained momentum after 1985. In the late 80s, the knitwear industry diversified very quickly and took up manufacture and export of other outer garments, viz, cardigans, jerseys, pullovers, ladies blouses, dresses, skirts, trousers, nightwear, and sportswear.

The knitwear industry in Tirupur has concentrated mainly on the production of garments for the spring and summer seasons. Of late, the industry has diversified its production range to include winter garments, using polar fleece and blended fabrics. At present, winter garments have come to hold a share of 20% in the total production of knitwear in Tirupur and the share of winter garments production is increasing in the cluster due to more demand for the products in the developed countries.

2.1.3 Raw Materials

The main raw material for Tirupur Textile cluster is cotton yarn of different thickness and is supplied by the agents of hundreds of spinning mills located in Coimbatore, Salem, Erode, and other adjoining cities. Several mills have set up their sales depots at Tirupur to provide raw material. Besides, there are also several cotton yarn merchants in Tirupur and Coimbatore. The other raw materials such as buttons, zip, laces, and sewing threads are available locally through specialty stores. Similarly, the dyes and chemicals are also other main raw materials for these units that are manufactured mainly in Gujarat and Maharashtra and are available through company's sales depots and through merchant's dealers in Tirupur itself.

2.1.4 Classification of Units

Textile units in Tirupur are classified based on the type of operation as well as production capacity.

Type of Operation

The units in Tirupur Textile cluster are engaged in six different types of operations; those are:

- Dyeing
- Compacting
- Knitting
- Embroidery

- Bleaching
- Stitching and finishing

The distribution of 3,200 textile units in Tirupur by type of operation of the unit is given below in Table 2.1.

Table 2.1: Distribution of units based on type of operation

Type of Industry/Activity	No. of Industries
Dyeing	570
Compacting	250
Knitting	750
Embroiding	1000
Bleaching	150
Stitching and finishing	500
Total	3,200

The percentage distribution of units in Tirupur Textile cluster based on type of operation is shown in Figure 2.1 below.

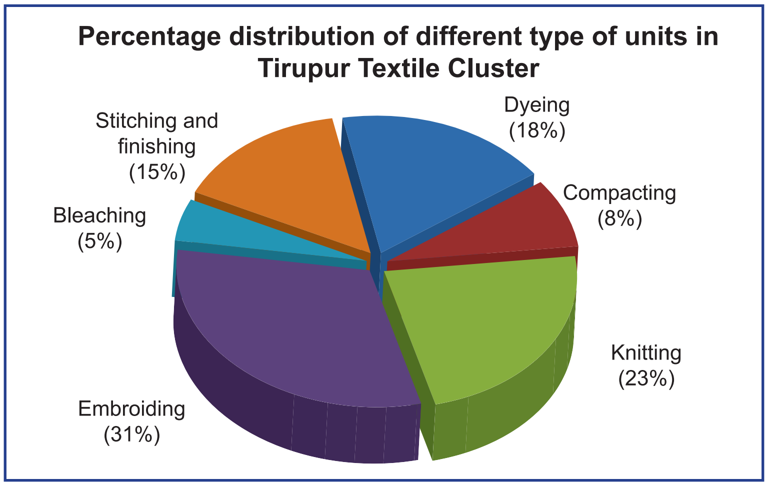


Figure 2.1: Distribution of units by type of operation

Production capacity

The classification of textile units in Tirupur cluster based on production capacity is furnished below in Table 2.2

Table 2.2: Distribution of units based on production capacity

Type of industry/Activity	No. of units (% share)	Production Range (TPA)
Dyeing	313 (55%)	1,000-3000
	256 (45%)	3,000-6000
Subtotal	569	
Compacting	163 (65%)	1,000-1500
	87 (35%)	1,500-4000
Subtotal	250	
Knitting	450 (60%)	1,000-1500
	300 (40%)	1,500-3000
Subtotal	750	
Embroidering	1,000	--
Bleaching	150	500-1,000

Annual Energy Bill

The annual energy bill of the units depends on the size of the plant and type of activity. The percentage distribution of units in Tirupur cluster based on annual energy bill of the units is furnished below in Table 2.3 and Figure 2.3.

Table 2.3: Distribution of units based on annual energy bill

Energy Bill per annum (₹ lakhs)	No. of units	Percentage (%)
Below 15	1,700	53
15 to 20	685	21
Above 20 lakhs	815	26

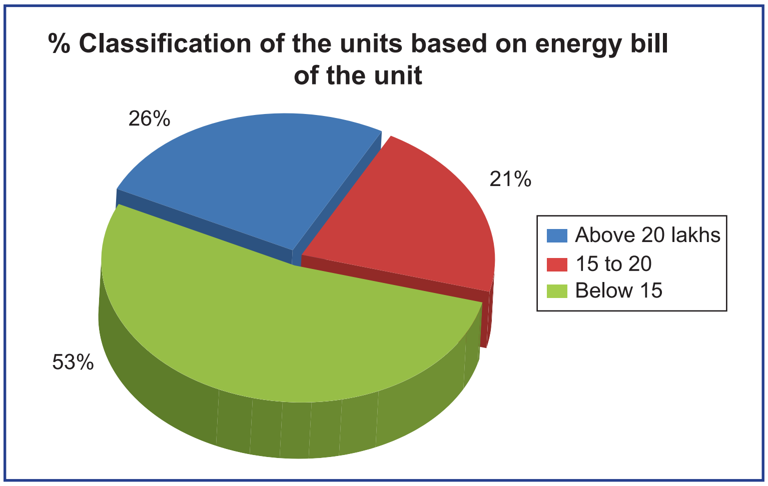


Figure 2.2: Distribution of units based on annual energy bill

2.2 Energy Situation in the Cluster

Major energy sources being used in Tirupur Textile cluster are electricity and fuels such as firewood, furnace oil, HSD, coconut husk, and LPG. The use of energy sources by units depend on the type of operation of the unit, equipment employed, and process adopted. A large majority of textile units in the cluster requires both electrical and thermal energy except for those units engaged in computer embroidery, stitching and finishing, which require electricity only. The fuels are used mainly for steam generation in boilers, thermic fluid heaters, heat setting, stenters, and stoves (chulhas). Electrical energy is being used for running the electrical utilities like blowers, pumps, air compressors, machine drives, and for process equipment.

The energy sources used by different types of units in Tirupur Textile cluster are furnished in Table 2.4.

Table 2.4: Energy source used by different types of units

Type of Industry/Activity	Energy source
Dyeing	Electricity & Thermal
Compacting	Electricity & Thermal
Knitting	Electricity
Embroiding	Electricity

2.2.1 Fuels used

The units of Tirupur Textile cluster use a variety of fuels to meet their thermal energy requirements. The landed price and gross calorific value of these fuels are presented in Table 2.5.

Table 2.5: Price & gross calorific value of fuels

Fuel used	Cost of fuel (₹/unit)	Unit	Gross Calorific value (kCal/unit)
Firewood	3	kg	3,800
HSD	45	litres	10,000
Coconut husk	2	kg	4,000
Furnace oil	28	kg	9,300
LPG	33	kg	8,800

2.2.2 Energy consumption

The total annual energy consumption of a textile unit depends on the type of unit/operation, products manufactured, and size of the unit.

The energy consumption in bleaching and stitching & finishing units is negligible and hence not considered in this study for analysis purposes.

The annual electrical and thermal energy consumption in typical textile units of dyeing, compacting, knitting, and computer embroidery are presented in Tables 2.6, 2.7, 2.8, 2.9.

Table 2.6: Annual energy consumption of Dyeing units

Details	Unit 1 (624 TPD)	Unit 2 (1120 TPD)
Annual electricity consumption		
kWh/year	102,128	561,702
lakh kCal/year	878	4,831
Annual fuel consumption		
tons/year	1,040	3,168
lakh kCal/year	41,600	120,384
Total annual energy consumption		
lakh kCal/year	42,478	125,215
Tons of Oil Equivalent (ToE)	425	1,252

Table 2.7: Annual energy consumption of Compacting units

Details	Unit 1 (960 TPA)	Unit 2 (1920 TPA)
Annual electrical energy consumption		
kWh/year	63,830	1,20,000
lakh kCal/year	549	1,032
Annual fuel consumption		
tons/year	450	750
lakh kCal/year	17,100	28,500
Total annual energy consumption		
lakh kCal/year	17,649	29,532
ToE	176	295

Table 2.8: Annual energy consumption of Computer Embroidery units

Details	Unit 1* (2,000 TPA)	Unit 2 (3,000 TPA)
Annual electrical energy consumption		
kWh/year	46,080	66,000
lakh kCal/year	396.2	567.6
Annual thermal energy consumption	Nil	Nil
Total annual energy consumption		
lakh kCal/year	396.2	567.6
ToE	4	5.7

**Lower annual production*

Table 2.9: Annual energy consumption of Knitting units

Details	Unit 1 (450 TPA)	Unit 1 (1500 TPA)
Annual electrical energy consumption		
kWh/year	2,23,404	3,82,979
lakh kCal/year	1,921	3,294
Annual thermal energy consumption	Nil	Nil
Total annual energy consumption		
lakh kCal/year	1,921	3294
ToE	19	33

The aggregate annual energy consumption for different categories of units in Tirupur Textile cluster is estimated and the summary of the same is presented below in Table 2.10:

Table 2.10: Aggregate annual energy consumption of different types of units

Type of unit	Energy consumption (toe)	Number of units	Total Energy consumption (toe)
Dyeing	1252	570	713,640
Compacting	295.5	250	73,875
Knitting	33	750	24,750
Computer Embroidery	5.7	1,000	5,700
Total	---	2,570	817,965

As can be seen from Table 2.10, the total annual energy consumption of Tirupur Textile cluster is approximately 817,965 toe. As discussed above, the energy consumption in bleaching and stitching units is negligible and hence not considered in the total energy consumption of the cluster. The percentage share of total energy consumption by different unit types in Tirupur Textile cluster is presented below in Figure 2.3.

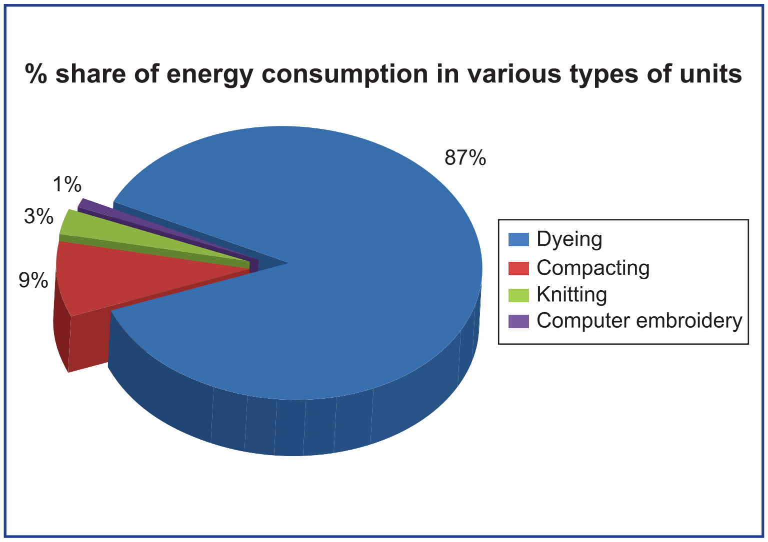


Figure 2.3: Percentage share of energy consumption by different type of units

2.2.3 Specific Energy Consumption

The specific energy consumption for different types of units of the cluster namely Compacting, Dyeing, Embroidery, and Knitting is estimated and furnished below in Table 2.11:

Table 2.11: Specific energy consumption of units

Type of Unit	Specific power consumption (kWh/kg)	Specific fuel consumption (kg/kg)	Electricity cost per kg (₹/kg)	Thermal energy cost per kg (₹/kg)	Total energy cost per kg (₹/kg)
Compacting	0.05	0.38	0.23	1.14	1.37
Dyeing	0.71	4.0	3.3	12	15.3
Embroidery	0.12	--	0.56	--	0.56
Knitting	0.26	--	1.2	--	1.2

2.3 Manufacturing Process

The production process and major steps involved in Tirupur Textile cluster is furnished below for different types of activities, namely, knitting, dyeing, compacting, and embroidery. The process adopted is almost similar in all units for a particular activity. However, depending on the final product, quality of final product, and raw material properties, the process flow is altered to suit the requirements. The typical process employed for various types of industries is furnished below:

Knitting

Knitting is the process of looping and inter-looping or inter-meshing the loops to form a fabric. The advent of knitting machine enhanced the speed of production and different designs. Knitting is becoming more and more popular because of the low cost of production and also of its single stage ornamentation. There are mainly two types of knitting, namely, weft knitting and warp knitting. The process diagram showing different stages of knitting operations is presented below in Figure 2.4.

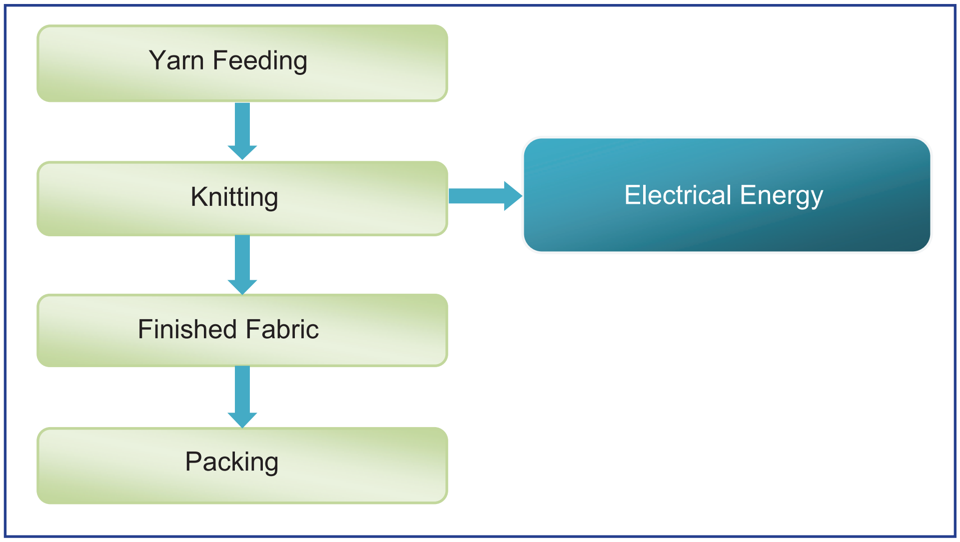


Figure 2.4: Typical production process employed by knitting units

Dyeing

The fabric scouring and cleaning is carried out in soft flow machines. Fabric scouring is done mainly to remove the oily substances, nitrogenous compounds, waxes and proteins and natural coloring material from the fabric by treating it with hot alkaline liquors containing other required chemicals like wetting agent, defoamer, detergent, and stabilizer.

