MANUAL ON ENERGY CONSERVATION MEASURES IN TEXTILE CLUSTER SOLAPUR




Bureau of Energy Efficiency (BEE)

Ministry of Power, Government of India

Prepared By

Zenith Energy Services Pvt. Ltd., Hyderabad

Table of contents

Table of contents……………………………………...……………………………..1

Acknowledgement…………………………………………………………...………..6

Chapter 1: Introduction……………………………………………….……...…7

1.1 About BEE's SME program…………………………….........................7

1.2 Project objectives……………………………………….........................7

1.3 Expected project outcome………………….……………………..……9

1.4 Project duration………………………………….……………....………10

1.5 Identified clusters under the BEE SME program………..…………..…11

1.6 About the Present study……………………………………………......12

1.7 Structure of the report…………………………………………………12

Chapter 2: About Solapur cluster………………………………..………...14

2.1 Overview of solapur SME cluster……………………………………...14

2.1.1 Cluster background……………………………………………………14

2.1.2 Product manufactured…………………………………….…………...15

2.1.3 Classification of units………………………………...………………….15

2.1.3.1 Classification based on dyeing process ……………………...………..15

2.1.3.2 Classification based on products manufactured in total cluster.…………16

2.1.3.3 Classification based on production capacity…………………….……17

2.1.3.4 Classification based on products manufactured in surveyed units …...…18

2.1.3.5 Classification based on production facilities………………...………..18

2.1.3.6 Classification based on thermal energy source………………….……19

2.1.3.7 Classification based on technology…………………………..………..19

2.1.3.8 Classification based on energy bill/annum…………………………...…19

2.1.4 Raw materials used…………………………………………...……20

2.2 Energy Consumption Scenario of the Cluster……………...………20

2.2.1 Energy Forms used……………………………………………………...21

2.2.2 Energy Consumption……………………………………..……...21

2.2.3 Specific energy consumption …………………………….……...22

2.3 Manufacturing process ……………………………...…………....22

2.3.1 Process technology…………………………………..…………..22

2.3.1.1 Doubling…………………………………………….………...22

2.3.1.2 Yarn Dyeing……………………………………….................….22

2.3.1.3 Winding………………………………………………..……....23

2.3.1.4 Warping……………………………………………..…………23

2.3.1.5 Weaving……………………………………………….…………23

2.4 Current policies and initiatives of local bodies……………..….......26

2.5 Major Barriers for Implementation of Energy Efficiency…........……28

2.5.1 Energy availability……………………………………..………..28

2.5.2 Technological issues…………………………………..……...29

2.5.3 Lack of technical know-how and organizational capacity……………....29

2.5.4 Financial issues………………………………………………..……29

Chapter 3: Energy Audit and Technology Assessment………………………30

3.1 Methodology adopted ….………………………………...…….…….30

3.1..1 Energy use and technical study……………………......……………30

3.1.1.1 Pre-energy audit activities…………………………….……………30

3.1.1.2 Preliminary energy study…………………………………….……..30

3.1.1.3 Detailed energy study……………………………….............…30

3.1.1.4 Technology audit……………………………...……………....31

3.2 Observations made ………………………….……….....…..…………31

3.2.1 Manufacturing process and technology employed…………….…….31

3.2.2 Energy consumption profile & availability………………………....…33

3.2.2.1 Wood………………………………………………………….…33

3.2.2.2 Electricity………………………………………………….......33

3.2.3 Capacity utilization ………………………………...………....34

3.2.4 Housekeeping practices………………………………………………34

3.2.5 Availability of data and information……………………………….........34

3.2.6 Any other relevant aspect…………………………………………….....35

3.3 Technology gap analysis……………………………………….......35

3.3.1 Technology up-gradation…………………………………...………...35

3.3.2 Process up-gradation……………………………………………………..36

3.4 Energy conservation measures identified……………………………..38

3.4.1 Proposals for energy conservation including technology up-gradation[1]...38

3.4.1.1 Proposal description including technology/product specifications for each proposal…………………………………………………………..38

3.4.1.2 Life cycle analysis for each proposal ………..……………….……...55

3.4.1.3 Cost of implementation ………………………………........................57

3.4.1.4 Monetary savings ………...…………………………………………...58

3.4.1.5 Issues/barrier in implementation of proposals…………………….......60

3.4.2 Availability of technology/ product in local/national/international market……………………………………………………….……...60

3.4.3 Availability of local service providers who can take up above - mentioned proposals………………………………..…………………………..61

3.5 Identification of technologies/equipments for DPR preparation…………………………………………………………...61

3.5.1 Justification (e.g. potential, replicability, etc. in the cluster) for technologies/equipments identified for DPR preparation………………………………………..……………...61

3.6 Environmental benefits……………………………...……………61

3.6.1 Reduction in waste generation (if applicable)… ……………...………..61

3.6.2 Reduction in GHG emission such as CO_2, NOx, etc……..……...…....61

3.6.3 Reduction in other emissions like SOx, etc…………………..……....62

[1] All energy saving proposals to be mentioned.

Chapter 4: Conclusions……………………………………………………..63

4.1 Summary of energy saving measures identified for the cluster…………………………………………………………….....63

4.2 Technology gap assessment for energy saving proposals identified for the cluster……….……..…………………………………………….….63

4.3 Techno-economics for suggested energy saving proposals…..............….69

4.4 Barriers in implementation of identified energy saving proposals……………………………………………………………....70

4.5 Short listed technology/products for DPRs………………………………72

4.6 Summary of level of awareness on energy savings and energy saving technologies in Solapur cluster……………………..….....................72

List of Annexures: ……………………………………………………….........73

Annexure- 1: Name and addresses of units in the cluster…………………………...…73

Annexure- 2: Better House Keeping practices…………………………………………76

Annexure- 3: Formats for monitoring energy and production…………………………78

Annexute- 4: Quotations for various proposals suggested…………………………….80

List of Figures:

Figure 1: Project Duration…………………………………………………...………10

Figure 2: Classification of units based on dyeing facility……………………………....16

Figure 3: Classification of units based on products manufactured…………….............16

Figure 4: Classification of units based on production capacity……………….............17

Figure 5: Classification of units based on products manufactured…………….............18

Figure 6: Classification of units based on production facilities………………………...18

Figure 7: Classification of units based on thermal energy……………………………...19

Figure 8: Classification of units based on energy bill……………………….……….20

Figure 9: General process flow diagram of a typical unit in Solapur cluster….............27

Figure10: Process flow chart……………………………………………………….…...32

List of Tables:

Table 1: List of cluster identified under BEE SME Program…………………………....11
Table 2: Annual energy consumption of a typical unit………………………………...21
Table 3: Specific energy consumption……………………………………….………...23
Table 4: Technical details of new boilers……………………………..... …………..47
Table 5: Life cycle analysis for energy saving proposals suggested………….............56
Table 6: Details of Cost of Implementation…………………………………….……..57
Table 7: Energy saving details for various proposals suggested……………………...58
Table 8: Details of energy saving for various proposals………………………………59
Table 9: Details of LPS's available for various equipments/technologies…..………..60
Table 10: Details of various energy saving proposals suggested for solapur cluster units……………………………………………………...…………………...63
Table 11: Technology gap assessment for various energy saving proposals suggested……………………………………………………………...………...63
Table 12: Techno – economic analysis for various energy saving proposals suggested…………………...…………………………………………………...69
Table 13: Barriers in implementation for various energy saving proposals suggested…………………...…………………………………………………...70

ACKNOWLEDGEMENT

Zenith Energy Services Pvt Limited places on record its sincere gratitude to the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India for giving us opportunity for implementation of ***"BEE – SME program for energy efficiency improvement at Solapur Textile Cluster, Maharashtra***". We express our gratitude to the below mentioned BEE officials for their support and guidance for successful completion of energy use and technology audits and cluster manual.

- Dr. Ajay Mathur - Director General, BEE
- Shri Saurabh Kumar – Secretary, BEE
- Shri Jitendra Sood - Energy Economist, BEE
- Shri Pawan Kumar Tiwari – Advisor – SME
- Shri Gaurav Kumar - Project Engineer

Zenith Energy Services Pvt Ltd is thankful for the support and co-operation to Shri Muralidhar Arkal, Chairman, Shri Srinivas Bura, Vice President, Shri Jayanth Aken, Secretary, Textile Development Foundation, Solapur.

Zenith Energy Services Pvt Ltd is also thankful to all the members "Textile Development Foundation" for their valuable inputs, cooperation, and support extended during the study and demonstration of measures in the units making the program successful in achieving energy efficiency.

We take this opportunity to express our appreciation for the excellent support provided by various SME owners, LSP's and various equipment suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the cluster manual.

We are also thankful to all the plant in charges and all workers of the SME units for their support during the Energy Use and Technology Audit studies and in implementation of the demonstration projects.

ZENITH ENERGY SERVICES PVT LIMITED

HYDERABAD

Chapter -1
INTRODUCTION

1.1 About BEE's SME Program

Due to high energy saving potential in industries, agriculture, domestic and transport sectors, to reduce the gap between demand and supply, to reduce environmental emissions through energy saving and to effectively overcome the barrier, the Government of India has enacted the Energy Conservation Act - 2001. The Act provides the much-needed legal framework and institutional arrangement for embarking on energy efficiency drive.

The Bureau of Energy Efficiency (BEE), an agency of the Union Ministry of Power, has introduced a programme called "BEE SME Program" to help small and medium enterprises (SMEs) to use energy efficiently.

As a part of the implementation of "BEE-SME Programme" about 35 SME clusters were identified. After ground-level situation analysis, 25 of them have been selected for further activities in consultation with the Ministry of Micro, Small and Medium Enterprises (MoMSME).

According to the Indian Institute of Foreign Trade, SMEs contribute about 6% of the country's GDP. Although energy is an important input required for economic and social development, attaining higher energy efficiency is considered as important element in meeting India's future energy challenges and ensuring its energy security.

The SME sector is facing rising energy costs and on the other hand, prices and cost pressures are soaring. The government, from time to time, has offered various fiscal incentives and other interventions to SMEs, as well as help for technology up-gradation and improvements in performance efficiency, but a programme for energy saving of this kind is novel and has tremendous potential.

Solapur is one of the identified clusters to implement the energy efficiency programme and BEE has entrusted M/s Zenith Energy Services (P) Ltd to implement the program for improving energy efficiency in cluster units.

1.2 Project Objectives

The BEE SME Program is aimed at improving Energy Efficiency of Small and Medium Enterprises by technological interventions in the various clusters of India. The Energy Intensity in SME is intended to be enhanced by helping these industries in the mostly energy intensive cluster units identified 25 SME clusters of India to through improve Energy efficiency and performance through technology interventions and also develop the consistent steps for successful implementation of energy efficiency measures and projects in the cluster units and also financial planning for the SME owners.

The project also aims at creating a platform for dissemination of best practices and best available technologies in the market for energy efficiency and conservation and to create awareness among cluster unit owners and also the demonstration projects may stimulate adoption of successful/available technologies.

The BEE SME program have been designed in such a way that to set up to deal with the specific needs of the industries in the SME sector for energy efficiency and designed to overcome all the common barriers for implementation of Energy Efficient technologies and equipments/processes. The following are proposed to be covered under BEE SME program:

1. **Energy Use and Technology Studies –** The studies are aimed for status of the technologies installed, energy use pattern and its cost, operating practices, identification of the technologies and measures for improving energy efficiency etc

2. **Conduct Dissemination Program –** Disseminate the technologies and measures identified & best practices in the cluster units in reducing energy consumption.

3. **Implementation of EE measures –** Preparation of bankable and replicable detailed project reports for facilitating the cluster unit owners for implementation. The DPR's are to be prepared for a minimum of 5 technologies for various capacities

4. **Identification of the Local Services Providers –** The program also aimed for identification of local service providers and capacity building to facilitate them for implementation of the technologies in the clusters

5. **Facilitation of Innovative Financing Mechanisms –** The program also aims for encouraging the SME owners in implementation of technologies through innovative financing schemes

The project also aims to impart training and capacity building for the officials of various financial institutions like SIDBI and local lead bankers of the cluster location for evaluating energy efficiency related projects.

The BEE SME program model developed is innovative and designed in such a way that the involvement of various stakeholders like SME owners, consultants, technology providers, Local Service Providers, Financial institutions etc to facilitate :

- To identify the technologies and process up-gradation from various detailed studies undertaken by the consultants

- Active involvement of Financial Institutions to overcome financial barriers and development of a financial model for the technologies/equipments identified which are readily available and at best possible interest

1.3 Expected Project Outcome

The BEE SME program aims at improving energy efficiency in various cluster units of the country. On overall, the program creates opportunities for all the stakeholders in the cluster viz. SME owners, Local Service Providers, Equipment Suppliers and Financial Institutions.

Initially, a situation analysis had been carried out and detailed information pertaining to the technologies employed, energy use pattern and financial strengths of SME's in the cluster were established.

The present BEE SME Program implementation in Solapur Textile Cluster, the following outcomes are expected

Energy Use and Technology Analysis

The comprehensive energy use and technology studies in various cluster units has explored the information on status of Solapur Textile Cluster, production capacities, present status of the technologies employed, energy consumption pattern, identified all possible measures for energy efficiency and conservation, techno-economic feasibility of the identified measures, energy saving potential in the units surveyed and in total cluster units, technologies and equipments available locally, technical capabilities of LSP's for implementation, environmental impact due to reduction in energy consumption, etc. The major projects to be implemented which have more impact on energy conservation and common technologies which are more or less applicable for all the cluster units were identified for preparation of bankable detailed project reports and incorporated in the manual

Implementation of EE measures

To facilitate SME owners for implementation of energy efficiency measures by developing the bankable detailed project reports for a minimum of 5 technologies for various capacities as per the suitability of cluster unit sizes. These DPR's can be replicated as per the unit suitability for availing loans from financial institutions. The DPR contains various technical and financial indicators like IRR, NPV, ROI, etc for projecting the project viability. A total of 15 DPR's will be prepared

Capacity Building of LSP's and Bankers

The local service providers and equipments suppliers has already been identified in Solapur Textile Cluster and the capacity building programs planned for various stakeholders like local service providers, bankers and equipments suppliers to facilitate them for implementation of the energy efficiency measures

A conclusion dissemination workshop to be conducted to provide the information for all the stake holders for the status and achievement of the program.

