सत्यमेव जयते
Ministry of Power
Government of India

Improving Energy Efficiency in Textile Sector

(Achievements and Way Forward)

Perform Achieve & Trade

September 2018

BUREAU OF ENERGY EFFICIENCY

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Published by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Published by BEE in Partnership with GIZ

Imprint

Bureau of Energy Efficiency (BEE), Ministry of Power, Govt. of India
4th Floor, Sewa Bhawan, Sector-1, R.K. Puram
New Delhi, 110066, India

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Registered offices: Bonn and Eschborn, Germany
Indo-German Energy Programme (IGEN)
C/o Bureau of Energy Efficiency
West Block-2, Sector-1, R.K. Puram, New Delhi, 110066, India

We acknowledge the cooperation extended by Ministry of Power, Government of India

Responsible
Winfried Damm
E: winfried.damm@giz.de

Contributing Authors
Bureau of Energy Efficiency (BEE)
Abhay Bakre, Pankaj Kumar, Ashok Kumar, Sunil Khandare, Ajitesh Upadhyay

Indo-German Energy Programme (IGEN)
Arvind Kumar Asthana, Rita Acharya, Nitin Jain, Piyush Sharma, Ravinder Kumar

Confederation of Indian Industry (CII)
K S Venkatagiri, P V Kiran Ananth, K Muralikrishnan, Balasubramanian M B and Team

Acknowledgement
Trident Limited, Arvind Limited, Ram Kumar Upadhyay (GBTL), Rajagopalan Subramaniam

Study by:
Confederation of Indian Industry (CII)
CII – Sohrabji Godrej Green Business Centre
Survey No. 64, Kothaguda Post, Near Hi-tech City, Hyderabad, 500084, India

Version: New Delhi, September 2018

Dr. Winfried Damm

Head of Energy, GIZ India

Textile has become an essential part of our daily lives ever since its invention. The industry has grown to become the most diversified sector in terms of product and process involved. India is world's third largest exporter of textile. The sector contributes to 4% in country's GDP, and consumes significant amount of energy, owing to the large number of plants. The plants in the sector ranges from being most energy efficient to least energy efficient. Due to the variety of process involved, there exists significant energy efficiency potential in the sector.

Germany has been playing a very active role in promoting energy efficiency in not only its own land, but also supporting the other countries to adopt the same. Germany has been supporting India in various fields since last 60 years, with an aim of promoting cooperation and involving public-private sectors of both sides in the areas of energy, environment and sustainable economic development. The Indo-German Energy Programme (IGEN), works as a partner of Bureau of Energy Efficiency (BEE) in supporting policies and programmes envisaged under the Energy Conservation Act, 2001.

It has been a privilege to work with BEE, the organization spearheading activities on energy efficiency in India. IGEN has been involved with BEE in the Perform Achieve and Trade since its inception, and hence it is blissful to know that the outcome of this scheme led to a huge savings in terms of CO_2 emission reduction and coal.

However, the real outcome of PAT scheme is not only the savings in terms of toe and CO_2, but it is the change in behavior towards energy efficiency. It is astonishing to see the amount of resources and concepts the industries have put together in achieving the target. Some state-of-the-art projects implemented in PAT cycle-I are cross cutting and could have significant potential across the sectors. Some of the positive outcomes of this scheme were the utilization of waste heat in generation of steam and power, adoption of cogeneration, use of alternate fuel and raw material, etc. This report analyses the outcome of PAT scheme in textile sector in multidimensional ways and forecasts the future savings along with innovative case studies having high replication potential. The estimate suggests the cumulative energy savings from the sector till 2030 to be 4.28 million TOE, which is quite impressive.

We are delighted to be a part of this historic journey where India has been a forerunner in implementing an exceptional scheme, customized to the benefit of the industries as well as the nation. I personally feel that the deepening of this scheme in textile sectors including SME would prove a game changer in the times to come. This scheme has tremendous opportunities for regional synergies and its adaptation by other countries could lead to address the global climate issues.

Dr. Winfried Damm

अभय बाकरे, आईआरएसईई
महानिदेशक
ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

ENERGY IS LIFE
CONSERVE IT

ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

FOREWORD

As we are embarking an ambitious path to provide electricity to all and raise the level of energy availability to the population across the country with limited resources at disposal; efficient use of primary energy resources is absolutely necessary.

Bureau of Energy Efficiency, under the Ministry of Power has been spearheading the promotion of energy efficiency in various aspects of the country's energy landscape, through programs such as Standards & Labelling for appliances, Energy Conservation Building Code (ECBC) for buildings and Demand Side Management (DSM) program for Agriculture and Municipality sectors.

One such flagship program for energy intensive industries namely Perform, Achieve and Trade (PAT) was launched under the National Mission for Enhanced Energy Efficiency (NMEEE). This scheme has demonstrated its value in its first cycle, in which 478 Designated Consumers have achieved 8.67 MTOE of energy savings against the target of 6.68 MTOE, exceeding by about 30 %.

With an objective to have further insight on the actions taken and other notable effects taken by these designated units in achieving the excellent results, a study has been taken up by BEE in partnership with GIZ. The report gives an in-depth analysis of the achievements, projections and success stories across various sectors covered in the first cycle of PAT scheme.

With the continued guidance of Ministry of Power, the Bureau of Energy Efficiency expresses its gratitude towards all the industries, associations and other stakeholders for their significant contribution to achieve the task of saving energy and adoption of energy efficiency measures. BEE intends to convey our congratulations to all who joined us on our collective endeavour of improving energy efficiency in the country.

Abhay Bakre.
(Abhay Bakre)

New Delhi: 19.09.2018

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ   Save Energy for Benefit of Self and Nation

चौथा तल, सेवा भवन, आर.के.पुरम, नई दिल्ली–110 066 / 4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066
टेली / Tel.: 91 (11) 26178316 (सीधा / Direct) 26179699 (5 Lines) फैक्स / Fax: 91 (11) 26178328
ई–मेल / E-mail : dg-bee@nic.in, abhay.bakre@nic.in, वेबसाईट / Website : www.beeindia.gov.in

Sectoral Expert Committee Members			
S. No.	**Name**	**Designation**	**Organization**
TEXTILE			
1	Mr. A. Sivaramakrishnan	Research Associate & In-Charge of Textile	SITRA
2	Mr M. Muthukumaran	Head Electrical	SITRA
3	Dr. Ram Asrey Lal	Director & OIC	Office of the Textile Commissioner
4	Shri. V.K.Kohli	Director	Office of the Textile Commissioner
5	Dr. J.V.Rao	Director	NITRA
6	Dr. Arindam Basu	Director	NITRA
7	Mr. H.M.Sharma	Sr. Technologist (Engg.)	The Bombay Textile Research Association
8	Mr A.N.Desai	Director	The Bombay Textile Research Association
9	Smt. Sarika Singh	Principal Scientific Officer	ATIRA
10	Ms. Bipasha Maiti	Principal Scientific Officer	ATIRA

Content

List of Figures

List of Tables

1.0 Executive Summary

In a bid to combat increasing energy consumption and related carbon emissions, the Government of India released the National Action Plan on Climate Change (NAPCC) in 2008 to promote and enable sustainable development of the country by promoting a low carbon and high resilience development path. Under the NAPCC, eight national missions were framed to focus on various aspects related to water, solar energy, sustainable habitat, agricultural, energy efficiency, ecosystems, etc. Perform Achieve and Trade scheme (PAT) is a component of the National Mission for Enhanced Energy Efficiency (NMEEE) which is one of the eight missions under the NAPCC.

PAT is a regulatory instrument to reduce specific energy consumption (SEC) in energy intensive industries, with an associated market-based mechanism to enhance cost effectiveness through certification of excess energy savings, which could be traded. Energy Savings Certificate (ESCerts) are issued to the industries which reduce their SEC beyond their target. Those companies which fail to achieve their target are required to purchase ESCerts for compliance, or are liable to be penalised. Trading of ESCerts are conducted on existing power exchanges.

PAT Cycle – I, which was operationalized in April 2012, included 478 units, known as "Designated Consumers" (DCs), from eight energy-intensive sectors viz. Aluminium, Cement, Chlor- Alkali, Fertilizer, Iron &Steel, Pulp & Paper, Thermal Power Plant and Textile were included. The annual energy consumption of these DCs in eight sectors was around 164 million TOE. The overall SEC reduction target in the eight sectors was about 4.05% with an expected energy saving of 6.68 million TOE by the end of 2014-15.