Initially, the soft flow machines are filled with required quantity of water and after attaining required temperature the fabric is loaded. The temperature of the liquor is raised by addition of indirect steam. When the temperature reaches 90–120^{o}C, the required chemicals like bleaching chemicals (Hydrogen peroxide) and brightening agent) are added and the water is completely drained after the process is completed.

The dyeing is carried out in the soft flow machines. The temperature of the solution is raised to 50^{o}C and concentrated dyestuff solution is prepared separately and is added to the liquor. After Dyes addition, the temperature is raised to 90^{o}C and is maintained at that temperature for 60 minutes. The normal batch time for complete washing, bleaching and dyeing process is varies from 10 to 12 hours depending on the fabric GSM and the normal material to liquor ratio is 8 for all old machines. Four cold washes and four hot water washes are carried out for each batch. After completion of the process, the fabric is unloaded and loaded in the centrifuges for removal of water and is then dried in open atmosphere.

After whitening/dyeing the fabric is unloaded from the machine and is first taken to the folding and rolling machines for improving the width of cloth which gets shrunk during the washing and dyeing process. Then the fabric is taken for heat setting.

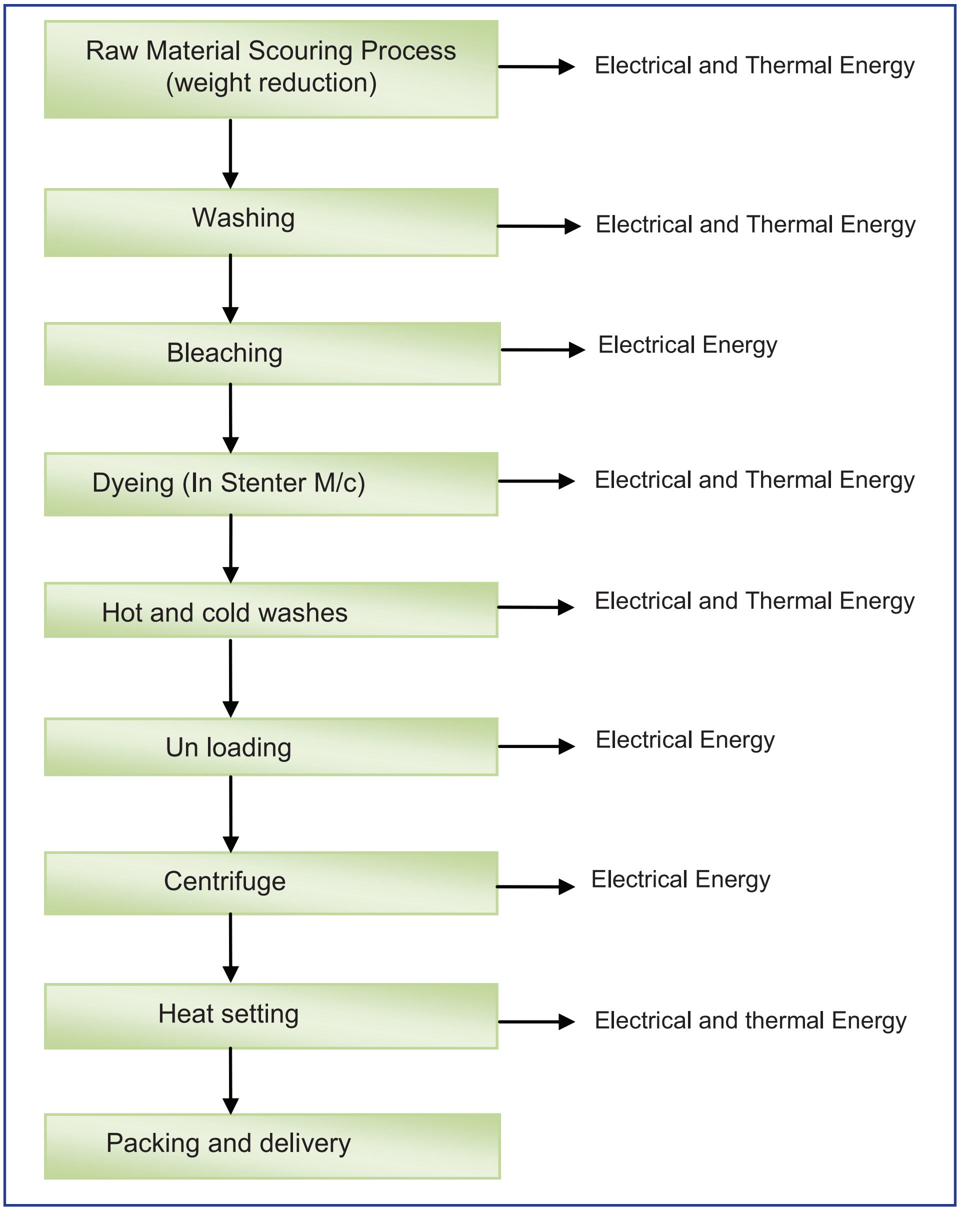


Figure 2.5: Production process in Dyeing units

Compacting

The dyed fabric is supplied by the traders for compacting of the fabric on job work basis. The dyed fabric is symmetrically folded in different layers by using the folding machine. The fabric is then fed in to the compacting machine where ironing and sizing is carried out. The purpose of the compacting is to remove the folds and enlarging the fabric and this is carried out by steaming and pressing. The steam is sprayed on the fabric for improving the quality of pressing.

The pressing is carried out by steam passing through a jacketed cylinder and where the fabric is pressed in between the rollers. The temperature is maintained about 90–130 ^{0}C and depends on the type of fabric to be finished. The compressed air is used for controlling the temperature control valves and for cleaning of fabric from dust and other particles. After completion of the compacting process, the fabric is then passed through folding machine, where fabric is folded and taken for packing and is taken for further process in other units.

The typical process employed for fabric compacting is shown below in Figure 2.6.

Dyed cloth

Folding Machine

Compacting

Finishing

Figure 2.6: Typical production process in Compacting Units

Embroidery

The customer will provide the design required for embroidery work to be done on the fabrics like sarees, shirts, kids wear and under wears. The embroidery work is done on job work basis and price depends on the size and design. The sized fabric will be provided by the customer along with designed sample piece. Based on the design required, the design is developed by the outside designer specialists and design is installed in the software of the machine.

The embroidery is carried out in the embroidery machine automatically through computer operated system. At a time, the embroidery work is carried out on 20 to 30 pieces at a time depending on the size and type of computer embroidery machine. After the batch is completed, the next batch of the fabric is loaded on to the machine. After completion of embroidery on the machine, the embroidery is finally finished manually by hand scissors. The time required for each batch depends on the type and size of the embroidery work. About 4 people work on the machine for loading, unloading, finishing and operation of the machine.

The process employed in Tirupur cluster by embroidery units is presented in Figure 2.7.

Initial Product

Embroidering

Finishing

Finished Product

Figure 2.7: Production Process in Embroidery work

2.4 Current Policies and Initiatives of Local Bodies

No policies are currently available for energy conservation and efficiency projects. The energy audit is mandatory for the industries having 500 kVA contract maximum demand by an empanelled consultant of the SDA.

2.5 Major Barriers for Implementation of Energy Efficiency

2.5.1 Energy Availability

The main energy sources used in the cluster are wood, HSD, furnace oil, coconut husk, LPG, and electricity. Though, electricity is available, the cluster units are facing power cuts imposed by state electricity board and also power shortage hence, the units depend heavily on diesel generators, which is costly. A large majority of the units have installed diesel generators in the cluster.

The existing textile units use wood and furnace oil for boilers and thermic fluid heaters. Wood is used by all the cluster units due to ready availability leading to heavy cutting of trees hence de-forestation. The use of these fuels create environmental problems such as high flue gas emissions, suspended particulate matter, fly ash, and sulphur dioxide emissions to the atmosphere, and also create health problems for workforce as well as people residing nearby.

2.5.2 Technological issues

The processes to do with technology and innovations in SMEs are different from those that take place in large industries. Technology in the SME sector has an increasingly complex or combinative character, and most of the SMEs units in cluster are regarded for their labour intensive and the capability to work with local resources. In the past, SME entrepreneurs have given less emphasis to technology in order to reduce initial cost of plant /machinery. Major barriers in up-gradation of technology in the cluster are:

- Lack of awareness on energy efficiency
- Lack of organizational commitment
- Narrow focus on energy
- Not clear about their existing level of operations and efficiency, due to lack of instrumentation & non availability of energy consumption data
- Limited manpower
- Cost of energy conservation options
- Orthodox mind set of entrepreneurs
- Non availability of clean fuels

Details of the other barriers in the implementation of energy efficient technologies / equipment in the cluster are presented in sections below.

2.5.3 Lack of Technical know-how and Organizational capacity

The majority of the textile unit owners do not have in-depth technical expertise, knowledge, or training about energy efficiency, and are dependent totally on local technology suppliers or service companies, who normally rely on established and commonly used technology. The lack of technical know-how made it impossible for the textile unit owners to identify the most effective technical measures. Though, some of the SME owners are interested in implementing energy efficiency measures, the lack of knowledge and technical know-how, made them to depend on the local suppliers.

These however can be overcome by motivating them to attend the awareness programs and detailed reports on the benefits of the measures identified and cost benefit analysis. Further, sourcing of expertise on maintenance service provider or training by the equipment supplier will definitely overcome the barriers.

2.5.4 Financial Issues

About 30% of the units in the cluster have good financial strength and are implementing various energy efficiency measures. The remaining 70% of the units in the cluster do not have adequate financial strength to implement the identified EE measures as it requires considerable investment. Such amount of significant investment is not commonly seen in the cluster units, as these industries have low financial strengths.

Further, from the business perspective of SMEs, it is more viable, assured, and convenient to invest in project expansion for improving the production capacity or quality, rather than make piecemeal investment in retrofit and replace options for energy savings.

Investment returns on large capacity addition or technology adoption shows up prominently in terms of savings and helps in benchmarking operations. Further, there is a strong feeling among the industry owners that, energy conservation-initiatives of replacement and retrofit nature is not a common practice as it involves large capital investment against low returns. In view of this and given the limited financial strength of the textile mills, it is clear that the operators would not have taken up the risks to invest in energy efficiency measures.

2.5.5 Scarcity of technical manpower

Skilled workers are locally available to run the machines in the cluster. However, the qualified technical personnel are not available in the cluster and most of them are working on the machines and process based on their experience and not based on their qualification thus the production process remains traditional even today as the same old practices are being followed by a vast majority of the units in the cluster. This is one of the lacunae of the cluster.

Specialized training with local service providers for better operation and maintenance of equipments, importance of the energy and its use will create awareness among workforce. These programs should be organized with equipment suppliers.

CHAPTER 3

Energy Audit and Technology Assessment Study

3.1 Methodology adopted for energy use and technology audit studies

A well planned methodology was adopted to execute the energy use and technology audit studies and to achieve the desired project objectives. Major steps, which were followed during the energy use and technology assessment studies for the representative units, are mentioned below:

- Discussions with the industry representatives/local industry association
- Inventorization of the units so as to understand their energy consumption pattern
- Selection of suitable representative units for carrying out energy use and technology assessment studies

The primary objective of the energy audits is to quantify the existing fuel consumption pattern and to determine the operating efficiencies of existing systems. The key points targeted through energy audits were determination of specific fuel consumption, various losses, operational practices like hot metal temperature, existing air-fuel ratio, and blower and burner parameters. Pre-planned methodology was followed to conduct the energy audits. The following sections describe details of methodology adopted in energy use and technology audits in Tirupur textile cluster.

3.1.1 Pre-energy use & technology audit studies

There are number of associations in Tirupur Textile cluster based on the type of the process adopted like dyeing, compacting, knitting, and embroidery. The active industry associations working in the cluster are furnished in Table 3.1.

Table 3.1: Active industry associations in Tirupur Textile Cluster

S. No.	Associations
1.	Tirupur Exporters Association (TEA)
2.	Dyers Association of Tirupur
3.	Computer Embroiderers Association
4.	Tirupur Industrial Federation
5.	Tirupur Bleachers Association

The association provides a platform for development of mutual understanding among the industries and discussion relating to common problems and identification of viable solution and also acts as coordinator between the cluster units and various government agencies. Therefore, as a first step for initiating the studies in the cluster, the association, and its office bearers were approached. Detailed discussions with the association were held on apprising the association about the objective of the project, tentative schedule of the activities being undertaken and expected project outcome and how the program will benefit the SME unit owners in the cluster

The office bearers of associations were apprised about benefits of the project for the industries and cluster. The association took up the task of dissemination of all this information among their respective member units. The outcome of this activity was introduction of project concept to the association and later on to the industry. This helped in identifying progressive and interested entrepreneurs in the cluster.

3.1.2 Preliminary energy audit studies

The methodology followed in preliminary energy audit study is presented below:

- Collection of past energy consumption details and energy bill
- List out major energy consuming areas of the plant
- Existing technology of various processes and utilities (latest or old, crude or efficient, local or reputed company make etc)
- Identification of the areas for special attention for low cost measures with quick payback period
- Understanding the detailed process with energy and material balance
- Establish specific energy consumption, if possible for each typical equipment/process
- Identify the areas for detailed energy audit study and measurements required

3.1.3 Detailed energy audit studies

The methodology adopted in detailed energy audit study is presented below:

- Collection of past energy consumption details and energy bill
- Listing of major energy consuming areas of the plant
- Identifying existing technology of various processes and utilities (latest or old, crude or efficient, local or reputed company make etc)
- Status of instruments installed in the plant and necessary instrumentation required for the detailed study
- Identification of the areas for special attention for low cost measures with quick payback period
- Understanding the detailed process with energy and material balance
- Monitoring and measuring different parameters of various equipment / machines to evaluate performance
- Collection of operational data from various measuring instruments / gauges installed in the plant
- Compilation of design data/name plate details of various equipment from design manuals and brochures
- Discussions with concerned plant personnel to take note of operating practices and shop-floor practices being followed in the plant and to identify specific problem areas and bottlenecks if any with respect to energy consumption
- Critical analysis of data collected and parameters monitored
- Identification of energy wastage areas and quantification of energy losses
- Identification of suitable energy conservation measures for reducing energy consumption

3.1.4 Technology Audit

The methodology adopted for conducting technology audit is as follows:

- Identify major equipment and technologies of the plant
- Whether the equipment installed is local make or reputed company make
- Various energy sources available in the vicinity of the cluster
- Energy use and specific energy consumption details
- Identify major constraints for installing energy efficient equipments
- Whether energy efficient equipment suppliers are available locally and identify the suppliers
- The strategy followed for selection of equipment suppliers by the management
- Any research or survey carried out prior to selection of the technologies adopted and available
- Detailed interviews with the management for the interest in adopting new technologies for efficiency improvement
- Financial strength and investment that can be made for the improvement of energy efficiency by the unit management.