1.4 Project Duration

The total duration of the project is 31 months and the details of the duration for each activity are furnished in the figure 1 below:

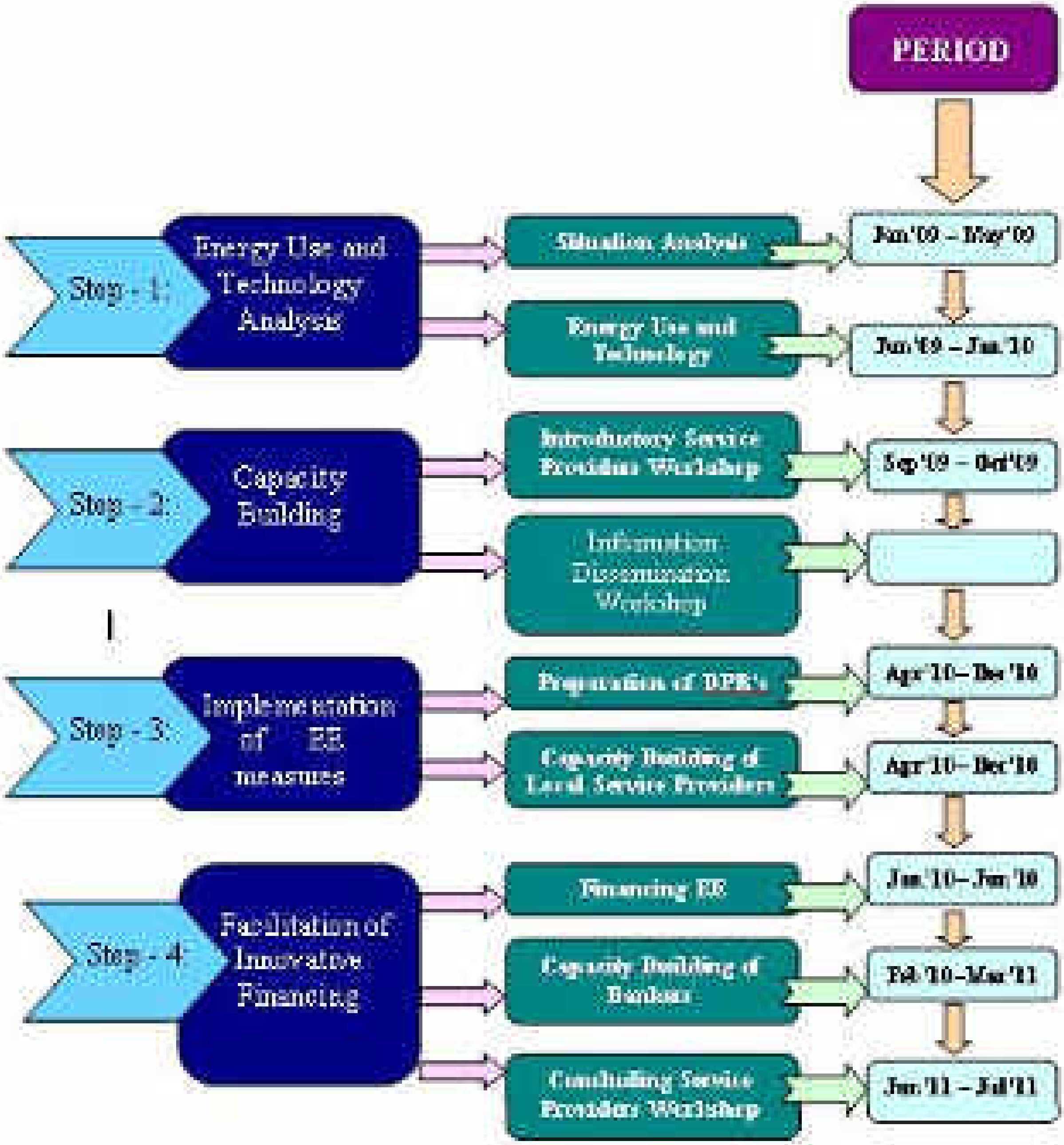


Fig.1 Project Duration

1.5 Identified Clusters under the BEE SME Program

The BEE has identified 25 SME Clusters to implement BEE SME program for energy efficiency improvement as furnished below in Table 1:

Table 1: List of clusters identified for BEE SME Program

S.No.	Cluster Name	Location
1.	Edible oil cluster	Alwar
2.	Machine components cluster	Bangalore
3.	Ice slabs cluster	Bhimavaram
4.	Brass cluster	Bhubhaneswer
5.	Sea food processing cluster	Cochin
6.	Fire bricks cluster	East &West Godavari
7.	Rice mills cluster	Ganjam
8.	Milk processing cluster	Gujarat
9.	Galvanizing and Wire drawing cluster	Howrah
10.	Foundry cluster	Jagadhri
11.	Limestone cluster	Jodhpur
12.	Tea processing cluster	Jorhat
13.	Foundry	Ludhiana, Batala, Jalandhar
14.	Paper processing cluster	Muzzafar Nagar
15.	Sponge iron cluster	Orissa
16.	Dyes and chemicals cluster	Vapi
17.	Bricks and tiles cluster	Varanasi
18.	Rice mills cluster	Vellore
19.	Dyes and chemicals cluster	Ahmedabad
20.	Brass cluster	Jamnagar
21.	Textile cluster	Pali
22.	Textile cluster	Surat
23.	Tiles cluster	Morbi
24.	Textile cluster	Solapur
25.	Rice mills cluster	Warangal

1.6 About the Present Study

BEE has awarded the Solapur Textile cluster study to Zenith Energy Services Pvt. Ltd. based on the competitive bidding under BEE SME program. Zenith Energy Services Pvt Ltd had taken the task of implementing the program and two full time energy auditors were deployed in the cluster and a project office had been established at local association office. As a part of the program, the details of the studies undertaken in cluster units are furnished below:

S.No	Type of audits	No. of units covered
1	Preliminary Energy Audits	6
2	Detailed Energy Audits	45
3	Technology audits	15

The studies were conducted covering all types of industries and capacities in the cluster and the reports were submitted to individual units for implementation of measures identified. Based on the studies carried out and data analysis, a cluster manual had been prepared for the following:

- Cluster details
- Products manufactured
- Energy forms used, costs, availability and consumption pattern
- Technologies/equipments installed
- Efficiency levels of the equipments installed
- Measures & technologies/equipments identified for energy conservation and saving, Investment required
- Simple payback period
- Various barriers for implementation
- Local Service Providers details

1.7 Structure of the Report

The present report has been divided into the following Chapters

Chapter 1: Introduction
Chapter 2: About Solapur Cluster
Chapter 3: Energy Audit and Technology Assessment
Chapter 4: Conclusions

Chapter 1: This chapter discusses about BEE SME program, project objectives, project outcomes and about the present study.

Chapter 2: Discusses broadly about the cluster, classification of units, energy situation, energy forms used and their availability, production capacities of the units, products manufactured, manufacturing process, technologies employed, current policies of various state and central government for energy efficiency and energy conservation, various issues and barriers in implementation of EE measures and technology up-gradation etc.

Chapter 3: Highlighted the methodology adopted, observations made on process and technologies, energy consumption profile, efficiencies of the equipments installed, house keeping practices adopted, availability of data and information, technology gap analysis, energy conservation and measures identified, cost benefit analysis, Local service providers availability, technology providers availability, etc

Chapter 4: Highlighted the environmental benefits and quantity of GHG emission reduction expected due to implementation of the measures identified for energy saving.

Chapter - 2
ABOUT SOLAPUR CLUSTER

2.1 Overview of Solapur SME Cluster

2.1.1 Cluster Background

Solapur is renowned for chaddars (bed sheets) and towels. The products manufactured in Solapur Textile Cluster units has domestic and export market. The products are also exported to various European and Gulf countries. Textile industry is one of the oldest and the most widespread in Solapur. The textile industries in Solapur produce cotton yarn and process yarn for doubling, dyeing, warping, and weaving by power looms. These industries are located at MIDC, Gandhi Nagar, Bhavani Peth, Bhadravathi Peth, and New Paccha Peth. Majority of the industries have been in operation for the last 20 to 30 years. The main raw material (cotton yarn) is being procured from local manufacturers/traders.

A decade ago, the cluster units were severely affected due to high operation cost and poor market conditions and many industries were closed. The government of Maharashtra has taken steps for helping these cluster industries by providing electricity as subsidized cost of Rs.1.50 per unit and tax exemptions. Due to encouragement of the government many industries came into operation and were running successfully. As per the local association “Textile Development Foundation (TDF)” and Power Looms Association, there are about 600 industries in the cluster, out of 600, 350 units are of integrated type and 250 units are having only weaving facility i.e., power looms.

Initially, the units were used to produce only bed sheets and due to reducing demand scenario for bed sheets and existence of large market potential for terry towels in the country, many of these cluster units were diversified for producing terry towels. Majority of the units are marketing their products through traders with low margins of profitability as the unit owners don’t have capability or strengths to market their products. However, this provided the entrepreneurs a wide market for selling their products throughout the country. Majority of the cluster units are of integrated type, where the raw material (yarn) is processed in-house to the final product.

Availability of the experienced design makers, raw material availability and subsidized and reliable power availability are the main positive features of the cluster. The cost of energy accounts for 8% to 10% of the total production cost and is next to the cost of raw materials.

2.1.2 Product manufactured

Majority of the units in the cluster are of integrated type. Initially, the units were producing bed sheets only. Over a period of time, due to varied market demand and the product range also changed with time and demand pattern. The units gradually diverted for producing other cotton products.

The major products manufactured in Solapur cluster units are – terry towels, napkins, bed sheets, cotton towels, T shirts and bed spreads. The products manufactured in the cluster mainly targeted for middle and lower income group people.

2.1.3 Classification of units

The Solapur Textile Cluster units can be broadly classified based on the dyeing process and products manufactured:

2.1.3.1 Classification based on dyeing process:

1. Manual Dyeing
2. Mechanical Dyeing

1. Manual Dyeing

The manual dyeing is one of the oldest conventional dyeing processes in India and is done manually. This process is used for dyeing all types of colors viz light, medium and dark colors. The hot water required is generated by open firing of wood in conventional chulhas and the vessel containing water mixed with dyeing agents is placed above chulha. The yarn is soaked in the water and heated for maintaining the temperature as required throughout the process. However, the products produced in these process have poor quality and inconsistency. There are about 250 units in the cluster having manual dyeing facility

2. Mechanical Dyeing

The mechanical dyeing is carried out in hank dyeing machines or cabinets. This processes require less manpower and the colors produced will have consistence and good quality. These units consist of the mechanical systems for rotating the yarn in the tanks or cabinets. The heat required in mechanical dyeing is either supplied by boilers or thermic fluid heaters. The dyeing carried out in cabinets will have better quality than hank dyeing, as dyeing is carried out in open conditions in hank dyeing system

There are 250 units in the cluster have manual dyeing and 100 units has mechanical dyeing facility and classification is presented graphically in Fig. 2

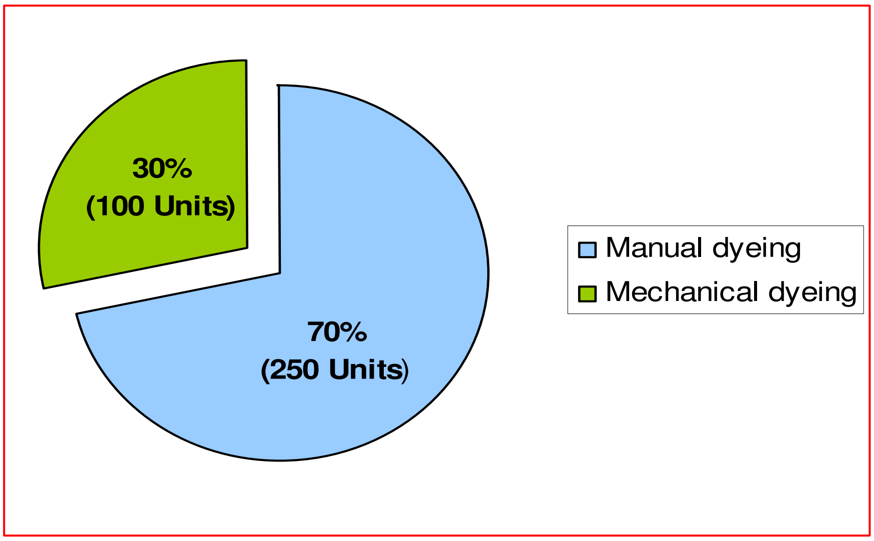


Figure 2: ***Classification of units based on dyeing facility***

2.1.3.2 Classification based on products manufactured

The main products of Solapur Textile Cluster are towels and bed sheets. Out of the 600 units, 480 units are engaged in the production of terry towels, 100 units produce bed sheets, and the remaining 20 units produce both bed sheets and towels. The classification of units based on products manufactured is furnished graphically in Figure 3.

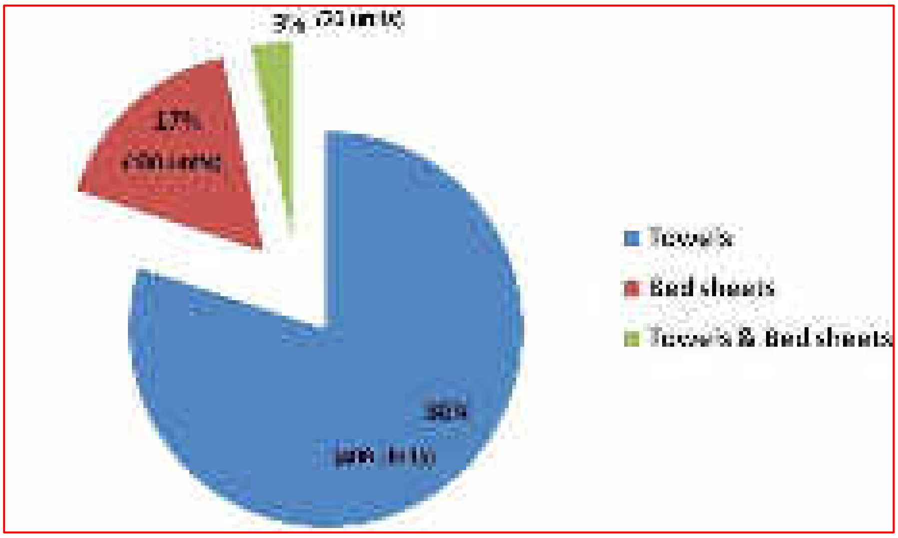


Figure 3: ***Classification of units based on products manufactured***

Production Capacity

Most of the units in Solapur Textile Cluster operated on single shift basis of 8 hours and six days a week. The production capacities of the units are in range from 150 to 2000 kgs per day. Based on the discussions with the association and other reliable sources, the annual production of the cluster is around 54,000 tons of finished material per annum.

Classification of the Units Surveyed (51 units)

2.1.3.3 Classification based on production capacity

i) Large-scale units having production capacity of above 1000 kg/day capacity

ii) Medium size units having production capacity less than 1000 kg/day and more than 500 kg/day

iii) Smaller units having less than 500 kg/day production capacity

Out of 51 units surveyed, three (3) units are large industries, 11 are medium size, and the remaining 37 units fall under small scale category. The total production capacity of the 51 units surveyed is 6,288 tonnes per annum and the categorization of the units based on production capacity is furnished graphically in Figure 4.

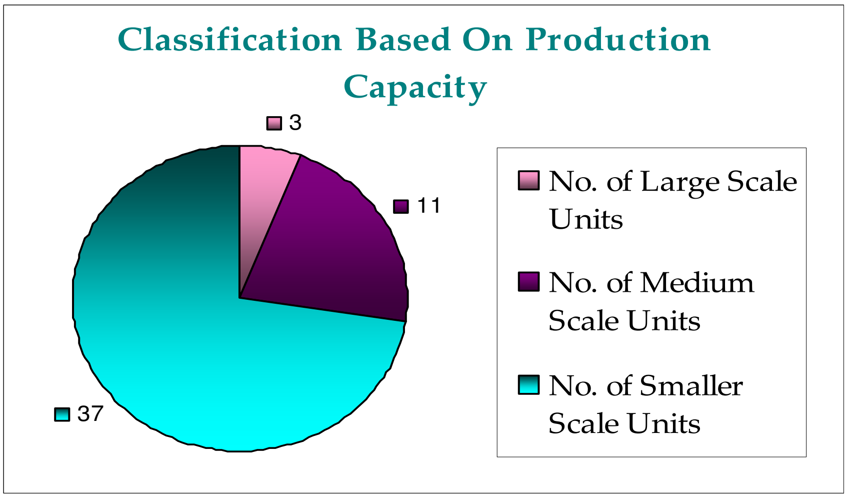


Figure 4: Classification of units based on Production Capacity

2.1.3.4 Classification based on products manufactured

The main products of Solapur Textile Cluster are towels and bed sheets (chaddars). Out of the 51 units surveyed, 40 units are engaged in the production of terry towels, 7 units produce chaddars, one unit produces napkins and the remaining three (3) units produce both bed sheets (chaddars) and towels. The classification of units based on products manufactured is furnished graphically in Figure 5.

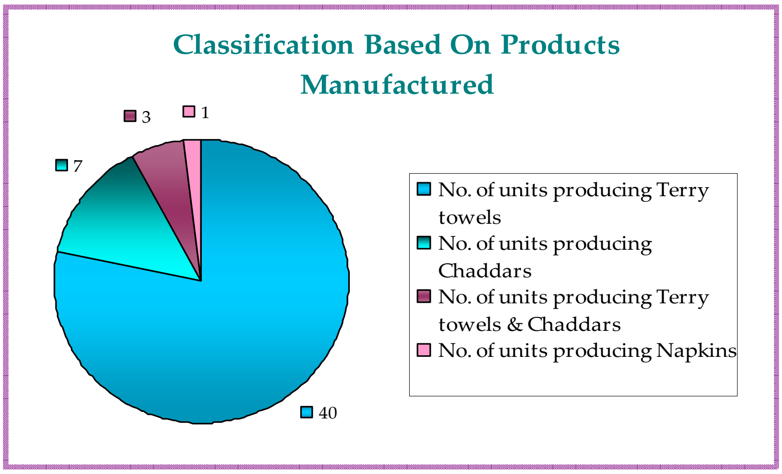


Figure 5: ***Classification of units based on products manufactured***

2.1.3.5 Classification based on production facilities

In Solapur Textile Cluster, about 39 units are of integrated type having both weaving and dyeing facilities and the remaining 12 units have weaving facilities only. The classification based on production facility is furnished graphically in Figure 6.