With the completion of the PAT Cycle – I in 2015, the reported overall achievement was 8.67 million TOE, exceeding the target for cycle 1 by almost 30%. The total energy saving of 8.67 million TOE is equivalent to saving of about 20 million tonnes of coal and avoided emissions of about 31 million tonnes of CO_2. In terms of monetary value, saving in energy consumption corresponds to Rs. 95,000 million.

PAT Cycle – I has witnessed an exceptional performance from all the sectors in terms of reducing their energy consumption. The DCs have made commendable efforts to achieve energy efficiency targets by adopting various improvement measures in technology, operational and maintenance practices, and application of management techniques.

Textile sector is the second lowest consumer of energy in PAT Cycle – I, with an annual energy consumption of 1.2 million TOE. The summary of the achievement by the textile sector in PAT Cycle – I is presented in Table 1.

Parameter	Units	Values
Number of DCs in the sector	Number	90
Total energy consumption of DCs in the sector	million TOE	1.2
Total energy savings target for Textile sector in PAT Cycle – I	million TOE	0.066
Total energy savings achieved by Textile sector in PAT Cycle – I	million TOE	0.13
Energy savings achieved in excess of target (PAT Cycle – I)	million TOE	0.064
Reduction in GHG emission for PAT Cycle – I	Million T CO_2 equivalent	0.62
Cumulative energy savings of PAT Impact till 2030[1] (over BAU)	million TOE	4.28

Table 1: Textile sector- achievements in PAT Cycle – I

The key focus of Textile sectoral report is on the energy savings resulting from PAT scheme as compared to the business as usual scenario (BAU). The report also includes the impact of PAT on GDP of the country, sector specific data analysis, process trends, sectoral benchmarking of specific energy consumption, success stories implemented in plants, and list of key technologies which can be implemented in the sector. Analysis has been presented until the year 2030.

1. Difference of energy consumption between PAT and Business as Usual scenario(BAU)

2.0 Textile sector in India

The Indian textile market is very large, about USD 150 billion as of July 2017, and plays a vital role in the Indian economy. It contributes to 4% of India's GDP, 14% of India's total manufacturing output, 14% of overall index of industrial production (IIP)[3] and 13% of India's export earnings. India has 6% share in world textile export market, amounting to 37.74 billion USD during FY 2017-18, and is the third largest exporter of Textiles.[4] The textile market is growing at a CAGR of 13.58% during 2009-2018. Indian Textile sector employs over 45 million people in about 3,400 mills.[5]

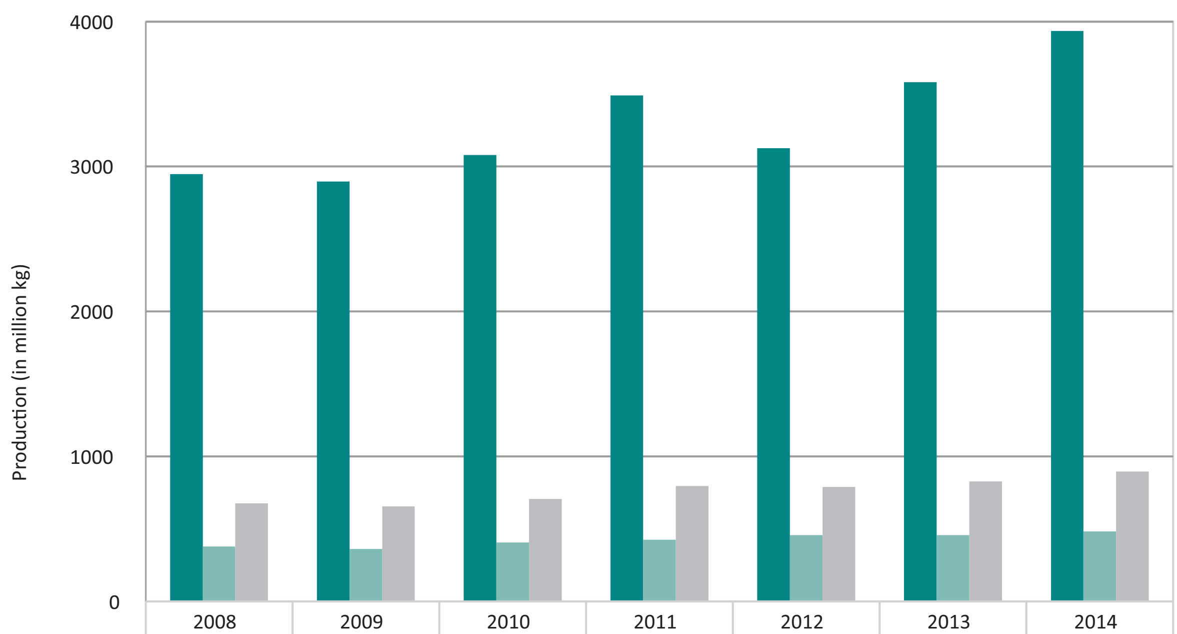
Indian Textile industry is highly diversified in nature. It varies from the traditional hand-spun and hand-woven textile sub-sectors to the large mills sector. Power looms and Knitting sector form the largest part of the textile sector. The sector consists of many processes like spinning, weaving, knitting, dyeing, printing, finishing, etc.

Cotton is the predominant fabric used in the Indian textile industry, accounting for nearly 60% of the total energy consumption in the entire textile sector. 75% of the spinning mills in India are for cotton yarn. The cotton yarn production in India is well established with a CAGR of 4.93%.[6]

HIGHLIGHTS OF TEXTILE SECTOR IN INDIA

SECTOR HIGHLIGHTS......

- India is the third largest exporter of textiles in the world
- Indian textile sector contributes to 4% share of country's GDP
- The sector contributes to 14% of overall index of Industrial Production
- A highly diversified sector in terms of products and processes involved



	2008	2009	2010	2011	2012	2013	2014
Cotton	2948.36	2896.15	3078.97	3489.77	3126.34	3582.69	3935.79
Non Cotton	377.75	360.95	407.15	426.38	457.08	456.76	483.54
Blended	677.11	654.89	707.31	796.47	789.29	828.19	895.99

Figure 1: Annual Yarn production in India

3. India Brand Equity Foundation (IBEF)- Textile and Apparels
4. World Trade Organization Secretariat
5. Ministry of textile
6. From Annual yarn production, Office of Textile Commissioner, data.gov.in

The capacity utilization in the spinning sector of the organized textile mill industry ranged between 80 to 90% while the capacity utilization in the weaving sector of the organized textile mill industry ranged between 42 to 62%.

2.1 Sectoral contribution to Country's Economic value

India's Textile Industry plays a vital role in terms of contribution to Indian economy through export. India's textile export was 37.74 billion USD during FY 2017-18. Indian Textile sector contributes to 13% of India's export earnings.

India has approximately 3,400 textile mills ranging from large to small to micro scale industries. Out of these, 90 units were identified as DCs under PAT Cycle – I, based on the minimum threshold of energy consumption of 3000 TOE. The energy intensity of the country is given in Table 5. Energy Consumption of DCs of textile sector covered in PAT Cycle-I is 1.2 million TOE, amounting to 0.73% of the total energy consumption by the DCs in PAT cycle-I .

The Energy Intensity of the country is given inTable 2. The calculated Energy Intensity does not consider energy consumption of non-conventional sources of energy.

Financial Year	Total Energy Consumption of India	Gross Domestic Product (GDP)	Energy Intensity
	million TOE	Billion USD	TOE/million USD
2008	427	1,187	360
2009	453	1,324	342
2010	512	1,657	309
Average Baseline[8]	464	1,389	334
2015	659	2,102[9]	313
2020	1018[10]	3,018	337
2025	1211[11]	4,233	286
2030	1440[7]	5,937[13]	243

Table 2: India's Energy Intensity

The contribution of DC's to overall energy intensity of India's GDP is 0.26% for baseline year. The sector has achieved 0.13 million TOE savings under PAT cycle-I. The contribution of this energy savings to overall energy intensity of India's GDP is 0.02 % for assessment year.