A total of 75 detailed energy use and technology audits were conducted in the Tirupur textile cluster covering all types and sizes of the industries.

3.2 Observations made

A comprehensive study of the units carried out by WII in Tirupur Textile cluster has revealed the following important points:

- The status of some of the technologies installed like thermic fluid heaters, boilers, dyeing machines, compressors, pumps, steam distribution system is poor as compared to the technologies and practices / equipment available in the market today. Various technological gaps have been identified in the units and these may be due to lack of awareness on the technologies available and non availability of local service providers (LSPs) or equipment suppliers.
- Though, the management of the units is interested in implementation of EE measures, the energy loss areas and EE technologies could not be ascertained by the management or LSPs for implementation due to lack of awareness. Hence, the unit owners are depending entirely on the local technology suppliers for their low cost and their availability so far.
- The textile mills have limited technology innovation and low R&D base as well as low level of human resource on knowledge of technology, and operational skill. The sector faces deficiencies such as inadequacies of strong organizational structure, and professional attitude.

3.2.1 Energy Consumption Profile

The major energy consuming equipment of textile units of different types in Tirupur cluster are as follows:

- **Dyeing**
  - Steam boilers
  - Thermic fluid heaters
  - Soft flow machines
  - Pumps
  - Air compressors
  - Other utilities

- **Compacting**
  - Compacting Machines
  - Steam Boilers
  - Pumps
  - Other utilities
  - Air compressors

- **Computer Embroidery**
  - Embroiding Machines
  - Air conditioners
  - Other utilities

- **Knitting**
  - Knitting machine
  - Air compressors
  - Other utilities

3.2.2 Capacity Utilization

The capacity utilization is above 80% for all the units surveyed. The high capacity utilization is due to the prevailing high market demand for the products from the cluster. However, Dyeing units having no effluent treatment plant (ETP) are permitted to operate for three or four days in a week by the State Pollution Board. The units having effluent treatment plant are operated for five days in a week.

3.2.3 Operational Practices

Majority of the units of Tirupur cluster are following operational practices in utilities, which are outdated and inefficient. There are no specific and standard procedures followed in any of the units for the operation of equipment/utilities in the units. The workers as well as the management do not have the requisite knowledge / awareness on energy conservation and efficiency. There is no monitoring, documentation, and analysis of fuels or electricity on daily basis in any of the units surveyed. However, most of the units have installed better process control systems for maintaining the quality of the products. By improving the operational practices in utilities in the units of the cluster, efficiency will improve by around 3–5%. Some of the suggested house-keeping practices in this respect are presented below:

- Monitor batch time of each process step of dyeing process in soft machines
- Maintain proper air-fuel ratio in boilers and Thermic fluid heaters
- Install automatic dosing system for dyeing machines
- Digital temperature indicators and automatic controllers in place of human monitoring further reduces the chances of overheating and hence energy and material loss
- Boiler and Thermic fluid heater grates should be opened only when required for fuel feeding
- Better monitoring of material to liquor ratio will reduce water costs and energy costs
- Monitor compressed air generation pressure and fix optimum set point to reduce power consumption of air compressors in dyeing and compacting

3.2.4 Availability of data and information

The data and information pertaining to energy procurement and consumption is available in some of the cluster units. However, the equipment-wise consumption and production data is not available as it is kept confidential.

3.2.5 Any other relevant aspect

Majority of the machine operators and helpers deployed in the cluster are non-technical and illiterate and their knowledge is based on the past experience. They do not have technical skills and knowledge on technical aspects and energy conservation. This is one of the important factors for inefficiency of the process and energy losses in the cluster.

3.3 Technology Gap Analysis

3.3.1 Technology upgradation

The technologies employed for a vast majority of the equipment are outdated as compared to the technologies available in the market. The technological gaps were identified in the units as highlighted below and these may be attributed to the lack of awareness on the technologies available, quantum of energy loss, monetary benefits, and lack of awareness among the workforce.

There is a tremendous need for the industry to modernize / upgrade its technology and adopt energy efficient technologies mainly in utilities. Further, as per the discussions held with the management of the units, they are interested in improving the efficiency of the utilities rather than process equipment.

Most of the units in the cluster adopted advanced equipment in the process for quality and throughput. However, equipment installed in utilities are old and highly in-efficient.

There are many technologies and energy efficient equipment available in the market and LSPs in dealing with these technologies.

3.3.2 Process upgradation

There is considerable potential for process up-gradation in the cluster units for improving the quality and enhancing production. Due to pollution related issues and high water cost for Dyeing units, the unit owners are gradually diversifying to latest technologies like low material to liquor ratio soft flow machines. In Tirupur Textile cluster, the unit owners are adopting latest technologies for the process equipment to withstand in the international market and due to market demand for better quality products. However, about 50% of the unit owners are not willing for process upgradation due to high investment and low returns.

From technology audit studies conducted in Tirupur Textile cluster, the areas identified for technology upgradation are as follows:

- Soft flow machines
- Boilers
- Thermic fluid heaters
- Pumps
- Air compressors
- Blowers
- Conventional Chulhas
- Heat setting machines

Technical gap analysis for the above described equipment is presented in Table 3.2 below.

Table 3.2: Technology gap analysis and recommended interventions

Equipments	Technology Gaps Identified	Technology Interventions
Softflow machines	High material to liquor ratio High water consumption and hence high water cost High fuel and electricity consumption High quantity of effluents generation and high treatment cost and environmental problems Hot water generated after completion of the process is drained to ETP	Install low material to liquor ratio soft flow machines. Energy efficient and reputed branded make pumps Waste heat recovery from hot drained effluents
Boilers	Old boilers Single or two pass system High flue gas losses Non water walled chambers Low loading of the boilers	New energy efficient boilers
Thermic fluid heaters	Heat generation by use of HSD is expensive	Install wood gasifiers for reducing fuel cost
ID and FD fans	No Speed control for ID and FD fans The air flow is adjusted by mechanical dampers	Install VFDs for ID and FD fans
Thermic fluid heater	No speed control for ID and FD fans No speed control for thermic fluid circulation pump	Install VFDs for ID and FD fans. Install automatic oxygen trim system Optimization of Thermic fluid pump speed by installing VFD
Boiler feed water pumps	Pumps are local make and are inefficient	Install energy efficient vertical pumps (Grundfos or CRI make)
Air compressors	Low output than the rated capacity Air is generated at higher pressure than required	Install new screw compressors Optimize air generation pressure

Equipments	Technology Gaps Identified	Technology Interventions
Chulhas	Low efficiency High radiation losses from all the sides No proper air circulation No waste heat recovery	Install new improved design chulha developed by WII
Boilers and thermic fluid heaters	High temperature flue gases is vented to the atmosphere without any heat recovery	Install waste heat recovery system such as Economizer or Air Pre-heater
Air conditioners	Air conditioners installed are non star rated and hence more power consumption	Install five star rated air conditioners
Grid electricity and steam generation in boilers	High cost and low efficiency	Install cogeneration system for steam and electricity generation wherever feasible.

3.4 Energy Conservation Measures Identified

3.4.1 Description of proposals including technology/product specifications

From technology audit studies conducted in Tirupur Textile cluster, the following areas are identified for reducing energy consumption in different types of units of the cluster and the proposals comprise of high, medium, low, and zero investment measures including good housekeeping:

- **Dyeing units**
  - Low material to liquor ratio soft flow machines
  - Heat recovery from hot drained water
  - Wood gasifiers
  - Energy efficient boilers
  - Energy efficient Thermic fluid heaters
  - Energy efficient pumps
  - Variable frequency drives
  - Waste heat recovery systems

- **Compacting units**
  - Condensate recovery and re-use
  - Waste heat recovery systems for hot water generation
  - Energy efficient boilers
  - Solar hot water systems
  - Screw compressors
  - Variable frequency drives

- **Computer embroidery units**
  - Five star rated air conditioners

- **Knitting units**
  - Screw compressors

- **Other energy saving proposals**
  - Wood gasifiers

- Energy efficient stenters
- Improved chulha
- Solar hot water systems

3.4.2 Energy efficient Boilers

The boilers are installed for steam generation in Dyeing and Compacting units. Based on detailed studies carried in representative units, some of the boilers were found to be inefficient due to inferior design like single/two pass system, high flue gas losses, no waste heat recovery system, low loading, and high radiation losses with thermal efficiency below 40%. The thermal efficiency of the boilers is found to be low due to the following reasons:

- High surface radiation losses, as the insulation was poor and damaged at many locations of the boiler
- Boilers are of two pass system only, hence less heat transfer and high flue gas losses
- Boiler feed water is not treated in smaller capacity boilers and municipal water is directly feed to the boiler and scale formation of heat exchanger tube surfaces had been observed and hence less heat transfer
- No waste heat recovery and high temperature flue gases is vented to the atmosphere
- No control over fuel feeding and high radiation losses from grate opening.

Boilers with thermal efficiency of 75%, which are available in the market, are suggested for replacing the present in-efficient boilers. The features of high efficiency boilers are as under:

- The boiler is of three-pass construction consisting of furnace section as first pass and two convective tubular pass
- The boiler is fully wet back construction, which is located in the rear of the furnace effectively, quenches streaks of flame entering it ensures complete turnaround mixing of the gases prior to entering the second pass
- The front smoke box also ensures complete turnaround and the mixing of the gases prior to entering the third and final pass of the smoke tubes
- The bigger diameter smoke tube ensure smooth passage of flue gases and prevent choking, clinkering at the tube ends. Further it makes cleaning easy
- Fuel firing system consists of fixed grate made of heat resistance, cast iron, complete with furnace refractory for reducing radiation losses
- Adequate heating surface ensures guaranteed performance
- Adequate grate area and furnace volume to ensure safe grate loading and furnace heat loading
- Optimum gas velocities are maintained to ensure minimum pressure drop on gas side and most effective heat transfer
- The staggered tube arrangement in convective zone ensures effective water circulation and hence heat transfer
- MS hinged door, completed insulated with heat resistance refractory provided for easy access to the smoke side of the boiler
- Compact, quick steaming, sturdy and dependable, this units are simple to install.

The select technical details of the proposed energy-efficient boilers are furnished in Table 3.3.

Table 3.3: Select technical details of energy-efficient boilers

Boiler capacity	200 kg/hr	3000 kg/hr
Steam output (kg/hr)	200	3000
Fuel	Wood	Wood
Steam pressure (kg/cm^2)	10.5	10.5
Efficiency (%)	70	75
Fuel consumption (kg/hr)	75	375
Electrical load (kW)	2.2	10
Application	Compacting units	Dyeing units

- **Benefits**
  - Reduces fuel consumption and faster generation of steam
  - Reduces GHG emissions
  - The boilers will have heat recovery unit, hence improves efficiency of the system
  - Improves working environment for workers due to reduction in radiation losses and flue gas temperatures
  - Barriers in implementation
  - High initial investment
  - Lack of awareness of energy losses in the present system
  - Lack of trained boiler operators
  - Lack of interest for implementation

- **Cost benefit analysis**

Cost benefit analysis of replacing the inefficient boilers with new energy efficient boilers in Compacting and Dyeing units is furnished in Table 3.4 and 3.5 respectively.

- **Compacting Unit**

Table 3.4: Cost benefit analysis of replacing old boiler with energy efficient boiler in a Compacting unit

Details	Units	Value
Rating capacity of boiler	kg/hr	200
Rated pressure	kg/cm^2	10.5
Efficiency of existing boiler	%	49
Efficiency of the new energy efficient boiler at 70% load	%	70
Annual fuel consumption of existing boiler	tons/year	576
% Savings expected	%	30%
Fuel savings per annum	tons/year	172
Cost of the fuel	₹/ton	2,000
Monetary savings per annum	₹ lakhs/year	3.44
Investment required for new boiler	₹ lakhs	4.00
Simple payback period	Years	0.8

- **Dyeing**

Table 3.5: Cost benefit analysis of replacing old boiler with energy efficient boiler in a Dyeing unit

Details	Units	Value
Rating capacity of boiler	kg/hr	6,000
Rated pressure	kg/cm^2	10.5
Efficiency of existing boiler	%	58
Efficiency of the new energy efficient boiler	%	70
Annual fuel consumption of existing boiler	tons/year	3,168
% Savings expected	%	16.00
Fuel savings per annum	tons/year	506.9
Cost of the fuel	₹/ton	3,000
Monetary savings per annum	₹ lakhs/year	15.2
Investment required for new boiler	₹ lakhs	30.0
Simple payback period	Years	2.0

3.4.3 Wood Gasifiers

In Tirupur cluster, there are number of heat setting units where hot air is generated in HSD fired thermic fluid heaters. The operational cost of HSD fired thermic fluid heater is high due to high fuel cost. It is recommended to install wood gasifier for thermic fluid heater, where the gas generated in wood gasifier is combusted for the heat generation for heating the thermic fluid oil.

- Benefits
  - Low energy cost
  - Low flue gas losses hence more efficiency
  - Reduces GHG emissions
  - Low operating costs
  - Reliable, continuous delivery of cost effective energy, and reduces dependence on fossil fuels
- Barriers in implementation
  - High initial investment
  - Lack of awareness of the wood gasifier in the cluster units
  - Lack of awareness on the financial benefits of the wood gasifier
- Cost benefits analysis
  - Cost benefits analysis of replacing the HSD fired thermic fluid heater with wood gasifier for a typical unit of heat setting is furnished in Table 3.6.