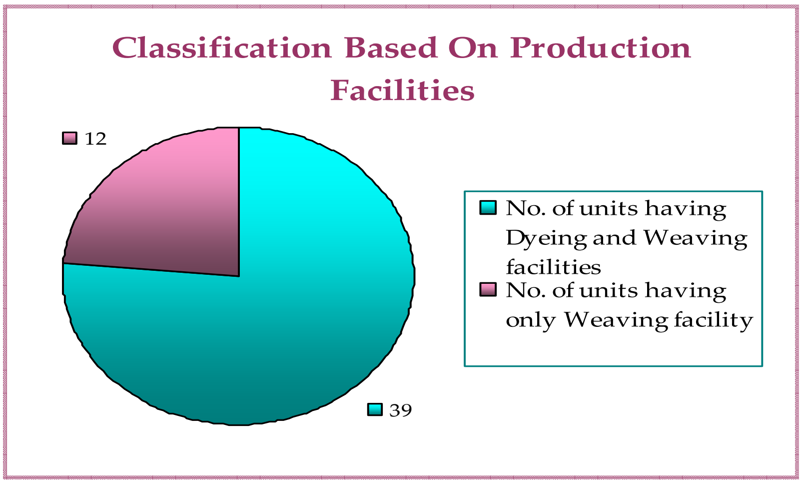


Figure 6: ***Classification of units based on production facilities***

2.1.3.6 Classification based on thermal energy source

Thermal energy in the form of hot water is required for dyeing and soaping process. The units in Solapur Textile Cluster have Boilers (IBR & non IBR), Thermic fluid heaters, and Chulhas. Boilers are predominantly used in the cluster. Out of 51 units only 39 units are using only thermal energy i.e., 17 units have boilers, 13 units have chulhas, 05 units have thermic fluid heaters, 03 units have hot water generators and 01 unit has employed solar hot water system for hot water generation. The classification based on thermal energy source is furnished graphically in Figure 7.

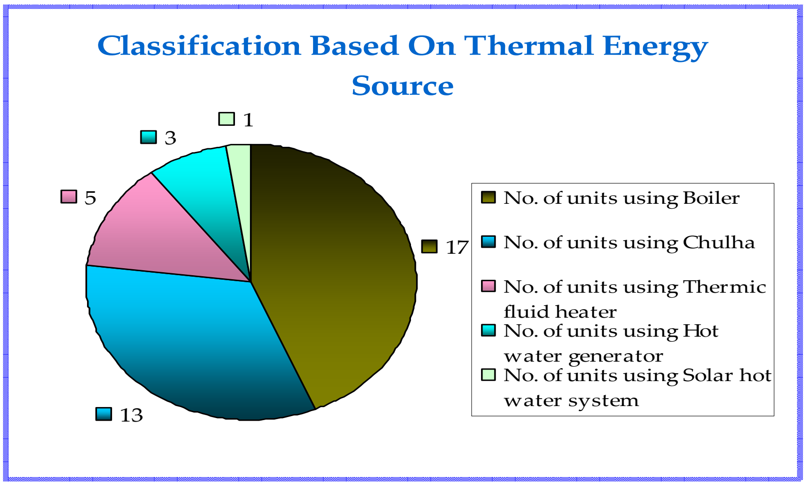


Figure 7: ***Classification of units based on thermal energy***

2.1.3.7 Classification based on technology.

Out of 51 units surveyed, only one unit has auto looms of shuttle less type and all the remaining units are power looms with shuttles. The auto looms have been installed for production enhancement and quality. The products produced in auto looms are sold at premium price when compared to normal power looms due to improved quality and demand in the market.

2.1.3.8 Classification based on energy bill/annum

Out of 51 units surveyed, 2 units have energy bill less than Rs. One lakh per annum, 45 units have energy bill above Rs.1.00 and less than Rs.10.00 lakhs per annum, 3 units recorded energy bill above Rs.10.00 lakhs and less than Rs. 20.00 lakhs per annum and one unit has energy bill above Rs. 20.00 lakhs.

The classification based on energy bill/annum is furnished graphically in Figure 8.

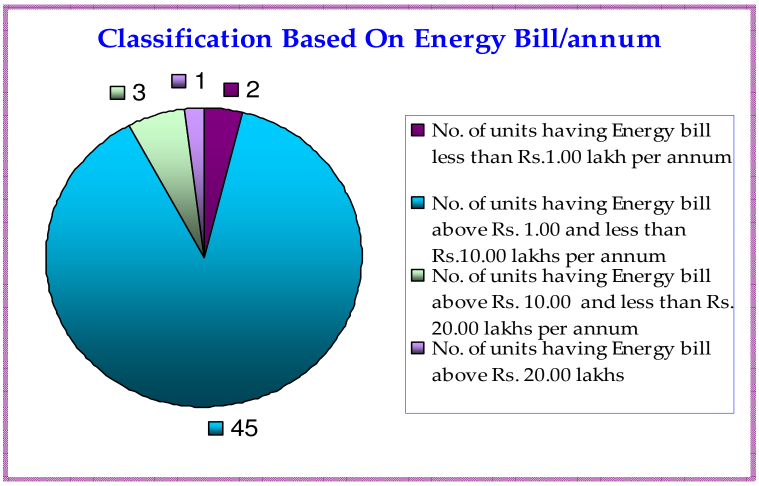


Figure 8: ***Classification of units based on energy bill***

2.1.4 Raw materials used

The raw materials used in Solapur Textile Cluster units are:

- Cotton yarn
- Dyeing agents
- Bleaching agents
- Caustic
- Soap stock

The cotton yarn is of normally 20's count and is procured from local traders. The other raw materials like dyes, caustic and bleaching agents required for dyeing and preparation process are also procured locally.

Very few units are depending on job works for dyeing and weaving from other local companies. Most of the units sell their products through the traders. The traders will do the marketing throughout the country. In this type of marketing, the traders are getting more profits than the unit owners and doing business without any investment. Further, the entire investment is made by the unit owners and material is supplied to the traders on 100% credit basis.

2.2 Energy Consumption Scenario of the Cluster

The cluster units require fuels and electricity for dyeing and weaving. Heat is used for dyeing process for application and dye fixation. Heat is also used for making dye solution. Electricity is required for operating the motors and lighting. The major fuels used in the cluster units are wood and GN husk briquettes.

2.2.1 Energy Forms used

Fuels

The clusters units have boilers, chulhas and thermic fluid heaters for heat generation in the form of steam, hot water and hot oil. The major fuels used in the cluster units are wood and groundnut husk briquettes. Majority of the units use wood and very few units are using briquettes. The wood is procured from local traders. Two units have installed solar hot water systems to cater hot water required for the process.

The wood is available at a landed cost of Rs.2500 to Rs.3000 per ton depending on the type and moisture content. The Julie-flora variety has higher price than other types of wood due to high heat value. The groundnut husk briquettes are priced at Rs.4250 per ton and are supplied by the Gujarat traders. The GCV of wood and GN husk briquettes is 3200 kcal/kg and 4200 kcal/kg respectively

Electricity

The electricity is supplied by Maharashtra State Electricity Distribution Company Limited to all the cluster units. Electricity is available for 6 days in a week and normally, the electricity is available for 24 hours in a day. Till recently, electricity is supplied to the cluster units at subsidized cost of Rs.1.50 per kWh for encouraging the unit owners and at present the tariff had been increased to Rs.2.50 per kWh .

2.2.2 Energy consumption

Electricity is used for driving the prime movers of pumps, hydro extractors, winding machines, power looms, lighting, etc. Wood is used as fuel in boilers, thermic fluid heaters and chulhas for hot water generation required for the process. The annual energy consumption of three typical units of the cluster is furnished in Table 2 below:

Table 2: Annual energy consumption of different units

Details	Value	Type 1	Type 2	Type 3
Electricity consumption*	kWh	1,97,784	1,08,040	3,35,600
Wood consumption	tonnes	140	28	--
Production**	kgs	2,88,000	72,000	3,60,000
Final product	kgs	1,44,000	72,000	3,60,000

**Electricity consumption is total plant consumption*

***production figure considered is for dyeing process only, as partly the dyed yarn is supplied to other units*

Type 1 : Integrated unit with Thermic Fluid Heater or boiler
Type 2 : Integrated unit with conventional Chulha
Type 3 : Only weaving

The annual consumption of fuels and electricity of the total cluster units is furnished below:

Wood Consumption : 32,000 tons (10,270 TOE)
Electricity Consumption : 74,150 GWh (6, 377 TOE)
Total : 16,647 TOE
(TOE - Tons of oil equivalent)

2.2.3 Specific energy consumption

The specific energy consumption for each of the equipment installed in the cluster units is furnished in table 3:

Table 3: Specific energy consumption(SEC)

S.No	*Equipment*	*Units*	*Minimum SEC*	*Maximum SEC*	*Average SEC (for whole cluster)*
1	Doubling machines	kWh/kg	*0.25*	*0.40*	*0.30*
2	Dyeing machines	kWh/kg	*0.04*	*0.07*	*0.05*
3	Power looms	kWh/kg	*0.47*	*0.60*	*0.52*
4	Dyeing process	Kg of wood/kg	*0.50*	*0.75*	*0.60*

2.3 Manufacturing Process

2.3.1 Process technology

The main process operations for production of towels and bed sheets in cluster units are as follows:

2.3.1.1 Doubling

In the Doubling process thin single yarn is converted to double yarn for strengthening the yarn by using doubling machine.

2.3.1.2 Yarn dyeing

Initially, the yarn is soaked in soap water for 24 hours to remove the dirt and other foreign materials and then the yarn is taken for bleaching. Bleaching is carried out by soaking the yarn in tanks mixed with bleaching agents. After the completion of bleaching, the yarn is washed with normal water.

The hank dyeing machine tanks are filled with required quantity of water, chemicals and dyeing agents. The temperature of the water is raised by either oil circulation or direct steam injection. Fire wood is used as fuel. The required colors are added to the yarn and the dyeing process takes about 90 to 120 minutes per batch. The dyeing temperature required depends on the colors and the details of the dyeing temperatures required for various types of colors are furnished below:

Type of color	**Temperature Required (^oC)**
Light	30 – 35 ^oC
Medium	55 – 60 ^oC
Dark	80 ^oC

After dyeing, the yarn is washed with normal water, and the yarn is taken for soaping for color fixation in hot water for about 20 minutes in hank dyeing machines. The water is drained to the waste drainage lines. The wet yarn is taken to hydro extractors for removing water in the yarn and taken for drying in the natural sunlight.

The yarn after drying is taken for winding in which the yarn is wounded to bobbins and cones. The winded yarn is taken for further process.

2.3.1.3 Winding

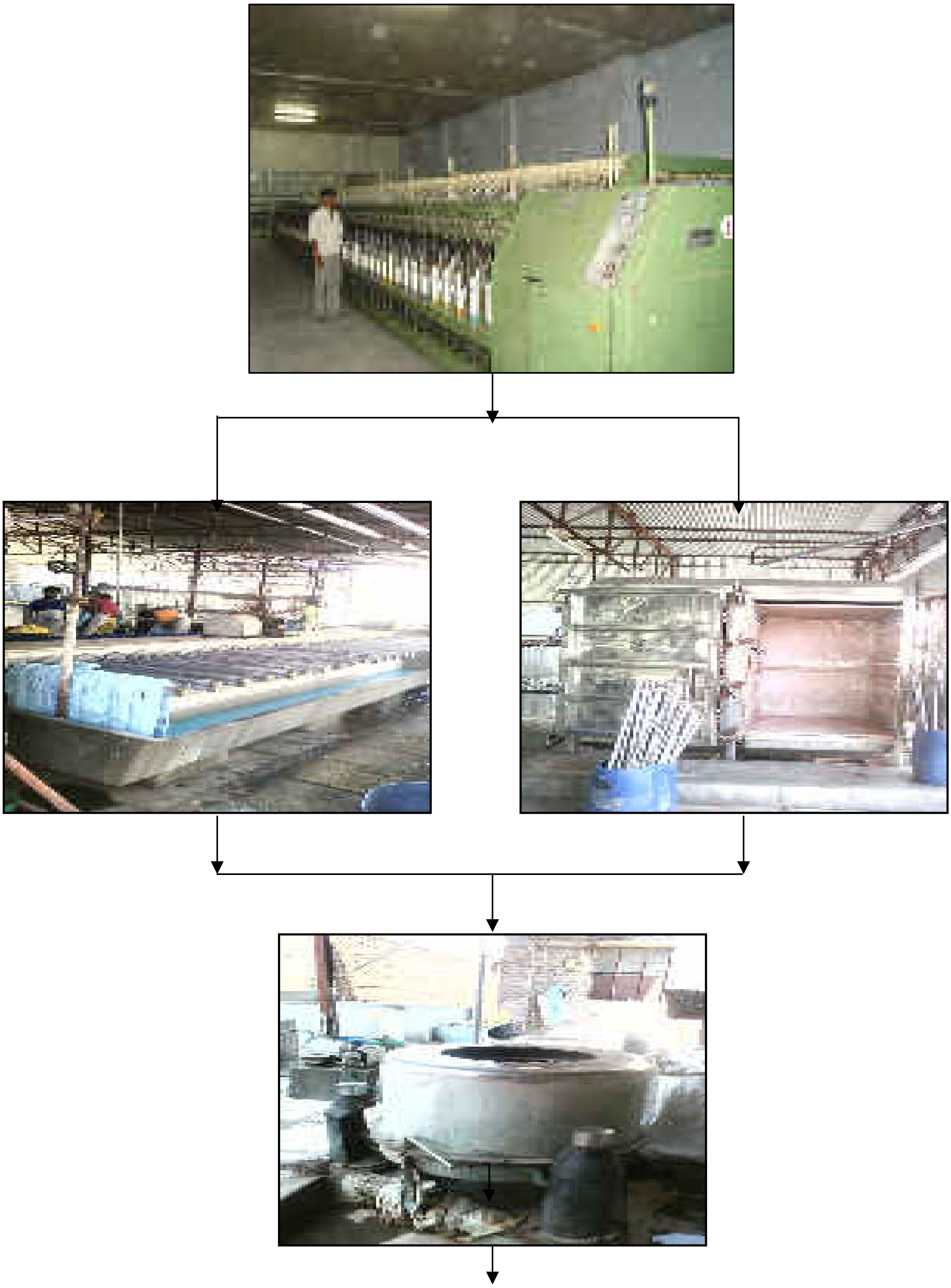
The production process as depicted in the below chart is typical to almost similar to most of textile units in the Solapur Textile cluster producing towels and cheddars. However, depending on the final product, quality of final product required, the process flow is altered as per the requirement of the industry.

2.3.1.4 Warping

In warping, the winded yarn is wound to beams according to designed pattern (customized designs). Then the beams are taken for Weaving.

2.3.1.5 Weaving

The beams which are wound with yarn are taken and placed in power looms where the designed pattern is already set. In power looms the yarn is converted to final product (Towel or cheddar) by weaving. The product obtained from weaving is taken for stitching and packing. The general process flow diagram of a typical unit for production of towels and chaddars is furnished in Figure 9.



2.4 Current Policies and Initiatives of Local Bodies

About Maharashtra Energy Development Agency (MEDA)
MEDA is a Government of Maharashtra Undertaking Agency established in the year 1985. MEDA is a 'Nodal Agency' for promotion of renewable energy sources and 'Designated Agency' for implementation of Energy Conservation Act, 2001 in the State of Maharashtra.