7. Ministry of textile
9. GDP from World Bank GDP for India – Upto 2015
10. India Energy Outlook, Year 2015 - IEA
11. Estimated by calculating CAGR for 2020 and 2040 in India Energy Outlook, Year 2015 - IEA
13. GDP values calculated based on CAGR value of 7.5% till 2020 and 7% between 2020 and 2030. Same assumptions have been considered in India Energy Outlook, Year 2015 - IEA

Financial Year	Total Production[14]	Total Energy Consumption	Gross Domestic Product (GDP)	Energy Intensity
	million tonnes	million TOE	Billion USD	TOE/million USD
Average Baseline	1.29	1.20	1,389	0.86
2015	1.56	1.24	2,102	0.59
2020	1.84	1.36	3,018	0.45
2025	2.17	1.49	4,233	0.35
2030	2.55	1.65	5,937	0.28

Table 3: Textile sector- Energy intensity

Textile sector Energy intensity contribution in baseline year and assessment year was **0.26%** and **0.19%** respectively.

14. Equivalent production of DCs under PAT cycle - I

3.0 Process, Technologies and Energy consumption trend of the sector

Textile industry can be divided broadly into 3 manufacturing processes:

- Spinning
- Weaving
- Processing

Spinning

In this process the raw material is converted into yarn in several steps. Yarn is then used for Weaving.

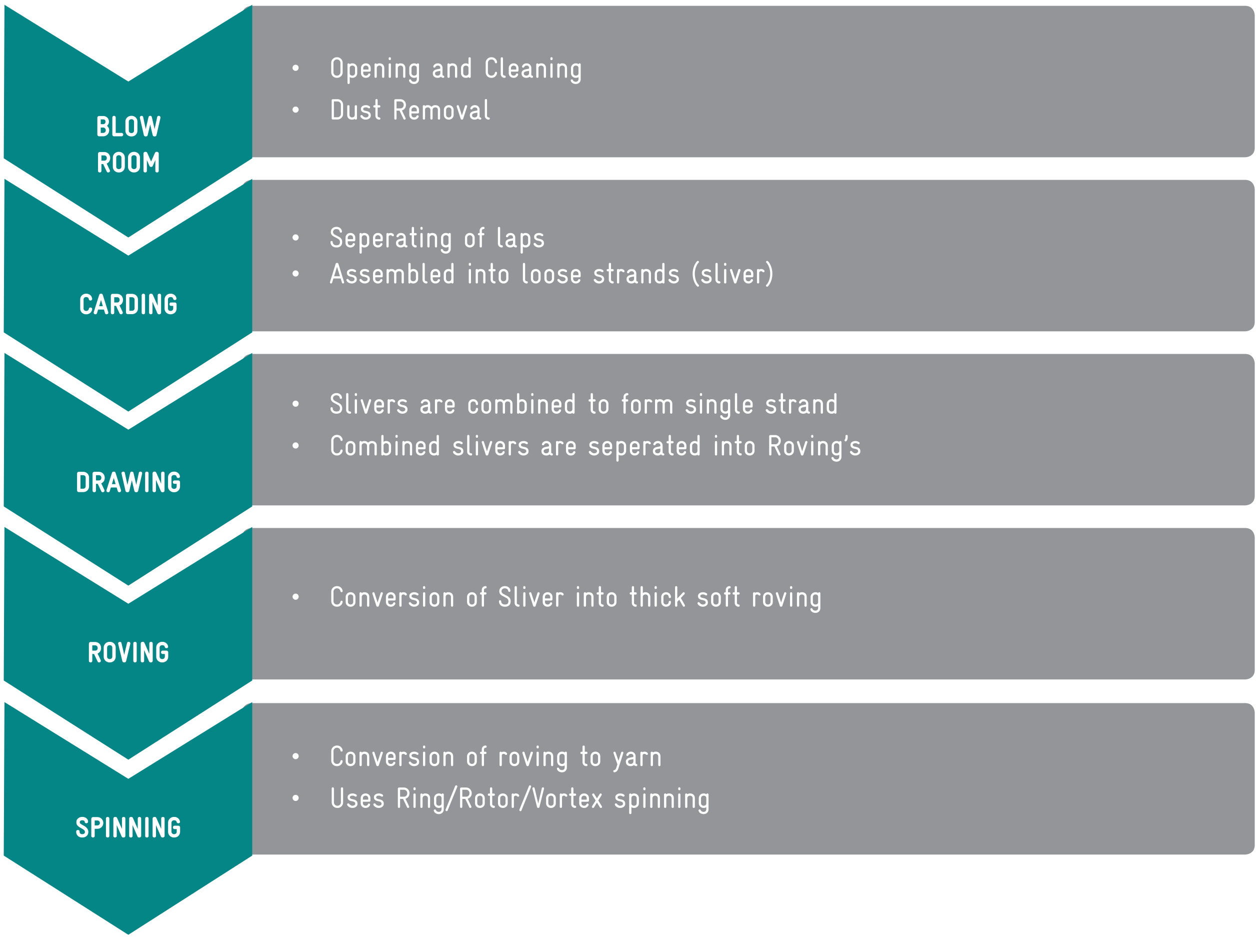


Figure 2: Process flow for Spinning

SIZING & WEAVING	• Yarn is seperated into warps and wefts and warp yarn is coated with starch for strength during weaving process on Looms Desizing
DESIZING	• The grey fabric's size coating is broken down by using catalysts and enzymes
SCOURING	• Process to remove natural wax and non-fiborous impurities
BLEACHING	• Bleaching is done to improve the whiteness of the fabric Increases the absorbancy of the fabric for dyeing
CALENDERING	• Fabric is passed between heated rollers to form smooth polished fabric
CALENDERING	• Fabric is immersed in an aqueous dye bath • Vats and reactives dyes are used as well
DYEING	• Conversion of roving to yarn • Uses Ring/Rotor/Vortex spinning
PRINTING	• Application of color in form of paste or ink onto th e fabric's surface

Figure 3: Process flow of Integrated Textile mill

In Integrated textile plants, all the processes are done sequentially, i.e., starting from the raw material to the finished fabric is done in the same plant. Entire manufacturing process is carried out there itself.

Weaving

Weaving is the process of making fabric or cloth from yarns obtained after spinning process. Two sets of yarns are interlaced to form fabric. Warp is the lengthwise thread that runs from front to the back of the loom and wefts are the crosswise yarns. To prevent warp yarns from breaking, they are coated with size (like starch) to increase the tensile strength.

Looms are used for weaving a fabric. Power looms and Hand looms are used in textile industry for knitting.

Handlooms are operated manually by humans without any electrical equipment whereas Power loom make use of motors for Knitting. Knitting is the process by which threads are converted to a piece of cloth. It is done by interlocking loops in which a short loop of one course of thread is wrapped over another course.

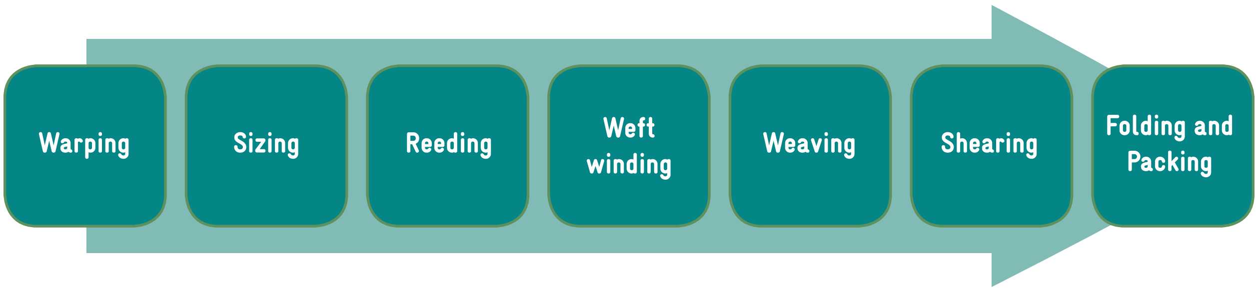


Figure 4: Processes in Weaving sub-sector

Processing

Processing include all sorts of processes that involve any sort of chemical or wet treatment.

Wet processing is divided into 3 stages:

- Preparation
- Dyeing
- Finishing

The technologies used will differ according to the type of material to be dyed.

A variety of machinery is available for dyeing the fabric. Some of the most commonly used machines are:

- Jigger dyeing machine
- Winch dyeing machine
- Padding dyeing machine
- Mangle dyeing machine
- Jet dyeing machine

In short processing is done to improve the appearance and quality of the rough fabric obtained after knitting. Wet processing consumes large quantities of water and chemicals. It is also the stage consuming the highest thermal energy in the plant.