Table 3.6: Cost benefit analysis of wood gasifier in a Heat Setting Unit

Details	Units	Value
Capacity of the thermic fluid heater	kCal/hr	400,000
No. of hours of operation per annum	hours	7,200
HSD consumption per day	litres/day	1,080
HSD consumption per annum	litres/year	324,000
HSD bill per annum	₹ lakhs/year	123.12
Wood gasifier		
Wood consumption for the same heat output	kg/year	1,134,000
Wood cost	₹/kg	3
Wood bill per year	₹ lakhs/year	34.02
Extra manpower required	Persons	6
Salary per month	₹/month/person	6,000
Annual manpower cost	₹ lakhs/year	4.32
Electricity consumption	kW/hr	7.5
Electricity consumption per annum for wood preparation	kWh/year	27,000
Electricity bill for wood gasifier	₹ lakhs/year	1.27
Total energy and operation cost for gasifier	₹ lakhs/year	39.61
Net monetary savings	₹ lakhs/year	83.51
Investment required for wood gasifier	₹ lakhs	22.00
Payback period	Months	3

3.4.4 Variable Frequency Drives (VFD)

Based on the detailed energy audits conducted in the cluster, for more than 90% of the units having boilers or thermic fluid heaters, the air flow of the blowers is controlled by mechanical dampers. This mechanical constriction will control the flow and may reduce the load on the fan motor, but the constriction itself adds energy loss, which is obviously inefficient. If the flow can be controlled by reducing the speed of the fan motor would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the fan is reduced, the flow will reduce partially, while the power required by the fan reduces with the cube of the speed.

The flow can be reduced by 10%; the corresponding speed reduction will be 10% of the normal speed; this will reduce the power consumption by 20%. This level of potential energy savings makes the use of VFD to control flow, one of the most cost effective investments in energy efficiency. The typical applications where energy savings can be confidently expected in Tirupur Textile Units, by using VFD, include:

- Induced draft fans and forced draft fans for boilers
- Water circulation pumps
- Stenters and heat setting machine blowers

- Benefits

The benefits of installing the VFD are as follows:

- Reduction in breakdowns and smooth start
- Unity power factor
- Reduction in breakage and motor burnt
- Improved life of the motor and increased production
- Reduction in production cost and maintenance cost due to frequent failures of belts, bearings, yarn breakages
- Improved power factor (0.98 across speed range)
- Maximize power distribution system
- Reduced Inrush Currents
- Minimize Peak Demand Charges
- Soft Start/Soft Stop
- Eliminates Mechanical Shock and Stress on Power Train (couplings, belts, drive shafts, gear boxes, etc.)
- Reduce Utility (Operating) Costs
- Reduced Energy Consumption, Process Operates at Most Efficient Point
- Allows Load Shedding
- Controlled Acceleration and Deceleration
- Eliminates Motor Voltage Imbalance
- Input Power Phase Reversal Protection

- Barriers in implementation
  - Lack of awareness of the VFDs for ID fans and FD fans of the blowers

- Cost Benefit Analysis
  - The cost benefit analysis of installing VFD for a typical unit having boiler where the flow of air is controlled by mechanical dampers is furnished in Table 3.7.

Table 3.7: Cost benefit analysis of Variable Frequency Drives

Details	Value	Units
Rated kW of Boiler ID fan	kW	5.6
Measured kW	kW	5.6
% savings due to VFD	%	20
Power savings	kW	1.02
No. of hours of operation per annum	Hours/year	4,800
Power savings per annum	kWh/year	4,896
Power cost	₹/kWh	4.7
Monetary savings per annum	₹/year	23,011
Investment required for VFD's	₹	25,000
Payback period	year	1.1

3.4.5 Energy Efficient Pumps

The pumps are one of the major energy consuming equipment in Tirupur Textile industries and the pumps are installed for boiler feed water and soft flow circulation. Based on the detailed studies undertaken on the pumps, it is revealed that majority of the pumps installed are of local make and found to be inefficient. KSB, CRI, and Grundfos pumps have higher efficiency than the local pumps as the impellers, diffusers, and shaft of these pumps are made up of AISI stainless steel and designed to deliver best possible hydraulic efficiency. The impellers and diffusers are of best efficiency and extended life. Also, these pumps are powered by a totally enclosed fan cooled, A.C induction motor, suitable for continuous duty. Motor stator is made of low watt loss steel laminations assembled under pressure and rigidly locked in the frame. Dynamically balanced rotor ensures vibration and noise free operations. Shaft is made of quality steel, precision ground of ample size for transmitting the rated Horsepower. The technical specifications of energy efficient pumps for various capacities of boiler feed water pumps are furnished in Table 3.8.

Table 3.8: Technical specifications of energy-efficient pumps for boiler feed water pumps

Model	300 kg/hr	3000 kg/hr
Capacity	5 HP	3 HP
Flow	500	500
Head	100 mH	100 mH
kW of the motor	3.7	2.2
Efficiency	60%	60%
speed	1,440	1,440
Operating temperature	50-90 ^{0}C	50-90 ^{0}C

Source: Grundfos Pumps & CRI

- Benefits
  - Reduces power consumption and hence effects the production cost
  - Low investment and high returns
  - Reduces GHG emissions due to reduction in electricity consumption
  - More discharge for the same power consumption hence reduces processing time
  - Reduces maintenance costs due to improved quality of pump parts
  - Reduces production down time

- Barriers in implementation
  - Lack of awareness of the energy efficient pumps
  - High investment

- Cost benefit analysis
  - The cost benefit analysis of replacing the inefficient boiler feed water pump with new efficient pumps is furnished in Table 3.9.

Table 3.9: Cost benefit analysis of energy efficient pumps

Details	Units	Value
Present efficiency of the boiler feed water	%	7.79
Efficiency of the new energy efficient pump	%	60
% saving expected	%	87%
Power consumption per annum	kWh	7,200
Power Savings per annum	kWh	6,266
Monetary savings per annum	₹	29,449
Investment required	₹	25,000
Payback period	Months	8

3.4.6 Waste Heat Recovery System

Based on detailed energy audit studies undertaken, it has been observed that majority of the boilers and thermic fluid heaters doesn't have waste heat recovery system and the temperature of the flue gases is measured to be above 220 ^{0}C and flue gases are vented to the atmosphere without heat recovery. As the wood is used as fuel, the heat can be recovered from flue gases from 220 to 120 ^{0}C. Hence, it is recommended to install waste heat recovery system for pre-heating the boiler feed water or pre-heating combustion air by using heat available in waste flue gases. This measure will be applicable to those units which may not opt to invest in new boiler in the near future.

- Benefits
  - Reduces fuel consumption
  - Reduces GHG emissions
  - Reduces process time and hence improvement in production
  - Reduces production cost

- Barriers for implementation
  - Lack of awareness

- Cost benefit Analysis
  - The cost benefit analysis of installing waste heat recovery system for generation of hot water is furnished in Table 3.10.

Table 3.10: Cost benefit analysis of installing Waste heat recovery system

Details	Units	Value
Temperature of flue gases	^{o}C	220
Temperature of flue gases after heat recovery	^{o}C	120
Temperature difference	^{o}C	100
% savings possible	%	5
Fuel savings per hour	kg/hr	3
Fuel savings per annum	kg/year	23,040
Fuel cost	₹/kg	2
Monetary savings per annum	₹/year	46,080
Investment required	₹	50,000
Payback period	Years	1.1

3.4.7 Condensate Recovery

In many industries, particularly in some of the Compacting units, there is no condensate recovery in the plant and the condensate is completely drained without recycle /re-use in the plant. It is recommended to recover the condensate and re-use as boiler feed water.

- Benefits
  - Reduces fuel consumption
  - Reduces Water charges
  - Reduces Effluents
  - Maximizes boiler output
  - Improves Boiler feed water quality

- Barriers for implementation
  - Lack of awareness of the losses and benefits of the condensate recovery

- Cost benefit Analysis
  - The cost benefit analysis of condensate recovery and its re-use as boiler feed water is furnished in Table 3.11.

Table 3.11: Cost benefit analysis of installing Condensate recovery system

Details	Units	Value
Quantity of steam generation	kg/hr	125
Quantity of condensate can be recovered	%	80
	kg/hr	100
Temperature of condensate	°C	80
Ambient Temperature	°C	32
Heat value of condensate	kCal/hr	4800
Boiler efficiency	%	39.44
Equivalent fuel savings per hour	kg/hr	3.0
No. of hours of operation per day	hours/day	24
No. of days of operation per annum	days/year	300
Fuel savings per annum	kg/year	21,904
Fuel cost	₹/kg	3
Monetary savings per annum	₹/year	65,713

3.4.8 Install Low Material to Liquor Ratio Soft flow Dyeing machines

In majority of the dyeing units, the dyeing machines are of high material to liquor ratio, which requires considerable quantity of water, fuel, and power consumption. Further, the effluents generation is also high and therefore increases treatment costs. Hence it is recommended to install new low material to liquor ratio soft flow machines for reducing water cost, fuel consumption, and power consumption.

- Benefits
  - Reduces water costs
  - Reduces water treatment cost
  - Reduces fuel and electricity consumption
  - Reduces chemicals and dyeing agents
  - Reduces operating cost of ETP
  - Reduces pollutants
  - Enhances the production
  - Low batch time.

- Barriers for implementation
  - High initial investment
  - Low financial strength of SME owners
  - Lack of awareness of the new machines.

- Cost benefit Analysis
  - The cost benefit analysis of replacing the high material to liquor ratio with low material to liquor soft flow machines is furnished in Table 3.12.

Table 3.12: Cost benefit analysis: Low Material-to-Liquor ratio soft flow machines

Details	Units	Value
No. of soft flow machines	Nos.	5
Capacity of the dyeing machines	kg/batch	1850
No. of batches of dyeing per day	Nos.	2
% utilization	%	70
Total quantity of dyeing per day	kg/day	2590
Present material to liquor ratio	--	8
Proposed material to liquor ratio for new soft flow machines	--	3.5
Reduction in material to liquor ratio	--	4.5
No. of washes per day	--	8
Quantity of water savings/day	litres/day	93,240
	kL/day	93.24
Water cost	Rs/kL	55
Monetary savings due to reduction in water consumption	Rs/day	5,128.2
Monetary savings due to reduction in water consumption	₹ lakhs/year	12.82
Fuel savings		
Reduction in fuel consumption	%	30
Annual fuel consumption in boilers	tons/year	1,500
Wood savings per annum	tons/year	450
Wood cost	₹/ton	3,000
Monetary savings per annum	₹ lakhs/year	14
Electricity savings		
Power consumption of pumps and stirrer motors of dyeing machines	kW	99
% savings expected	%	20
	kW	19.7
No. of hours of operation per annum	hours	6,000
Power savings per annum	kWh/annum	1,18,614
Power cost	₹/kW	4.7
Monetary savings	₹ lakhs/year	5.57
Total monetary savings per annum	₹ lakhs/year	31.90
Investment required for new dyeing machines	₹ lakhs	156
Payback period	months	59

3.4.9 Hot Drained Water

The soft flow machines in cluster units are operated continuously. As a part of the process, hot water is used in washing, scouring, bleaching, and dying process and hot water is circulated in the dyeing machine in the ratio ranging from 1:8 to 1:10 depending upon the fabric and finishing required. The required hot water is generated by steam in heat exchangers installed in each machine. After completion of each process, hot water at 90 ^{0}C is drained to the ETP. About four hot water washes are carried out for each batch resulting huge quantity of hot water is drained in a day from all the machines and considerable amount of heat is wasted.

The process requires considerable quantities of hot water in various processes such as washing, dyeing and for boiler feed water. Before draining, the hot water can be passed through a heat exchanger to recover heat for generation of hot water and can be used for further process or as boiler feed water.

- Benefits
  - Utilizes heat available in hot drained water of soft flow machines and hence reduces fuel consumption
  - Enhances the production capacity and reduces production cost
  - Improves working environment due to reduction in temperature of hot drained water
  - Low investment and high returns
  - No operation and maintenance costs.

- Barriers in Implementation
  - Lack of awareness of the technology
  - High initial investment
  - Space availability

- Cost benefit Analysis
  - The cost benefit analysis of installing waste heat recovery system from hot drained water is furnished in Table 3.13.

Table 3.13: Cost benefit analysis heat recovery from hot drained water

Details	Units	Value
No. of Soft Flow Machines	6	Nos.
Capacity of the dyeing machines	1,400	kg/batch
No. of batches of dyeing per day	2	Nos.
% utilisation	70	%
Total quantity of dyeing per day	1,960	kg/day
Material to liquor ratio	8	
No. of times hot water washes	4	
Quantity of hot water drained	62,720	liters/day
Temperature of hot water	70	^{0}C
Ambient Temperature	30	^{0}C
Heat available in hot water	2,508,800	kCal/day
% Heat can be recovered	80	%
Quantity of heat can be recovered	2,007,040	kCal/day
Efficiency of the boiler	60	%
Calorific value of wood	3,800	kCal/kg
Equivalent fuel savings	880	kg/day
No. of days of operation per annum	250	days
Fuel savings per annum	220,070	kg/year
	220	tons/year
Cost of wood	3,000	₹/ton
Monetary savings	660,210	₹/year
Investment required	600,000	₹
Payback period	11	months

3.4.10 Solar Hot Water System

In Tirupur Textile Cluster, dyeing and bleaching is carried out in 90 ^{0}C hot water. The solar energy resource in Tirupur is particularly strong. Average daily solar radiation on a collector surface tilted at an angle of 25° to the horizontal is 5.08 kWh/m² per day, equivalent to 1,854 kWh/m² per annum. The system proved to be very satisfactory from environmental, aesthetic, and technical points of view.

The capacity of the solar hot water system is worked out considering the following parameters:

- The aruiooukjlea available on the terrace of the building
- Hot water requirement for dyeing process and bleaching process or can be used as boiler feed water
- Availability of sunny days.

The working of solar water heating system is based on the principles of black body absorption & Heat Transfer. The black surface of the collector absorbs the heat from the solar radiation and transfers it to the water passing through the copper tubes of the absorber panel. Hot water being lighter than cold water rises to the top of the collector and into the hot water tank. This cycle goes on during hours of sunshine (usually between 10 am to 4 pm). At the end of the day the tank is full of hot water at designed temperature.

The hot water at 70 ^{0}C can be generated for about 5 months and water at 55 ^{0}C for 2 to 3 months. The hot water generated from solar hot water system is either used for dyeing/soaping process or as boiler feed water as per the availability and the requirement in the units. The solar hot water systems are available from 100 LPD to 10,000 LPD capacity and the soft loans are available from various financial institutions. The cost benefit analysis of installing solar hot water for a typical requirement of 1,000 LPD is furnished in Table 3.14.