The main objectives of MEDA are:

- To promote and develop, Non-conventional, Renewable and Alternate Energy
- Sources and Technologies
- To assist GOI and GOM in Renewable Energy Programmes
- To install Demonstration Projects
- To pursue Power Projects, based on Renewable Energy
- Rural Electrification through Renewable Energy (remote villages)
- To Implement Energy Conservation Act , 2001 and related schemes

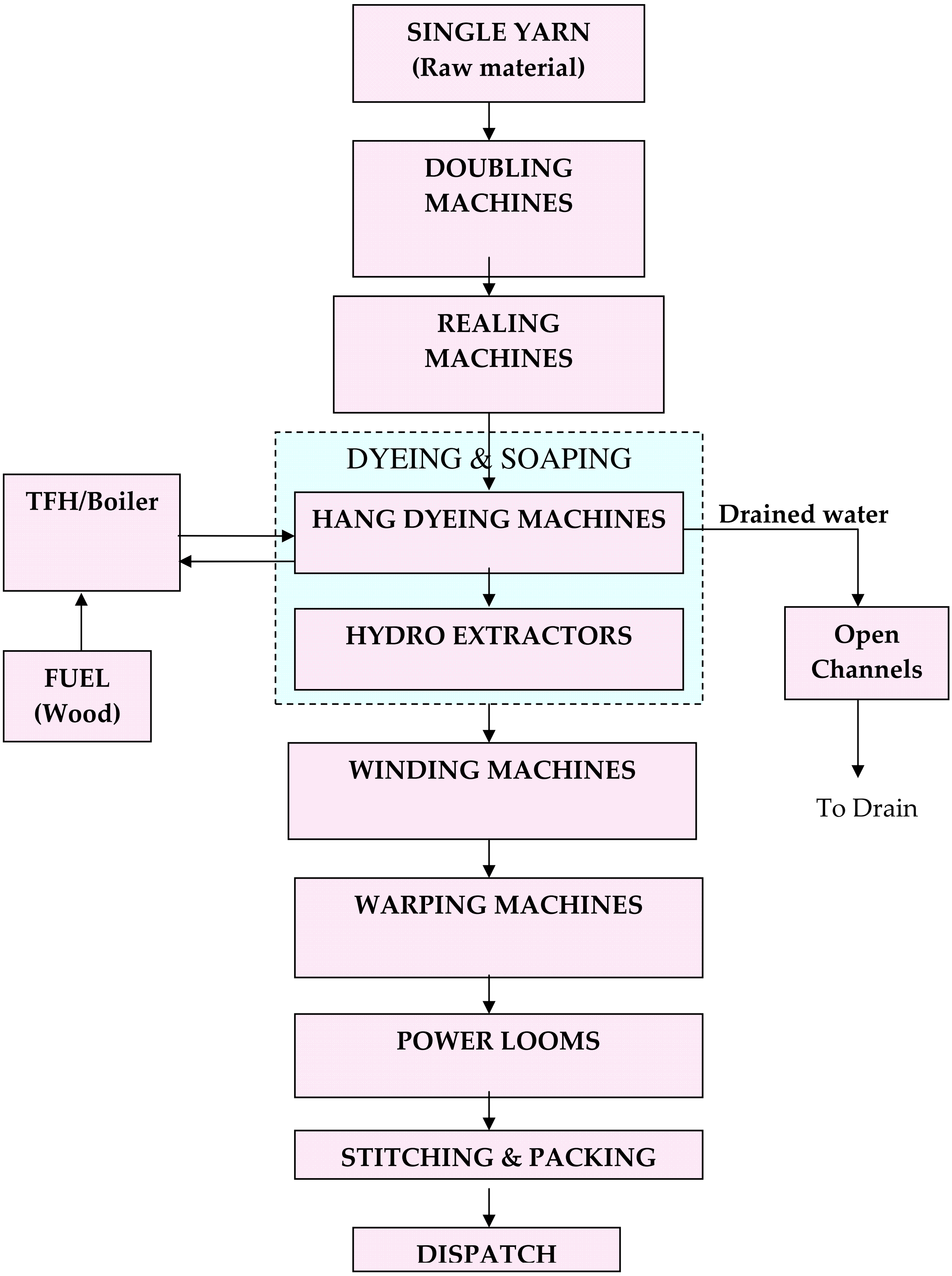
Since MEDA's inception, MEDA is promoting several programs for energy conservation and renewable energy related activities:

Solar Hot Water Systems
The MEDA is offering soft loan through various financial institutions for installing solar water heating system, loans up to 85 % of cost of the system having ISI mark is available at 2% (for individual), 3% (for non profit making organization) and 5% (for profit making organization) interest from some nationalized & co-operative banks. This has been arranged by MNES with a few nationalized banks. The MNES has plans to include more nationalized banks for such loan facilities in the future. The loan repayment period is 5 years. In addition, Indian Renewable Energy Development Agency (IREDA), New Delhi, is also extending soft loans to end users under certain terms and conditions. In Maharashtra there are eight manufacturers who have got ISI mark for solar flat plate collectors from BIS authorities.

If loan is not availed, central subsidy of Rs 2200/- per collector for not-for-profit institutes and Rs.1650/- per collector for profit making institutes is available.

MEDA Waste Heat Recovery Scheme
Large quantity of hot flue gas is generated from Boilers, Kilns, Ovens and Furnaces. If some of this waste heat could be recovered, a considerable amount of primary fuel could be saved. The energy lost in waste gases cannot be fully recovered. However, much of the heat could be recovered and loss minimized by adopting various measures. The high temperature heat recovery potential is available in many industries. The high temperature waste heat available can be utilized for power generation, heating of water, air, process heating etc. Considering the acute shortage of power, this ready source can prove a boon to the industry in more than one way. Hence to encourage waste heat recovery and utilization, MEDA has proposed to provide financial assistance to industries for preparation of detailed project report (DPR) for power generation, utilization of waste heat for heating of water, air, process heating from waste heat recovery.

Figure 9: General process flow diagram of a typical unit in Solapur cluster



Eligibility Criteria

- A Unit / facility should be situated in Maharashtra state
- A Unit/ facility should be regular payer of electricity bill
- The Detailed Project Report (DPR) should be prepared by MEDA's empanelled consultant
- In case of Semi Govt./ Government Undertaking / Local Self Government, Buildings/ Buildings of Urban Local Bodies & Maharashtra Industrial Development Corporation (M.I.D.C.) supporting documents to clarify the undertaking of State / Central Govt. is necessary.
- If the unit is already availing financial assistance from any Government organization for preparation of detailed project report study then the unit is not eligible for this assistance.

Financial Assistance

Financial Assistance will be given as below:

- Of Rs. 100,000/- (One Lakh) per project or 50% of consultant fee for preparing DPR, whichever is less for power generation.
- Of Rs. 50,000/- (Fifty thousand only) per project or 50% of consultant fee preparing DPR, which is less for other purpose of heating.

Further details regarding MEDA financial schemes may be obtained from:

Manager EC

Maharashtra Energy Development Agency (MEDA)

MHADA Commercial Complex, 2nd Floor

Opp. Tridal Nagar, Yerwada, Pune 411 006

Tel No. : +91-020-26614393/ 403

Fax No. +91-020-26615031

Email: eee@mahaurja.com / econ@mahaurja.com

Website: www.mahaurja.com

The association is taking considerable efforts to improve the quality, marketing of the products, identifying the units having surplus capacity and providing contract jobs for the small units in the cluster**.**

2.5 Major Barriers for Implementation of Energy Efficiency

2.5.1 Energy availability

- Initially, the electricity cost is Rs.1.50 per unit for all the cluster units and had been increased to Rs.2.50 per unit from last 10 months.
- Though, the electricity is available at subsidized cost and availability of the electricity is 6 days in a week only.
- Major fuels used in the cluster units is wood and no other fuels are available in the cluster like NG and LPG and Coal is not used.

2.5.2 Technological issues

The major barriers that prevented the implementation of energy efficiency measures in the cluster units are:

- Lack of awareness and information among the technologies
- Dependency on local technology suppliers and in-flow of state-of-the-art technology is limited in this business
- Most of the units have manual dyeing process and hence less machinery requirement.
- The decentralized conventional power looms are used in majority of the units
- Non availability of local service providers for supplying energy efficient equipments also made the cluster unit owners impossible to implement energy efficient technologies
- Further, so far no single program on energy efficiency had been implemented in the cluster. This is also one of the factors for lack of awareness on energy efficiency

2.5.3 Lack of technical know-how and organizational capacity

Majority of the textile unit owners do not have in-depth technical expertise, knowledge or training about energy efficiency

There is a strong feeling in the owners, that energy efficiency initiatives is a challenge to take the risk of such business interruption due to production loss against the drive to save energy

Additionally, the textile industry generates liquid effluents. Some of the proposed measures require operation under appropriate conditions and clean environment. From the view of the operators, maintaining the equipment requires additional efforts, organizational capacity and technical know-how not related to the core business, all together resulting in additional costs. Therefore, even if they were aware of the benefits many textile unit owners are shied away from such measures or investments.

These are however can be overcome by motivating them to attend the awareness programs and detailed report 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

- Solapur Textile units are very small units and these unit owners don't have financial strengths to invest in new technologies.
- The owners are also not accessed to bank loans due to dense policies and documentations

The availability of skilled manpower is also one of the major barrier facing in these cluster units.

Chapter - 3
Energy audit and technology assessment

3.1 Methodology Adopted

To achieve the desired objectives of the program, Zenith Energy Services Pvt Limited has carried out 45 detailed energy audits, 6 preliminary audits and 15 technology audits under the energy efficiency intervention.

3.1.1 Energy Use and Technical Study

3.1.1.1 Pre-energy Audit Activities

Collection of preliminary information from cluster units for products manufactured, production capacity, status of technologies / equipments installed, willingness of the unit for the study, and implementation of the measures identified.

3.1.1.2 Preliminary Energy Study

The following methodology has been adopted for pre-energy audit:

a) Collection of past energy consumption details and energy bill
b) Establish specific energy consumption, if possible
c) List out major energy consuming areas of the plant
d) Level of technologies adopted (latest or old, crude or efficient, local or reputed company make)
e) Status of instruments installed in the plant and necessary instrumentation required for the detailed study
f) Identify areas for special attention for low cost measures with quick payback period
g) Understanding detailed manufacturing process with energy and material balance
h) Identify areas for detailed study and measurements required
i) Analyze bottleneck areas of the plant for detailed study
j) Collection of best practices adopted in the plant

3.1.1.3 Detailed Energy Study

The following methodology has been adopted for detailed energy study:

- Monitoring of energy related parameters of various equipment / machines using Zenith Energy Services Pvt Limited portable instruments
- Collection of operating data from various measuring instruments / gauges installed in the plant
- Collection of past operating data / historical data from log books and data registers
- 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 / monitored by Zenith Energy Services Pvt Limited
- Technology status of the equipments installed
- Detailed process flow of the plant
- Identification of energy wastage areas and quantification of energy losses
- Identification of suitable measures for reducing energy wastages
- Identification of areas for reuse, recycle and recover

3.1.1.4 Technology audit

The following methodology has been adopted for conducting technical audit:

- Identify energy intensive areas and equipments of the plant
- Whether the equipments 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 plant management

3.2 Observations Made

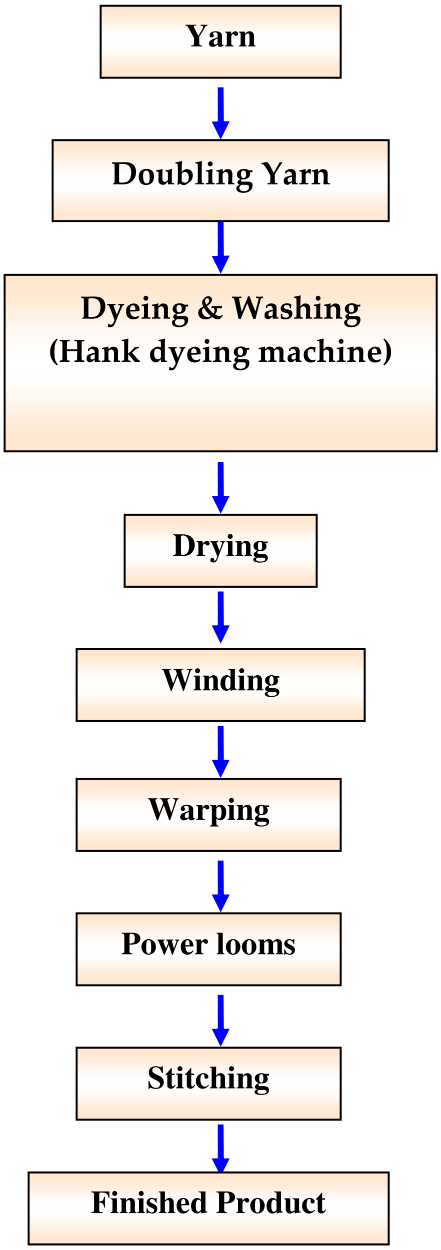
3.2.1 Manufacturing process and technology employed

There are about 600 units in the cluster, which are engaged in the production of terry towels and chaddars. The process is more or less similar for the units. The process flow diagram of a typical unit of the cluster is furnished in the figure 10 below:

The detailed studies were carried for following equipments:

a) Doubling machines
b) Hank dyeing machines
c) Cabinet dyeing machines
d) Manual dyeing
e) Drying process
f) Winders
g) Warping machines
h) Power looms
i) Centrifuges
j) Boilers and steam distribution
k) Thermic fluid heaters efficiency and utilization
l) Conventional chulhas
m) Electrical distribution system

Figure 10: Process flow chart ***(For a typical textile unit in the cluster)***



A comprehensive study of the units revealed the following:

i) The status of technology / equipments installed is poor as compared to the technologies available in the market.

ii) As these units are small, the process control is limited and only in few units, the process parameters are monitored and though instrumentation is installed, they are either not in place or malfunctioning.

iii) Though, the management is interested in implementation, the energy loss areas and EE technologies could not be identified either by the management or local service providers for implementation due to lack of awareness.

iv) No single unit doesn't have a waste heat recovery systems, though the flue gas temperatures is above 350 ^{o}C, this shows that there is lack of knowledge in identifying energy loss areas.

v) Further, The EE technology providers from other areas also have never approached the cluster unit owners. Hence, the cluster unit owners are depending on the local technology suppliers for their low cost and their availability at any point of time.

vi) The sector faces deficiencies such as the lack of access to technology and technology sharing and the inadequacies of strong organizational structure, professional attitude etc.

3.2.2 Energy consumption profile & availability

The supply and consumption pattern of energy inputs are analyzed in the cluster and the details are furnished below:

3.2.2.1 Wood

The majority units of the cluster are using wood as fuel for hot water generation in boilers, thermic fluid heaters, and chulhas. The wood consumption of the units varies from 100 kg to 2000 kg per day depending on production capacity, equipment installed. The average specific wood consumption varies from 0.50 to 0.75 kg/kg of yarn.

The dyeing process adopted in various units of the cluster varies and also type of the colors of dyeing and hence the evaluating the benchmark figures may practically not possible.

3.2.2.2 Electricity

The power is supplied from the nearby 33 KV substation located in industrial area. All the cluster units have multiple connections and are supplied through common distribution transformers. The power is available for 6 days in a week and the quality of power is good. The electricity is available to all the cluster units at a subsidized cost of Rs.2.50 per unit. Very few DG sets were found in the cluster units

The annual electricity consumption in cluster units varies from 24,600 kWh to 4,52,900 kWh and the average specific electricity consumption (For final product) is 1.00 to 1.48 kWh/kg depending on the quality, process adopted, products produced, production capacity of the units installed, type of equipments installed and others etc. The specific electricity consumption variation in cluster units is furnished below:

S.No	Details	Specific electricity consumption (kWh/kg)
1	**Minimum**	1.00 (best value)
2	**Maximum**	1.48
3	**Average**	**1.24**

3.2.3 Capacity utilization

Baby and packaged boilers, conventional chulhas and thermic fluid heaters are installed for hot water generation. Wood is used as fuel in all the cluster units and wood consumption varies from 100 kg to 2000 kg per day. The capacity utilization of the equipment varies from 20 to 60% on installed capacity.

In process, the units operate at 80 to 100% capacity utilization as against the installed capacity and all the cluster units operate on single shift of 10 hours per day.. The Economic Recession was slightly affected on the cluster units and the plant load factor of the cluster is 42%

3.2.4 Housekeeping practices

The housekeeping practices adopted in the cluster units are poor. There are no specific procedures to be followed in any of the units for the operation of the various equipments. Either the workers or the management doesn't have the knowledge on energy conservation and efficiency. Based on comprehensive studies conducted in cluster units, the better housekeeping practices were prepared for optimizing energy consumption and also enhancing the production and provided in Annexure 2

3.2.5 Availability of data and information

The availability of data and collecting the same from the cluster units is vulnerable and no single unit was ready to reveal production and energy consumption data. However, the data was made available and data was kept transparent for few units. However, the data such as energy consumption and production monitored during the field visits have been used for evaluating specific energy consumption and potential for energy saving.