SINGEING
- Flames are used to remove fuzzy fibers

DESIZING
- Removal of sizing ingredients by using solvents

SCOURING
- Removes impurities like wax and oil
- Carried out in alkaline conditions, high pressure and temperature greater than 100°C

BLEACHING
- Whiten fabric by using chemicals

MERCERIZATION
- Increases tensile stength and dye absorption of fabric

DYEING
- Imparts the required colour to the fabric by diffusion of dye pigments

PRINTING
- Colored patterns are printed on the surface of the fabric
- A final washing is also done to remove the excess colour paste and gives a uniform colour

Figure 5: Process flow of Processing sub-sector

Finishing process is done after printing to get the final product- the finished fabric. Finishing consists of Drying, Calendering and Softening:-

- Drying removes the moisture,
- Calendering gives a glossy appearance to the fabric and
- Softening softens the stiff fabric

4.0 Methodology adopted for the project

The activities were initiated with the collection of sector specific data from Bureau of Energy Efficiency (BEE). In addition, data was also collected through secondary research. Analysis of the data was done to assess the impact of PAT cycle-I on energy intensity in the Business as usual v/s PAT scenario, GDP of the country, trend analysis for energy efficiency, quantification of energy saving in terms of TOE and coal saving. A feedback was also collected from DCs on benefits and the challenges experienced through the PAT scheme.

DATA COLLECTION

- Sector specific data from Bureau of Energy efficiency
- GDP of the country
- Benchmarking
- Miscelleneous data through Secondary research

DATA ANALYSIS

- Analysis of sector specific data and finding out specific energy consumption of individual processes based on PAT scheme
- Identifying GDP contribution of the sector
- Impact on energy intensity
- Assumptions considered for calculations for the sector

FEEDBACK FROM PAT STAKEHOLDERS

- Identifying key senior people from sectors
- Contacting Designated consumers and collecting feedback on PAT scheme

SUCCESS STORIES

- Shortlisting of case studies
- Visit to specific plants to obtain information on Case studies
- Preparation of case studies and sharing case studies with plant team

Figure 6: Methodology followed for Impact assessment of PAT Cycle – 1

The case studies were shortlisted based on higher savings, low cost implementation, innovative projects and high replication potential across the sector. With the assistance of BEE and GIZ, various plant visits were scheduled and conducted across various sectors to study the technical benefits and challenges faced by designated consumers in implementing their projects. Based on the feedback from the respective plants, success stories were developed on the same.

5.0 PAT Cycle – I and its Impact on Textile sector

PAT is a regulatory instrument to reduce specific energy consumption (SEC) in energy intensive industries, with an associated market-based mechanism to enhance cost effectiveness through certification of excess energy savings, which could be traded. Energy Savings Certificate (ESCerts) are issued to the industries which reduces their SEC beyond the target, whereas, those who fails to achieve their target are entitled to purchase the certificate for compliance, or liable to be penalised. The platform for trading of ESCerts are the existing power exchanges.

PAT cycle-I came into force from 2012, with financial years 2007–08 to 2009– 10 as the baseline. The minimum gate-to-gate energy consumption (threshold) of textile sector was notified as 3,000 TOE; plants in the sector consuming energy above the threshold value were notified as DCs. These plants were given the target Specific Energy Consumption (SEC) reduction based on the average value of specific energy consumed by the them for the baseline line years. Under PAT cycle-I, 90 textile units were listed as DCs and were mandated to reduce their energy consumption as per the target given. The total reported annual energy consumption of these designated consumers was about 1.2 million TOE in the baseline period. These DCs were given SEC target reduction of 5.5% and energy saving target of 0.066 million TOE, which was 0.99% of the total national energy saving target under PAT cycle-I.

Subsequently, after the completion of PAT Cycle-I, 99 units in Textile sector were notified as DCs with total energy consumption of 1.47 million TOE in PAT cycle-II. The targeted energy saving for PAT Cycle – II is 0.09 million TOE. In PAT Cycle-III, 34 DCs were notified with an annual energy consumption of 0.66 million TOE and target of 0.04 million TOE.

5.1 Impact of PAT Cycle- I

Textile sector has achieved 0.129 million TOE in comparison to the target of 0.066 million TOE in Cycle-I. This achievement has resulted in avoided emissions of 0.62 million tonnes of CO_2 equivalent.

Figure 7: Savings achieved by Textile sector in PAT

The savings are attributed to a number of measures adopted by the DCs. Some of the DCs have implemented short term measures with minimal investment, others have opted for medium and long-term measures requiring considerable investment. Investment was reported by 71% of DCs in the sector against implementation of energy conservation. The emissions reduction due to PAT Cycle-I and contribution of these emissions are mentioned in Table 4. The emission reduction considers the emissions of fossil fuels only and is based on the fuel mix in the sector.

Parameter	Value
Reduction of CO_2 emission due to implementation of PAT Cycle 1(All sectors)	31 million Tonnes of CO_2 equivalent
Reduction of CO_2 emission due to implementation of PAT Cycle 1 in Textile sector	0.62 million Tonnes of CO_2 equivalent
Contribution to CO_2 emission reduction in overall PAT cycle- I	2%

Table 4: Reduction in CO_2 emissions from the PAT cycle

5.2 Energy Scenario at Business as usual (BAU) vis-à-vis with PAT impact

PAT cycle-I witnessed large investments towards implementation of energy efficient projects. These projects enabled the plants to reduce the overall energy consumption and thus specific energy consumption of the industry. Therefore, a comparison of annual energy consumption of the sector with and without (business as usual) these projects would illustrate the impact of implementation of the PAT scheme for the cycle-I period as well as in the future, which is shown in Table 5.

Particulars	Unit	Value
Number of plants in the sector	Nos.	90
Baseline Energy Consumption in PAT Cycle - I for the sector	million TOE	1.2
Energy reduction target for the sector	million TOE	0.066
Energy Savings achieved in PAT Cycle - I for the sector	million TOE	0.129
Reduction in GHG Emissions in Cycle - I for the Sector	million T CO_2	0.62
Cumulative energy savings of PAT Impact till 2030[15] (over BAU)	million TOE	4.28

Table 5: Achievements of Textile sector in PAT cycle- I and projections till 2030

The energy saving of 8.67 million TOE declared for PAT cycle-I has been calculated based on notified production for the baseline period, whereas the actual energy saving obtained will be higher while considering the subsequent production of individual sectors for subsequent years. The methodology of calculation involves SEC consumption of individual years and the achieved energy savings till 2030.

The reduction in specific energy consumption in the baseline year from 2007 – 08, 2008 – 09 and 2009 – 10, has been calculated and considered as Business as Usual scenario (BAU). This reduction in specific energy consumption is used to project the reduction by the sector till 2030.