Table 3.14: Cost benefit analysis for Solar Water Heaters

Details	Units	Value
Capacity	litres/day	1,000
Temperature of hot water	^{0}C	70
Water inlet temperature to SHWS	^{0}C	30
Temperature difference	^{0}C	60
Heat required per day	kCal/day	600,000
Efficiency of the present hot water generation	%	15
No. of days per annum	Days/year	150
Wood savings per annum	kg/day / year	21,000
Wood cost	₹/kg	3.6
Monetary savings per annum in lakhs	₹ lakhs / year	0.75
Cost of solar hot water system	₹ lakhs	1.61
Simple payback period	Years	2.1

- Benefits of Solar Hot Water System
  - Solar energy is a renewable energy and is available abundantly
  - Solar Hot water system doesn't require any fuel and hence reduces de forestation due to reduction in wood consumption in the cluster and the biomass residues saved can be used for other productive purposes
  - SHW system uses clean form of energy and doesn't emit toxic gases and protects environment
  - SHW doesn't require manpower for operation and is maintenance free
  - Low margin money and interest rated and the amount saved due to reduction in fuel consumption can be paid as loan installment
  - Subsidy from the central government, if loan is not taken from the financial institution upto 20% of total cost.

3.4.11 Improved Chulha

There are about 56 chulhas in the cluster of various sizes for generating hot water for bleaching. The chulha are of conventional type and are of open firing. Based on detailed studies carried out on chulha, the efficiency was found to be 15%. The low efficiency of the chulha is due to the following reasons:

- Traditional local chulha has no mechanism for air circulation and smoke removal
- Heat losses through the grate openings from the front and back end sides
- No control on air supply for combustion
- Radiation losses from the all sides of the chulha
- Lack of monitoring of wood feeding.

Winrock International India (WII) has developed an improved design chulha. The improved chula is basically a 'Smokeless Chulha', of bigger size with a provision for regular air circulation, damper for regulating the air flow for combustion, optimized furnace area, improved design grate for reducing heat losses, maximum utilization heat in waste flue gases and a chimney for the removal of smoke. These chulhas are easy to construct and training required is minimal. The efficiency of new chulha will be around 30%.

The chulhas are constructed in various sizes as per the requirement of the plant and basic design will be identical and only size of the chulha varies. The efficiency evaluation and cost benefit analysis of improved chulha is furnished in Table 3.15.

Table 3.15: Thermal Efficiency of conventional Chulha

Details	Units	Value
Fuel used		Wood
Quantity of hot water generated	litres/batch	1500
Initial temperature of water	^{0}C	30
Final temperature of water	^{0}C	90
Heat output	kcal/batch	90,000
Quantity of fire wood consumption	kg/batch	150
Quantity of yarn bleaching	kg/day	200
Specific firewood consumption	kg/kg	0.75
Calorific value of fire wood	kcal/kg	4000
Heat input	kcal/day	600,000
Efficiency of the chulha	%	15

The cost benefit analysis by replacing conventional chulha with improved chulha is as follows:

Present wood consumption	:	45 tons/year
Efficiency of the new improved chulha	:	30%
Increase in efficiency	:	15%
Fuel savings estimated	:	50%
Wood savings	:	22 tons/year
Monetary savings	:	₹81,000
Investment required	:	₹25,000
Payback period	:	4 months

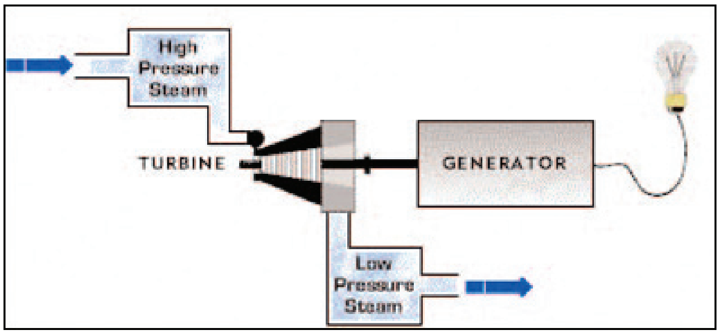
There are about 56 chulhas in the cluster and these chulhas can be replaced with new improved chulhas. The annual fuel savings estimated is 1232 tons of non renewable wood and monetary savings of ₹36.96 lakhs per annum. The total investment required for 56 units is ₹14 lakhs and simple payback period is 4 months.

- **Benefits of New Improved chulha**
  - Easy to construct, operate and repair. Maintenance required is minimal too.
  - Reduces processing time by more than 50% and hence increased production
  - Reduces man hours for the same production and can be utilized for other purposes
  - Improved chulha efficiency will be around 25–30% and thus reduces energy bill by more than 50% and enhances profitability of the company.
  - Payback period is less than 4/5 months
  - Installing a improved chulha would eventually decrease the cutting down of trees, and provide assistance in saving our environment
  - The health of the workers and working environment will be improved

3.4.12 Cogeneration

The Tirupur textile cluster units require significant quantum of thermal energy in the form of steam and electricity. At present, the steam is generated in low pressure boilers and wood is used as fuel in the boilers whereas, electricity is imported from the grid. For a typical industry of production capacity of 3,000 kg/day of processing, about 500 kVA power and about 5 TPH steam is required.

Cogeneration is the concept of producing two forms of energy from one fuel. One of the forms of energy must always be heat and the other may be electricity or mechanical energy. In a conventional power plant, fuel is burnt in a boiler to generate high-pressure steam. This steam is used to drive a turbine, which in turn drives an alternator through a steam turbine to produce electric power. The exhaust steam is generally condensed to water which goes back to the boiler. As the low-pressure steam has a large quantum of heat which is lost in the process of condensing, the efficiency of conventional power plants is only around 35%. In a cogeneration plant, very high efficiency level in the range of 75–90%, can be reached. This is so, because the low-pressure exhaust steam coming out of the turbine is not condensed, but used for heating purposes in factories or houses.



Since cogeneration can meet both power and heat needs, it has other advantages as well in the form of significant cost savings for the plant and reduction in emissions of pollutants due to reduced fuel consumption The co-generation plants are best suited for Tirupur Textile cluster units, as both electricity and thermal energy required is well balanced. The cogeneration plant essentially consists of a high pressure boiler, Extraction cum back pressure or back pressure turbine and alternator of the required capacity. The high pressure steam generated is passed through the turbine- alternator for generation of electricity and the exhaust steam from the turbine at low pressure is used for the process requirement. The schematic diagram of a typical cogeneration system is furnished on the left.

The product specifications for a typical 500 kW cogeneration plant are furnished in Table 3.16.

Table 3.16: Technical specifications of 500 kW Cogeneration plant

S. No	Details	500 kW
1	Boiler capacity (MCR)	6 TPH
2	Pressure and super heat temperature	35 kg/cm^2 & 350 ^{0}C
3	Turbine steam inlet pressure	33 kg/cm^2 & 350 ^{0}C
4	Turbine steam outlet pressure	3.5 kg/ cm^2
5	Quantity of steam inlet	6 TPH
6	Power generated	500 kW
7	Steam available for process requirement	5.5 TPH

Source: Turbotech Precision Engineering Pvt. Ltd

❒ **Benefits**

- Cogeneration is a low-cost future source of power for meeting the in-plant requirements of steam and power
- Augments supply of power in a regime of endemic shortages in the power sector
- Promotes energy conversion efficiency and thereby conserves scarce fossil fuels.
- Ensures reliable, continuous delivery of cost effective power and reduces dependence on fossil fuels.
- Carbon released to the atmosphere as CO_2 by cogeneration is no greater than what would have been produced by alternative methods
- It insulates the Textile units from the undependable utility supplies and reduces production costs considerably

- Cogeneration is a viable strategy to meet future energy needs of the textile sector
- Cogeneration results in benefits of localized power generation, particularly at the tail end of the grid, in terms of zero transmission and distribution losses, reliable and quality power, reduced equipment wear and tear of the transformer taking pressure off from the central grid
- Cogeneration system reduces the GHG emissions offers an environment friendly solution for additional power generation with the same quantity of coal is used for steam generation
- It eliminates foreign exchange out flow as most of the plant and machinery required for co-generation plant, are indigenously available
- Cogeneration plant has a lower gestation period compared to the gestation period of conventional power plants
- It has much lower installation and operating costs compared to the conventional power plants
- Cogeneration plant places no financial and administrative burden on the utility as it is executed and managed by the same units
- The return on investment is attractive with a lower pay back period.

3.4.13 Life cycle analysis for the suggested energy saving proposals

The life cycle analysis for each of the suggested energy saving proposal has been prepared as per the Indian industry norms, government policies, and as per the guarantee provided by the equipment/technology suppliers and presented in Table 3.17.

Table 3.17: Life cycle analysis for energy saving proposals suggested

Energy Saving Proposal	Life cycle analysis
Energy efficient boiler	The life of new energy efficient boiler is considered at 15 years. The depreciation is considered at 5.28% by straight line method.
Wood gasifier	The life of wood gasifier is considered at 15 years and the initial rated efficiency is 70% and the efficiency de-rates by 2% for each year of operation. The depreciation is considered at 80% by straight line method
Variable frequency drive	The life of variable frequency drive is considered at 15 years. The depreciation is considered at 80% by straight line method
Energy efficient pumps	The life of the pumps is considered at 15 years. The depreciation is considered at 5.28% by straight line method
Waste heat recovery from boiler flue gases	The life of the Waste Heat Recovery system is considered at 15 years. The depreciation is considered at 80% by straight line method
Low material to liquor ratio Soft flow dyeing machines	The life of the Low Material to Liquor Ratio Soft flow dyeing machines is considered at 15 years. The depreciation is considered at 5.28% by straight line method
Heat recovery from hot drained water	The life of the Heat recovery system from hot drained water is considered at 15 years. The depreciation is considered at 80% by straight line method
Solar hot water system	The life of the Solar Hot Water system is considered at 15 years. The depreciation is considered at 80% by straight line method
Improved chulha	The life of the Improved Chulha is considered at 5 years. The depreciation is considered at 5.28% by straight line method
Steam based cogeneration system	The life of the boiler, steam turbine and alternator is considered at 15 years. The depreciation is considered at 80% by straight line method

3.4.14 Cost of Implementation

The investment required for various proposals identified for different capacities of the measures identified for Tirupur Textile Cluster is furnished in Table 3.18.

Table 3.18: Details of cost of implementation

Equipment Details	Plant and Machinery (lakh)	Civil Works (lakh)	Electrical works (lakh)	Erection & commissioning (lakh)	Miscellaneous costs (lakh)	Total cost (lakh)
Energy Efficient Boiler						
200 kg	4.00	0.20	--	--	0.11	4.31
1000 kg	8.00	0.20	--	--	0.21	8.41
Wood Gasifier						
0.46 MW	22.00	0.20	--	--	0.56	22.76
Variable frequency drives						
7.5 HP	0.30	-	-	0.05	0.01	0.36
5 HP	0.21	-	-	0.05	0.01	0.27
Energy efficient Pumps						
3 HP	0.20	0.05	-	-	0.01	0.26
5 HP	0.25	0.05	-	-	0.01	0.31
Waste Heat Recovery from Boiler Flue Gases						
0.2 TPH	0.50	--	-	0.02	0.01	0.53
3.0 TPH	2.0	--	-	0.02	0.05	2.07
Low Material to Liquor Ratio Soft flow dyeing machines						
450 kg	60.0	--	--	0.40	1.50	61.9
600 kg	68.0	--	--	0.60	1.70	70.3
1200 kg	88.0	--	--	0.75	2.20	90.9
Heat recovery from hot drained water						
2 KL	4.50	-	-	0.30	0.12	4.92
4 KL	6.00	-	-	0.40	0.16	6.56
Solar Hot Water system						
1000 LPD	1.55	--	--	0.02	0.04	1.61
Improved Chulha						
1500 LPD	0.30	0.25	--	--	0.01	0.56

The details of unit-wise investment required for proposals suggested are furnished in Annexure 6.

3.4.15 Monetary savings & simple payback period

As per the detailed audits carried out on various equipments of Tirupur Textile Units, the monetary savings and simple payback period have been estimated for each proposal and the details are furnished in Table 3.19.

3.4.16 Issues / barriers in implementation of EE proposals

The major barriers identified for implementation of the proposals in the cluster are described as below:

- One of the major barriers is the lack of awareness and information among the cluster owners on energy / monetary losses, EE technologies, and energy efficiency. A few demonstration projects may motivate them to take up the projects
- About 70% of the cluster unit owners doesn't have financial strength for implementation of high cost technologies like gasifiers, energy efficient boilers, heat recovery systems. However, the owners are interested to implement low cost measures having quick payback periods of less than two years
- Though, LSPs are available in the cluster, they don't have technical strengths for supply of efficient equipments
- Production loss during implementation of the energy saving proposals.

Table 3.19: Energy saving details for the suggested energy saving proposals

Equipment Details	Electricity savings (kWh/year)	Fuel savings (tons/year)	Monetary savings (₹ lakhs)	Investment (Rs lakhs)	Simple payback period (months)
Energy Efficient Boilers	--	172	3.44	4	10
Wood Gasifier	--	92	83.51	22	3
Variable frequency drive	4,896	--	0.23	0.25	13
Energy efficient pumps	6,266	--	0.29	0.25	8
Waste Heat Recovery from boiler flue gases	--	23	0.46	0.5	13
Condensate Recovery	--	21	0.65	--	Immediate
Low Material to Liquor Ratio Soft flow dyeing machines	118,614	450	31.9	156	59
Heat Recovery from Hot drained Water	--	220	6.60	6	11
Solar Hot Water System	--	21	0.75	1.61	25
Improved Chulhas		22	0.77	0.25	4

3.5 Availability of technologies in local / national / international market

For majority of the technologies and proposals identified, the equipments suppliers/ dealers / branch offices are available locally in Tirupur and Coimbatore. The high investment technologies like soft flow machines, cogeneration system, high efficiency gas stenters need to be procured from other places like Chennai and abroad. Among the technologies / equipment identified for implementation for Tirupur Textile cluster units, some of the measures can be implemented by the local service providers and the balance equipment can be procured at nearest city i.e., Coimbatore . The details of equipment which can be implemented by LSPs and those needs to be procured from other cities are furnished in Table 3.20.

Table 3.20: Availability of technologies for the suggested EE proposals

Equipment details	Tirupur & Coimbatore	India	International
Wood gasifier		✓	
Heat recovery from hot drained water	✓	✓	
Heat recovery from boiler flue gases	✓	✓	
Condensate recovery	✓	✓	
Energy efficient boilers		✓	
Variable frequency drive	✓	✓	
Energy efficient pumps	✓	✓	
Low material to liquor ratio soft flow dyeing machines	✓	✓	✓
Steam based cogeneration system	✓	✓	
Lighting	✓	✓	

✓ *Available*

3.6 Availability of LSPs for implementation of suggested EE proposals

Details of availability of LSPs for implementation of energy saving proposals identified are furnished in Table 3.21.

Table 3.21: Availability of LSPs for implementation of suggested EE proposals

Equipment Details	LSPs	India	International
Wood gasifier		✓	
Heat recovery from hot drained water		✓	
Heat recovery from boiler flue gases	✓	✓	
Condensate recovery	✓	✓	
Energy efficient boilers		✓	
Variable frequency drive	✓	✓	
Energy efficient pumps	✓	✓	
Low material to liquor ratio soft flow dyeing machines	✓	✓	✓
Reduction of pressure from the compressor	✓	✓	
SWHS	✓	✓	✓
Lighting		✓	
Steam based cogeneration system		✓	

The details of LSP's for each proposal are furnished in Annexure 2.

3.7 Identification of technologies for DPR preparation

The majority of the industries in the cluster are engaged in the processing of cotton fabric and production of T shirts, inner wear, etc. The manufacturing processes and equipment installed are identical for most of the cluster units. Based on the detailed studies carried out, there is considerable potential in all cluster units for energy conservation and efficiency. As the process and equipment are more or less similar in all cluster units, all the technologies / equipment identified can be replicated as per the requirement and detailed project reports for the specific technologies prepared also can be replicated for different units as per the capacity requirement.

The technologies/equipments considered for preparation of detailed project report are furnished in Table 3.22.

Table 3.22: List of technologies identified for DPR preparation

Technology/equipment	No. of DPR's	Capacities
Wood gasifier	1	4 lakh kCal/hr
Energy efficient boilers	2	❑ 200 kg ❑ 1,000 kg
Low material to liquor ratio soft flow dyeing machines	2	❑ 450 kg ❑ 600 kg ❑ 1,200 kg
Energy efficient pumps (boiler feed water pumps)	2	❑ 3 HP ❑ 5 HP
Variable frequency drive	2	❑ 7.5 kW ❑ 5.6 kW
Solar water heating system	1	❑ 1,000 LPD
Economizer	2	❑ 200 kg ❑ 3,000 kg
Hot drained water	2	❑ 2 kL/hr ❑ 4 kL/hr
Energy efficient chulha		❑ 1,500 LPD

Environmental Benefits

4.1 Reduction in waste generation

By implementing various energy saving proposals identified, there is significant reduction in waste generation/ effluents from soft flow machines, washing section, and boiler blow down.

4.2 Reduction in GHG emissions

The major GHG emission reduction source is CO_2 due to implementation of the technologies identified, as the technologies will reduce grid electricity consumption and fossil fuels like coal. The total emission reductions is estimated as 62,580 tons of CO_2 per annum (total grid electricity can be saved is 68 GWh/annum and emission factor is 920 tCO_2/GWh) due to reduction in grid electricity consumption and 501,708 tons of CO_2 due to reduction in wood consumption (quantity of wood savings is 334,472 tons and emission factor for non renewable wood is 1.50 tCO_2/ton of wood). The total estimated CO_2 emission reduction per annum is 564,288 tons of CO_2 in the entire cluster.

4.3 Reduction in other emissions

The technologies identified upon implementation for the Tirupur Textile cluster units will reduce grid electricity and wood consumption. The reduction in grid electricity consumption will reduce sulphur dioxide and SPM emissions to the atmosphere at the power plants.

CHAPTER 5

Conclusions

The level of awareness on energy savings among the SME owners in Tirupur cluster is poor. About 25% of the unit owners have good conscious on energy saving technologies and is limited to some selected technologies like variable frequency drives and waste heat recovery systems but their knowledge on other energy saving technologies like cogeneration system, steam distribution system, selection of traps, energy loss areas in the plant and quantities is poor. The lack of awareness may be due to lack of skilled and technical manpower among other factors. Further, the unit owners do not have interest on costly products, as the same low efficient products/equipments are available at half of the cost.

The energy saving technologies are implemented based on success stories in the cluster units and practical demonstration of the energy saving technologies in the units. Some of the low cost demonstration projects in the cluster may motivate the SME owners in implementation of the energy saving technologies.

5.1 Summary

In this section, the summary of outcome of energy use and technology studies conducted in Tirupur Textile cluster is discussed, which includes identified energy conservation measures, its energy and monetary benefits, payback period, and issues in implementation. The summarized information is furnished in Table 5.1.

Table 5.1: Energy conservation measures, its energy and monetary benefits, payback period and issues in implementation

Energy conservation measure	Annual Energy/Fuel savings	Annual Monetary saving (₹ lakhs)	Implementation cost (₹ Lakhs)	Simple payback period (Years)
Energy efficient boilers	172 tons	3.44	4	10
Wood gasifier	92 tons	83.51	22	3
Variable frequency drive	4,896 kWh	0.23	0.25	13
Energy efficient pumps	6,266 kWh	0.29	0.25	8
Waste heat recovery from boiler flue gases	23 tons	0.46	0.5	13
Condensate recovery	21 tons	0.65	--	Immediate
Low material to liquor ratio soft flow dyeing machines	118,614 kWh 450 tons	31.90	156	59
Heat recovery from hot drained water	220 tons	6.60	6	11
Solar hot water system	21 tons	0.75	1.61	25
Improved chulhas	22 tons	0.77	0.25	4
Air compressor pressure reduction	6,975 kWh	0.32	--	Immediate

5.2 Summary of energy saving measures identified for Tirupur cluster

The list of the energy saving proposals identified for Tirupur Textile units is furnished in Table 5.2.

Table 5.2: List of energy saving proposals identified for Tirupur Textile cluster

S. No	Energy Saving Proposals
1	Energy efficient boilers
2	Wood gasifier
3	Variable frequency drive
4	Energy efficient pumps
5	Heat recovery from boiler flue gases
6	Condensate recovery
7	Low material to liquor ratio soft flow dyeing machines
8	Heat recovery from hot drained water
9	Solar water heat system
10	Improved chulhas
11	Screw compressors
12	Energy efficient lighting systems
13	Steam based cogeneration plant

5.3 Shortlisted technologies / products for DPRS

The following technologies/products were identified for preparation of DPRs for Tirupur Textile Cluster:

- ❑ Wood Gasifier
- ❑ New efficient boilers
- ❑ Variable frequency drives
- ❑ Hot Drained Water
- ❑ Energy Efficient pumps
- ❑ Low Material to Liquor Ratio Soft flow dyeing machines
- ❑ Solar water heating system
- ❑ Economizer

	Issues in implementation	Short listed for DPR preparation (Yes/No)	No of units this can be implemented	Annual energy saving potential in cluster
	1. Lack of awareness 2. Cost of implementation	Yes	70	12,040 tons
	1. Lack of awareness 2. Cost of implementation	Yes	15	1,380 tons
	1. Lack of awareness	Yes	450	2,203,200 kWh
	1. Lack of awareness	Yes	650	4,072,900 kWh
	1. Lack of awareness	Yes	550	12,650 tons
	1. Lack of awareness	No	70	1,470 tons
	1. Lack of awareness EC measure 2. New technology development 3. High initial investment	Yes	450	53,376,300 kWh 202,500 tons
	1. Lack of awareness EC measure	Yes	450	99,000
	1. Lack of awareness EC measure 2. High initial investment and low returns	Yes	200	4,200 tons
	1. Lack of awareness EC measure 2. Non availability of technology	Yes	56	1,232 tons
	1. Lack of awareness EC measure	No	1,200	8,370,000 kWh

ANNEXURE 1

Detailed technology/equipment assessment report including the design technical specifications, in the format provided by BEE

Technology gap assessment for the suggested energy saving proposals

Equipments	Technology Gaps Identified	Technology Interventions
Softflow machines	– High material to liquor ratio – More water consumption and hence more water cost – High fuel and electricity consumption – More effluents generation and more treatment cost and environmental problems – Hot water generated after completion of the process is drained to the ETP	– Install low material to liquor ratio soft flow machines. – Energy efficient and reputed branded make pumps – Waste heat recovery from hot drained effluents Energy efficient and reputed
Boilers	– Old boilers – Single or two pass system – High flue gas losses – Non water walled chambers – Low loading of the boilers	– New energy efficient boilers
Thermic fluid heaters	– Heat generation by use of diesel oil is costly	– Install wood gasifiers for reducing fuel cost
ID and FD fans	– No Speed control for ID and FD fans – The air flow is adjusted by mechanical dampers	– Install VFD's for ID and FD fans.
Thermopac	– No speed control for ID and FD fans – No speed control for thermic fluid circulation pump	– Install VFD's for ID and FD fans. – Install automatic oxygen trim system – Optimization of Thermic fluid pump speed by installing VFD
Boiler feed water pumps	– Pumps are local make and are inefficient	– Install energy efficient vertical pumps (Grundfos or CRI make)
Air compressors	– Low output than the rated capacity – Air is generated at higher pressure than required	– Install new screw compressors – Optimise air generation pressure
Chulhas	– Low efficiency – High radiation losses from all the sides – No proper air circulation – No waste heat recovery	– Install new improved design chulha developed by WII
Boilers and thermic fluid heaters	– High temperature flue gases is vented to the atmosphere without any heat recovery	– Install waste heat recovery system such as Economizer or air pre-heater
Air conditioners	– Air conditioners installed are non star rated and hence more power consumption	– Install five star rated air conditioners
Grid Electricity and Steam generation in boilers	– High cost and low efficiency	– Install cogeneration system for steam and electricity generation.

ANNEXURE 2

Details of technologies/services providers for the cluster

Company Name	Contact person	Phone no's	Address
Veesons Energy Systems P. Ltd (Boiler)	--	9842453775	8, Kongu Nagar 3st, T-7 veesonsstpr@satyam.net.in
Shanthi Mechanical Engineering Works	Mr Joseph Gilbert A	9843040093	No 222, Kumaran Road, Tirupur Tirupur - 641601 (Also serves Tirunelveli)
Ennar Engineers (ISO)		0421-2214618	2, Vavila Complex Near Tamilnadu Theatre Palladam Road Tirupur - Tamil Nadu
Yes Pee Engineers (Boiler Spares)		9842240203	Tirupur Bazaar, Tirupur
New Tech Engg Works (Boiler service)		9443398546	1/785, Lakshmi Nagar Pazhavanji Palayam Pirivu Dharapuram Road, Tirupur-641608
C.E.C. Associates (Air Compressors)	Mr. Sampath Kumar	9842261591	NEW NO. 450, COLLEGE ROAD, Tirupur - 641606
City Electricals (Air Compressors)		(91)-421-2204534	No 139, Kumaran Road, Tirupur Ho, Tirupur - 641601
Confident Automation in Coimbatore (A. C Drives)		0422-3218099	23, Venkatalakshmi Nagar Trichy road, Singanallur Coimbatore-5
Lakshmi Marketing (Pumps)	Mr Kathiresan	9894026899	32,Eswaramoorthi Layout Laruvam Palayam, 1st Street Tirupur Bazaar, Tirupur - 641604
Sri Suguna Electricals (Pumps)	Mr Sureshkumar	9843016737 9585516737	No 290, Near Pazhamudir Nilayam, Palladam Main Road Tirupur Bazaar, Tirupur - 641604
NUVA Machine Works India Private Limited		0421 - 2262989 0421 - 2260555	2/658-B, I Street, Hare Rama Hare Krishna Nagar, Mangalam Road, Andipalayam Post, Tirupur - 641687, Tamilnadu, India
Hi lite Technologists P. Ltd (Solar)		9942488887	121/2 B, Tata Solar Shop, Sakthi Nagar 3 street, Boyam Palayam Bus stop, Tirupur-641602
A.B.B AC Drives		9944919574	Arul Jothi, 29/3,13 Binny Compound, Tirupur-641601

ANNEXURE 3

Quotations or Techno-Commercial Bids from Service / Technology Providers

Commercial Bids from Service / Technology Providers

DyeTech INDIA

6

Quality brand for QUALITY TEXTILES

ATMOSPHERIC (98°C)

Model: Ambus	DTA 600	DTA 1200
Nom. Capacity (kg)	600	1200
Tubes	2	4
Quantity	1 Set	1 Set
Price	INR 68 LAKHS	INR 88 LAKHS

PAYMENT TERMS:

25% advance and balance75% by DD With in month before delivery of machine.

ACCOUNT HOLDERS : DYETECH TEXTILE ENGINEERING INDIA PRIVATE LIMITED

BANK DETAILS : ORIENTAL BANK OF COMMERCE
A/C.No: 05581131001746
To Further credit To
Oriental Bank of Commerce
SWIFT: ORBCINBBTPR

PRICE : Including insurance & excluding domestic taxes, VAT etc. The machine is delivered up to customer factory.

DELIVERY : With in 90 days upon receipt DD

PACKING : Standard packing.

ERECTION : DyeTec provides supervisor for the mechanical and electrical set up which normally takes about 1 week. The buyer shall provide the necessary personal for the mechanical and electrical work (normally one mechanic, one electrician and three helpers) the buyer shall pay for the DyeTec technicians daily allowance, Local transportation and full board hotel accommodation (room & hotels)

DyeTech Textile Engineering India Private Limited
34, Saban salai, Binny Compound, Tirupur - 1 | Ph : 91 0421-2233567, 2233588 | Fax : 2204657 | Mail : dyetechindia@yahoo.in
DyeTech India - Factory 3 Gem Garden, Athipalayam Pirivu Junction, Ganapathy, Coimbatore - 6 Ph : 0422 253 567
DyeTec International UG Karl Kurz Str. 36 74523, Schwaebisch hall, Germany | Tel : 00 49 2642 6682 | Fax : 00 49 2542 91658

DİLMENLER MAKİNA ve TEKSTİL SAN.TİC.A.Ş.
HEAD OFFICE : Çobançeşme Çalışlar Sok. No: 5 34530 Yenibosna / İSTANBUL Tel : (+90) 212 551 18 27- 551 67 74 Fax : (+90) 551 11 62
FACTORY : Vakıflar Koyu Mevkıı, Saray Kavşağı / ÇORLU Tel : (+90) 282 672 25 07 (5 hat) Fax: (+90) 282 672 22 63
GSM : (+90) 533 514 92 88 - (+90) 533 521 95 47
http:// www.dilmenler.com.tr E-mail : info@dilmenler.com.tr

DMS 11 450 KG ATM JUMBO FABRIC DYEING MACHINE FULLY AUTOMATIC RDS

Nominal capacity	:	**approx.3 x 150 Kg = 450 kg**
Liquor ratio	:	min 1:5
Operating Temperature	:	**140 –98° C**
J box width	:	730 mm

DMS 11 600 KG ATM JUMBO FABRIC DYEING MACHINE FULLY AUTOMATIC RDS

Nominal capacity	:	**approx. 4 x 150 Kg = 600 kg**
Liquor ratio	:	min 1:5
Operating Temperature	:	**140 –98° C**
J box width	:	730 mm

DMS 11 900 KG ATM JUMBO FABRIC DYEING MACHINE FULLY AUTOMATIC RDS

Nominal capacity	:	**approx. 6 x 150 Kg = 900 kg**
Liquor ratio	:	min 1:5
Operating Temperature	:	**140 –98° C**
J box width	:	730 mm

TOTAL PRICES FOR ATM MACHINES

MACHINE NAME	UNIT PRICE	QTY	TOTAL PRICE FOB ISTANBUL
DMS 11 450 KG ATM JUMBO FABRIC DYEING MACHINE FULLY AUTOMATIC RDS	60.000 EURO	1	60.000 EURO
DMS 11 600 KG ATM JUMBO FABRIC DYEING MACHINE FULLY AUTOMATIC RDS	78.000 EURO	1	78.000 EURO
DMS 11 900 KG ATM JUMBO FABRIC DYEING MACHINE FULLY AUTOMATIC RDS	98.000 EURO	1	98.000 EURO

The machine consists of 5 parts;

1-) Main kier with necessary pipeline and instruments
2-) Hot pro 100 % reserve tank with necessary instruments
3-) Chemical dissolving tank with pipeline and equipment
4-) Dyes preparation and dosing tank with pipeline and equipment
5-) Control board with operator panel and main control board with inverters and electronic pneumatic equipment

1. **All parts coming in contact with the processing liquor are manufactured from special stainless steel (AISI 316 L).**
2. 2250 outer dia
3. **Teflon linings in the chambers for smooth fabric transport**

4

DILMENLER CORPORATION USA
AMERICAN OFFICE CENTERS:
3020 Old Ranch Parkway, Suite 336 Seal Beach, CA 90740 Tel : (+1) 562 799-5575 Fax : (+1) 562 799-5572
E-mail : dms.corp@verizon.net

All-Flow
Trust on us for Pumping Power

All-Flow Pumps & Engineers
S.No. 13-59, Indira Gandhi Nagar, Opp : IDPL Colony Main Gate, Balanagar, Hyderabad - 500037,
Ph.No : 040 - 2307 7585 / 86, 6526 7456 , Fax : 040 - 2307 7587
E-mail : info@allflow.co.in / sales@allflow.co.in Url : www.allflow.co.in

Ref: 7112-2011-APE-SS Date 09.03.2011

Winrock International India
E-24, Vikrampuri
Secunderabad - 500009
Andhra Pradesh
Tel: +91-40-27845276 / 27843787
Fax: + 91- 040-27840988
Email: wii-hyderabad@winrockindia.org

Dear Sir,

Ref: Your E-mail Inquiry forwarded by MR.SRIDHAR M/S.C.R.I PUMPS
Sub: OFFER for the supply of Vertical Multi Stage in-Line Centrifugal Pumps – reg.

Good Day and greetings from everyone at All-flow family.

Further with reference to the above, we would like to thank you for giving us an opportunity to quote for your valued requirements and are pleased to here with enclose our Revised Quote for the following pumps as under:

1. **"C.R.I" Make Vertical Multi Stage In – Line Centrifugal Pumpset.**

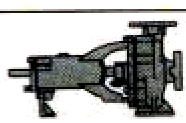
Hope that the same will be inline with your requirement and in case you have any further queries please feel free to contact us at your ease.

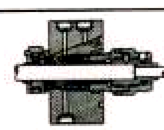
Thanking you and look forward to receive your valued purchase order.

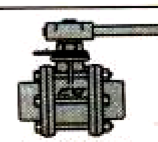
Regards,
For All-Flow Pumps & Engineers,

J. Bhaskar – Managing Partner.

C.R.I. PUMPS


We, FLOW


We, SEAL


We, CONTROL

All-Flow Pumps & Engineers

TECHNICAL SPECIFICATIONS
VERTICAL IN-LINE PUMPS

Item No. →	001	002	003
Qty.	1 Nos.	1 Nos.	1 Nos.
Application	Boiler Feed	Boiler Feed	Boiler Feed
Liquid	**Water**	**Water**	**Water**
Temperature	100 Deg.C	100 Deg.C	100 Deg.C
Specific Gravity	1.0	1.0	1.0
Flow Rate - Max	**1 M^3/Hr**	**3 M^3/Hr**	**5 M^3/Hr**
Discharge Head	**120 Mtrs**	**120 Mtrs**	**120 Mtrs**
Suction Type	Flooded	Flooded	Flooded
Pump Make	**C.R.I**	**C.R.I**	**C.R.I**
Made in	**India**	**India**	**India**
Pump Model	**MVC-2/15 TR**	**MVC-2/18T R**	**MVC-4/16T R**
Pump Type	Vertical Multi Stage In - Line Centrifugal Pump	Vertical Multi Stage In - Line Centrifugal Pump	Vertical Multi Stage In - Line Centrifugal Pump
No. Of Stages	15	18	16
Motor KW / HP / RPM VERTICAL FLANGED	1.5 kW/ **2.0 HP**/ 2900 RPM	2.2 kW/ **3.0 HP**/ 2900 RPM	3.0 kW/ **4.0 HP**/ 2900 RPM
Degree of Protection	IP 55	IP 55	IP 55
Insulation Class	F	F	F
Type of Duty	S1 (Continuous)	S1 (Continuous)	S1 (Continuous)
MATERIAL OF CONSTRUCTION			
Pump Outer Sleeve	**SS 304**	**SS 304**	**SS 304**
Impellers	**SS 304**	**SS 304**	**SS 304**
Shaft	**SS 304**	**SS 304**	**SS 304**
Diffuser	**SS 304**	**SS 304**	**SS 304**
Pump Bracket	**C.I**	**C.I**	**C.I**
Pump Base	**C.I**	**C.I**	**C.I**
Pump Bearings & Sleeves	**Tungsten Carbide**	**Tungsten Carbide**	**Tungsten Carbide**
Shaft Sealing	**Mechanical Seal**	**Mechanical Seal**	**Mechanical Seal**
Motor Frame	AL. / C.I	AL. / C.I	AL. / C.I
Delivery Size	40 mm	40 mm	40 mm
Suction Size	40 mm	40 mm	40 mm
Price of Pump Set	**Rs. 29,600.00**	**Rs. 34,755.00**	**Rs. 37,870.00**
Discount	**-12%**	**-10%**	**-12%**

ANNEXURE 4

Detailed Energy Audit Reports for All Units

(Enclosed Separately)

ANNEXURE 5

Policy / Guidelines (if any) of Local Bodies for Improving Energy Efficiency in the Cluster

- **Mandatory Energy Audit for Designated Consumers**
  - The State Designated Agency (SDA), i.e., Tamil Nadu Electrical Inspectorate is in the process of notifying the designated consumers for energy audit in Tamil Nadu.
  - So far, SDA has identified about 100 designated consumers for whom the Bureau of Energy Efficiency would be sending the notice for taking up the mandatory energy audit.
  - TNEB's Thermal and Gas Turbine Stations are also among the designated consumers. TNEB is taking steps to conduct energy audit for the same.

- **Energy audit for Non Designated Consumers**
  - TNEB has requested the Government to initiate steps for making energy audit mandatory for non-designated HT industrial and commercial establishments as followed in Gujarat and Kerala.
  - TNEB has requested the HT services with sanctioned demand between 500 kVA and 700 kVA to take up energy audit voluntarily.

ANNEXURE 6

Financial schemes (if any) Available with Local Banks for Improving Energy Efficiency in the Cluster

- **Credit linked capital Subsidy scheme(CLCSS)**

  Under this scheme, the ministry of MSME is providing subsidy to upgrade technology (Machinery/plant equipments). Subsidy limit per unit is ₹15 lakh or 15% of investment in eligible machinery/Plant equipments whichever is lower. For more details of the scheme visit: www.laghu-udyog.com/scheme/sccredit.htm

- **SIDBI Financing Scheme for Energy Saving Projects in MSME sector under JICA Line of Credit**

  The Japan International Corporation Agency (JICA) has extended a line of credit to SIDBI for financing Energy Saving projects in Micro, Small and Medium Enterprises (MSMEs). This project is expected to encourage MSME units to undertake energy saving investment in plant and machinery to reduce energy consumption, enhance energy efficiency, reduce CO_2 emissions, and improve the profitability of units in the long run.

- **Eligible Sub Projects/ Energy Saving Equipment List under JICA line of Credit**
  - Acquisition (including lease and rental) of energy saving equipments, including newly installing, remodeling and upgrading of those existing
  - Replacement of obsolete equipments and/or introduction of additional equipment which would improve performance
  - Equipments/ Machinery that meets energy performance standards/Acts
  - Introduction of equipments that utilize alternative energy sources such as natural gas, renewable energy etc., instead of fossil fuels such as Oil and Coal etc.
  - Clean Development Mechanism (CDM) projects at cluster level that involves change in process and technologies as a whole, duly supported by technical consultancy will be eligible for coverage.

- **Financial parameters**

  The financial parameters for appraising the project are:

Parameter	Norms
Minimum Assistance	₹10 lakh
Minimum promoters contribution	25% for existing units; 33% for new units
Interest rate	The project expenditure eligible for coverage under the line will carry a rate of interest rate of 9.5-10% per annexure
Upfront fee	Nonrefundable upfront fee of 1% of sanctioned loan plus applicable service tax
Repayment period	Need based. Normally the repayment period does not extend beyond 7 years. However, a longer repayment period of more than 7 years can be considered under the line if necessary

- **Eligibility criteria for units (Direct assistance)**
  - Existing units should have satisfactory track record of past performance and sound financial position.
  - Projects will be screened as per Energy Saving List, which is available in SIDBI website.
  - Units should have minimum investment grade rating of SIDBI.
  - Projects which may result environmental impacts and negative social impacts are also not eligible under this scheme.

For further details eligible energy saving equipments/machinery, projects can be financed under this scheme and details of scheme, please contact the nearest SIDBI branch office or refer to SIDBI website (www.sidbi.in).

- **Technology Upgradation Fund Scheme (TUFS) for Textile & Jute Industries in SSI Sector**

  A scheme devised by Govt. of India, Ministry of Textiles, to enable SSI units Textile/Jute industrial sector) to induct State-of-the-art technology in which technology levels are bench marked in terms of specified machinery for each sector of textile industry machinery with technology levels lower than that specified will not be permitted for funding under the TUF scheme.

Eligible Borrowers	Sole Proprietorships, Partnerships, Co-operative Societies, Private/Public limited companies. ❐ Existing units with or without expansion and new units ❐ Existing units proposing to modernize and/or expansion with state-of-the-art-technology ❐ New units which are being set up with appropriate technology
Quantum Of Loan & Mode Of Assistance	Assistance shall be need based and NO CEILING on project cost/amount of loan. Assistance shall be by way of Term Loan.
Margin	15 to 25% of the project cost
Security	❐ 1st charge on fixed assets financed under the scheme Additional security such as personal guarantees, pledge of promoters share holdings as determined by Bank on merits of the case ❐ Incentive Available Under The Scheme ❐ Interest Reimbursement at the rate of 5% of the interest payment made by the unit to Bank on the loan outstanding. No Interest Reimbursement will be available for the extended period of loan or during the NPA status of the loan.
Repayment	Within 7 years including moratorium up to 1 year

ANNEXURE 7

Name and address of Tirupur textile units where energy audits are conducted

Name of the industry	Address
DYEING	
M/s. Allwin Colours	Murugampalayam, Iduvampalayam Post Tirupur-641687 Ph: 9843035656
M/s. Standard Colours	SFNo 642, Sundamedu, Murugapalayam Road Veerapandi Village, Tirupur-641687
M/s. Do Win Processing Mills	SF No.207/3 Murugampalayam Iduvampalayam (P.O), Tirupur-641687 Ph: 0421-3295734
M/s. Senbagam Process	Murugampalayam, Iduvampalayam Post Tirupur-641687 Ph: 0421-2214040
M/s. D.G.K Dyeing Mills	Kasi Palayam, Vijayapuram Post Tirupur Ph: 9994336333
M/s. Ajantha Processers	Thamban Chetty Thottam, Murugampalayam, Tirupur-641687 Ph: 0421-2213805
M/s. Ever Green Process unit 1	Pachankattupalayam, Karaipudur Arul Puram Post, Tiripur Ph: 9600942422
M/s. Ever Green Process unit 2	Pachankattupalayam, Karaipudur, Arul Puram Post Tiripur. Ph: 9600942422.
M/s. Micro Knit Process	Kudi kinaru thottam, Murugampalayam Iduvampalayam Post, Tirupur – 641 687 Ph: 0421-2261498; Cell-98946 46648
M/s. K.A.K Textile Processing	K.A.K Compound, Kuppana Chettiar Street Palladam Road, Tirupur 641 604 Ph: 2214028, 2211517
M/s. Paliniyandavar bleaching & dyeing	Thandakkaran Thottam, Murugampalayam Iduvampalayam Post, Tirupur – 641 687 Ph: 2260065
M/s. Sandhiyaa Bleaching&Dyeings	SF No.671, Iduvampalayam (P.O), Murugampalayam, Tirupur-641687. Ph 0421-2210868

Name of the industry	Address
M/s. Rithishwer Dyeing Co	SF No.184, Murugam Palayam, Iduvam Palayam, Tirupur-641687 Ph: 0421-3260071
M/s. International Colours	SF No.666, Iduvampalayam, Murugampalayam, Tirupur-641687
M/s. Dotex Process	ThandakkaranThottam, Murugampalayam Iduvampalayam, Tirupur-641 687 Ph: 2561423
M/s. Sri Arul Murugan(Sri Ram) Textile Process	641, Murugampalayam Iduvampalayam Post Tirupur-641 687
M/s. Akber Exporters	Kuppandampalayam, Veerapandi Post Tirupur-641 605 Ph: 0421-2210073
COMPACTING	
M/s. G.K.P Knit Compators	1-S.V.Colony, Om Sakthi Road, Near-E.B.Office Tiruppur-641607 Ph.No-2242620-2234590
M/s. Surya Knit Copactors	41, Karaib thottam, Palladam Road, Tirupur-641604
M/s. Krishna Squeezer& Dryer	1,Thiruvalluvar Nagar, Near New Bus Stand 60 Feet Road, P.N.Road, Tirupur-641602
M/s. Karunambia Compacting unit 1	#9/381c, 9(2), K.P.P. Garden, Kongu Main Road, Opp:Bharat gas service, Tirupur-641607 Ph: 0421-4338134
M/s. Karunambia Compacting unit 2	#9/381c, 9(2), K.P.P. Garden, Kongu Main Road, Opp: Bharat gas service, Tirupur-641607 Ph: 0421-4338134
M/s. Rado Compacting	4/253 Tnk Puram Main Road, Muruganathapuram Kongu Mainroad, Tirupur-0641 607 Ph: 3265376
M/s. Sree Ambal Knit Finishers	SF No: 50/1, Kottai Thottam Sivan theatre North, Tirupur-641602 Ph: 0421-2477598
M/s. Cotton Knit Finishers	No.772, P.N. Road, Opposite Karnataka Bank, Near New Bus Stand Tirupur-641602
M/s. Sterling Knit Finishers	474, Mohan Knitting Compound, opp: Thennampalayam Water Tank Palladam Road, Tirupur-641604
M/s. GKM Knit Finishers	5/3,Thiruvalluvar Nagar Near New Bus Stand, Tirupur-641602 Ph: 0421-2472874

Name of the industry	Address
M/s. Sangavi Relax Dryer	291/1,I.G.Colony, Sundamedu Iduvampalayam, Murugampalayam, Tirupur-641605
M/s. Krishna Knit Compactors	A.P.S.N. Compound, Opp. Ceematti Petrol Bunk P.N. Road Tirupur-641602
M/s. Supreme Knit Finishers	S.F.No.655/1,Indira Nagar L.R.G. College Back Side Palladam Road Tirupur-641605
M/s. Fab Knit Finishers	No.23, Kombai Thottam Mission Street, Tirupur-641604 Ph 0421-2427774
M/s. Tip Top Heat Setting	647/1-B T.R.A. Ginning Mill Compound Palladam Road Tirupur-641605
M/s. Deluxe Compacting	709-k,Siva complex Opp. Shanthi Theater P.N.Road,Tirupur-641602
M/s. Adith Knitting Mills	No.71/A, A.S.(Ginning Compound) Kangayam Main Road Tirupur-641604
M/s. B.V.R. Compacting	7/6-A,Cheran Nagar Rackiyapalayam Pirivu, Cine Park Backside, Kangayam Road Tirupur-6 Ph: 0421-4355100
M/s. Velavan knit Compacting	27-c,Postal Colony, Near Sivan theatre P.N. Road,Tirupur-2 Ph: 0421-2478103
M/s. Akshaya Knit Finishers	28-A, Kottya Thottam Near Sivan Theater, Kumarandapuram Tirupur-641602
M/s. Vani Compacting	S.F. No. 40 M.R.Weigh Bridge Compound Opp. Gayathri Hotel Kangaya Road,Tirupur-641687
M/s. Balaji Compacting	No 1, CPS Garden Rackiyapalayam Pirivu, Kangayam Road Tirupur-641687
M/s. Mani Compacting	16-A, Kuppanna Chettiar Street Tirupur-641604

Name of the industry	Address
M/s. Brindaa Knit Finishers	S.F.NO: 655/1 Indira Nagar L.R.G College Back Side Palladam Road, Tirupur-641604
M/s. P.M.R. Knit Finishers	S.F. No: 438/2 Site No: 12 Jeeva Nagar, Thiruneelakandapuram (North) Tirupur – 641 607
M/s. Thiru Murugan Knit Finishers	Thattan Thottam Main Street Palladam Road, Tirupur-641604
M/s. Cottony Finishers	No.37, N.G.R.Nagar, Kasikadu Thottam Anaikadu,Tirupur-641601
M/s. Fashion Gate Compacting	SF No. 35/1B1 Near Coolipalayam Nal Road, S. Peripalayam (Po) Tirupur-641607
M/s. Sun Bright Compacting	No.9, Gayathri Nagar Palayakkadu, Opp.IBP Bunk,Uthukuli Road Tirupur-641607
M/s. Sun Rise Fab Compacting	SF No.284 Vaathiyar Thottam, Karumarampalayam, Mannarai (Po) Tirupur-641687
M/s. Ever Fine Compacting	14, L.R.G. Layout 3rd Street Karuvampalayam, Tirupur-641604 Ph: 0421-2205181
M/s. Knit House Fashion	124-c, S.N.V.S Compound, Kongu Main Road Tirpur-641607
M/s. Apex Knit Finishers	18, Chitra Bleaching Compound ABT Road 4th Street, Karuvampalyam Tirupur-641604
M/s. Aruna Washing	D.No-45-(S.F.No.621/2) Aruna Garden, Anaipalayam Railway Track College Road, Tiruppur-641603 Ph.No-2261220-5571303
M/s. Anand Knit Finishers	41, Karaib Thottam Palladam Road Tirupur-641604
KNITTING	
M/s. Mathul Fashions	S.No: 334 T.K.T Mill Road Kuppandam Palayam Veerapandi (po) Tirupur-641605

Name of the industry	Address
M/s. S&G Knits Pvt ltd	Ghandi Nagar Tirpur-641687
M/s. C.P. Knits	109/63-2,MRD compound Near Karnataka ATM, P.N. Road, Tirupur-641602
M/s. ESS ENN Exports	131 ASHER NAGAR TIRUPUR – 641 603 Ph:2478237
M/s. Siemense Knitting Company	E.V.G Compound 16, Union mill Road Tirupur-641601 Ph: 0421-2202654
M/s. Bindhu Knittings	SF no 351 P.S. Pnagar Pappanayakenapalayam east Tirpur-641607
M/s. Thalapathi Knit Garments	51 New R.k.puram Main road Tiirupur-641 607 Ph: 0421 2221624,8857
M/s. Emarold Collars	S.F 588/2 Kattabomman Nagar New. R.K Puram Telephone Exchange Pappanaikan palayam Road Tirupur-641607
M/s. Knit & Knits	20/186-A,ThilagarNagar 15Velampalayam Anupparpalayam Post Tirpur-641652
M/s. Sri Karthik Tex	5/2c Jai Nagar 1st Street Ranganatha Puram Kongu Main Road Tirupur 641607
M/s. Sushil Frabrics	2/647-A&B,S.F. No 45 Venus Grden Mangalam Road Tirpur-641687
COMPUTER EMBROIDERS	
M/s. Veeramathi fashion (P) Ltd	260/1 Amman Nagar 2nd Street Siripooluva Patti Tirupur-641603 Ph no 0421-2479842

Name of the industry	Address
M/s. Design Craft India	8/35A A.V.P Layout Ghndi nagar Tirupur-641687
M/s. Sri Guru Ragavendra Embroidaries	126/A Ghndi Road 15Velampalayam Road Anupparpalayam pudur Tirpur-641652
M/s. Sushil Embroidary	2/647-A&B S.F. No 45 Venus Grden Mangalam Road Tirpur-641687
M/s. Eshwar Embroideries	7-A Asher Nagar North 1st Street Tippur-641687
M/s. Sri Ayyappan Embroidery	40, Padmavathipuram 6th Street A.V.P. Layout Tirupur-641603
M/s. Star Knit Fashions	10, Muthu Nagar Extension 5th Street N.R.K Puram Main Road Tirupur-641607
M/s. Kavya Embroideries	126/A, Ghndi Road 15 Velampalayam Road, Anupparpalayam Pudur Tirpur-641652
M/s. Pavitham ebroidery	499, Palladam Road, Near T.K.T Motors Tirupur-641604 Ph: 2210746
M/s. D.G.K Compurter Embroidary	204/25, Samundi Puram Main Road, Tirupur-641603
M/s. Theepam Embroideries	49, Ram Nagar,4th street Tirupur-2 Ph: 2241189
M/s. Deluxe Embroidery	709-K, Siva Complex, Opp. Shanthi Theater P.N. Road Tirupur-641602
BLEACHERS	
M/s. M.S. Bleachers	Thambanchetty Thottam Murugampalayam Iduvampalayam Post Tirupur-641 687

ANNEXURE 8

Details of the unit wise annual consumption of fuels and electricity, electricity savings, fuel savings and monetary savings

Name of the industry	Power Consumption kWh/annum	Fuel Consumption TPA	Electricity Savings in kWh/annum	Fuel savings in TPA	Monitory Savings in lakh
M/s. Allwin Colors	920,145	3,168	262,493	1,080	44.7
M/s. Standard Colors	153,191	1,750	74,770	896	30.4
M/s. Do Win Processing Mills	81,702	720	2,527	516	15.6
M/s. Senbagam Process	420,000	1,500	240,051	741	33.5
M/s. D.G.K Dyeing Mills	561,702	3,168	92,318	3,332	104.3
M/s. Ajantha Processers	102,128	1,040	21,625	854	26.6
M/s. Ever Green Process unit 1	350,385	1,056	16,291	1,584	48.3
M/s. Ever Green Process unit 2	374,137	792	63,602	539	19.2
M/s. Micro Knit Process	183,830	1,584	96,923	1,620	53.2
M/s. K.A.K Textile Processing	127,660	1,250	11,400	734	22.6
M/s. Paliniyandavar bleaching & dyeing	289,746	1,920	125,479	1,292	44.7
M/s. Sandhiyaa Bleaching & Dyeing	63,830	432	5,910	249	12.7
M/s. Rithishwer Dyeing Co	258,959	375	8,702	150	4.9
M/s. International Colors	1,54,468	1,750	9,110	1,215	43.0
M/s. Dotex Process	33,191	375	18,517	129	5.4
M/s. Sri Arul Murugan (Sri Ram) Textile Process	63,830	468	10,639	270	10.0
M/s. Akber Exporters	269,106	780	9,716	416	15.0
M/s. G.K.P Knit Compactors	76,596	300	6,266	31	1.4
M/s. Surya Knit Compactors	57,120	450	14,424	234	8.9
M/s. Krishna Squeezer& Dryer	306,909	3,200	24,286	0	1.1
M/s. Karunambia Compacting unit 1	218,886	930	17,550	380	14.1
M/s. Karunambia Compacting unit 2	517,288	2,600	22,477	793	28.8
M/s. Rado Compacting	45,432	450	10,255	218	8.1
M/s. Sree Ambal Knit Finishers	147,525	624	10,425	149	5.0
M.s. Cotton Knit Finishers	102,127	1,092	19,287	405	13.1
M/s. Sterling Knit Finishers	81,664	300	16,302	142	5.0
M/s.GKM Knit Finishers	289,076	1,705	26,290	567	18.2
M/s. Sangavi Relax Dryer	153,191	1,376	2,150	0	0.1
M/s. Krishna Knit Compactors	63,830	450	6,561	24	1.3
M/s. Supreme Knit Finishers	134,624	650	18,180	307	13.1
M/s. Fab Knit Finishers	66,754	325	10,519	127	5.6
M/s. Tip Top Heat Setting	100,560	324,00 ltrs	13,824	20,954	10.1
M/s. Deluxe Compacting	204,255	480	7,114	112	3.7
M/s. Adith Knitting Mills	246,497	620	15,776	31	1.7
M/s. B.V.R. Compacting	267,754	600	15,137	30	1.6

Name of the industry	Power Consumption kWh/annum	Fuel Consumption TPA	Electricity Savings in kWh/ annum	Fuel savings in TPA	Monitory Savings in lakh
M/s. Velavan knit Compacting	114,565	360	11,639	131	4.5
M/s. Akshaya Knit Finishers	51,063	312	6,937	15	1.0
M/s. Vani Compacting	121,991	450	12,807	22	1.6
M/s. Balaji Compacting	142,996	650	16,589	33	2.3
M/s. Mani Compacting	109,731	325	10,663	135	6.6
M/s. Brindaa Knit Finishers	74,523	360	14,596	194	6.5
M/s. P.M.R. Knit Finishers	105,356	600	12,484	243	7.9
M/s. Thiru Murugan Knit Finishers	136,710	672	8,021	272	8.5
M/s. Cottony Finishers	115,781	600	14,897	30	1.6
M/s. Fashion Gate Compacting	102,128	624	16,496	38	1.9
M/s. Sun Bright Compacting	182,016	530	16,717	26	1.6
M/s. Sun Rise Fab Compacting	113,365	600	13,247	30	1.5
M/s. Ever Fine Compacting	102,127	900	13,785	45	2.0
M/s. Knit House Fashion	99,807	450	13,409	197	6.5
M/s Apex Knit Finishers	153,191	1,080	24,046	54	3.8
M/s. Aruna Washing	261,159	960	15,137	21	1.3
M/s. Anand Knit Finishers	63,830	450	13,963	233	7.6
M/s. Mathul Fashions	217,021	---	15,120	---	0.7
M/S.S&G Knits Pvt ltd	76,596	---	3,820	---	0.2
M/s.C.P. Knits	12,766	---	33,191		1.6
M/s. ESS ENN Exports	63,830	---	40,212		1.9
M/s. Siemense Knitting Company	102,128	---	39,574		1.9
M/s. Bindhu Knitting's	223,404	---	34,468		1.6
M/s. Thalapathi Knit Garments	95,745	---	12,127		0.6
M/s. Emarold Collars	51,064	---	4,680		0.2
M/S. Knit & Knits	382,979	---	35,744		1.7
M/s. Sri Karthik Tex	63,830	---	10,212		0.5
M/s. Sushil Fabrics	76,596	---	5,531		0.3
M/s. Veeramathi fashion (P) Ltd	115,344	---	20,173		0.9
M/s. Design Craft India	81,000	---	17,286		0.8
M/s. Sri Guru Ragavendra Embroidaries	108,000	---	19,373		0.9
M/s. Sushil Embroidery	188,800	---	27,290		1.3
M/s. Eshwar Embroideries	66,000	---	11,530		0.5
M/s. Sri Ayyappan Embroidery	103,800	---	15,686		0.7
M/s. Star Knit Fashions	87,600	---	31,373		1.5
M/S. Kavya Embroideries	40,800	---	9,965		0.5
M/s. pavitham ebroidery	118,200	---	43,373		2.0
M/s. D.G.K Compurter Embroidary	46,080	---	11,702		0.5
M/s. Theepam Embroideries	66,000	---	12,730		0.6
M/s. Deluxe Embroidery	67,800	---	13,191		0.6
M/s. M.S. Bleachers		45		22	1

List of References

- Energy Audit reports of various companies
- Records of the industries and energy bills
- Equipment/technology suppliers – quotations and technical specifications
- SIDBI Website
- Andhra Bank Website

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