Furthermore, many units in the cluster have more than one unit and doesn't have break up separately for each unit for fuels and production. Various necessary formats have been prepared based on the observations made during the study for various equipments and plant for regular monitoring and were furnished in Annexure 6

3.2.6 Any other relevant aspect

The major barrier for energy efficiency improvement in the cluster has been lack of trained and skilled manpower. Most of the workers are illiterates and doesn't have technical exposure and gained little knowledge based on past experience and hence doesn't have any knowledge on energy losses and doesn't have capabilities of exploring new ideas. These workers generally have strong feeling that, adoption of new technologies and practices is complex and do not have any impact on performance.

3.3 Technology Gap Analysis

3.3.1 Technology up-gradation

The production of cotton textiles is a very old production process and during olden days, the dyeing was carried out manually soaking in the water mixed with dyeing agents and weaving is done on the conventional handlooms. Over a period time, the process was modified for faster production and handlooms were replaced with power looms and manual dyeing replaced with mechanical dyeing for faster production and quality and has got fully matured over the years.

There was considerable development in the dyeing process; the manual dyeing system was replaced with cabinet dyeing and hank dyeing systems for faster production and quality. Only big companies having high production capacity, adopted hank dyeing and cabinet dyeing systems. Due to high initial investment for these systems,. The smaller units could not adopt. Apart from above, there was no drastic technological development in the process.

In worldwide, there is tremendous development in power loom sector for enhancing production, quality and economic point of view. However, in majority of the units surveyed in Solapur Textile Cluster units conventional power looms had been installed. There has been a tremendous growth in the production of fabrics in the Powerlooms catering to the domestic and export market. But the quality of the fabrics produced by these Powerlooms is by and large inferior compared to the international standards, in spite of availability of better quality of yarn. Due to lack of financial strengths of the unit owners, the shuttle less looms could not adopted

The most energy consuming equipments of the cluster units are heat generation equipments like boilers/chulhas/thermopacks and doubling machines. The boilers/chluhas/thermopacks installed were old and supplied by local equipment suppliers. The efficiencies of these equipments were low due to inferior design and unit owners could not adopt better systems due to lack of knowledge and non availability of local efficient equipment suppliers.

The high efficiency doubling machines are available in the market, but to high initial investment and lack of financial strength and low returns on investment made impossible for the unit owners to implement.

However initiative of technologists to build Energy Efficiency intrinsically into machinery itself and development of computer enabled process control methodology to existing machinery has brought sea change in the way textile processing is done.

Equipments Utilized

The units in the Solapur Textile Cluster can broadly be classified as

- Manual Dyeing
- Mechanical Dyeing

Manual Dyeing

Normally, in manual dyeing process units doesn't require much machinery and the production is done by manually. All the operations like dyeing, de-watering, washing and soaping etc is carried out manually. Though, the energy consumption is low in these units compared with mechanical dyeing, the efficiency levels are low and the quality of output is not comparable. These units would need a model change to switch over from manual to mechanization and requires re modeling of all equipments and other business systems like raw materials procurement, production and market network.

Mechanical Dyeing

In mechanical dyeing systems, the heat energy is the major energy form required for the process. The heat is either generated in the form of steam in boilers or hot water is generated by oil circulation by thermo packs. The boilers and thermo packs installed in Solapur Textile Cluster have low efficiency due to various reasons as discussed in previous and subsequent sections. These equipments either to be replaced or retrofitted for better efficiency

3.3.2 Process up – gradation

The process used in the Solapur Textile Cluster units is more or less same. As far as the process improvement concerned, only the dyeing process requires improvement for better quality, optimization of chemicals and dyes etc.

Based on detailed energy use and technology audits revealed that there may not be technology change required in the cluster units and only retrofit or additional equipments may require for improving efficiency. The details of equipment-wise technology gaps identified and technology interventions required are furnished below:-

S,No	Equipments	Technology Gaps Identified	Technology Interventions
1	**Chulhas**	• No mechanism for air circulation and smoke removal • High Heat losses through grate openings from front and back ends • No control on combustion air supply • Radiation losses from all sides • Lack of monitoring of wood feeding	Improved chulha with efficiency 25%. The main features of Improved Chulha are : 1. Provision for regular air circulation. 2. Damper for regulating combustion air flow 3. Optimized furnace area 4. Improved grate design 5. Chimney for removal of smoke.
2	**Thermic Fluid Heaters**	• Single flue gas path system • Poor heat transfer efficiency • Heat losses from charging door • No Waste Heat Recovery and high flue gas losses • Low loading of the thermic fluid heater •	1. Economizer for hot water generation or air Pre-heater 2. Energy Efficient Hot Water Generators
3	**Boilers**	• Single flue gas path system • Poor heat transfer efficiency • No Waste Heat Recovery and high flue gas losses • Low loading of the boiler	New Improved Design high efficiency boiler
4	**Doubling Machines**	• Constant speed for varying loads • High weight spindles • Conventional tapes for transmission system	Variable Frequency Drives

5	**Hot Water Generation**		Solar Hot water systems
6	**Power Looms**	• Poor quality and hence less price for the product • More manpower cost • Frequent breakdowns due to shuttles • Low production	Auto looms
		Retrofitting Measures	
7	**Boilers**	• Optimize hearth area for under-loaded boilers • Optimize excess air supply by ID/FD fans or by dampers in natural draft boilers • Soot Blowing and removal of scale from heat transfer tubes	---
8	**Thermic Fluid Heaters**	• Optimize hearth area for under-loaded • Optimize excess air supply by ID/FD fans or by dampers in natural draft systems • Soot Blowing and removal of scale from heat transfer tubes	---

3.4 Energy Conservation Measures Identified

3.4.1 Proposals for energy conservation including technology up–gradation

3.4.1.1 Proposal description including technology/product specifications for each proposal

The various proposals had been identified for implementing in the cluster units for reducing energy consumption:

a) Replace inefficient Boilers and Thermo packs with Hot Water Generator

Background

The temperature required for dyeing process varies from 55 ^oC to 80 ^oC. The Solapur Textile Cluster units require hot water for dyeing, soaping and maska operations. There are about 95 boilers and 10 Thermic fluid heaters in the entire cluster. The boilers and thermic fluid heaters are installed for hot water generation and for maintaining the temperature during dyeing and soaping process. The boilers and thermic fluid heaters installed are having low efficiency due to following reasons.

- Single flue gas path system
- Poor heat transfer efficiency
- No Waste Heat Recovery and high flue gas losses
- Non water walled chambers
- Low loading of the boiler and thermo packs i.e., less than 25%
- No control on combustion air supply

The efficiency and various associated losses had been evaluated for few units and details are furnished below:

Thermic Fluid Heater Efficiency

S.No	Summary of Various Losses	kcal	%
1	Heat in waste flue gasses	782496	40.7
2	Losses due to un-burnt carbon	178560	9.3
3	Radiation losses	115200	6
4	Heat in the oil	172800	9.0
5	Heat loss due to moisture in wood	44160	2.3
6	Unaccounted losses	96000	5.0
7	**Total**	**1389216**	**72.3**

Efficiency of the thermic fluid heater = 100 – total losses = 100 – 72.3 = **27.7%**

Boiler Efficiency by Direct Method

S.No	Details	Units	Value
1	Boiler Capacity	kgs/hr	600
2	Steam pressure	Kgs/cm^2	7
3	No. of hours of operation/day	hrs	10
4	Quantity of steam generated	kgs/day	400
5	Boiler feed water temperature	^0C	30
6	Briquettes Consumption	kgs/day	265
7	Calorific value of fuel	Kcal/Kg	4200
8	Enthalpy of steam (@ 5 kgs/ $cm^{2)}$	Kcal/Kg	665
9	Heat Input	Kcal/day	1113000
10	Heat output	Kcal/day	254000
11	**Efficiency**	%	**22.8**

Recommendations

It is recommended to replace the present boilers with hot water generators. The hot water generator is a compact and packaged system and can be installed wherever space is available and doesn't require major civil foundations. It does not require any special room like boiler house. It falls outside the policies applicable of Indian Boiler Regulations.

The cost benefit analysis for a single unit having a boiler is furnished below:

S.No	Parameter	Units	Value
1	Efficiency of the hot water generator	%	60
2	Efficiency of the present boiler	%	22.8
3	Increase in efficiency	%	37.2
4	Fuel savings	%	62
5	Present briquette consumption	tonnes/annum	64
6	Briquette savings	tonnes/annum	40
7	Monetary savings(@ Rs. 4250 per tonne)	Rs. lakhs/annum	1.68
8	Investment required for a hot water generator of 1,00,000 kcal/hr	Rs. lakhs	2.00
9	Payback period	years	1.2

The hot water generator can be implemented in about 20 units. The annual fuel savings for the whole cluster is estimated as 1050 tons of non renewable wood and monetary savings of Rs.26.25 lakhs per annum. The total investment required for 20 units is Rs.40.00 lakhs and simple payback period is 1.50 years.

Description of the Technology

The proposed hot water generator mainly consists of the following elements.

- The hot water generator converts the energy available in fuels into thermal energy in the form of hot water
- The hot water generator consists of a pump for circulating the water from the tank to generator. The hot water generated can be directly used for the process or can be circulated in the heat exchanger tubes for heating the fluids.
- The hot water generator is of natural draft system and doesn't have FD and ID fans
- The fuel is fed manually and also ash removal

The suggested technical specifications of the hot water generator are furnished below:

Heat output : 100,000 kcal/hr
Maximum temperature : 95 °C
Hot water flow rate : 20,000 liters/hr
Fuel : wood
Fuel consumption : 41 kg/hr (at 70% efficiency & NCV 3500 kcal/kg)
Firing control : Manual
Combustion draft : natural
Water pump motor : 3 HP
Efficiency : 70%
Electricity consumption : 3,380 kWh per annum (for 8 hours/day and 240days/year)

Different capacities of hot water generators are available from 1,00,000 kcal/hr to 10,00,000 kcal/hr and can be installed as per the requirement.

Benefits of Hot Water Generator

- High efficiency of over 75% under normal operating conditions
- Reduces wood consumption
- Reduces processing time due to fast generation of hot water
- Reduces GHG emissions
- Compact, easy to operate and low operation and maintenance costs
- Quick payback periods and low investment than the boilers and thermic fluid heaters of the same capacity
- Maximum utilization of heat due to improved design aspects

b) Use of the Solar Hot Water System

Recommendation

In Solapur Textile Cluster units, dyeing is carried out in normal water for light colors, medium colors in 55 °C water temperature, and dark colors at 75 to 80°C hot water. The solar energy resource in Solapur is particularly strong. Average daily solar radiation on a collector surface tilted at an angle of 25° to the horizontal is 8.0 kWh/m² per day, equivalent to 2,000 kWh/m² per year. 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 the following parameters:

- The area available on the terrace of the building
- Hot water requirement for dyeing process / soaping
- Availability of sunny days

- As per normal utility and consumption pattern of 1000 liters per batch in the hank dyeing machine

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^{o}C can be generated for about 5 months and water at 55 ^{o}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 the various financial institutions.

The cost benefit analysis of installing solar hot water for a typical requirement of 1000 LPD is furnished below:

S.No.	Details	Units	Value
1	Capacity	liters/day	1000
2	Temperature of hot water	^{o}C	70
3	Water inlet temperature to SHWS	^{o}C	30
4	Temperature difference	^{o}C	40
5	Heat generation per day	kcal/day	40000
6	Efficiency of the present hot water generation	%	36.7
7	Wood savings per day	kgs/day	50
8	No. of days per annum	days	240
9	Wood savings per annum	kgs/day	12000
9	Wood cost	Rs./kg	2.5
11	Monetary savings per annum	lakhs	0.30
12	Cost of solar hot water system	lakhs	1.0
13	Simple pay back period	years	3.3

On an average, the solar hot water system can be installed in about 150 units of 2000 LPD capacity. The annual wood savings is estimated as for all the cluster units is 3600 tons of wood per annum and monetary savings of Rs.90.00 lakhs. The investment required for installing solar hot water system is Rs.300.00 lakhs and simple payback period is 3.3 years

Benefits of Solar Hot Water System

- The solar energy is a renewable energy source and is available abundantly
- The 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
- The SHW system uses clean form of energy and doesn't emit toxic gases and protects environment
- The SHW doesn't require manpower for operation and is maintenance free
- Low margin money and interest rate 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 up-to 20% of total cost

c) Installation of Economizer in boilers and thermic fluid heaters

Background

Boilers and Thermic Fluid heaters are the most commonly found equipment in the Solapur Textile Cluster industries. All the boilers and thermic fluid heaters are of wood fired. Based on detailed studies carried out in various units, no single boiler or thermic fluid heater has waste heat recovery system. In many cases, the temperature of the flue gases at the exit of the boilers is found to be varying between 230 ^{o}C to 270 ^{o}C and 330 to 360 ^{o}C in thermic fluid heaters.

Recommendations

Installing economizer for hot water generation by utilizing the heat in waste flue gases will reduce the fuel consumption and hot water generated can be used in the process. The economizer size and savings varies case to case, based on capacity of the boiler/thermic fluid heater, quantity of hot water required, temperature of hot water, quantity of flue gases, space availability etc. The cost benefit analysis of installing economizer for a typical unit is furnished below:

Heat in flue gases measured in a typical unit having thermic fluid heater

Fuel firing rate = 600 kgs/day
Theoretical air required per kg of wood = 5.8 kg/kg
Actual mass of air supplied = (1 + EA/100)*theoretical air
= (1 + (121/100)) * 5.8
= 12.7 kg/kg of wood
Heat in dry flue gas = m * Cp ($t_2 - t_1$)
= Flue firing rate *actual Air supplied/kg of wood
* Specific heat constant * ($t_2 - t_1$)
= 12.7 * 0.26 * 600 * (360 - 30)
= 7,82,496 kcal/day

The cost benefit analysis of installing economizer for hot water generation for a thermic fluid heater is furnished as under:

Temperature of flue gases	: 360 ^{o}C
Temperature of flue gases after economizer outlet	: 120 ^{o}C
% Fuel savings expected	: 12%
Present fuel consumption	: 144 tons/year
Wood savings per annum	: 17 tons
Monetary savings (@ Rs. 2,500 per tonne)	: Rs.42,500
Investment required	: Rs.75,000
Payback period	: 1.76 years

Thermic Fluid Heaters (10 nos)

There are about 10 thermic fluid heaters in the cluster, the economizers can be installed for all 10 units. The average annual fuel savings is estimated is 170 tons of non renewable wood and monetary savings of Rs.4.25 lakhs per annum. The total investment required for installing economizers for 10 units is Rs.7.50 lakhs and simple payback period is 1.76 years

Boilers

The cost benefit analysis of installing economizer for preheating of boiler feed water is furnished as under:

Temperature of flue gases	: 260 ^{o}C
Temperature of flue gases after economizer outlet	: 120 ^{o}C
% Fuel savings expected	: 7%
Present fuel consumption	: 168 tons/year
Wood savings per annum	: 12 tons
Monetary savings (@ Rs. 2,500 per tonne)	: Rs.30,000
Investment required	: Rs.50,000
Payback period	: 1.67 years

Out of 95 boilers in the cluster; the economizers can be installed for about 55 units. The annual fuel savings is estimated is 660 tons of wood and monetary savings of Rs.16.5 lakhs per annum. The total investment required for 55 units is Rs.27.50 lakhs and simple payback period is 1.67 years

Benefits of Economizer

- Utilizes heat available in waste flue gases and hence no fuel is required
- Hot water generated can be directly used for the process, hence reduction in processing time
- Increases production for the same period
- Improves working environment due to reduction in temperature of flue gases
- Low investment and high returns
- No operation and maintenance costs

d) Replace the old boilers with Energy Efficient Boilers

Background

The boilers are installed in the cluster units for hot water generation and to maintain the temperature in the dyeing and soaping process by direct injection of steam. Based on detailed studies carried in cluster units, some of the boilers were found to be inefficient due to inferior design like single pass system, high flue gas losses, high radiation losses, conventional furnace walls instead of water walled chambers, low loading etc. The efficiencies of these boilers are found to be in the range of 22 to 40%.

Recommendation

The present boilers can be replaced with new boilers of 75% efficiency. The features of high efficiency boilers are:

- The boiler is three pass constructions 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 turn around mixing of the gases prior to entering the second pass.
- The front smoke box also ensures complete turn around 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 refractories 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.
- M.S. 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.