15. Difference of energy consumption between PAT and Business as Usual scenario(BAU)

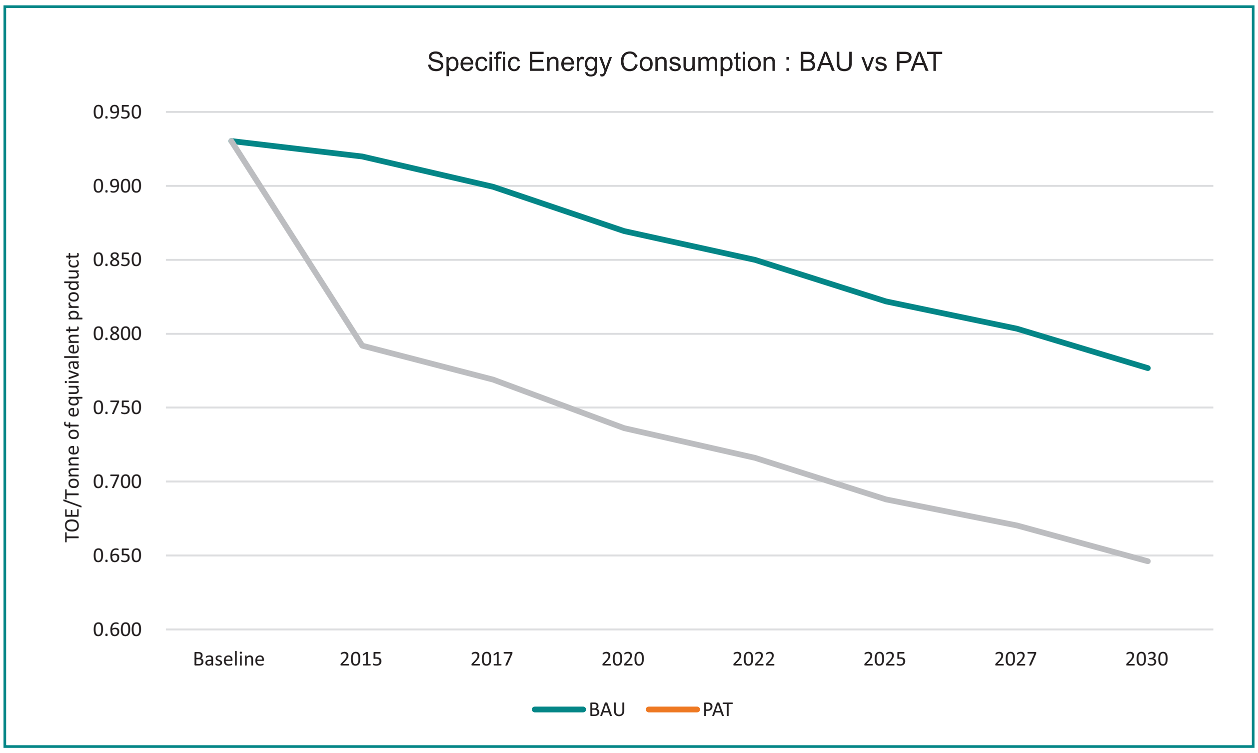


Figure 8: SEC reduction for textile sector BAU vs PAT

The graphs in this section show specific energy consumption, energy consumption for Business as usual and impact of PAT. Figure 8 shows the specific energy consumption estimated for the sector till 2030 – 31.

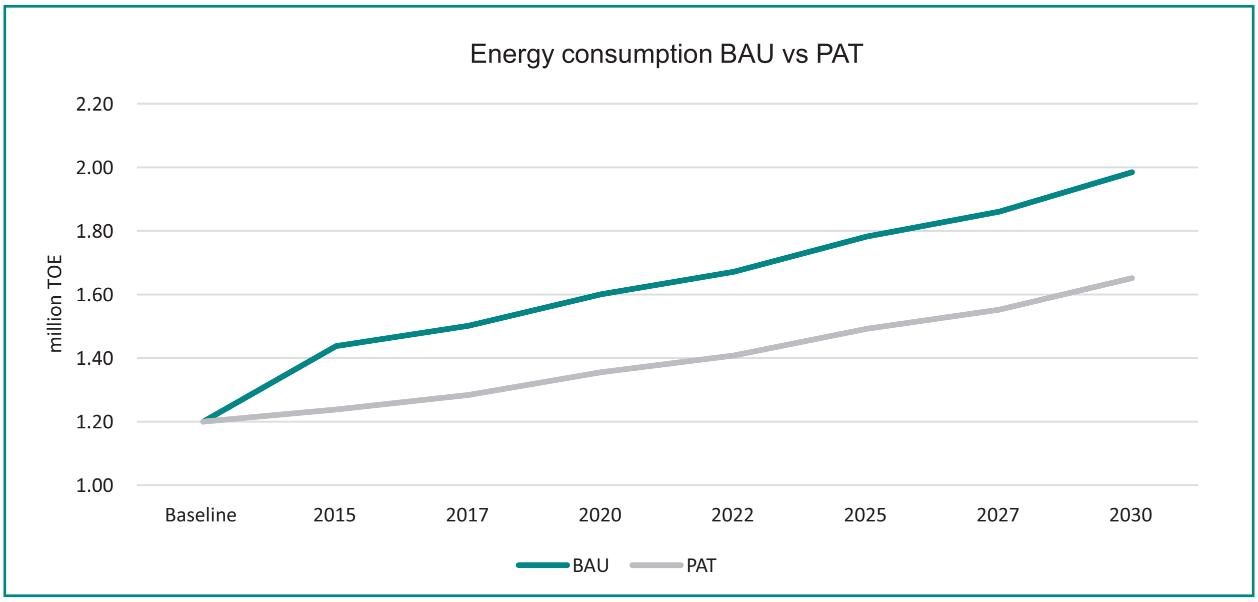


Figure 9: Total Energy Consumption Trend – BAU v/s PAT

The total energy consumption for Textile sector in the year 2030 without the impact of PAT is estimated to be **1.98 million TOE**, which may reduce to **1.65 million TOE** considering the impact of PAT.

The figure 9 indicates that the PAT scheme would have a positive impact on the sector and would help in reducing the energy consumption additionally by 0.33 million TOE over the BAU in 2030 and collective energy benefits for all years (2015-2030) would be 4.28 million TOE.

Figure 10: A view of Textile plant

Year	GDP	Business as usual	With PAT
	Billion USD	Energy Intensity	Energy Intensity
		Toe/million USD	Toe/million USD
Baseline	1,389	0.86	0.86
2015	2,102	0.68	0.59
2020	3,018	0.53	0.45
2025	4,233	0.42	0.35
2030	5,937	0.33	0.28

Table 6: Energy intensity with PAT and BAU for textile sector

Assumptions considered for BAU Vs PAT calculation till 2030

Specific Energy Consumption

- The SEC of the sector has been calculated by considering the total production of the sector and the total energy consumption in the sector, and hence may not represent the actual SEC of any particular sub-sector/ product/ process.

Business as usual scenario:

- The plant would have undertaken activities on energy efficiency on its own, even without the intervention of PAT scheme.
- The reduction in specific energy consumption in the baseline year, from 2007 – 08, 2008 – 09 and 2009 – 10, has been calculated and the same reduction is projected till the year 2030 to get the BAU scenario.

With PAT scenario:

- The actual energy saving achieved in the PAT cycle-I is taken for the assessment year 2014 – 15.
- It has been assumed that the plants meet the target allotted to them till the years 2030.
- The target for the subsequent PAT cycles is based on the average reduction in % target of PAT Cycle I and II
- It has been considered that the target will go on decreasing in the subsequent cycles owing to the diminishing potential in the plant as they implement projects on energy efficiency.
- It has also been considered that some breakthrough technological advancement might provide further reduction potential in the sector.
- The projection for production has been made based on the existing DCs under PAT cycle-1.

5.3 Textile sector specific data analysis of PAT cycle-I

The following section contains the details on the various aspects of energy efficiency in Textile sector based on the data submitted by the designated consumers under the PAT Scheme. The total number of DCs in Textile sector for PAT Cycle – I is 90. The capacity utilization of various sub sectors in Textile are mentioned in Table 7.

Sub Sector	Baseline	Assessment
Yarn spinning	103.87	101.20
Open end yarn	85.61	90.50
Dyed Fiber	80.50	70.9
Weaving@60 PPI	80.11	85.4
Cotton based Fabric	76.49	80.4

Table 7: Capacity utilization in Textile sub sectors (in Percentage)

The specific energy consumption of different sections in textile sector is mentioned in Table 8. The values are varying based on different blend of material used in the system. Some of the sub sectors had higher specific energy consumption due to lower capacity utilization, different final products or increase in quality of products.

Parameter	Unit	Baseline Year		Assessment year	
		Lowest	Average	Lowest	Average
Electrical UKG upto winding (Yarn-40s count)	kWh/kg	3.460	5.650	3.385	5.375
Electrical UKG (Open-end Yarn)	kWh/kg	0.426	1.255	0.392	1.349
Electrical UKG (Fiber Dyeing)	kWh/kg	0.230	0.437	0.122	0.461
Electrical UKG (Weaving)@ 60 PPI	kWh/kg	1.177	3.658	1.313	3.429
Thermal SEC (Weaving)@ 60 PPI	kcal/kg	221.320	1648.741	89.936	1231.110
Electrical UKG (Knitting)	kWh/kg	0.367	4.162	0.204	2.126
Electrical UKG (Cotton based fabric)	kWh/kg	0.437	1.455	0.637	1.499
Thermal SEC (Cotton based fabric)	kcal/kg	1736.312	7550.825	1818.000	7170.670
Electrical UKG (Polyester cotton based fabric)	kWh/kg	0.643	1.385	0.616	1.714
Thermal SEC (Polyester cotton based fabric)	kcal/kg	1718.954	9284.364	1908.280	8564.530

Electrical UKG (Lycra Fabric)	kWh/kg	1.371	1.543	1.144	1.211
Thermal SEC (Lycra Fabric)	kcal/kg	1736.379	5697.438	1619.780	4517.770
Electrical UKG (Wool based fabric)	kWh/kg	1.150	1.150	1.007	1.007
Thermal SEC (Wool based fabric)	kcal/kg	4300.914	4300.914	3630.360	3630.360

Table 8: Specific Energy Consumption of various sections in Textile sector

6.0 List of major energy saving opportunities in the sector

A list of major energy saving opportunities in the sector have been identified and listed below. The projects are listed based on readiness level, co – benefits obtained by installing the system and based on expected payback range by implementing the project.