Boiler Efficiency

S.No	Parameters	Units	value
1	Boiler Capacity	kgs/hr	200
2	Steam pressure	kgs/cm^2	5
3	No. of hours of operation/day	hrs	8
4	Quantity of steam generated	kgs/day	500
5	Boiler feed water temperature	^{0}C	30
6	Fuel Consumption	kgs/day	300
7	Calorific value of fuel	Kcal/Kg	3200
8	Enthalpy of steam (@ 5 kgs/ cm^2)	Kcal/Kg	656
9	Heat Input	Kcal/day	960000
10	Heat output	Kcal/day	313150
11	Efficiency	%	32.6

Cost benefit analysis of installing new energy efficient boiler

S.No	**Parameter**	**Unit**	**Value**
1	Proposed capacity of the boiler	Kgs/hr	200
2	Efficiency of the new boiler	%	75
3	Efficiency of the present boiler	%	32.6
4	Increase in efficiency	%	27.4
5	Fuel savings	%	56
6	Present wood consumption	tons/annum	72
7	Wood savings	tons/annum	40
8	Monetary savings (@ Rs. 2500 /tonne)	lakhs/annum	1.00
9	Investment	Rs. lakhs	3.00
10	Payback period	years	3.0

Table 4: Technical details of new boilers

S.No	Capacity	250 kg/hr	500 kg/hr	1000 kg/hr
1	Steam output (kgs/hr)	**250**	**500**	**1000**
2	Fuel	**wood**	**wood**	**wood**
3	Steam pressure (kg/cm^2)	**7.00**	**10.54**	**10.54**
4	Efficiency	**75 ± 2**	**75 ± 2**	**75 ± 2**
5	Fuel consumption (kgs/hr)	**63**	**125**	**250**
6	Electrical load (HP)	**1.5**	**2.0**	**7.5**

Out of 95 boilers in the cluster, the new efficient boilers can be installed in about 20 units by replacing existing boilers. The annual fuel savings is estimated as 800 tons of non renewable wood and monetary savings of Rs.20.00 lakhs per annum. The total investment required for 20 units is Rs.60.00 lakhs and simple payback period is 3.0 years.

Benefits of new efficient boilers

- Reduces wood consumption and faster generation of steam
- Enhances production capacity of the plant
- Reduces GHG emissions
- The boilers will have waste heat recovery unit, hence improves efficiency of the system
- Improves working environment for workers due to reduction in radiation losses and flue gas temperatures

e) Use of energy efficient Improved Chulha's

Background

There are about 250 chulhas in the cluster of various sizes. The chulhas are used for generating hot water and preparation soap stock. The chulhas are of conventional type and are of open firing. Based on detailed studies carried out on chulhas, the efficiency was found to be in the range of 6 to 10%. The low efficiency of the chulhas is due to the following reasons:

LOCAL CHULHA

- The 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

IMPROVED CHULHA

Recommendation

Zenith Energy Services Pvt Limited 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.

A improved chulha had been constructed at one of the unit of Solapur Textile Cluster and the efficiency of the chulha has been found to be around 20% and about 70% of wood consumption had been reduced. The chulhas can be 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 below:

Efficiency evaluation

S.No	Details	Units	Value
1	Quantity of hot water generated	liters/day	350
2	Initial temperature of water	°C	30
3	Final temperature of water	°C	90
4	Fuel Consumption	kgs/day	130
5	Calorific value of fuel	Kcal/Kg	3200
6	Heat Input	Kcal/day	416000
7	Heat output	Kcal/day	21000
8	Efficiency	%	5.04

The cost benefit analysis by replacing conventional chulha with improved chulha is furnished below

Present wood consumption	: 28 tonnes/annum
Efficiency of the new improved chulha	: 20%
Increase in efficiency	: 15%
Fuel savings estimated	: 70%
Wood savings	: 20 tonnes/annum
Monetary savings	: Rs. 0.50 lakhs
Investment required	: Rs. 0.25 lakhs
Payback period	: 6 months

There are about 250 chulhas in the cluster and these chulhas can be replaced with new improved chulhas. The annual fuel savings is estimated is 5,000 tons of non renewable wood and monetary savings of Rs.125.00 lakhs per annum. The total investment required for 250 units is Rs.62.50 lakhs and simple payback period is 6 months.

Benefits of New Improved chulha

- Easy to construct, operate and repair. Maintenance required is minimal.
- 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 to 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

f) Use of Variable Frequency Drives (VFD) in various process & utility sections

Background

There are no. of equipments in Solapur Textile Cluster units, where the flow is controlled by mechanical dampers for fans and valves for pumps. Further, majority of the doubling machines are operated at constant speed irrespective of the load on the machine.

If the flow can be controlled by reducing the speed of the pump motor this 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 or pump is reduced, the flow will reduce partially, while the power required by the fan or pump reduce with the cube of the speed.

The mechanical constriction of the flow may reduce the load on the motor/fan/pump motor. But the constriction itself is an energy loss, which is obviously an inefficient operation. If the flow or speed can be controlled by reducing the speed of motor, this 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 pump is reduced, the required speed/flow will reduce partially, while the power required by the pump reduce with cube of speed, for instance, if the speed is reduced by 10%, the flow reduces by 10%, pressure reduces by 15% and power consumption reduces by 25%.

Recommendations

Hence, it is recommended to install VFD's for ID/FD fans, oil circulation pumps and doubling machines. A minimum savings of 20% can be realized. The variable frequency drives are available as per the capacity of the motor and no. of speeds required. The cost benefit analysis of installing a VFD is furnished below:

S.No	Details	Unit	Value
1	No. of doubling machines	nos	2
2	Capacity	HP	12.5
3	No. of working hours per day	Hours	12
4	No. of Working days in a year	Days	300
5	Energy consumption of doubling machines	kWh/annum	46998
6	Savings		20%
7	Estimated annual savings	kWh	9400
8	Cost	Rs/kWh	2.5
9	Monetary savings	Rs/annum	23499
10	Monetary savings	Lakhs/annum	0.23
11	Cost of variable frequency drive	Rs.	30000
12	Investment	Lakhs	0.6
13	Pay back period	Months	31

Install VFD's for ID fans and Oil circulation pumps

There are about 40 ID fans and 10 oil circulation pumps in the cluster and VFD's can be installed for ID fans and oil circulation pumps. The annual electricity savings is estimated is 1,07,300 kWh per annum and monetary savings of Rs.2.68 lakhs per annum. The total investment required is Rs.12.50 lakhs and simple payback period is 4.66 years.

Install VFD's for Doubling machines

There are about 500 doubling machines in the cluster and VFD's can be installed for all doubling machines. The annual electricity savings is estimated is 23,50,000 kWh per annum and monetary savings of Rs.58.75 lakhs per annum. The total investment required is Rs. 150.00 lakhs and simple payback period is 2.55 years.

Benefits of VFD's

The benefits of installing the drives are as follows:

- Reduction in breakdowns and smooth start
- Unity power factor
- Reduction in breakages and motor burnts
- 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 (.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
- May Qualify for Utility Rebates
- Controlled Acceleration and Deceleration
- Eliminates Motor Voltage Imbalance
- Input Power Phase Reversal Protection

g) Solar Drying Systems

Background

The yarn need drying in order to reduce their moisture content as part of processing. While open sun drying may be the most inexpensive and extensively used option for the cluster units for drying yarn, the process is time-consuming and results in poor quality.. One option is to use a conventional fuel such as biomass, oil, or electricity for drying applications. However, such fuels are expensive, and their use causes pollution. With the rising costs of conventional fuels and increasing awareness of the dangers of pollution, solar dryers are becoming a technically and economically viable option in many industrial applications.

Solar energy can be used to temperatures needed for most of the drying applications. Solar dryers use are heated through solar energy collectors, which can be installed in modules according to the requirements of hot air. Drying is basically a heat and mass transfer process: moisture from the surface and inside of the product is vaporized, and the vapour is removed by flowing hot air. Important factors affecting the drying process are listed below.

- Relative humidity and temperature of air
- Airflow rate
- Initial moisture content of the product

- Final desired moisture content of the product

Types of solar dryers
Integrated solar dryers

An integrated solar dryer is one which solar energy collection and drying take place in a single unit. Cabinet dryers, rack dryers, tunnel dryers, greenhouse dryers, and multi-rack dryers fall under this category. Normally, these dryers are small in size and are stand-alone units.

Distributed solar dryers

A solar dryer in which solar energy collection and drying take place in separate units is known as a distributed solar dryer. This type of solar dryer has two parts: (1) a flat-plate air heater and (2) a drying chamber, Air is heated in the flat-plate heater placed on the roof of the building or on the ground. Hot air from the air heater is circulated in the drying chamber with the help of a blower. These dryers can be designed in different sizes with various configurations, depending upon the temperature of hot air, airflow rate, types of products to be dried, etc.

Mixed-mode solar dryers

A solar dryer in which solar energy collection takes place in both air heater and drying unit, and drying takes place only in the drying unit, is known as a mixed-mode solar dryer. In this dryer, solar energy is collected through flat-plate solar collectors and also by the roof of the drying chamber. In large industrial drying systems, the solar-heated air is combined with air heated by conventional energy; this adds to the reliability of the system and at the same time helps in significantly reducing conventional energy consumption.

Advantages

- Solar dryers are more economical compared to dryers that run on conventional fuel/electricity.
- The drying process is completed in the most hygienic and eco-friendly way.
- Solar drying systems have low operation and maintenance costs.
- Solar dryers last longer. A typical dryer can last 15-20 years with minimum maintenance.

Limitations

- Drying can be performed only during sunny days, unless the system is integrated with a conventional energy-based system.
- Due to limitations is solar energy collection, the solar drying process is slow in comparison with dryers that use conventional fuels.
- Normally, solar dryers can be utilized only for drying at 40-50 ^{o}C.

Cost

The cost of a solar dryer of 50 kg capacity ranges form about Rs 30,000 to Rs 50,000. Larger dryer for yarn drying may cost between Rs 4 lakhs and Rs 5 lakhs.

Subsidies

The MNES is implementing a national programme on solar thermal energy, which provides interest subsidy in the form of soft loans available through IREDA and banks. The MNES also provides capital subsidy of up to 50% of the project cost for a specific demonstration project that is based on new technology and or is located in a new area.

There are a few manufacturers in India who are capable of supplying solar dryers for specific purposes and in specific sizes. Larger systems for industrial establishment have to be designed and installed on a project-by-project basis.

g) Auto looms

In majority of the units surveyed in Solapur Textile Cluster units conventional power looms had been installed. There has been a tremendous growth in the production of fabrics in the Powerlooms catering to the domestic and export market. But the quality of the fabrics produced by these Powerlooms is by and large inferior compared to the international standards, in spite of availability of better quality of yarn. And also, cost wise it is becoming very difficult to compete with other developing countries like China, Pakistan, Korea, Taiwan, Thailand, Malaysia, Indonesia etc., Modernisation is one of the tools to improve the weaving performance and hence for the success of the trade.

Need for Shuttleless Weaving

In the conventional shuttle looms, it is necessary to pass a shuttle weighing around half a kilogram through the warp shed to insert a length of weft yarn which weighs only few grams. The shuttle has to be accelerated rapidly at the starting of picking cycle and also to be decelerated, stopped abruptly at the opposite end. This process creates heavy noise and shock and consumes considerable energy. Beat-up is done by slay motion which again weighs a few hundred kilograms. The wear life of the picker and checking mechanism is also limited due to heavy shock. Due to the above reasons smooth sequence of weaving is disturbed which affects the maximum running speed and hence machine production. In multi colour weft insertion, Drop box motion is attached which is also further limits the speed of the machine. The small weft package in the shuttle requires frequent replenishments and for each loom stoppage there is a possibility of one defect. The probability of weft way fabric defects are high to the tune of 70% in shuttle looms. Even in automatic shuttle looms there is chances of transfer failures and weft lashing in defects.

Disadvantages of Shuttle Looms

Some very commonly known disadvantages of shuttle looms are

(i) Limitation in quality of fabric
(ii) Limitation in loom speed and hence productivity
(iii) More consumption of energy and frequent replacement of spares parts.

To overcome the above limitations of shuttle loom, the need for better weft insertion system without shuttle has been realized.

Recommendations

Hence, the present shuttle looms can be replaced with shuttles looms or auto-looms. Analysis of the results shows that shuttle less looms are more economical than shuttle looms due to the following reasons.

a) **Less Value Loss**

The reduction in value loss due to the improvement in quality is the major factor for better profitability. Even 5% reduced value loss in shuttleless loom than a shuttle loom for a fabric costing Rs.60 per metre will give additional profit of Rs.3 per metre.

b) **Higher Production per Loom**

Apart from the higher speed of shuttleless looms, the efficiency advantage of shuttleless looms is about 10-15% as compared to conventional loom. This is mainly due to shuttle changes and mending / unweaving of damages due to warp and weft breakages and also due to reduced down-time for warp changes. 5% higher efficiency of shuttleless looms than shuttle looms may give additional profit of Rs. 1/- per metre. This is due to the reduction of labour cost, over-heads cost, power cost etc., due to higher production of cloth.

c) **Less Ex - Works cost**

Ex - works cost is less for the shuttleless looms due to less mending cost for rectifying the defects and less inspection charges due to better quality of fabrics. Ex-works cost is also less in shuttleless looms due to non-requirement of pirn winding process.

From the above illustration, Air-jet looms would be more economical for mass production of low priced fabrics. However from technology point of view it lacks versatility for weaving different fabrics. Then comes projectile looms. But rapier looms are more suitable and economical for value added fashion fabrics. If the fabric doesn't get better price, reduction in value loss alone cannot fully compensate the increased cost in rapier looms. So, the projects with shuttleless looms will be more successful if the product mix is also changed towards high value added products.

Conclusion

With liberalization and globalisations of the trade and phasing out of multi fibre agreement in 2005, there is an urgent need for examining our poor contributions towards export of textiles compared to other developing countries and strategies for modernisation, marketing etc., must be evolved to recover the lost ground and also for the healthy future growth of our textile industry.

Advantages of Shuttleless Weaving Technology

The Shuttleless weaving is becoming more and more popular due to the following advantages compared to conventional looms.

..High labour and machine productivity due to high speed and wider width of looms.
..Reduced labour cost due to higher allocation of looms and productivity.
..Defect free cloth for longer length.
..Better environment due to low noise level.
..Pirn winding process is eliminated
..Less value loss of fabrics.
..Low consumption of stores and spares.
..Less space requirement per metre of cloth.
..More colours in weft direction (upto 12) by Pick and Pick method.
..Wider width fabrics and multi width fabrics can be woven,
..High degree of flexibiligy to suit a wide range of fibres and counts.
..Easily adaptable for market trends.
..Bigger flanges can accommodate 3 times more yarn.
Due to less beam changes lower down-time and lesser wastages.
..Less dependency on labour skill.
..Higher design capabilities dut to microprocessor and electronic controls.
..Easy maintenance and less work load for Jobbers.
..Lesser accidents.

There are about 12,000 looms in Solapur Textile Cluster producing about 54,000 tons annually and 1620 lakh meters. The estimated monetary savings is estimated as Rs. 64.00 crores per annum. About 3600 looms are required for replacing all power looms with auto looms. The investment required is around Rs.216.00 crores and the simple payback period works out at 3.5 years.

3.4.1.2 Life cycle analysis for each proposal

The life cycle analysis for each of energy saving proposal had been prepared as per the Indian industry norms, government policies and as per the guarantee provided by the equipment/technology suppliers

Table 5: Life cycle analysis for energy saving proposals suggested

S.No	Energy Saving Proposal	Life cycle analysis
1	**Hot water generator**	The life of the hot water generator is considered at 20 years and the initial rated efficiency is 75% and the efficiency de-rates by 1% for each year of operation. The depreciation is considered at 10% by straight line method.
2	**Economizer**	The life of the economizer and other waste heat recovery equipments is considered at 20 years. The depreciation is considered at 80% as per IT policy of the India
3	**Boiler (Energy efficient)**	The life of the boiler is considered at 20 years and the initial rated efficiency is 75%. The depreciation is considered at 80% as per IT policy of the India
4	**Solar hot water system**	The life of the solar hot water system is considered at 10 years The depreciation is considered at 80% during the first year as per the central government policies
5	**Variable frequency drive**	The life of the variable frequency drive is considered at 20 years. The depreciation is considered at 80% as per IT policy of the India
6	**Auto Looms**	The life of the autolooms is considered at 20 years. The depreciation is considered at 10% as per Indian industry norms
7	**Solar Dryer**	The life of the solar dryer is considered at 10 years The depreciation is considered at 80% during the first year as per the central government policies

3.4.1.3 Cost of implementation

The investment required for various proposals identified for different capacities for Solapur Textile Cluster:

Table 6: Details of Cost of Implementation

Equipment Details	Plant and Machinery Cost (Rs. In Lakhs)	Other Costs (Rs. In Lakhs)	Total cost (Rs. In Lakhs)
Hot water generator			
(0.8 Lkcal/hr cap)	2.00	0.89	2.89
(1. 0 Lkcal/hr cap)	2.50	1.00	3.50
(1.2 Lkcal/hr cap)	3.00	1.10	4.10
Economizers			
3.0 Lkcal/hr TFH	0.75	0.05	0.80
4.5L kcal/hr TFH	0.90	0.10	1.00
2.0 TPH boiler	0.75	0.15	0.90
1.0 TPH boiler	0.60	0.05	0.65
600 kgs/hr boiler	0.50	0.10	0.60
Solar Hot Water Systems			
500 LPD	0.50	0.15	0.65
1000 LPD	1.00	0.20	1.20
2000 LPD	2.00	0.25	2.25
3000 LPD	3.00	0.30	3.30
5000 LPD	5.00	0.40	5.40
Variable Frequency Drives			
3 HP	0.20	-	0.20
5 HP	0.25	-	0.25
7.5 HP	0.30	-	0.30
10 HP	0.40	-	0.40
Improved Chulha			
Bigger size	0.25	-	0.25
Medium size	0.20	-	0.20
Smaller size	0.15	-	0.15

Boilers			
200 kg/hr	3.75	0.25	3.95
500 kg/hr	6.25	0.30	6.55
1000 kg/hr	9.00	0.40	9.40
Auto looms			
China Make	6.00	1.00	7.00
European Make (new)	25.00	2.00	27.00
European Make (old)	12.00	1.00	13.00
Solar Dryers			
Solar Dryer for 500 Kgs capacity	5.00	--	5.00

3.4.1.4 Monetary savings

As per the detailed audits carried out on various equipments of Solapur Textile Units, the monetary savings have been estimated for each proposal and the details are furnished in the following Table 7:

Table 7: Cost benefit analysis for various proposals suggested

Equipment Details	Electricity savings (kWh/year)	Wood savings (tonnes/year)	Monetary savings (Rs. in lakhs)	Simple payback period (months)
Hot Water Generator	_	52	1.30	19
New efficient Boiler	_	40	1.00	36
Economizers	_	17	0.43	21
Solar Hot Water System	_	24	0.60	40
Variable Frequency Drives	4700	-	0.12	30
Improved Chulha	-	20	0.50	6
Auto looms	--	--	--	--
Solar Dryer	--	--	--	--
Heat recovery from hot drained water	--	--	--	--

Table -8: Total Potential for Energy saving in Solapur Cluster

S. No.	Energy Conservation Measures	Energy Saving Potential		Total Saving Potential in kTOE	Monetary Savings (Rs.in Lakhs)	Cost of the implementation, (Rs.in Lakhs)	Simple Payback Period (In years)	No. of units may adopt the technology	Total Saving potential of the cluster, KTOE	Total saving potential of the cluster (Rs. In lakhs)
		Electricity, kWh/Year	Wood, Tonnes /year							
1	Hot Water Generator	–	52	0.017	1.30	2.00	1.5	20	0.33	26.00
2	Solar Hot Water System	–	24	0.008	0.60	2.00	3.3	150	1.15	90.00
3	Economizers(for TFH)	–	17	0.005	0.43	0.75	1.8	10	0.05	4.25
4	Economizers(for boilers)	–	12	0.004	0.30	0.50	1.7	55	0.21	16.50
5	New efficient Boiler	–	40	0.013	1.00	3.00	3.0	20	0.26	20.00
6	Variable Frequency Drives	4700	–	0.000	0.12	0.30	2.6	540	0.22	63.45
7	Improved Chulha	–	–	0.006	0.50	0.25	0.5	250	1.60	125.00
8	Auto looms	–	–	–	1.8	6.00	3.3	3600	0	6400.00
9	Solar Dryer	–	–	–	--	--	--	–	--	--
10	Heat recovery from hot drained water	–	20	0.006	0.50	--	--	100	0644	50.00
	Total								4.46	6795.20

* The Monetary saving are due to improved quality and reduction in manpower cost

3.4.1.5 Issues/barrier in implementation of proposals

The following are the major barriers identified for implementation of the proposals in the cluster units are:

- As there is lack of awareness and information among cluster owners on the losses, EE technologies and energy efficiency, a few demonstration projects may motivate to take up the projects
- Majority of the SME owners don't have financial strength for implementation of high cost technologies like auto-looms, new efficient boilers, hot water generators, solar hot water systems etc, however, the owners are interested to implement low cost measures having quicker payback period. Majority of the units have shown interest to implement modified chulha due to low investment and substantial savings
- Though, local service providers are available in the cluster, the LSP's don't have technical strengths for supply of efficient equipments
- As the electricity is supplied at subsidized cost by EB for the textile cluster units, the cost benefit analysis is not attractive for power saving equipments and hence doesn't have interest in implementation of schemes like VFDs, Auto looms, and Energy Savers for power looms

3.4.2 Availability of technology/product in local/national/international market

Among the technologies / equipments identified for implementation for Solapur cluster units, some of the measures can be implemented by the local service providers and other equipments can be procured at nearest city i.e., Pune or Mumbai. The details of equipment which can be implemented by LSPs and those need to be procured from other cities is furnished below in table 9:

Table 9: Details of LPS's available for various equipments/technologies

S.No	Equipment Details	LSPs	Pune/Mumbai
1	Hot Water Generator	√	√
2	Economizers	√	√
3	Solar Hot Water System	**NA**	√
4	Variable Frequency Drives	**NA**	√
5	Improved Chulha	√	**--**
6	Autolooms	**--**	√
7	Solar Dryer	**--**	√
8	Heat Recovery from Hot drained water	√	√

√ Available
NA Not available

3.4.3 Availability of local service providers for implementation of above-mentioned proposals

The local service providers are available for taking up the identified proposals for hot water generators, boilers, economizers, chulhas etc. The details of LSP's are furnished in Annexure 4

3.5 Identification of Technologies/Equipments for DPR Preparation

3.5.1 Justification (e.g. potential, replicability, etc. in the cluster) for technologies/equipments identified for DPR preparation

The majority of the industries in the cluster are engaged in the production of towel and/or bed sheets. The manufacturing processes for both the products are similar and the equipments installed can be used either for towels or bed sheets production and majority of the units are producing towels and bed sheets.

As the process and equipments are more or less similar in all cluster units, all the technologies/equipments identified can be replicated as per the requirement of the units and detailed project reports for the specific technologies prepared can be replicated for different units as per the capacity requirement. The following technologies/equipments were considered for preparation of detailed project report:

- Hot water generator
- Waste heat recovery systems (Economizer/Air Pre heater)
- New efficient boilers
- Solar hot water system
- Improved chulhas
- Auto looms
- Variable frequency drives
- Solar Dryers

3.6 Environmental Benefits

3.6.1 Reduction in waste generation (if applicable)

There is no significant impact in waste generation due to implementation of the various technologies identified for the cluster for reducing electricity and fuels consumption.

3.6.2 Reduction in GHG emission as CO_2, NOX, etc

The major GHG emission reduction source is CO_2 in the cluster units. Due to implementation of the technologies identified will reduce grid electricity consumption and non renewable firewood. The emission reductions is estimated as **2058** tons of CO_2 per annum (total grid electricity can be saved is 2.45 GWh/annum and emission factor is 840 tCO_2/GWh) due to reduction in grid electricity consumption of all the cluster units and **18,612** tons of CO_2 due to reduction in non renewable wood (quantity of wood savings is 11,280 tons and IPCC default value for non renewable wood is 1.65 tCO_2/ton of wood). The total estimated CO_2 emission reduction per annum is **20,670** tons in the whole cluster units.

3.6.3 Reduction in other emissions like SOX, etc.

The technologies identified upon implementation for the Solapur Textile cluster units will reduce grid electricity and non renewable wood hence there is no impact in other emission sources.

Chapter - 4
CONCLUSIONS

4.1 Summary of Energy Saving Measures Identified for the Cluster

The details of various energy saving proposals identified for Solapur Textile units is furnished below in Table 10:

Table 10: Details of various energy saving proposals suggested for Solapur cluster units

S. No	Energy Saving Proposals
1	Hot water generator
2	Waste heat recovery systems for hot water generation
3	Energy efficient boilers
4	Solar hot water systems
5	Recover heat from hank dyeing machines
6	Reduce excess air supply in the boilers/Thermic fluid heaters
7	Reduce the hearth area
8	Improved chulhas with waste heat recovery
9	Variable frequency drives for doubling machines, ID fans and thermic fluid oil circulation pumps
10	Replace power looms with auto looms
11	Solar Dryer for drying yarn
12	Heat recovery from hot drained water

4.2 Technology gap assessment for Energy saving proposals identified for the cluster

The technology gap assessment had been carried for each of the energy saving proposal recommended and is furnished below in Table 11.

Table 11: Technology gap assessment for various energy saving proposals suggested

S.No	Technology Identified	Gap Assessment
1	**Hot water generator**	The hot water is required in the cluster units at 55 to 60 ^{o}C for dyeing and soaping process, baby boilers and thermic fluid heaters are used for generating the hot water. Normally, the

<table>
<tr><td></td><td></td><td>boilers are used, where the required temperature is more than 100 °C and thermic fluid heaters are used for temperatures for above 180 or 200 °C. Due to lack of awareness and guidance on the technologies available among the unit promoters, the boilers and thermic fluid heaters are used for hot water generation.

Technology gaps/design in wood fired thermic fluid heaters are identified and described the details below

• The thermic fluid heaters are of Single flue gas path system leading to low heat transfer and high flue gas losses
• Low loading of the thermic fluid heaters and boilers less than 20%
• No waste heat recovery leading to reduction in efficiency of the system
• High Heat losses from the grate and surface due to damaged insulation and opening of the charging doors
• No control on fuel firing
• High excess air supply than required

The salient features of the energy efficient hot water generators

• Multi-pass system heating for maximum utilization of heat in flue gas gases
• High efficiency of 70%
• Low wood consumption
• Provides secondary air diverting part of the flue gases for complete combustion
• Water walled chambers for quick heating and maximum heat utilization of heat
• Optimized hearth area for better efficiency
• Optimally sized for better efficiency

The hot water generator is a compact, non IBR, easy to operate, heat quickly than the present systems.</td></tr>
<tr><td>2</td><td>Economizers</td><td>Boilers and Thermic Fluid heaters are the most commonly found energy equipment in the Solapur Textile Cluster industries. No single boiler or thermic fluid heater has waste heat recovery</td></tr>
</table>

		system. In many cases, the temperature of the flue gases at the exit of the boilers is found to be varying between 230 °C to 270 °C in the case of boilers and 330 to 350 °C for thermic fluid heaters. Losses were more than 20 to 40% of the total heat input. The following are advantages of installing waste heat recovery systems • Reduces fuel consumption • Increases efficiency of the system • Hot water is readily available and hence reduces the time for hot water generation As per estimates, about 5 to 12% of fuel consumption can be saved in the cluster units.
3	**Boiler**	The boilers had been installed in the cluster units for hot water generation and to maintain the temperature in the dyeing and soaping process. Based on detailed studies carried in considerable of industries, some of the boilers were found to be inefficient and the efficiencies were found to be only 25 to 40%.. The following technological gaps were identified for low efficiency: • The boilers are of Single pass or two pass flue gas path system leading to low heat transfer and high flue gas losses • Low loading of the boilers less than 20% • No waste heat recovery leading to reduction in efficiency of the system • High Heat losses from the grate and surface due to damaged insulation and opening of the charging doors • No control on fuel firing • No monitoring of air supply than required • Partial combustion leading to un-burnt carbon The boilers with 75% efficiency are available in the market and the LSP's are available for supplying the same. The features of high efficiency boilers are furnished as under: • The boiler is three pass constructions 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 turn around mixing of the gases prior to entering the second pass. • The front smoke box also ensures complete turn around 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 refractories 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.
4	**Chulhas**	There are about 250 chulhas in the cluster of various sizes. The chulhas are used for generating hot water and preparation soap stock. The chulhas are of conventional type and is of open firing. The detailed studies carried out on chulhas and the efficiency is found to be only in the range of 6 to 10%. The low efficiency of the chulhas is due to the following reasons: • The 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 The technological superiority of the improved chulhas are :

		• High efficiency due to proper air circulation • Low heat losses from the openings and surface due to better insulation and grate due to grate is closed and opened during fuel feeding only • 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 • chimney for the removal of smoke.
5	**Doubling Machines /Variable Frequency Drives**	All the doubling machines in the textile cluster are driven by stepped pulley for various speed requirements. Speed variation achieved by variator pulley. The loading on the doubling machine motors will be low during initial stages and gradually load increases, as the yarn quantity on the spindle increases. The following are the technological gaps were identified • No speed variation leading to increased power consumption • No control over speed of the doubling machine • Low power factor • Frequent failures of the machine Installing variable frequency drive, it is possible to operate the motor on low speeds with increase in production and also to achieve wide speed variation and Smooth startup as well as energy saving due to running the motor at low speeds. Due to lack of awareness on the equipments available, as on date, only in 1 or 2 units VFD's had been installed. The variable frequency drives can be installed on doubling machines, ID and FD fans, oil circulation pumps, winding machine motors etc in the cluster equipments. About 15 to 20% of the total energy consumption can be reduced by installing VFD's

6	**Power looms**	The majority of the power looms installed is of more than 20 years old and is of shuttle type. These power looms are low efficient and low quality. There is considerable technology development in the weaving equipments and high end power looms are available in the market such as fully automatic power looms. Though the unit owners are aware of the technologies, due to lack of financial strength and market risk for the products manufactured, only few cluster unit owners had been installed auto looms.
7	**Solar hot water systems**	The present practice of hot water generation has the following disadvantages • High wood consumption • De-forestation of the area due to cutting of trees • Manpower required for operating the equipments • High production cost The benefits of solar hot water system: • No fuel required and solar energy is abundantly available • No manpower required for operation • Simple and easy to operate • Reduces production cost due to free fuel • Solar energy is available through out the year
8	**Solar Dryer**	The drying of yarn is done open conditions due to availability of sunlight. The following are the disadvantages of normal drying: • The quality of the yarn color will be poor • Shades are formed due to uneven drying • Low market value for the product

4.3 Techno – economic analysis for suggested energy saving proposals

The details of techno economic analysis of various energy saving proposals identified for Solapur Textile units is furnished below in Table 12:

Table 12: Techno – economic analysis for various energy saving proposals suggested

S.No	Saving proposal	Techno economic analysis
1.	**Hot Water Generator**	The simple payback period for the proposed hot water generator works out at 22 months. The technology will replace inefficient boilers & thermic fluid heaters, proven technology, locally service providers available, easy to operate & maintenance, falls under non IBR category, high efficiency, etc. ***Technically & financially viable***
2.	**New efficient Boiler**	The simple payback period for the proposed new efficient boiler works out at 44 months. The technology will replace inefficient boilers, proven technology, locally available, falls under non IBR category, high efficiency, available in various capacities, etc. ***Technically & financially viable***
3.	**Economizers**	The simple payback period for new waste heat recovery system (economizer) for hot water generation works out at 10 months. The technology will recover heat in flue gases, reduces fuel consumption, enhances thermal efficiency, proven technology, locally available, available in various capacities, etc. ***Technically & financially viable***
4.	**Solar Hot Water System**	The simple payback period for solar hot water system works out at 28 months. As the solar energy availability is intermittent in nature and requires auxiliary source for hot water generation and requires additional investment. However, due to low interest rate on term loans, low margin money, 80% depreciation in the first year, easy operation, no operation cost etc ***will makes the technically and financially viable option***
5.	**Variable Frequency**	The simple payback period for installation of variable frequency drives for doubling machines works out at 48 months. The

	Drives	payback period is high due to subsidized cost electricity and the units are operated for 8 hours in a day. However, installation of drives, will improve the equipments life and production due to lesser breakdowns. ***Technically & financially viable***
6.	**Improved Chulha**	The installation of improved chulha has low payback period, low investment, faster production, easy to construct and operate, proven technology, local service providers available etc ***Technically & financially viable***
7.	**Auto looms**	Though the investment is high, due to increased productivity and quality, reduced manpower cost, premium price for the products in the market will make auto-looms a viable option for investment. ***Technically viable***
8	**Solar Dryer**	Though the investment is high, due to improved quality and the price for the product can be more than the normal price in the market will make solar dryer a viable option for investment ***Technically viable***

4.4 Barriers in implementation of identified energy saving proposals

Table 13: Barriers in implementation for various energy saving proposals suggested

S.No	Saving proposal	Barriers identified	Steps to overcome barriers
1	**Hot Water Generator**	• Initial investment is high, No demonstration project and difficult to maintain the required temperature for black color dyeing. • Need successful stories for implementation	• A few Demonstration projects in the cluster will disseminate the technology • Providing soft loans may motivate unit owners for implemtation
2	**Economizer**	• Lack of Space and high initial investment	• Providing soft loans may motivate the units for implementation
3	**Solar hot water system**	• High initial investment, high payback period and low returns • Auxiliary system is required Intermittent availability	• Providing soft loans and subsidies may motivate the unit owners for implementation

		• No capital subsidy	
4	**Energy efficient boilers**	• High initial investment • low returns and payback period over 4/5 years, • no willingness among the promoters due to high investment	• Providing soft loan and subsidy may motivate the unit for implementation
5	**Improved chulhas**	• No barriers due to less investment and more returns	• Partial funding from MNRE for construction of improved chulhas may penetrate the technology faster
6	**Variable frequency drives**	• No Local Service Provider to supply • Financially not attractive for SME owners due to subsidized electricity cost and low operational hours • Operation and maintenance problems	• Capacity building of LSP's for operation and maintenance of VFD's • Motivate local electricity equipment dealers to take dealership of VFD's
7	**Heat recovery from hank dyeing machines**	• Space • Low quantum of energy saving	• A few Demonstration projects in the cluster will disseminate the technology
8	**Auto Looms**	• High initial investment • low returns and payback period over 6 years, • no willingness among the promoters due to high investment and also fear over the market demand variation	• Providing soft loans and subsidy may motivate the unit for implementation
9	**Solar Dryer**	• High initial investment, and low returns • No capital subsidy	• Providing soft loans and subsidies may motivate the unit for implementation

4.5 Short listed technology/products for DPRs

The following technologies/products were identified for preparation of detailed project reports for Solapur Textile Cluster

- Hot water generator
- Waste heat recovery systems (Economizer)
- New efficient boilers
- Solar hot water system
- Auto looms
- Variable frequency drives
- Solar dryers

4.6 Summary of level of awareness on energy savings and energy saving technologies in Solapur cluster

The level of awareness on energy efficiency is poor in the cluster. Out of 51 units surveyed, only 2 industry owners have knowledge on energy efficiency and EE products. The other unit owner doesn't have awareness on either on energy efficiency or EE products, due to non availability of LSP's or equipment suppliers could not implement. Though the clusters units are in operation since last 4 decades, no single program on energy efficiency either from the local bodies or central government had been implemented in the cluster.

LIST OF ANNEXURE

ANNEXURE - 1

Name and address of units in the cluster

S. No	Unit Name	Address	Contact Person	Telephone No's	Products Manufactured	Prodution capacity (tonnes /annum)
1	Burgul Textiles	E - 67/2, M.I.D.C, Akkalkot Road, Solapur	Charvak Burgul	0217 - 2653116/3296661, 91 - 9370424799	Chaddar	80
2	Chatla Textile Industries	A - 3, MIDC, Akkalkot Road, Solapur	Mahendra Chatla	0217 - 2720632/2651525, 91 - 9822436782	Chaddar	120
3	Madur Textiles	Plot No: 31/32, M.I.D.C., Akkalkot Road, Solapur	Sanjay Madur	0217 - 2748461/2748460, 91 - 9881068843	Terry Towel	180
4	Marda Textiles	252/253, M.I.D.C., Akkalkot Road, Solapur	Gokul Marda	0217 - 2653535, 91 - 9822119981	Terry Towel	120
5	Marda Textile Industry	Plot No: 205, M.I.D.C., Akkalkot Road, Solapur	Sagar Marda	0217 - 2391858/2329797, 91 - 9822655858	Terry Towel	75
6	Rapelli Exports Pvt Ltd	P B No: 614, D - 7, M.I.D.C, Akkalkot Road, Solapur	Dinesh Rapelli	0217 - 2745720, 91 - 9422460088	Terry Towels & Chaddar	60
7	Singam Textiles	B - 7, M.I.D.C., Akkalkot Road, Solapur	Gangadhar singam	0217 - 2744942, 91 - 9370424741	Terry Towel	120
8	Shrinivas Textiles	1848, Bhadravati Peth, Solapur	Vidap Shrinivas	0217 - 2622625, 91 - 9422066300	Terry Towel	45
9	SRL Towel Industry	33/1, Geetha Nagar, New Paccha Peth, Solapur	Laxman Singam	0217 - 2651754, 91 - 9370424344	Terry Towel	90
10	Vadnal Textiles	33/3/20, New Paccha peth, Geetha Nagar, Solapur - 413 006	Narasaiah Vadnal	0217 - 2651180/ 2652101	Chaddar	60
11	Yele Textiles	102 - D - 104, Bhavani Peth Solapur	Shrinivas Yele	0217 - 2745711, 91 - 9372217794	Chaddar	55
12	Ajantha Textile Corporation	221, M.I.D.C., Akkalkot Road, Solapur	Sunil Jain	0217 - 2747980/2747981, 91 - 9422645393	Terry Towel	55
13	Adam Textiles	C - 21, M.I.D.C., Akkalkot Road, Solapur	Adam Ravindra	0217 – 2652656 /2652740, 91 - 9371169664	Terry Towel	66
14	Balla Textile Mills Pvt Ltd	D 38 & 39, M.I.D.C, Akkalkot Road, Solapur	Madhukar Balla	0217 - 3297799, 91 - 9850500513	Napkins	145
15	Chakrapani Arkal Textiles	B-19, Padmashali Nagar, Near MIDC, Solapur	Chakrapani Arkal	91 - 9921474809	Terry Towel	70
16	Channa Textiles	C - 26/23, Vin So., M.I.D.C, Solapur	Channa Vasudeo	91 - 9326079923	Terry Towel	45

17	Dasari Textiles	D - 37, M.I.D.C, Akkalkot Road, Solapur	Shrinivas Dasari	91 - 9371108168	Terry Towel	75
18	Shripada-Vallabaha Textiles	102 - C/47, Bhavani Peth, Solapur	Dhulam Mahesh	0217 - 2325170/ 2326014, 91 - 9822804999	Terry Towel	75
19	Yemul Industries	E - 14, M.I.D.C, Akkalkot Road, Solapur	Rajesham Yemul	0217 - 2651843/2652160, 91 - 9422460271	Terry Towel	99
20	Bolli Textiles	860, Ashok Chowk Nr Sidr Bk, Solapur	Raju Bolli	0217 - 2747601, 91 - 9420659801	Terry Towel	90
21	Gulapalli Textiles	D - 1, M.I.D.C, Solapur	M.K.Gulapalli	0217 - 2743342	Terry Towel	60
22	Kalpataru Textiles	Plot No: 20, M.I.D.C., Akkalkot Road, Solapur	Sangvi Sheetal	0217 - 2651257/2732994, 91 - 9423332480	Terry Towel	30
23	Mutkiri Textiles	Plot No: A - 17, M.I.D.C., Akkalkot Road, Solapur	Arun Mutkiri	0217 - 2651368 , 91-9370423820 /9420490989	Terry Towel	450
24	Nalla Textiles	C - 30, M.I.D.C., Akkalkot Road, Solapur	Srinivas Nalla	0217 - 2652535/ 2652705	Terry Towel	66
25	Naval Textile Corporation	C-10-2-9, Nr M.I.D.C, Police Chowk, Akkalkot Road, Solapur	Rama krishna Udgiri	0217 - 2652881, 91 - 9422653505	Terry Towel	60
26	Vivek Trading company	Plot No: 3, M.I.D.C, Akkalkot Road, Solapur	Alli Dhananjaya	0217 - 2745650/2745651, 91 - 9420994000	Terry Towel	90
27	A – Tex	155/2 B, Gandhi Nagar, Akkalkot Road, Solapur	Muralidhar Arkal	0217 - 2745823/2745825, 91 - 9420490929	Terry Towels & Chaddar	450
28	Chilka Weaving Mill	C-10 - 11 -16, M.I.D.C, Akkalkot Road, Solapur	Chilka Venkatesh	0217 - 2625156/2628970, 91 - 9422067433	Terry Towel	120
29	M C Irabatti Weaving Mill	C - 24, M.I.D.C., Akkalkot Road, Solapur	Dinesh Irabatti	0217 - 2651622/2651629, 91 - 9422065550	Terry Towel	450
30	Pulgam Textiles	P - 18, M.I.D.C, Solapur	Nityanand pulgam	-	Terry Towel	180
31	Rajashree Industries	E - 1/1, M.I.D.C, Near Water Tank, Akkalkot Road, Solapur	Govind Bura	0217 - 3297002/3297001, 91 - 9422065882	Terry Towels & Chaddar	90
32	Banda Industries	E - 95, MIDC, Akkalkot road, Solapur	Banda Basavraj	0217 - 2749959, 91 - 9822072171	Terry Towel	200
33	Bhoopathi Textiles	A - 16, M.I.D.C., Akkalkot Road, Solapur	Samleti Balaji	0217 - 2651761, 91 - 9422066906	Terry Towel	180
34	Devsani Textiles	E - 22, M.I.D.C, Akkalkot Road, Solapur	Kumar Devsani	0217 - 2745120/2745123, 91 - 9422066128	Terry Towel	105
35	Gaddam Textiles	E - 1/2, M.I.D.C., Akkalkot Road, Opp. Akashwani, Solapur - 413 006	Siddeshwar Gaddam	0217 - 2745070/ 2745073, 91 - 09822436830	Terry Towel	180

36	Himalaya Textiles	E - 25, M.I.D.C, Akkalkot Road, Solapur - 413 006	Satyaram Myakal	0217 - 3296778/2652001, 91 - 9422066922	Terry Towel	165
37	Jamuna Industries	E -17, M.I.D.C, Akkalkot Road, Solapur	Praveen Kota	0217 - 2653401/2620019, 91 - 9371005401	Terry Towel	120
38	Kendole Textiles	187, MIDC, Akkalkot Road, Solapur	Gyaneshwar Kendole	0217 - 2748583/2748586, 91 - 9326161772	Chaddar	80
39	Khandelwal Textiles	M.I.D.C., Akkalkot Road, Solapur	Kailash Khandelwal	91 - 9423066851	Terry Towel	400
40	Lakshmipathi Industries	E - 1/2, M.I.D.C, Akkalkot Road, Solapur	Lakshmipati Gaddam	0217 - 2745072/2745073, 91 - 9822092031	Terry Towel	100
41	Mayuri Textiles	C - 2/B, M.I.D.C, Akkalkot Road, Solapur	Pavan Bomdyal	0217 - 2329765, 91 - 9370729765	Terry Towel	120
42	Adgatla Textiles	C - 26/72, Vinkar Socy, M.I.D.C., Akkalkot Road, Solapur	Satyanarayan Adagatla	0217 - 2747750/3291225, 91 - 9370460406	Terry Towel	60
43	Bomdyal Textiles	D - 17, M.I.D.C., Akkalkot Road, Solapur	Narayan Bomdyal	0217 - 2651152/2652275, 91 - 9890920001	Terry Towel	165
44	Birru & Birru Textiles	155/3A, Plot No. 9, Gandhi Nagar, Akkalkot Road, Solapur - 413 006	Shridhar Birru	0217 - 2377139, 91 - 09370401339	Terry Towel	90
45	Munot Textiles	Plot No: 11/12, M.I.D.C, Akkalkot Road, Solapur	Munot Vasant	0217 - 2745280/2320136, 91 - 9422066123	Terry Towel	75
46	R.B.Mills	34A/56 Kamtam Nagar New Paccha Peth, Solapur	Kamtam Bhutilak	0217 - 2744530, 91 - 9422458010	Terry Towel	90
47	Somanath Textiles	168/A - 2, Gandhi Nagar, Akkalkot Road, Solapur	Nihanta Ramdas	0217 - 2745530, 91 - 9822314040	Terry Towel	150
48	Marta Textiles	E - 39, M.I.D.C, Akkalkot Road, Solapur	Mallikarjun Marta	0217 - 2652411/2328195, 91 - 9370088111	Terry Towel	40
49	Sidral Textiles	C 29/27,26 Nath.So.,M.I.D.C, Akkalkot Road, Solapur	Sidral Bhagwant	0217 - 2747431/2652424, 91 - 9422650124	Chaddar	75
50	Vittal Trading Company	Plot No: 202, M.I.D.C.,Akkalkot Road, Solapur	Yanganti Tulasidas	0217 - 2748451/ 2748450, 91 - 9420663266	Chaddar	60
51	D.D.Mills	34 - 3, New Paccha Peth, Solapur	Dasari Ambadas	0217 - 2744540	Terry Towel	70

ANNEXURE – 2

BETTER HOUSE KEEPING PRACTICES

1. A 22^{o}C reduction in the flue gas temperature reduces the fuel consumption by 1%
2. Recover the sensible heat from the hot flue gas for hot water generation.
3. Every 6 ^{o}C rise in feed water temperature by heat recovery will reduce fuel consumption by 1%.
4. For every 1% reduction of residual oxygen in flue gas reduces fuel consumption by 1%.
5. Install temperature gauges at all steam consuming equipments to avoid overheating.
6. Insulate steam/condensate pipes and hot water tanks.
7. Install temperature gauges for process equipments to avoid overheating.
8. Firing of the boilers and chulhas should be carried out one hour before the dyeing process to optimize fuel consumption.
9. Monitor damper control on continuous basis and kept full open during initial firing and reduce damper opening after attaining the required temperature.
10. Avoid frequent on and off the boilers, chulhas and thermic fluid heaters.
11. Provide auto controls for boilers and thermic fluid heaters to avoid idle operation of the boiler.
12. Carryout dyeing for two shifts continuously instead of one shift/day.
13. Recover heat from drained water for pre-heating process water.
14. Optimize blow down and monitor periodically the feed water TDS and blow-down TDS.

15. Always use optimum sized motors.
16. All new replacements should be done with energy efficient motors having 3-5% higher efficiency.
17. It is better to replace the old motor than re-winding of motors more than 3 times.
18. Install VSD's for pumps, fans and motors.
19. Operate the doubling machines at maximum possible speeds for enhancing production.
20. Use low weight spindles for reducing power consumption of doubling machine.
21. Use synthetic tapes instead of conventional tapes for reducing power consumption of doubling machine.
22. Keep spare shuttles wounded with yarn for reducing the machine down time
23. Install timers for hydro extractors for optimizing the operational hours.

ANNEXURE – 3

DAILY MONITORING REPORTS

Date	Production (kgs)	Electricity Consumption (kWh)	Wood Consumption (kgs)	Specific Power Consumption (kWh/kg)	Specific Power Consumption (kgs/kg)

Dyeing Process

Date	Time	Temperature (Hank dyeing 1) (°C)	Temperature (Hank dyeing 2) (°C)

Boiler

Date	Time	Steam Pressure (bar)	Steam Temperature (°C)	Flue gas Temperature (°C)

Thermic Fluid Heater

Date	Time	Hot oil inlet Temperature (°C)	Hot oil outlet Temperature (°C)	Flue gas Temperature (°C)

Chulha

Date	Wood Consumption (kgs)	Production (kgs)	Specific Wood Consumption (kWh/kg)

DG Sets

Date	Hours of operation (hours)	Diesel Oil consumption	Units generated	Flue gas HSD

ANNEXURE – 4

Quotations for various proposals suggested

Bureau of Energy Efficiency (BEE)

(Ministry of Power, Government of India)

4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066

Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352

Websites: www.bee-india.nic.in, www.energymanagertraining.com