Technology Readiness Level (TRL):	Co-Benefits: PQCDSME	Payback Horizon (PB)
TRL 1 – Research (Basic or Advanced)	Productivity (P)	PB 1 - less than 1 year
TRL 2- Proof of concept	Quality (Q)	PB 3 – 1 year to 3 years
TRL 3- Demonstration(Pilot)	Cost(C)	PB 5 – 3 to under 5 years
TRL 4- First of a Kind	Delivery (D)	PB 8 – 5 to under 8 years
TRL 5- Fully Commercial	Safety (S)	PB 12 – 8 to under 12 years
	Moral (M)	PB >12 – over 12 years
	Ethics, Environment (E)	

SL No.	Technology	Co-Benefits e.g.: (P, Q, C, D, S, M, E)	Readiness Level (TRL)	Payback
1	Centrifugal compressors installation	C, E	TRL-5	PB 5
2	Energy monitoring and management system	C, D, E	TRL-3	PB 8
3	Variable frequency drive	C, E	TRL-5	PB 3
4	Install waste heat recovery for stenters	C, E	TRL-5	PB 5
5	Replacing Electric heating with thermic fluid heating in Polymeriser	C, E	TRL-5	PB 3
6	Installation of photo cells for speed frames	C, E	TRL-5	PB 5
7	Installation of TIC controller for Processing machines	C, E	TRL-5	PB 3
8	Optimisation of Balloon settings in TFO machine	C, E	TRL-5	PB 5
9	Installation of Synthetic Flat belts for spinning ring frames	C,E	TRL-5	PB 3
10	Install automatic valves in continuous washing machine	C,E	TRL-5	PB 5
11	Condensate recovery in wet processing plant	C,E	TRL-5	PB 5
12	Install trans-vector nozzle for cleaning	C,E	TRL-5	PB 5
13	Installation of mechanical pre-drying	C,E	TRL-5	PB 3
14	Energy efficiency in electrical equipment (EE motors & LEDs)	C,E	TRL-5	PB 3
15	Cooling tower up-gradation (Retrofitting of CT & installation of VFDs)	C,E	TRL-5	PB 5

Table 9: List of Energy saving technologies

7.0 Success stories – Case studies in textile sector

7.1 Case study 1 : Elimination of 2 bath by combining bio-polish and Dyeing

Introduction

Trident Group, a USD 1 billion Indian business conglomerate and a global player, is a leading diversified group of businesses headquartered in Ludhiana, Punjab. Trident Limited, incorporated in the year 1990, is the flagship company of the Trident Group.

Trident has been at the forefront in incorporating some of the finest and latest energy management practices in its operations.

With consistent investment in technology, constant research and an innovative approach, Trident has acquired wide and varied global scale capabilities in terry towel and bed sheet production. From a variety of fibers and yarns to a range of colors, both in piece dyed and yarn dyed, plains & jacquards, to a complete collection of performance finishes and surface decorations, the product range keeps expanding to meet the unique needs of the market.

Description of the project

The project has been implemented in the towel manufacturing section of the plant. With an objective to further reduce the energy consumption and save water in the dyeing section of towel manufacturing steps to optimize the system were taken.

Detailed assessment of the dyeing section by the plant team revealed an opportunity for elimination of two bath process by combining Bio wash with Dyeing Process in Combi process. Trident team decided to take trial of the proposed scheme.

Trident Ltd., top management and the plant team took this target as an excellent opportunity to further enhance their overall process performance.

Trials were undertaken to combine the bio-wash and dyeing process to eliminate the bio-polishing stage in after treatment. For this a need for a new enzyme was felt which would perform the dual function of peroxide killing and bio-polishing. The challenge was discussed with the enzyme vendor, who subsequently engineered an enzyme to solve the dual purpose.

After series of discussions, permission for trails was obtained and trials were conducted for modification in the process with the ultimate objective of maintaining the product quality. The process, before and after the implementation of the scheme, is depicted in the following diagram.

Pretreatment	
Before 1. Scouring/Bleaching 2. Hot washing 3. Acid & Peroxide killing by using green acid and an enzyme	After 1. Scouring/Bleaching 2. Hot washing 3. Acid killing by using green acid

Dyeing	
Before 1. Dye spreading 2. Alkali dosing 3. Cold Washing	After 1. Cellunase combi dosing & dye spreading 2. Alkali dosing 3. Cold Washing

After treatment	
Before 1. Soaping 2. Hot wash 3. Bio-polishing (enzyme based) 4.Cold wash	After 1. Soaping 2. Hot wash 3. Cold wash

Figure 11: Pre-treatment, Dyeing & After-treatment before and after elimination of bio polishing in after treatment stage

As depicted in Figure 11 the enzyme dosing in pre-treatment step for peroxide killing has been eliminated followed by cellulase combi enzyme dosing in dyeing stage before the dye spreading. This results in elimination of bio-polishing in the after-treatment stage.

The enzyme performs dual action of peroxide killing and bio polishing in dyeing stage itself. The enzyme has been engineered specifically for serving this dual purpose by the vendor. Also, the introduction of this enzyme has led to the elimination of peroxide killing enzyme which was used earlier in the pre-treatment stage.

The plant team continuously checked the quality of the product during the trials and found that there was no impact of this modification on the product quality. This modification has additionally led to tangible savings in terms of steam saving by elimination of bio-polishing and water saving as well.

Benefits

Parameter	Units	Values
Energy savings	million Rs	4.43
TOE equivalent savings	TOE	142.4
Investment	Rs million	NIL
Payback(months)	Months	Immediate
GHG reduction	Tonne CO_2equivalent per year	3680
Replication Potential	% of plants in the sector can opt for this technology	60% of the plants in this sector
TOE savings in the entire sector	TOE	300 TOE[17]

Table 10: Plant Details

17. Considering DCs in PAT cycle 1 that produce cotton based fabric

THT-1 plant

As a result of the elimination of 2 bath process by combining bio-polishing with dyeing process, annual cost saving of INR 1.64 million including INR 0.15 million from water savings (basis: 2.41 TPD steam saving for 15% of total production and 6m3/h water consumption reduction for 15% of total production).

THT-2 plant

As a result of the elimination of 2 bath process by combining bio-polishing with dyeing process, annual cost saving of INR 3.28 million including INR 0.31 million from water savings (basis: 4.82 TPD steam saving for 15% of total production and 6m3/h water consumption reduction for 15% of total production).

The implementation of this scheme did not involve any investment and hence the payback is immediate.

Challenges faced and modifications done

The Trident team was able to complete the project overcoming the challenge of maintaining the quality of the product. There was no shut down required for implementation of the measure.

Other Benefits

- Zero Down time
- Water saving
- Saving of 20 minutes in the complete cycle by combining bio-washing with dyeing process

Replicability

At least 60 % of the plants in India have similar saving opportunities and can adopt this approach after proper trials.

Plant Contact details for the project	
Plant Name	Trident Limited
Person to be contacted	Mr. Sasanka Sekhar Aich
Designation	VC Operations- Towel Punjab
Contact number	+91-9878999769
Email – ID	SasankaAich@tridentindia.com
Address for communication	Trident Ltd., Dhaula complex, Mansa road, Barnala, Punjab 148 101

Table 11: Contact Details for Trident Ltd., Barnala

7.2 Case Study 2: Optimisation of stenter using waste heat recovery and automation

Introduction

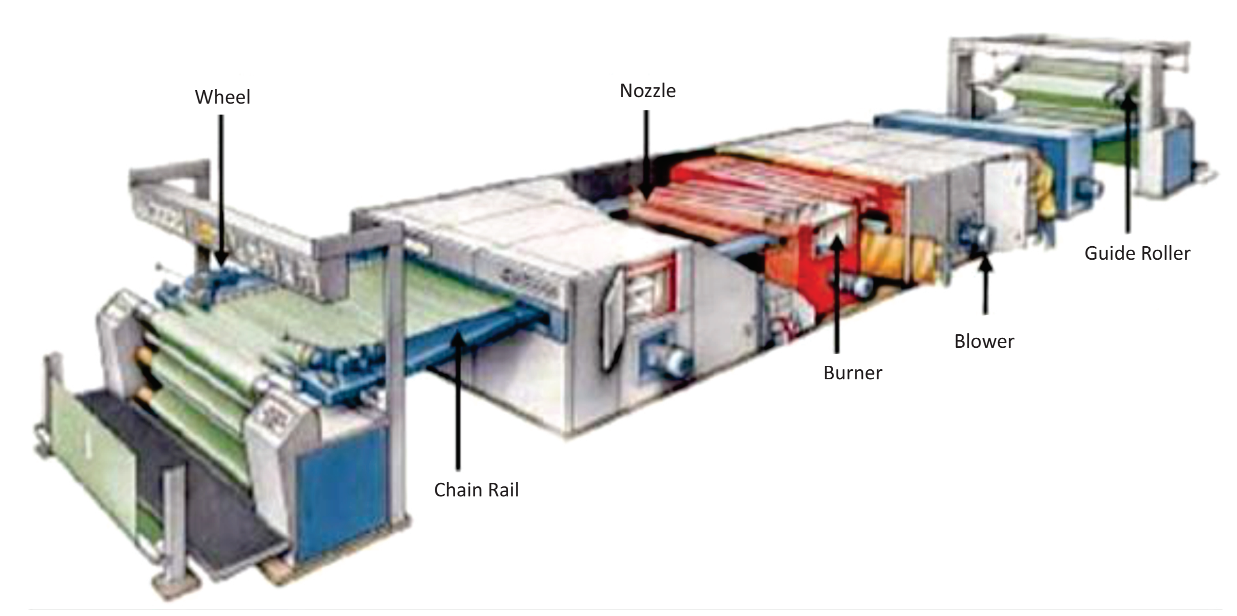
Arvind Limited is a textile company with headquarters in Ahmedabad, Gujarat. Founded in 1931, globally it is now among top 5 organized denim manufactures and is among the largest textile companies in India. Arvind Limited has also been taking many initiatives for environment sustainability and has set benchmarks for pursuing environment management and sustainability. The company operates one of the largest zero liquid discharge plant in Asia and has one of the largest solar PV rooftop installation in the country. The textile unit located in Gandhinagar is among the most efficient textile units in the country and this has been achieved by continuous efforts on energy efficiency measures.

Project Background

Textile stenters have two main purposes – convection drying so as to remove the moisture in the fabric and secondly to provide for fabric width control. During the previous stages of processing the fabric is subjected to length wise tension to varying degrees resulting in shrinkage in width. In the stenter, width control is achieved with the aid of a series of clips or pins mounted on a pair of endless chains. Apart from these functions stenters are also used for the following:

- Dry-heating process like, heat setting of synthetic fabrics and their blends
- Dry curing process namely, resin finishing with built-in catalysts
- Partial curing of pigments dyeing

Stenters being a major energy consumer in a textile mill offers opportunities for energy conservation.



Drying is achieved by impinging high velocity air jets uniformly across the full width of the fabric on both sides. The air being used is heated to a temperature of about 140-150oC. The hot air is re-circulated and a certain amount of air is continuously removed from the system through exhaust fans so as to avoid build-up of excessive humidity. To that extent, the system is supplemented by fresh air. The fabric enters the stenters after the pre-drying cylinders with moisture of about 60 – 65 %. This moisture needs to be dried and vented out in the stenters. The stenters have normally two exhaust blowers which are operating continuously venting hot air & moisture.

The unit implemented two projects for optimisation of energy consumption in the stenter unit resulting in significant savings.

1. Automation in Stenter Machine
2. Waste Heat Recovery in Stenter Machine

Automation in stenter machine: Stenter machines are operated to dry the moisture from fabric and also to strengthen it further, if the parameters are monitored properly it can lead to high amount of waste of energy in heating. Thus, automation in stenter machines can significantly help in reducing the cost and also raise the productivity of the process. Under this measure, the speed of the fabric is controlled using three parameters – exhaust humidity, fabric temperature and residual moisture. Depending on these parameters the speed of fabric as well as thermal energy input is controlled. This would result in maintaining the optimum conditions of speed, temperature and humidity for drying the cloth and also impart required properties to the fabric. Figure 12 indicates the installation of various sensors to measure the required parameters.

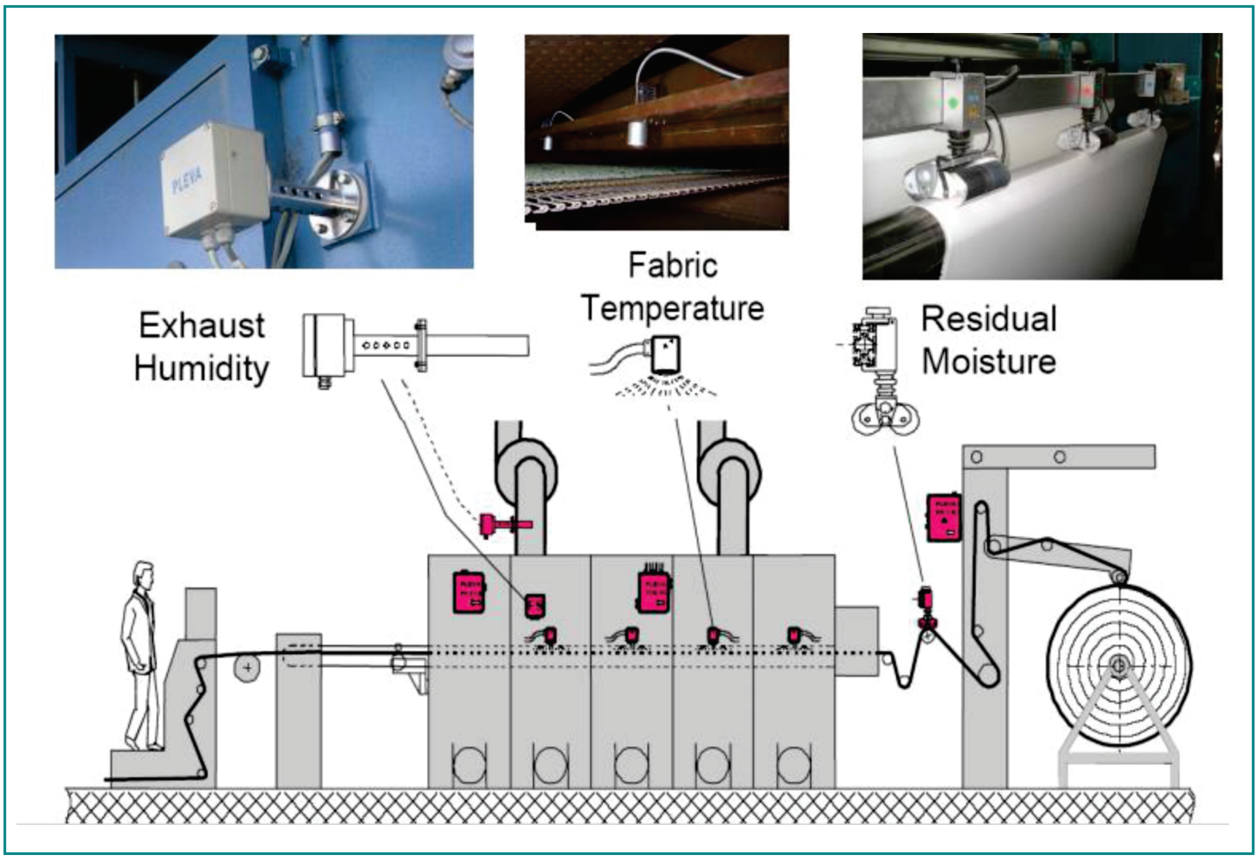
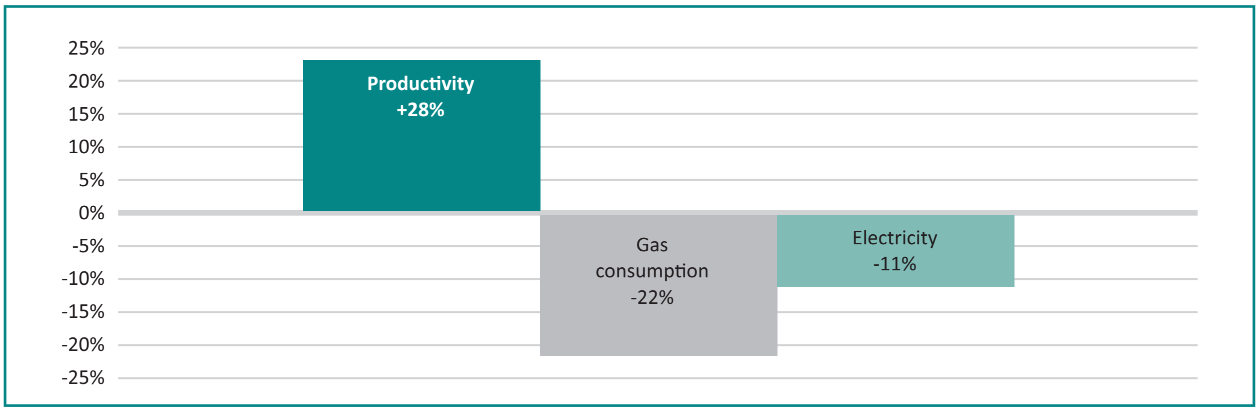


Figure 12: Diagram of overall setup

These measures would not only contribute in saving electrical and thermal energy but would also increase the productivity as there is very minimum human intervention as the parameters are controlled through auto feedback (PLC) and inputs based on type of cloth. Following is the benefit achieved by implementation of the measure:



The investment is required for the sensors and the new stenter machine come equipped with these types of automation.

Waste Heat Recovery: The other major energy saving opportunity in the stenter machine is heat recovery from the exhaust gas. The thermal energy requirement in stenter is for heating the air to dry the cloth. The exhaust gas from the stenter exits at 190 oC, thus large amount of heat is available which can be recovered. By installation of air pre-heater, the heat available in the exhaust gas is recovered and fresh air is heated through waste heat. This has helped reduce the heat demand by 15-20% for finishing. Following is the schematic of the waste heat recovery system in stenter system.

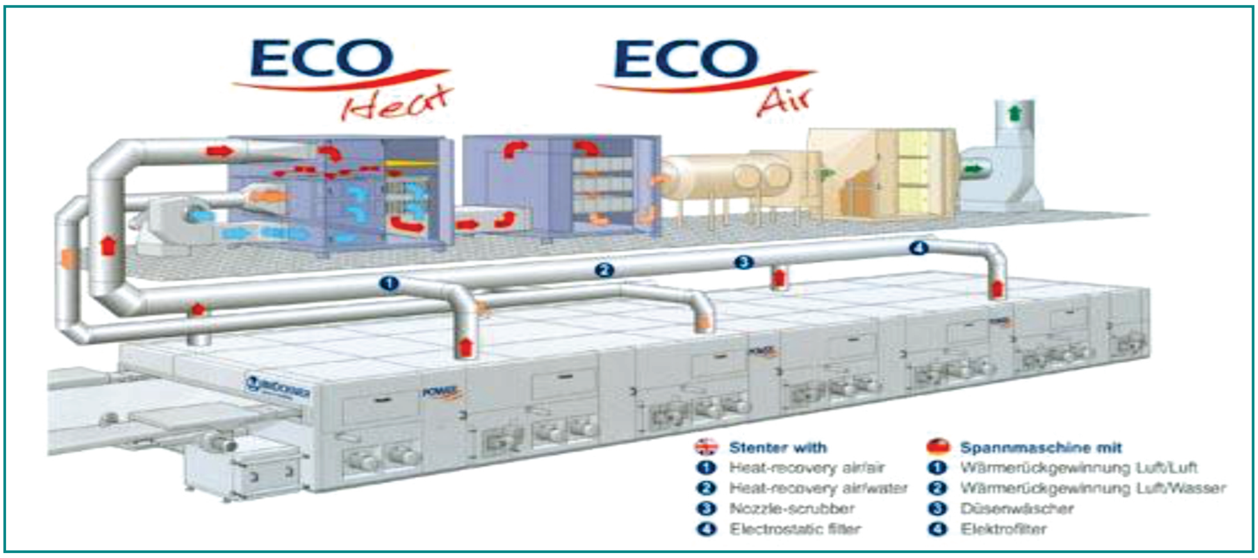


Figure 13: Waste Heat Recovery Stenter (Source: Indian Textile Journal)

Benefits

As a result of the interventions, annual cost saving of INR 13.5 million was achieved. As the project involved capital expenditure for installation of automation system and waste heat recovery, the investment required was INR 6.5 million. Thus, the project payback is very attractive. Following table provide the cost benefit details for each project.

Sl. No.	Measure	Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Cost Savings (%) /1000 m
1	Installation of Automation System	91	20	36%
2	Installation of Waste Heat Recovery	44	45	15%

Table 12: Savings due to Automation and Waste heat recovery

Parameter	Units	Values
Energy savings	Rs million	13.5
Investment	Rs million	6.5
Payback(months)	Months	6 months
Replication Potential	% of plants in the sector can opt for this technology	70% of plants in composite mill sector

Table 13: Energy Saving due to implementation of project

Replicability

The textile units that operate on the earlier generation stenters, have the opportunity for installation of automation and heat recovery systems. Approximately 70% of composite mills can install this system.

Plant Contact details for the project	
Plant Name	Arvind Ltd.
Person to be contacted	Mr. Kushal Trivedi
Contact number	+91 97230 69994
Email – ID	Kushal.trivedi@arvind.in
Address for communication	Arvind Ltd., Gandhinagar, Gujarat

Table 14: Contact Details for Arvind Ltd.

8.0 List of Technology suppliers

S No	Company Name	Technology	Website link
1	Honeywell Process Solutions	Automation Solutions	https://www.honeywellprocess.com
2	Rieter India Pvt. Ltd.	Fiber and Spinning preparation solutions	https://www.rieter.com
3	Temac India Pvt. Ltd.	Spinning and Weaving machines	https://www.temacindia.com
4	Forbes Marshall	Steam Distribution Systems	https://www.forbesmarshall.com/
5	Outotec	Automation, Optimisation System	http://www.outotec.com
6	ABB	Energy Efficient motors, Busbar collector systems,etc	http://www.abb.com
7	Jhonson India	Steam and condensate systems	https://www.kadant.com
8	Batliboi India	Textile air engineering, Textile machinery	https://www.batliboi.com
9	LMW	Integrated Spinning solutions	https://www.lakshmimach.com
10	Picanol India	High-tech weaving machines	https://www.picanol.be
11	Atlas Copco	Waste heat recovery from compressors	https://www.atlascopco.com/en-in
12	Ingersoll Rand	Waste heat recovery from compressors	https://www.ingersollrand.co.in

Table 15: List of key technology suppliers in Textile sector

Abbreviations

BAU
Business as usual, 15, 17
Business As Usual, 2, 3, 5, 15, 16
BEE
Bureau of Energy Efficiency, 13
CAGR
Compounded annual growth rate, 7
CO_2
Carbon dioxide, 7, 8, 13, 14, 17
DC
Designated consumer, 7, 14
DCs
Designated consumers, 4, 7, 8, 14, 19, 25
ESCerts
Energy saving certificates, 4, 14
GDP
Gross domestic product, 7, 8, 13, 17
GHG
Green house gases, 4, 5, 7, 14, 15, 16, 25
IEA
International Energy Agency, 7
INR
Indian Ruppee, 7, 8, 14
kWh
kilo Watthour, 19, 20
million TOE
million metric tonne of oil equivalent, 15, 16,8
MTOE
Metric ton of oil equivalent, 7, 30
PAT
Perform, Achieve and Trade, 2, 3, 4, 5, 6, 7, 8, 13, 14, 15, 16,17,19,25
SEC
Specific energy consumption, 3, 4, 14, 15, 16, 19, 20
TOE
tonne of oil equivalent, 14, 25, 30
TRL
Technology Readiness Level, 21, 22
UKG
Units per kilogram, 19, 20
USD
Unnited States Dollar, 7, 8, 23
VFDs
Variable Frequency Drives, 22

Bureau of Energy Efficiency

Ministry of Power, Government of India
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066 (INDIA)
T: +91 11 26766700 I F: +91 11 26178352
Email: admin@beenet.in I www.beeindia.gov.in
Follow us on @BEEIndiaDigital on Facebook & Twitter

Leading Towards Energy Efficiency Economy

Confederation of Indian Industry

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Published by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH