# CLIMATE ACTION TRAINING FOR THE FASHION INDUSTRY

## Module 5.1: Energy Efficiency

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia

Global Climate Action
United Nations Climate Change

## Content

# 1 Introduction

Welcome to the fifth module of the online training 'Climate Action for the Fashion Industry'.

## 1.1 Key lessons

In this module, you will learn about:

a. **Energy consumption in the textile supply chain** – Which processes in the fashion industry consume the most energy?

b. **Energy management systems (EnMS)** – How can EE measures be implemented and monitored systematically and sustainably? What are the typical steps of developing an EnMS?

c. **Submetering and Energy Management Tools to understand energy consumption** – What are these and how can they help factories understand their energy consumption?

d. **Energy efficiency** – What measures can be taken to increase EE, drawing examples of energy saving in general operations, lighting, heating, ventilation, and air conditioning (HVAC) and steam systems?

e. **Energy efficiency for general operations**

f. **Energy efficiency for lighting systems**

g. **Energy efficiency for steam systems**

h. **Energy efficiency for heating systems**

i. **Overview of energy savings opportunities**

j. **Business case and financial returns** – Why should you invest in EE and what are examples of no-/low-cost and high-cost energy savings measures for factories?

k. **Developing an action plan** – What does an action plan for energy-saving measures look like?

You can review and apply what you have learned at the end of the module by:

- Checking your knowledge in a short **quiz** covering the main topics of this module.
- Developing an action plan to improve your energy consumption at your facility with a **real-life assignment.**

You can also have a look at the **frequently asked questions (FAQs)** for this module.

- The time required for this module.
- Going through the core content of this module will take approximately one (1) hour. For the assignment, plan for another two (2) hours.
- Before we start, take a minute to reflect:
- What are the capabilities you expect to gain from taking this module?

Think about this before you continue. If you like, note down your expectations so that you can revisit them at the end of the module.

# 2 Energy Consumption in the Textile Supply Chain

In the previous GHG accounting module (e.g., Module 3), you learned that the textile manufacturing process is energy-intensive, with Scope 1 and 2 emissions at factories considered particularly significant.

The module will concentrate on energy savings. Being efficient in energy consumption provides opportunities for a factory to reduce its operational emissions and meet any climate targets it may have. More importantly, efficient consumption of energy reduces production costs from energy-related consumption. The emissions profile of a factory and the reduction opportunities available to it will depend on how much of the total energy comes from electricity (e.g. in powering sewing machines) versus thermal energy (e.g. in heating water for dyeing).

Understanding where your energy comes from is the first step to reducing your energy consumption. The type of measures you can implement will depend largely on your factory and the machines and processes you use.

Let's take a look at typical energy consumption patterns in the textile supply chain. Please note that the energy consumption breakdown may vary based on the facility set-up (for instance, whether the facility has a centralized air-conditioning/heating system) and the figures presented below may not reflect your facility's actual share of energy consumption.

## 2.1 Energy Consumption in Apparel Industry

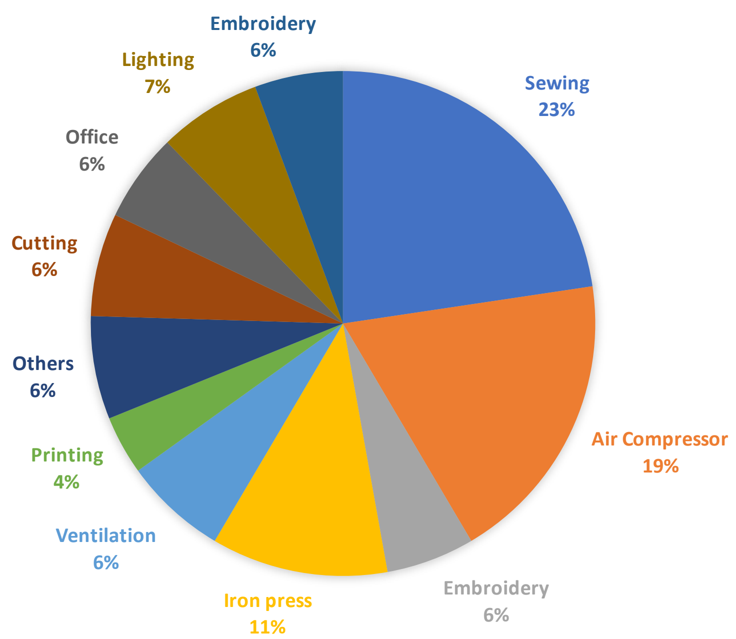



*Figure 2-1 Energy consumption in the Apparel Industry*
*Source: Adidas 2019*

Energy Consumption in Apparel - Around 60% of the energy consumption of Apparel Tier 1 facilities typically comes from electricity used for equipment, such as that required by sewing machines, air compressors and lighting systems (see figure).

## 2.2 Energy Consumption in Spinning Mill

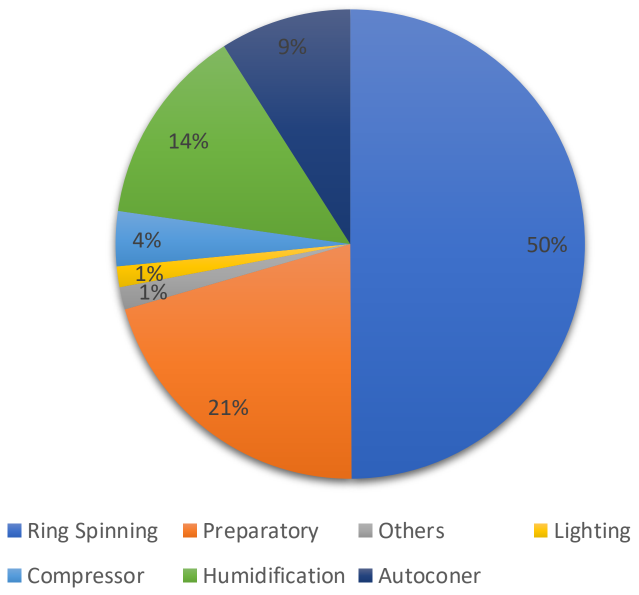



*Figure 2-2 Energy consumption in spinning mill*
*Source : Research Gate - Analysis of Energy Consumption in Spinning Mill*

The major portion of Energy is consumed by the Ring frame department followed by Humidification Department.

## 2.3 Electricity Consumption in Weaving Mill[1]

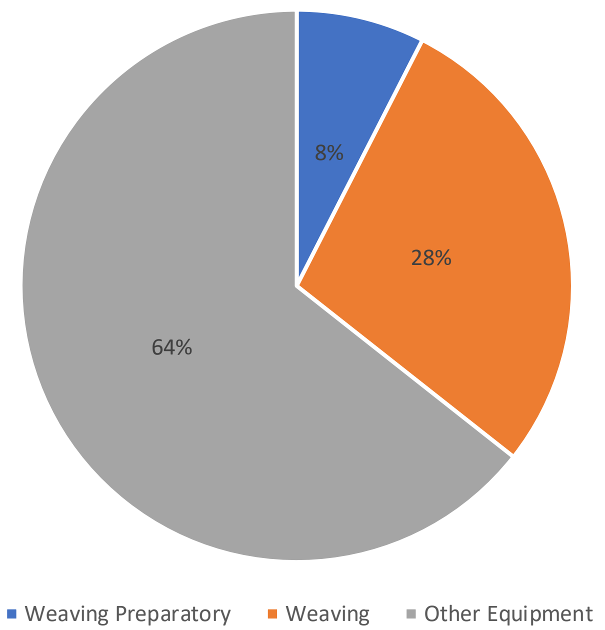



Figure 2-3 Electricity consumption in weaving mill
*Source: Research Gate – Monthly Energy Consumption in Weaving Mill*

## 2.4 Energy Consumption in textile wet-process (Apparel Tier 2) Unit

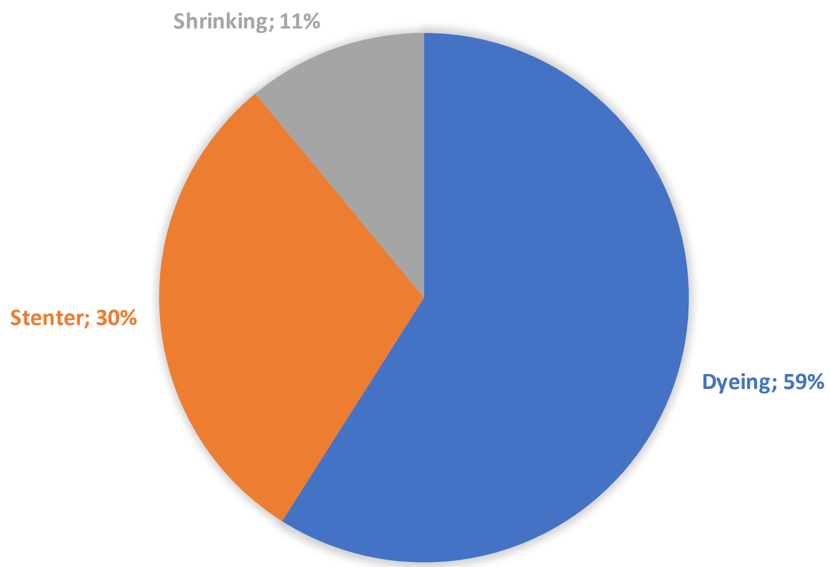



*Figure 2-4 Thermal consumption from fuel*
*Source : Adidas 2019*

For a factory in APP Tier 2, 90% of energy consumption typically comes from fuel. Its primary use is in the dyeing process (59%), followed by power for the stenter (30%) and shrinking (11%).

## 2.5 Electricity Consumption for textile wet-process (Apparel Tier 2) Unit

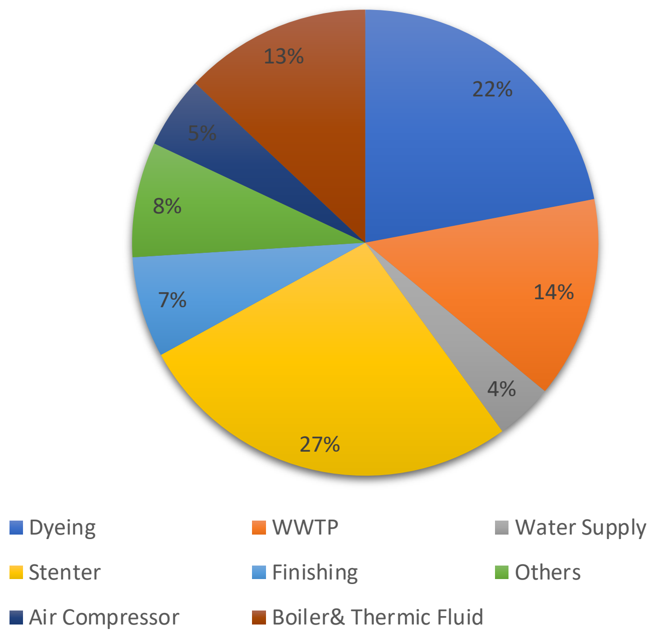



*Figure 2-5 Electricity consumption in wet-processing unit*
*Source : Adidas 2019*

For a factory in Apparel, Tier 2 (Electricity) -The top 3 processes namely Stenter machines, dyeing process and Boiler and Thermic fluid heater consume a major portion of electrical energy.

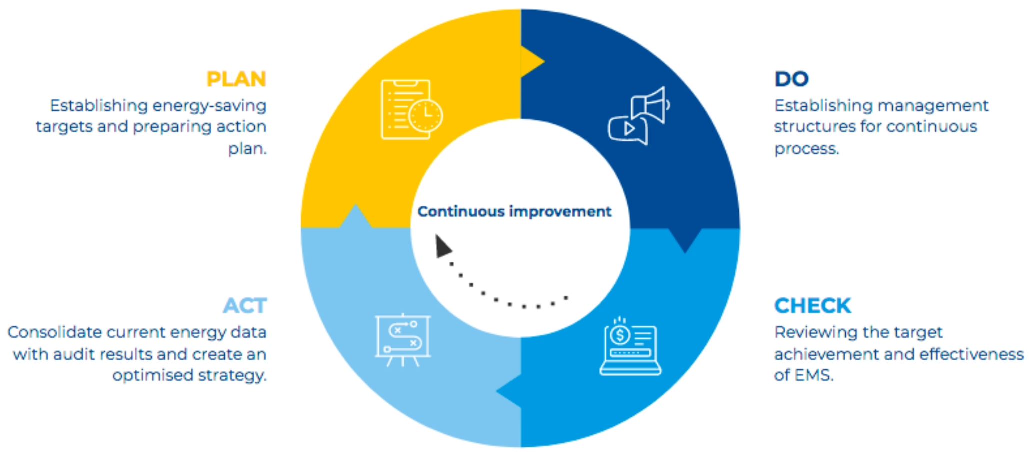
# 3 Energy Management Systems (EnMS)

Let’s use our fictitious company, Chino Cotton Textile, as an example. Chino Cotton Textile would like to introduce EE measures at its facilities. After conducting some research, the facility manager presents a proposal to his management team. To implement a long-term EE strategy, Chico Cotton Textile needs to develop an in-house EnMS to enable EE opportunities to be identified and an energy action plan to be implemented.

**What is an Energy Management System (EnMS)?**

An EnMS is a framework within which to implement an energy action plan and manage a plant’s energy consumption. This framework acts as a foundation for continuously improving your energy performance and ensures that the associated costs, savings and energy reductions from the measures implemented are sustained.

There is no ‘one size fits all’ EnMS. All EnMSs should, however, seek to continuously improve energy performance at the lowest possible cost whilst following a Plan-Do-Check-Act cycle.




**What are the benefits of EnMS?**

Implementing an EnMS provides benefits to companies through:

- Reducing energy, utility and material costs.
- Improving productivity and reducing energy intensity and GHG emissions.

- Facilitating better decision-making and monitoring on the part of senior management through performance indicators.
- Setting clear climate targets and goals for the management team.
- Enhancing energy security and cost optimization.
- Offering continuous monitoring of sustainable EE improvements.
- Complying with client international standards and objectives (if the client(s) demand that ISO 50001 be adopted).

Although specific EnMS designs may vary, each EnMS shares a set of common elements.

Let’s put the concept of EnMS to work in an example using our fictitious company, Chino Cotton Textile. Chino Cotton Textile wishes to implement an ambitious EE action plan.

This action plan seeks to enable a significant number of energy savings measures in different areas of the factory. To realise this, operations, maintenance, production, quality, HSE and other areas of the business will each need to be engaged. The management team is now planning to **put an EnMS in place to control and optimise energy management**.

The process will look as follows:

**a. First step: Define an energy policy (part of factory’s climate targets)**

The first step of an EnMS is developing an energy policy. It demonstrates a firm commitment on the part of company management to using energy more efficiently. The written energy policy should indicate its key objectives and must be:

- Integrated into business policy.
- Well-communicated internally.
- Underpinned by a budget to ensure the necessary resources and funds are available for implementation.
- Backed by upper management to signal the factory staff and external stakeholders.

**b. Second step: Appointing a qualified energy management (EM) team**

Putting an EnMS in place and overseeing the implementation of its energy action plan component requires dedicated resources, particularly during the initial phase of the system’s implementation.

Setting up dedicated EM teams is part of an EnMS’s organisational set-up. The roles within the EnMS should be fulfilled by staff with the required competencies to perform the tasks necessitated by the EnMS and make the greatest use of internal resources wherever possible.

Whilst the energy/facility manager oversees and drives the energy management programme forward, they need to be supported by a multidisciplinary team in implementing and monitoring the system in the factory. The factory's team may also be supported to varying degrees by external service providers such as consultants and EE equipment providers.

**c. Third step: Energy assessment to identify opportunities for EE**

During the energy assessment, factory staff and/or external consultants look to identify EE opportunities. This exercise is not something that is done only once but is, rather, part of a continuous effort to improve energy performance. All factory personnel have a role to play in identifying ways in which to save energy and reduce emissions, particularly when it comes to identifying ways in which to operate equipment more efficiently. Factory staff need to be aware of how to save energy and are motivated to do so.

Bear in mind that energy assessment only offers a 'snapshot' of energy savings at a given point in time.

**d. Fourth step: Documentation**

Now, it is important that you record all the above activities (e.g. the objectives, scope, organizational set-up, submetering diagram, action plan and reporting templates) together in a document. The goal is to ensure that newer, more energy-efficient operating procedures, maintenance routines and equipment procurement criteria introduced over the course of the action plan's implementation become the norm in the factory.

The EnMS document is a living document and should evolve as the lessons are learned, improvements are made and the EnMS's overall design changes. Having such a document in place facilitates staff training and instils confidence in external stakeholders that a formal EnMS is in place.

The manual is not a standardised document but should present the individual components of the EnMS in place.

**e. Fifth step: System evaluation**

**There's always room to improve. An EnMS is no exception, and its performance should be subject to periodic review.** Such a review can be undertaken by factory staff or external specialists. This review will demonstrate to the energy team that all components of the EnMS work properly.

The assessment results will be presented to management and will help with undertaking future energy-saving activities with the full support of everybody in the organisation.

It is important to highlight that the **EnMS has a role in ensuring past gains in EE are not lost over time**. This is particularly the case where more efficient O&M practices/schedules are introduced and take time to be fully adopted by O&M staff.

### f. Sixth step: Monitoring and reporting (M&R) system

Last is the monitoring and reporting (M&R) system that sits at the core of the EnMS.

It is the energy manager's key tool for obtaining the data that is needed to both manage energy on a day-to-day basis and report performance to different stakeholders within the factory. This helps steer the energy manager's effort along a path that enables the factory's energy objectives and targets to be met.

It is key for delivering on any $CO_2$ reduction targets. Submetering and a fit-for-purpose M&R system are essential tools for enabling energy to be managed efficiently.

> **Tools for EnMS**
>
> Software tools of the Advanced Manufacturing Office (AMO)
>
> AMO's energy system and energy management software tools help manufacturers increase EE at the plant level and in specific systems. Learn step-by-step ways to identify opportunities, monitor progress and improve efficiency in any facility by accessing the tools listed on this website.
>
> Click here to get to the list: https://www.energy.gov/eere/amo/software-tools

# 4 Submetering and Energy Management Tools to Understand Energy Consumption

Previously, you were introduced to the steps of developing an EnMS. This lesson will take you through the selection of energy savings opportunities commonly used in textile facilities.

To identify energy efficiency opportunities, you need capable measuring instruments to measure energy consumption. Once you understand your facility's energy consumption, you can determine how you can save energy.

A factory's main meters do not provide enough information to manage its energy and utilities consumption. However, dedicated metering in specific areas of the plant and major items of plant equipment do provide sufficient information for monitoring. Whilst meters don't save energy, they do offer the data needed to figure out how to do so effectively.

Meters and measurement software are relatively inexpensive. Below is the estimated price of different types of meters commonly used in textile factories, based on reports from the Natural Resource Defence Council (2013).

| ELECTRICITY METERS | | |
|---|---|---|
| Mechanical meters | USD 24 – 70/unit | 25 years of lifetime |
| Electrical smart meters | USD 125 – 313/unit | 15 years of lifetime |
| **WATER METERS** | | |
| Mechanical type meters | USD 150/unit | 10 years of lifetime |
| Electromagnetic flow meters | USD 2,500 – 3,900/unit | 15 years of lifetime |
| **STEAM METERS** | | |
| Orifice flow meters | USD 780 – 1,250/unit | 15 years of lifetime |
| V-cone flow meters | USD 2,400 – 4,800/unit | 15 years of lifetime |

Setting up a submetering system, however, can incur significant costs. A cost-effective EnMS can optimise the level of submetering needed.

## 4.1 Energy management (EM) software

EM software allows to capture of all the metered data that your submetering systems provide to you, alongside processing it and making it easier for you and others involved in the EM effort to analyse it.

Proper EM software will also allow you to quantify the impact of any energy-saving actions taken, identifying successes and key indicators of energy-saving progress and producing EM reports that are suitable for the differing needs of EnMS stakeholders. As an example, shift supervisors, operators and plant engineers require a far finer level of detail on plant performance than a plant manager.

Once knowing the quantity of resources (e.g., energy, water and steam) utilised on the whole by a facility or present at the equipment level, the next step is to identify applicable energy-saving measures. There are plenty of measures that can be implemented to save energy and reduce emissions. To give you an idea of the number of measures that can be put in place at once, IFC's Vietnam Improvement Programme (VIP) has allowed Tier 1 footwear suppliers to apply an average of 15 energy-saving opportunities at each site, with savings ranging from 14–31% of their annual energy consumption.

To start, we will look at a few examples of energy-saving measures commonly found at textile facilities within general operations, lighting, steam, and heating systems. At the end of this section, you will find a more extensive list of measures and their total emission reductions.

# 5 KPI for Energy Management in Textile Supply Chain

A key performance Indicator, otherwise called KPI, is a scientific approach to measuring the performance of a process or an organization. KPIs are quantifiable and tracked on a daily, weekly, or monthly basis depending on the need. Key performance indicators are a set of measures that an organization implements to gauge its progress towards achieving its key business objectives and set targets for the processes or organization.


The textile supply chain can track energy consumption either by absolute numbers or by intensity. The details of the absolute number and intensity are mentioned below:

## 5.1 Energy KPI by Absolute Numbers

In this approach, the total consumption of energy is measured. The production output is not accounted for in the Energy KPI. For Example, In the month of January 2022, Global Clothing Manufacturer consumes 5000 kWh of electricity units and produces 50,000 garments and for the month of February 2022, it consumes 8000 kWh of electricity units and produces 55,000 garments. **The Energy KPI for the Global clothing for January is 5000 kWh and for February is 8000 kWh**. The production for January and February is not accounted for by Energy KPI.

## 5.2 Energy KPI by Intensity:

In this approach, Energy consumption is measured with respect to the production output. For Example, In the month of January 2022, Global Clothing Manufacturer consumes 5000 kWh of electricity units and produces 50,000 garments for the month of February 2022 it consumes 8000 kWh of electricity units and produces 55,000 garments. **The Energy KPI for the Global Clothing for January is 0.1 kWh / piece of garment and February is 0.15 kWh / piece of garment.**

The Energy KPIs for the textile supply chain is mentioned in the below table:

| Textile Business Type | Application | Electrical Energy | Thermal Energy[1] (Steam Production by Burning Fuels like Coal /Wood / Biomass / Natural Gas etc.) | Energy KPI |
|---|---|---|---|---|
| **Spinning** | Machinery | • kWh / kg of yarn produced | Not applicable | • kWh / kg yarn produced |
| **Knitting** | Machinery | • kWh / kg of fabric produced | Not applicable | • kWh / kg fabric produced |
| **Weaving** | Machinery | • kWh / kg of fabric produced | Not applicable | • kWh / kg fabric produced |
| **Wet Processing** | Machinery | • Mega Joules / kg of fabric produced *(A)* | • Mega joules / kg of fabric produced (B) | • Mega joules / kg of fabric produced<br>• (A+B) |
| **Garment (Apparel Manufacturing)** | Machinery | • kWh / piece manufactured<br>• kWh / piece manufactured | • MJ / piece manufactured<br>• MJ / kg of garment | • MJ / piece manufactured<br>• Kg of garment |
| **Laundry** | Machinery | • kWh / piece manufactured<br>• kWh / kg of garment | • MJ / piece manufactured<br>• MJ / kg of garment | • MJ / piece manufactured<br>• MJ / kg of garment |

[1] The data shown above is Sample data for understanding purpose

Before we move to the next session, let's refresh our memories with a few exercises:

**[Exercise 1]**

Steam is required in Spinning Process, say true or false.

**(The correct answer is false)**

**[Exercise 2]**

What is the Energy KPI for Spinning Business Process?

- Megajoules per kg of fabric
- KWh per kg of yarn **(correct)**
- KWh per Bobbin produced

**[Exercise 3]**

What is the Energy KPI for Laundry Business Process?

- Megajoules Per kg of Garment **(correct)**
- Megajoules Per Piece of Garment Produced
- None of the Above

**[Exercise 4]**

NatWest Textile Dyer's monthly production and monthly coal consumption are as mentioned below. Coal is used in steam boilers for producing steam which is required for the dyeing process. The calorific value of coal is 30 MJ per Kg of coal. What is the average energy KPI for the past 6 months for the wet processing unit?

| | Jan | Feb | March | Apr | May | June |
|---|---|---|---|---|---|---|
| Fabric production (kg) | 197,964 | 1,821,178 | 190,508 | 174,494 | 196,831 | 207,592 |
| Coal (tonne) | 1,005 | 968 | 962 | 963 | 1,136 | 1,273 |

**The correct answer is 140.4 MJ/kg**

**[Exercise 5]**

Sero's Denim Laundry Monthly production and Monthly Coal Consumption are as mentioned below. Coal is used in Steam Boilers for producing Steam which is required for the Dyeing process. The Calorific Value of Coal is 27 MJ Per Kg of Coal. What is the Average Energy KPI for the past 6 months for the Laundry?

| | Jan | Feb | March | Apr | May | June |
|---|---|---|---|---|---|---|
| Laundry production (kg) | 98,982 | 910,589 | 95,254 | 87,247 | 98,416 | 103,796 |
| Coal (tonne) | 302 | 290 | 289 | 289 | 341 | 382 |

**The correct answer is 75.8 MJ/kg**

## 5.3 Energy Efficiency for General Operations

Let's look at the example below:

Chino Cotton's first attempt to reduce energy consumption is through simple behavioural measures. This includes simple measures such as placing instruction signs around their facilities reading, for example, "Turn off the lights when there is no one in the room," or "Turn off machines when not in use". Chino Cotton Textile assigns shift supervisors to enforce the implementation of these practices.

**[Exercise 6]**

How much electricity can be saved by Chino Cotton's non-technical measures (i.e., turning off machines when not in use)?

- None
- 1 – 5% **(correct)**
- 10 – 20%
- Nearly 50%

Turning off machinery when not in use also improves the lifespan of the equipment. Based on this first simple measure, Chino Cotton gets interested in further improving its energy savings potential. How can Chino Cotton increase its efficiency in this area even further?

Chino Cotton decides to invest in timers for their HVAC systems, allowing these systems to automatically power down during lunch time (between 12–1 PM) and past work hours (after 5 PM) when not needed. The HVAC system is also used to control temperature and humidity within Chino Cotton's facilities, avoiding additional electricity costs in preventing overheating or overcooling.

This measure can save another 5–10% of Chino Cotton's electricity consumption from the specific HVAC system.

# 6 Energy Efficiency for Lighting Systems

*Figure 6-1 Natural sunlight system*

Lighting Layout and Lux levels (the standard unit for measuring the light level intensity) play an important role in the productivity of manufacturing organizations. The organization has benefited from a 10% increase in productivity and a 30% reduction in errors by improving the lighting system.

Best practices of lighting system include:

- Upgrading lamps to LED type.
- Natural sunlight system: utilize natural lighting system for a reduction in electricity bills.
- Needle point light: it is recommended to use pale colors for walls and white color for the ceiling for more light reflections.

Let's look at how North Sewing reduces its energy consumption from its lighting.

North Sewing uses 500 T8 fluorescent lamps across their company. As an energy-saving measure, they replaced all 500 of these T8 fluorescent bulbs with Light Emitting Diodes (LEDs) at a cost of around USD 4,000.

**[Exercise 7]**

How much electricity do you think North Sewing saves after switching to LED bulbs?

- No significant saving
- Less than 10% of electricity consumption
- 10 – 15% of electricity consumption
- 20 – 40% of electricity consumption **(correct)**

To give you an idea of the scale of these savings, here are the costs and energy outputs for three types of bulbs commonly used in an operational setting. The estimated cost is based on 25,000 hours of bulb lifespan.

| | Incandescent | Compact fluorescent lamp (CFL) | LED |
|---|---|---|---|
| Approximate cost per bulb | USD 1 | USD 2 | USD 8 or less |
| Average lifespan | 1,200 hours | 8,000 hours | 25,000 hours |
| Watts used | 60 W | 14 W | 10 W |
| No. of bulbs needed for 25,000 hours of use | 21 | 3 | 1 |

*Source: Adidas Environmental Good Practice Guide & Toolkit (2019)*

**[Exercise 8]**

Using the cost table above, could you calculate the total operational costs for 25,000 hours for each type of light bulb? Assume that the cost of electricity would be $0.12/kWh for 25,000 hours.

- USD 150 (incandescent), USD 30 (CFL), and USD 20 (LED)
- USD 120 (incandescent), USD 42 (CFL), and USD 30 (LED)
- USD 180 (incandescent), USD 60 (CFL), and USD 25 (LED)

- USD 201 (incandescent), USD 48 (CFL), and USD 38 (LED) **(correct)**

*Incandescent bulb:*

>> Total purchase price of incandescent bulbs for 25,000 hours = USD 1 x 21 = USD 21

>> Total cost of electricity used (25,000 hours at USD 0.12 per kWh) =

60 W x 25,000 hours = 1,500,000 Wh = 1,500 kWh x USD 0.12/kWh = USD 180

**Therefore, the total operational costs for 25,000 hours = USD 21 + USD 180 = USD 201**

*CFL bulb:*

>> Total purchase price of CFL bulbs for 25,000 hours = USD 2 x 3 = USD 6

>> Total cost of electricity used (25,000 hours at USD 0.12 per kWh) =

14 W x 25,000 hours = 350,000 Wh = 350 kWh x USD 0.12/kWh = USD 42

**Therefore, the total operational costs for 25,000 hours = USD 6 + USD 42 = USD 48**

*LED bulb:*

>> Total purchase price of CFL bulbs for 25,000 hours = USD 8 x 1 = USD 8

>> Total cost of electricity used (25,000 hours at USD 0.12 per kWh) =

10 W x 25,000 hours = 250,000 Wh = 250 kWh x USD 0.12/kWh = USD 30

**Therefore, the total operational costs for 25,000 hours = USD 8 + USD 30 = USD 38**

Switching to LED lighting (LED retrofitting) is one of the few energy-saving measures that most factories are aware of. It is estimated that replacing fluorescent lamps with LEDs could save 20–40% of electricity consumption from lighting alone. Remembering that lighting accounts for nearly 7% of an Apparel Tier 1 facility's energy consumption, North Sewing can reduce GHG emissions by 1–3% overall should they replace their light bulbs with LEDs.

A few additional advantages provided by LEDs include:

- LEDs offer more precise electronic control, allowing for additional reductions in energy consumption in return; and
- LEDs are mercury-free, contributing to a safer work environment and ensuring no recycling fees at disposal.

# 7 Energy Efficiency for Steam System

As you know, a considerable amount of equipment used in textile and garment factories relies on steam and hot water. The generation of steam and heated water is a textile factory's most fuel-consuming activity.

The five best practices for fuel usage reduction for steam are:

1. Recovering heat from hot water.
2. Improving boiler efficiency.
3. Maintaining steam traps and steam systems.
4. Insulating equipment and tanks.
5. Recovering heat from flue gases.

We will look at each of the measures in more detail later.

*Note: all the reduction potential shown on the steam section is taken from the Clean by Design report (2013), more information can be found in 15.1 Resources Referenced in Document.

# 8 Recovering Heat from Hot Water

During the manufacturing process, large quantities of hot water are used to dye, rinse and finish fabric. The heat from the hot water can be used to preheat incoming water for the next process use.

- Reduction potential: total steam consumption by 10 – 30%
- Cost-saving potential: high
- Payback period: 4 – 7 months

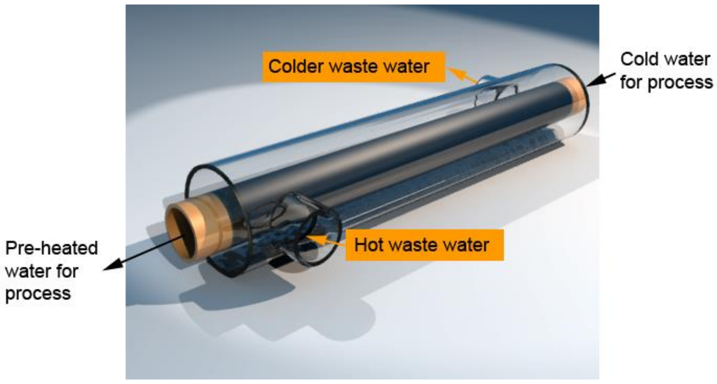



*Figure 8-1 Hot water recovery systems at preheating*

## 8.1 Improving Boiler Efficiency

### 8.1.1 Best practices for boiler operation includes:

- Have a routine inspection and maintenance check on steam traps and steam lines for leakages. Repair steam leaks and replace faulty steam traps as and when detected.

- Do a boiler tuning program to optimize the O2% and increase the combustion efficiency.
- Do proper insulation on steam distribution pipelines and condensate return piping, and hot water storage tanks.
- Blowdown is the periodic or continuous removal of water from a boiler to remove accumulated dissolved solids. The Blowdown should be carried out when Blowdown water has reached above recommended TDS Levels.
- Develop and implement routine inspections and maintenance programs on condensate pumps.
- Do an inspection regularly on both the waterside and the fire side of the boiler. If required, clean the tube surfaces to ensure optimal heat transfer thereby maximizing system energy efficiency.
- Install water meters for both makeup water and condensate water return for Boiler feedwater.

### 8.1.2 Recover heat from flue gas to pre-heat fresh air.

Recovery of waste heat by air preheater from flue gas of boilers. Waste heat is energy that is rejected by the environment. It arises from equipment and operating inefficiencies. Often, part of waste heat could potentially be used for some useful purpose.

High-temperature stack gases represent the major area of energy loss in combustion processes. The air pre-heater is a heat exchange device that uses the exhaust gases from the boiler to preheat the incoming boiler air. This is used for recovering the hot air waste to preheat incoming boiler air or other processes with heating near the boiler room.

- Applicable to boilers where stack loss is high.
- Payback period: less than 18 months
- Cost-saving potential: high
- Payback period: 6-10 months

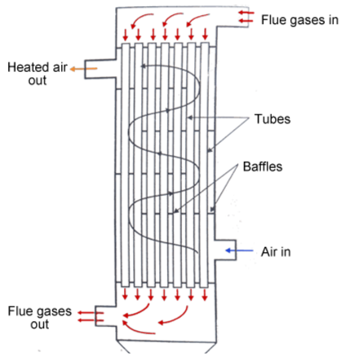



*Figure 8-2 Waste heat recovery from boiler flue gas*

### 8.1.3 Install economizer to recover heat from boiler flue gas.

Flue gas heat from boilers is released into the atmosphere at a very high temperature ~~of 240ºC and 220ºC respectively~~, thus installation of an economizer at the outlet of boilers can recover heat and hence preheat boiler feed water. Preheated feed water can be returned to the feed water tank. Feed water entering the boiler shall have a maximum temperature ideally above 95ºC, to avoid damage to the metal surface. Preheated feed water will result in substantial savings in fuel.

- Applicable to boilers which have low feed water temperature and high stack temperature.
- Payback period: less than 18 months

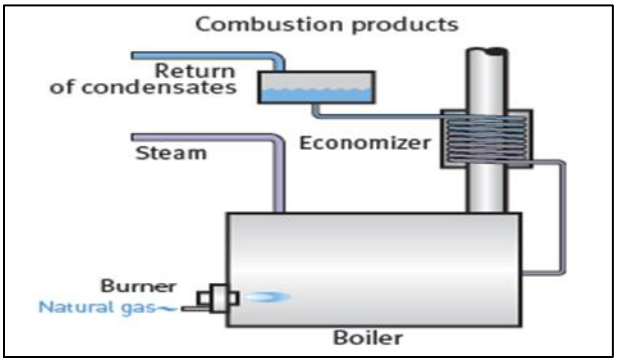



*Figure 8-3 Economizer for boiler waste heat recovery*

### 8.1.4 Other boiler efficiency improvement areas

- Pre-screening fuel (standardising the feed size and allowing for more efficient combustion).
- Calibrating the boiler burner.
- Insulating the boiler casing.
- Installing automated oxygen trim controls on the combustion feed inlets.
- Reduction potential: annual fuel consumption by 3 – 7%
- Cost-saving potential: high
- **Payback period**: 5 – 13 months

*Figure 8-4 Boiler improvement*

### 8.1.5 Insulating equipment and tanks

Insulating equipment typically leads to large reductions in steam and fuel consumption.

- Reduction potential: reduce steam consumption by 1.4 – 3.2%
- Cost-saving potential: high
- Payback period: 6 – 10 months

*Figure 8-5 Equipment insulation*

## 8.2 Recovering Heat from Finishing Machine Flue Gases

Hot flue gas leaving boilers and finishing machines is a significant source of heat energy that can be used beneficially. The captured energy from the boiler flue can equal 0.8–3.8% of a year's steam consumption.

- Reduction potential: reduce steam heating needs by 0.7% to 2.8%
- Cost-saving potential: medium to high
- Payback period: 7 – 18 months

*Figure 8-6 Waste heat recovery from finishing machine*

## 8.3 Maintaining steam traps and steam systems

Factories often have extensive steam systems that distribute heat to various parts of the factory. It is very common to find small leaks that can add up to significant resource waste.

*Figure 8-7 Result of the steam leak, Source: David Seibold on flickr.com, CC-BY-NC 2.0*

**[Exercise 9]**

Can you guess how many litres of oil a small steam leak (invisible but detectable by sound) can waste per year?

- 20 litres
- 300 litres
- 800 litres **(correct)**

The correct answer is 800 litres. A leak of this size can cause a loss of 800 litres of fuel oil per year. However, a steam leak that is visible by the naked eye can cause a loss of up to 2,000–4,000 litres of fuel oil per year.

**What can you do about it?**

The answer is quite simple: identify and plug the leaks. Steam traps can be monitored through:

- Preparing regular leakage inspections and procedures for a check/repair programme.
- Ensuring sufficient steam trap maintenance.

The purpose of a steam trap is to automatically open (releasing condensed steam and air) and close (preventing steam loss). When the steam trap fails to perform either of those functions effectively, steam leaks and money is lost.

Especially relevant for Apparel Tier 2 facilities are steam traps on condensate pipes. Most facilities don't have these installed, resulting in fresh steam flowing into the condensate pipe when the ironing equipment is on standby and causing excessive steam discharge. Overall, replacing or repairing steam traps and fixing steam leaks is key to reducing energy and steam waste.

**Reduction potential:**

- Maintaining steam traps and systems saves 1 – 4.3% of steam consumption

- Maintaining steam traps: 0.4 – 1.2% of steam consumption
- Repairing steam leaks: 0.3 – 1.9% of steam consumption
- Overall cost-saving potential from the above measures: medium to high
- Payback period from the above measures: 2 – 7 months

**Case study: How PUMA makes factories in its supply chain more sustainable**

PUMA is collaborating with the Partnership for Cleaner Textiles in Bangladesh, led by the International Finance Corporation (IFC) in implementing resource efficiency improvement programmes.

Square Fashion Limited — one of their factories in Bangladesh — has installed a waste heat recovery system to redirect waste heat from gas engine exhausts into generating steam for process heating. The waste heat recovery boiler has a capacity of 5.7 tonnes of steam per hour and the factory saves on natural gas consumption by around 340 $m^3$ per hour. **This means that the factory can save over 2 million $m^3$ of natural gas per year and achieve GHG ERs of 4,354 tonnes of carbon dioxide equivalent ($CO_2e$).**

Source: PUMA CATch up (2021)

**Useful information on steam leak detection, calculation, and prevention**

On this website, you will find common causes for steam leaks and a list of preventive measures:

https://www.thermaxxjackets.com/leaking-steam-trap/

**Steam Theory**

TLV provides an entire section on steam on their website. There you can learn about steam, steam traps, condensate recovery and more. Click the link to the start of the tutorial: https://www.tlv.com/global/TI/steam-theory/

**For steam trap selection, you can find more information here:**

https://www.tlv.com/global/TI/steam-theory/steam-trap-selection-part-2.html

**Ways to detect broken steam traps:**

https://www.tlv.com/global/TI/steam-theory/steam-trap-test.html

# 9 Energy efficiency for Heating Systems

A loss of heat always means a waste of energy. A common way to lose heat is through either uninsulated or poorly insulated pipes and machines. This can affect steam and other thermal distribution lines, as well as your equipment.

**Did you know?**

Uninsulated steam/thermal distribution lines are a constant source of waste energy. 100 feet of uninsulated 1-inch steam lines can result in annual heat losses of 300,000 MJ.

**What does the 300,000 MJ loss mean from an economic perspective?**

As an example: if your plant uses 1,120 feet of bare 1-inch diameter steam line (pipe thickness) operating at 150 PSIG and has a fuel cost of USD 8/MMBtu, the uninsulated steam line translates to a total heat loss of about 3,192 MMBtu/year. **With a fuel cost of USD 8/MMBtu, your plant ends up losing approximately USD 25,536/year!**

**[Exercise 10]**

Chino Cotton Textile, despite what their company name might suggest, also dyes polyester. It has installed 15 dyeing machines with 70 tubes used for polyester dyeing.

In an attempt to reduce energy consumption, Chino Cotton conducts temperature measurements of their dyeing machines and discovers that they emit a lot of heat. Temperatures inside each machine reach 130°C at their peak, whilst heating regularly rises to 115°C in the area outside of the machines. This means that not only is an enormous amount of energy lost, but also massive strain is placed on the employees that have to cope with these temperatures.

Chino Cotton decides, therefore, to insulate their polyester dyeing machines with Heat Shield paint to reduce heat loss and emissions.

How much do you think they save with this measure?

- 3–5% thermal energy
- 15–20% thermal energy **(correct)**
- 70–80% thermal energy

Coating their polyester dyeing machines with Heat Shield paint saves Chino Cotton about 15–20% of thermal energy usage.

## 9.1 Detecting Heat Loss

You can use a thermal camera to identify points of surface heat loss on steam/thermal oil distribution lines.


*Figure 9-1 Thermal image of a computer, Source: with plex on pixabay*

**What can you do against heat loss?**

- Select and install high-quality insulation materials (i.e., an insulation box or jacket) for steam/thermal oil pipes, valves, and flanges.
- Develop a regular insulation monitoring and maintenance programme to avoid neglecting new steam leaks or other sources of heat loss.

**What are the benefits of proper insulation of thermal systems?**

*Figure 9-2 Insulation jacket over valves, Source: www.thermaxxjackets.com*

The economic benefits are obvious:

- Energy loss can be reduced by up to 90% (source: U.S. Department of Energy).

- Steam pressure will be optimised, saving additional energy and money, and contributing to an extended lifespan for equipment.

Additionally, your workers will also benefit from:

- **Avoiding factory accidents** — uninsulated valves are considered a safety hazard. With proper insulation, accidental burnings can be avoided.
- **Improvement of working temperature** — insulation will decrease ambient temperatures, improving working conditions and resulting in higher staff productivity.

| **Thermal imaging guidebook for industrial applications** |
|---|
| This PDF guide describes the use of thermal imaging cameras in industrial applications. Thermal imaging cameras will help you both to detect steam leaks and heat losses in electrical and mechanical devices or pipes. Click here to download the PDF. |

## 10 Overview of Energy Savings Opportunities in the Textile Supply chain

Examples of energy saving measures to implement at manufacturing facilities.

### 10.1 Cross-sector energy saving measures:

a. General operations

- Turn off machines at the end of the day and when not in use (either manually or automatically).
- Set up an auto turn-off system for optimising the HVAC system.

- Adjust the working hour schedule for the workshop area to maximise production line utilization.

b. Lighting
   - Replace fluorescent lamps with LED lamps.
   - Manually turn off lights when not in use.
   - Install motion sensors to optimise on/off time for lights.
   - Install additional light switches for better zoning control.
   - Eliminate double-layer lights.
   - Lower the lighting fixture height level.

c. Steam end use and steam system
   - Fitting steam traps to irons.
   - Regular steam trap check/repair programmes.
   - Regular steam leakage check/repair programmes.

d. Air conditioning
   - Install temperature/humidity control using HVAC systems.

e. Compressed air system
   - **Arrest all leakages in the compressor for electricity savings:** adopt systematic and regular air leakage improvement program for identifying and fixing the air leakages in the compressed air system (compressor, piping, end-use). Reduction of leakage can result in reduction of delivery air pressure required at air compressor. Every 1 bar reduction in air pressure will result in an average of 4% to 5% energy savings.

f. Thermal energy
   - Introduce a programme of regular thermal imaging checks.
   - Proper insulation for thermal systems (e.g. piping, valves and flanges, machine body).
   - Stenter exhaust heat recovery for air preheating.
   - Dryer control enhancement, humidity control for stenter and dryer.

g. Piping
   - Install steam trap on condensate pipe to limit the flow of steam for ironing process.

h. Variable speed drive (VSD) retrofitting
   - Install VSD for cooling tower fan.
   - Install VSD and modulating valve for air handling unit.
   - Install VSD for chilled water pumps.
   - Install VSD for condenser water pumps.
   - Install VSD for air compressors.
   - Install VSD for variable load motors

i. Motors
   - Replace low-efficiency motors (IE1/IE2) with high-efficiency motors (IE3/IE4).
   - Replace induction and hydraulic motors with servo motors.

## 10.2 More energy efficiency measures for spinning mill:

a. **Change the Vee-belts to cogged Vee-belts**: replace existing Vee-belts by raw cogged belts with matching pulleys. The advantages of raw cogged belts over Vee belts are better power transition efficiency and cooling effect. Conversion from Vee belts to raw cogged belts will reduce electricity consumption by 10-15%.

b. **Replace the aluminum blades with FRP blades for supply and return air fans in humidification plants:** the optimal aerodynamic design of FRP (fibreglass reinforced plastic) fan impellers provide higher efficiency and a reduction in the overall weight of fans. Fans with FRP impellers consume less electricity compared to fans with aluminum alloy impellers under the same working conditions.
c. **Installation of energy-efficient excel fans in place of conventional aluminum fans in the suction of ring frame:** ring frames have suction fans, which are used to collect fibres when a yarn break occurs. Energy-efficient excel fans could be installed in place of conventional aluminium fans in the suction system of ring frames for energy savings.
d. **Use false ceiling in ring spinning section:** the spinning process needs to be done under a maintained temperature and humidity. This is done in a humidification area within plants. The energy used by the humidification facility is directly related to the volume of the facility where the spinning process is carried out. The use of a false ceiling can help to reduce this volume, thereby reducing energy consumption.
e. **Others:**
    - Installation of electronic roving end-break stop-motion detector instead of pneumatic system in speed frame / simplex machine.
    - Use Synthetic sandwich tapes for ring frames.
    - Optimization of ring diameter for yarn count in ring frames.
    - The use of lightweight bobbins in ring frame

## 10.3 More energy efficiency measures for weaving mill:

a. **Compressor pressure optimization in air jet weaving as per the fabric sorts/fabric properties:** detailed study must be conducted to standardize the air pressure requirement for fabric quality in various air jet looms within a shed. The study should focus on important parameters such as air consumption on main nozzles, sub nozzles, opening and closing of nozzles with respect to degrees etc. where a significant percentage of compressed air is consumed. Air consumption may be reduced by utilizing the proper pressure setting of main nozzles, and sub nozzles for a fabric construction/quality. The standardization of Air consumption / Air pressure with respect to fabric construction can lead to a minimum of 2 % electrical savings in compressor.

## 10.4 More energy efficiency measures for wet processing/textile dyeing:

a. **Proper Insulation of stenter:** proper insulation of stenter envelopes reduces heat losses to a considerable extent. Savings in energy consumption of 20% can be achieved if the insulation thickness is increased from 120 to 150 mm (provided that the same insulation material is used).
b. **Install heat recovery equipment on stenter**: the heat of hot exhaust gas from stenter machine can be recovered using two types of heat recovery equipment:

- Heat-recovery air/air: Uses exhaust air heat to heat fresh air supplied to the stenter. Exhaust heat recovery can be achieved by using air-to-air systems such as plate heat exchangers, glass tube heat exchangers or heat wheels.
- Heat-recovery air/water: Uses exhaust air heat to heat service water for wet finishing (for example washing, dyeing, and bleaching).

c. **Installing heat recovery equipment in the continuous washing machine: i**nstalling heat recovery equipment on a continuous washer is usually a simple but very effective measure since water inflow and effluent outflow are matched and this eliminates the need for holding tanks. One option is a self-cleaning, rotating element exchanger which has an efficiency of about 70%

d. Interlocking the running of exhaust hood fans with water tray movement in the yarn mercerizing machine.

e. Interlocking cooling blower motor with fabric gas singeing machine's main motor

f. Interlocking shearing machine's blower motor with the main motor.

g. Other:

- **The use of Cold-Pad-Batch dyeing system**: cold-pad-batch dyeing is a flexible, versatile dyeing method. At the start, the prepared fabric is impregnated with a liquor containing premixed fibre-reactive dyestuff and alkali. Excess liquid is squeezed out on a device known as a mangle. The fabric is then batched onto rolls or into boxes and covered with plastic film to prevent absorption of CO2 from the air and evaporation of water. The fabric is then stored for 2 – 12 hours. Cleaning operations are minimal due to the flexibility of pad-batch equipment and the use of water-soluble dyes. Cold pad batch has the potential to reduce 50% of energy reduction when compared to the conventional dyeing process.
- Automatically control dampers to maintain exhaust humidity within a specified range, thereby reducing air losses without significantly affecting fabric throughput.
- Optimize exhaust humidity of stenter to avoid too large exhaust volume and excessive energy consumption.

## 10.5 More energy efficiency measures for laundry:

a. Replace High Liquor Ratio machine (greater than 1:10) by Low Liquor Ratio Machines for water and steam savings.

b. Recover heat from Hot effluent to incoming hot water in the process for steam savings.

c. Reuse last bath in washing for water savings.

d. Improve automation practice for washing like water level indicators, steam supply and cut off, chemical dosing for water.

Presented here is a more extensive list of measures, along with a selection of illustrative ERs that could feasibly be achieved once these measures have been put into effect. The amount of energy that can be saved and $CO_2$ avoided is always site-specific. **It is worth noting that this list is not exhaustive: many additional energy-saving opportunities outside of the ones listed here are bound to exist within your factory.**

| Category | Measures | Electricity consumption savings | Payback period |
| --- | --- | --- | --- |
| General operations | Turn off machines at the end of the day and when not in use (either manually or automatically) | 1–5% of the factory’s electricity consumption | 0–3 months |
| | Set up auto turn-off system for optimising HVAC system | | 0–3 months |
| | Adjust the working hour schedule for workshop area to maximise production line utilisation | | Immediate |
| Lighting | Replace fluorescent lamps with LED lamps | 20–40% of lighting electricity consumption | 15–30 months |
| | Manually turn off lights when not in use | 1–5% of the factory’s electricity consumption | Immediate |
| | Install motion sensors to optimise on/off time for lights | | <12 months |
| | Install additional light switches for better zoning control | | |
| | Eliminate double-layer lights | | Immediate |
| | Lower the lighting fixture height level | | 4–6 months |
| Steam system | Regular steam trap check/repair | 1–5% of steam consumption | 0–3 months |

| | | | |
|---|---|---|---|
| | programmes | | |
| | Regular steam leakage check/repair programmes | | |
| Steam end use | Fitting steam traps to irons | Up to 20% of steam consumption | Less than half a year |
| Thermal energy | Introduce a programme of regular thermal imaging checks | 1–5% of the factory's energy consumption | 0–3 months |
| | Proper insulation for thermal systems (e.g. piping, valves and flanges) | 1-4% of steam consumption | 6–12 months |
| | Stenter exhaust heat recovery for air preheating | 5–10% of the heat supply | 18–24 months |
| | Dryer control enhancement | 5–10% of drying's energy consumption | 12–24 months |
| Air conditioning | Install temperature/humidity control using HVAC systems | 5–10% of the factory's electricity consumption | More than 12 months |
| Variable speed drive (VSD) retrofitting | Install VSD for cooling tower fan | 10–30% of the factory's electricity consumption | 12–24 months |
| | Install VSD and modulating valve for air handling unit | | |
| | Install VSD for chilled water pumps | 15-30% of the water pump's energy consumption | |
| | Install VSD for condenser water pumps | | |

| | | | |
|---|---|---|---|
| | Install VSD for air compressors | 10–35% of air compressors' energy consumption | 15–30 months |
| Piping | Install steam trap on condensate pipe to limit flow of steam for ironing process | 10–20% of steam consumption | 6–12 months |
| Motors | Replace low efficiency motors with high efficiency motors | 5–10% of motor consumption | |
| | Replace induction and hydraulic motors with servo motors | 50–70 % from sewing/cutting machine consumption | 24–36 months |

*Source: Adidas Environmental Good Practice Guide & Toolkit (2019)*

Additional information on energy efficiency savings measures for textile factories

**Clean by Design Ten Best Practices**

Clean by Design, a programme of the Apparel Impact Institute has identified ten (10) best practices for reducing energy, water consumption and emissions in textile mills, also recommended by the UN Fashion Industry Charter (some of which have been discussed already in the steam section above). Click here for the document.

**A review of energy use and EE technologies for the textile industry by Ernest Orlando Lawrence Berkeley National Laboratory**

This document provides information on the different energy-efficiency measures, reduction potentials and costs for spinning, weaving and wet processing activities. Click here for the document.

# 11 Business Case and Financial Returns

There is a strong business case for EE measures. Any EE measures that are implemented directly affect your energy consumption and, in turn, your operating costs.

> **Do you know what percentage of your production costs come from electricity?**
>
> According to data from Vietnam, electricity accounts for 27% of production costs. Imagine how much money you can save by reducing your electricity use by just 10-20%!

Many energy-saving measures are highly attractive in a financial sense. Saving energy doesn't always require a large investment and substantial savings can be achieved within 1–2 years or less (sometimes by simply improving how equipment is run). Most textile companies may achieve energy savings of up to 10% through better energy management practices alone (i.e. without any additional investment).

Some measures we have introduced in this module require relatively low investment, while others may require more financing and have longer payback periods. When developing your energy action plan, it helps to differentiate EE measures between:

| $ | $ $ | $ $ $ |
|---|---|---|
| No-/low-cost operations and maintenance measures (with a payback period of up to 3 months) | Mid-size projects | Capital expenditure (CAPEX) projects |

**Start with no-/low-cost energy savings measures**. If you are just starting to implement EE measures, you have considerable scope for energy savings opportunities through no-/low-cost measures.

A project conducted by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has shown that once aggregated, these reductions can amount to savings above 10% (and in many cases even more). For instance, for a company with an energy bill of USD 300,000/year, about USD 30,000/year of operating budget can be freed up just by adopting no-/low-cost measures. These savings can then be reinvested to achieve even greater cost savings.

Such measures rarely require approval from senior management to pursue as they involve very small investments and do not interfere with a factory's operations. However, factory floor management approval is still required.

**[Exercise 11]**

Match the different measures below according to the level of investment and/or project size:

No-/low-cost operations and maintenance

- Recovering heat in the cooling process by reducing dyeing temperatures to 70°C.
- Turning off machines at the end of the day and when not in use.
- Introducing regular steam traps and leakage checks.

Mid-size projects

- Replacing fluorescent lamps with LED lamps.
- Installing high-quality insulation materials.
- Replacing induction or hydraulic motor with servo motor.
- Variable speed drive (VSD) retrofitting.

Capex projects

- Installing solar photovoltaics.
- Replacing a boiler or a chiller.
- Installing solar thermal system.

## 11.1 Backpack/ Footwear Manufacturer

**Case study 1**

A backpack production company based in Bien Hoa spent **less than USD 27,000** on energy efficiency improvement projects. Significant savings are achieved from the implementation.

*Source: Timberland's commitments to better product and a greener future converge with a programme to increase factory efficiency (2020)*

| Resource Reduction Areas | Areas Improved |
|---|---|
| Electricity | Replacement of light tubes with LED |
| | Fixing compressed air leakages |
| | Reducing the inlet air temperature to the compressors |
| | Replacing clutch motos |
| Resource & Annual Financial Savings | Water –16,658 $m^3$ |
| | Electricity – 303,923 kWh |
| | USD – 40,153 |

**Case study 2**

*Source: Timberland's commitments to better product and a greener future converge with a programme to increase factory efficiency (2020)*

A footwear company located in Thanh Hoa City, Vietnam spends USD 1,060,390 on improvement projects. The facility enjoys a payback within 3.9 years.

| Resource Reduction Areas | Areas Improved |
|---|---|
| Electricity | Replacing 300 of their 480 sewing machines with more efficient models with servo motors |
| | Using a piping distribution loop and reducing the pressure setting |
| | Fixing compressed air leaks |
| Water | Fixing the water leakage from the cooling tower |
| | Collecting and reusing cool water from the extruder machine, and optimizing water consumption used to clean their printing screens |
| Resource & Annual Financial Savings | Water – 22,095 $m^3$ |
| | Electricity – 225,691 kWh |
| | USD – 274,207 |

## 11.2 Denim Apparel Manufacturer

The factory produces denim. Cutting, Sewing, ironing, packaging, and washing are the main processes. There is also printing, piece-dyeing, and laser processes in the factory.

**Case study 1**

Source : wwf_guideline_cleaner_production_textile_2018.pdf (d2hawiim0tjbd8.cloudfront.net)

| Resource Reduction Areas | Areas Improved |
|---|---|
| Electricity & Natural Gas | Effective insulation for cogeneration waste heat recovery and steam boilers |
| | Improve Insulation in hot water and steam distribution systems |
| | Repair and replace faulty steam Traps |
| | Replacement of inefficient halogen lamps with LED lighting |
| Wastewater | Reduction of wastewater pollution load and improvement of treatment pool usage |
| Resource & Annual Financial Savings | Water – 16,367 $m^3$ |
| | Electricity – 53,020 kWh |
| | Chemical – 316,197 kgs |
| | Natural Gas –14,711 $m^3$ |
| | TRY – 29,732 |

**Case study 2**

**Source :** wwf_guideline_cleaner_production_textile_2018.pdf (d2hawiim0tjbd8.cloudfront.net)

| Resource Reduction Areas | Areas Improved |
|---|---|
| Chemicals | Installation of the chemical dosing system |
| Electricity, Water and Chemicals | Installation of new machinery for using the laser method in the denim bleaching process |
| Electricity | Removal of all air leakages in the facility |

| Resource Reduction Areas | Areas Improved |
|---|---|
| | Replacement of fluorescent lamps with LED lightings at the washing department |
| | illumination of working area by LED lighting in the sewing machines |
| Resource & Annual Financial Savings | Electricity – 213,677 kWh |
| | Natural Gas – 210,000 $m^3$ |
| | TRY -5,775,937 |

## 11.3 Knit Dye House with Printing Facility

This facility produces 90% knit fabric. Production capacity is 20 tons/day. The raw materials being used are cotton, viscose, synthetic and blended fabrics. Production stages and processes are dyeing, printing, cold pad-batch, and mercerized production.

**Case study 1**

**Source :** wwf_guideline_cleaner_production_textile_2018.pdf (d2hawiim0tjbd8.cloudfront.net)

| Resource Reduction Areas | Areas Improved |
|---|---|
| Electricity | Renovation of dryer |
| | Use of LED lighting system applications in the apparel department |
| Electricity & Water | Installation of a servo system in fabric cutting edge process. Servo systems are closed-loop systems which have some benefits over open-loop systems, including the fact that they improve transient response times, reduce steady-state errors, and reduce system sensitivity to load parameters |
| | Installation of a new foulard machine and new technology for the dyeing process |
| Resource & Annual Financial Savings | Electricity – 81,500 kWh |
| | Natural Gas – 78,000 $m^3$ |
| | TRY – 301,788 |

**Case study 2**

**Source :** wwf_guideline_cleaner_production_textile_2018.pdf (d2hawiim0tjbd8.cloudfront.net)

| Resource Reduction Areas | Areas Improved |
|---|---|
| Electricity | Replace conventional pumps by Energy Efficient Pumps |
| | Replace conventional Lights by LED Lamps |
| | Installation of a compressed air leakage maintenance program to reduce the Electrical energy use |
| Water | Use of Reverse Osmosis systems in boiler feedwater |
| Natural Gas and Coal | Repair and Replace faulty Steam traps |
| | Improve Insulation in Steam and hot water pipes |
| Resource & Annual Financial Savings | Electricity – 316187 kWh |
| | Coal – 494,250 Kgs |
| | Natural Gas – 27,300 $m^3$ |

| Resource Reduction Areas | Areas Improved |
|---|---|
| | TRY – 187,683 |

## 11.4 Integrated Textile Unit- Spinning, Weaving and Dyeing

The facility is a knit dye house with a 30-ton/day capacity: 10 tons of printing (there are 3 rotary screen-printing machines) and 20 tons of dyeing. Operating activities are high-temperature dyeing, rotary screen printing and finishing.

| Resource Reduction Areas | Areas Improved |
|---|---|
| Natural Gas & Electricity | Effective insulation on steam and hot water pipes |
| Electricity | Separation of compressor room from each cogeneration apartment (atmospheric fresh air intake of the compressor) to make the compressor work efficiently |
| | Installation of functional lamp and automation of the lighting |
| | Maximization of daylight use |
| Natural Gas & Electricity | Adjust the temperature of the boiler room to a specific degree to make the boiler work efficiently |
| | Control of compressed air leakage |
| | Installation of the air tank traps to avoid loses |
| Resource & Annual Financial Savings | Electricity (KWh) – 201,586 |
| | Natural Gas (m3) – 876,28 |
| | TRY – 107,768 |

# 12 Develop an Action Plan

Once you have identified the energy-saving opportunities within your factory, the next step is to capture these measures in an action plan.

**What are the objectives of having an action plan?**

To set energy-saving and Energy Rating targets at the factory level and serve as an energy management support tool to help factories keep track of identified energy-saving opportunities and their implementation status.

**What elements are included in an action plan?**

Typically, an action plan includes the following information:

- A brief description of the proposed energy savings measure, in terms of its technical scope and how it saves energy.
- An outline of the staff that will be responsible for undertaking energy savings implementation (e.g., using in-house experts or hiring externals).
- Estimated energy savings.

- Whether implementation will result in additional benefits, such as quality, output, system reliability and additional co-benefits.
- Estimated cost savings in order of magnitude.
- Order of magnitude emissions reductions.
- Indicative costs and simple payback.
- Management approval needed for implementation.
- Status of the measure at any given point in time (e.g., under development, implemented or rejected).
- The technical support you think may be required from your factory's staff or from external experts if necessary.
- The financial support needed to pursue the measure.

| | ENERGY SAVING MEASURE DESCRIPTION | | | FEASIBILITY | | | | | | | STATUS | | | | | SUPPORT REQUIRED | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Energy saving measure (1) | Descrip-tion | Energy source | Est. energy savings (MWh/yr) | Est. $CO_2$ red. ($tCO_2$/yr) | Pot. cost savings (USD/yr) | Capex req. (USD) | Simple payback (yr) | Capex Board approval req.(Y/N) | Earliest commissio ning date | Under assess-ment | Approv ed | Under impleme n-tation | Imple-mented | Re-jected | Tech. | Fin. |
| Energy Management | | | | | | | | | | | | | | | | | |
| Compressed Air | | | | | | | | | | | | | | | | | |
| Other meassures | | | | | | | | | | | | | | | | | |

*Figure 12-1 Sample action plan*

As a next step, factory staff and management assess the various measures presented and select:

- Those that will be pursued using internal human and financial resources.
- Those that will be pursued with external support (i.e., through third-party funded technical support or co-funding).

The selected measures are then communicated to upper management for internal approval. This action plan defines the priorities for the coming year (short-term) but should also include mid- and longer-term measures.

EE action plans such as the one above provides a good initial overview of the energy and cost savings and $CO_2$ reductions that can be delivered over the years by implementing several measures. They also provide valuable insight into the level of effort, the scope of external support and the financial reserves that are bound to be needed to implement them.

Below is an example of how an action plan would look in a factory:

| Categories | Energy saving measures | Energy source | Estimated energy savings | Estimated CO2 reduction | Potential cost savings (USD/year) | Capex (USD) | Payback period (year) | Earliest commisioning date | Project status |
|---|---|---|---|---|---|---|---|---|---|
| No-/low-cost and medium costs (up to USD 20,000) | Replace 280 common sewing machines with electronic servo machines in a plant in Ho Chi Minh city | Electricity | 50–70% | 46 tCO2e/year | 114 | 430 | 3.78 | April 2021 | Ongoing |
| No-/low-cost and medium costs (up to USD 20,000) | Replace 500 T8 flurescent lamps with light-emitting diode (LED) lamps | Electricity | 20–40% (42,000 kWh/year) | To be determined based on the outcome of energy audit | To be determined based on the outcome of energy audit | 8/bulb | 15–30 | August 2021 | Preparation |
| Large Capex (over USD 20,000) | Optimisation of air-fuel ratio for boiler or oil heater | Fuel (natural gas) | 5–15 | To be determined based on the outcome of energy audit | To be determined based on the outcome of energy audit | 27,000 | 0.8–2 | September 2021 | Preparation |
| Large Capex (over USD 20,000) | Installation of waste heat recovery unit to recover heat (WHRU) in warming boilers' feed-water | Coal | 423 tonnes of coal/year | 1,265 tCO2e/year | 49,097 | 24,548 | 0.5 | December 2022 | Preparation |

Note: The USD 20,000 is not a hard threshold. It is simply to illustrate the range of measures a plant can do and somewhat differentiate them based on how expensive they are.

We are almost at the end of Module 5.1. Did you do the self-evaluation at the start of the module? If so: were your expectations met?

Compare your personal takeaways with the notes you might have made when starting the module.

Before we proceed with the practical assignment, please check your knowledge with a short quiz.

**[Quiz 1]**

**What is the aim of the action plan?**

- Identifying feasible energy-saving opportunities
- Capturing and creating an overview of energy-saving opportunities **(correct)**
- Supporting the factory management in setting ER targets by estimating ERs expected to result from the energy savings opportunities **(correct)**
- Allocating staff to oversee the implementation, the development/implementation of energy savings measures **(correct)**

**[Quiz 2]**

**How does the action plan support the decision-making process for setting a reduction target?**

- Allocating resources to achieve the ER target
- Setting a timeline for achieving the target
- Estimating the reduction potential of all identified measures **(correct)**
- Defining the energy policy

**[Quiz 3]**

**The energy management function is generally vested in:**

- Senior management
- One energy management or co-ordinator **(correct)**

- Distributed among a number of middle managers **(correct)**
- CEO of a company
- Textile workers

**[Quiz 4]**

What are the objectives of energy management?

- Minimising energy costs **(correct)**
- Minimising energy waste **(correct)**
- Maximising production
- Maximising quality of product

**[Quiz 5]**

What are the appropriate energy efficiency measures for a steam system?

- Proper pipe sizing **(correct)**
- Installing VSD
- Replace induction and hydraulic motors with servo motors
- Proper insulation **(correct)**
- Checking and monitoring steam traps **(correct)**

**[Quiz 6]**

**Please state if the following sentences are true or false.**

The majority of the emissions in Apparel Tier 1 and 2 suppliers come from electricity.
Answer: FALSE. For Tier 1 the statement is correct (60%) but for Tier 2 the majority of the emissions come from fuel usage.

An energy assessment is a framework within which to implement an energy action plan and manage a plant's energy in an ongoing process that enables continuous improvement in energy performance.
Answer: FALSE. This description fits the EnMS. An energy assessment is only the first step towards a comprehensive energy management strategy.

Every action plan should include a list of the proposed energy saving measures, their estimated energy savings, indicative costs and cost savings and details on who will implement each measure and how this will be achieved.
Answer: ***Correct. The listed elements are all part of the action plan.***

# 13 Your assignment for this week

Choose three (3) of the most energy-intensive equipment or areas at your factory. Create a draft action plan (following the template attached separately) to reduce your energy consumption and estimate the reduction potential that you could obtain!

Please follow the steps below:

1. Choose a set of energy savings measures that you feel are relevant for these three (3) areas or items of plant equipment (you may use the references provided in the 'Adidas EGPG training (pages 30 - 59) and Energy saving in the textile industry' by Enerteam materials and/or any other sources of info of your choice).
2. Populate the template with the info obtained in 1. above.
   a. Energy saving measure description:
      - Provide a brief description of the proposed energy savings measure, in terms of its technical scope and how it saves energy.
      - Input energy source.
   a. Feasibility:
      - Indicate the estimated energy savings.
      - Indicate the magnitude of emissions reductions (ERs based on the examples used).
      - Input the cost savings based on the information you have researched.
      - Indicate the CAPEX costs.
      - Indicate simple payback (simple payback can be calculated by dividing CAPEX with potential cost savings)
      - Indicate whether the implementation of the measure might result in additional benefits, such as quality, output, system reliability and other additional co-benefits. If you're not sure, simply add "to be investigated."
   c. Implementation status:
      - Earliest commissioning date.
      - Project status.
   d. Support required:
      - **Technical support** - Indicate, to the best of your knowledge, the staff you think would need to be involved to undertake energy savings implementation (e.g., using in-house experts such as your plant

manager, ops manager, shift supervisor, plant engineer and operator, or hiring externals).

- **Financial support** - indicate the financial support needed to pursue the measure and if an additional budget is required.

3. Calculate how much energy (*Column E24*), $CO_2$ (*Column F24*) and cost (*Column G24*) can be saved through the implementation of measures that you consider to be:
    - zero-/low-CAPEX
    - mid-CAPEX
    - high-CAPEX
4. Calculate the total CAPEX (*Column H24*) of each of the above groups of energy savings measures (i.e., total CAPEX needed to implement all the zero-/low-CAPEX measures).

Note: this exercise is only for illustrative purposes. Whether the savings measures considered are actually relevant or not to your factory can only be established by carrying an assessment in your plant. Moreover, the energy and cost savings and required CAPEX will also always be specific to each factory.

# 14 Frequently Asked Questions

| |
|---|
| I am a small textile supplier. Do I still need to have an EnMS in place?<br><br>**Answer:** All organisations (be they big or small!) are recommended to have an EnMS in place. This can be formal or informal, but the EnMS should be designed in a way that allows the objectives and targets that your company has set itself to save energy and reduce $CO_2$ emissions to be delivered. Effective EnMSs are those that are designed fit for purpose. |
| What if I don't have the internal resources or knowledge to conduct an energy assessment?<br><br>**Answer:** Many factories lack the staff and/or instruments needed to assess the broad range of energy-saving measures that might be up for grabs. Don't let this put you off, as this scenario is more common than you might think. Industry Associations and Technical Cooperation agencies can often point you to qualified consultants and suppliers that can assist in this process if needed. Your customer (e.g., fashion brands) may also be able to assist. |
| What if my energy bill is not large enough to justify implementing the full scope of the EnMS described above?<br><br>**Answer:** An EnMS is an investment and like any investment, it needs to provide your business with the necessary returns. Outsourcing certain EnMS functions is an option to consider in such cases, provided proper oversight is ensured. Whether outsourced or not, the EnMS still needs to ensure that your objectives and targets can be met. |

# 15 Resources

### 15.1. Resources Referenced in the Document

**Adidas (SEA Environment),** Environmental Good Practice Guide & Toolkit (EGPG) (2019), PDF: 99 slides

**Enerteam,** Energy saving in the textile industry - Document is downloadable from the online module), PDF: 45 slides

**Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH,** Setting GHG emission reduction targets for sustainable textile supply chains (2019) - The document is downloadable from the online module**,** PDF: 31 pages

**Clean by Design,** NRDC's 10 best practices for textile mills to save money and reduce pollution - A practical guide for responsible sourcing Version 2.0, (2013) – Document is downloadable from the online module, PDF: 32 pages

**Cleaner production guide for Textile Sector,** Efficiency in use of resources, a decrease in costs, HARMONY WITH THE ENVIRONMENTwwf_guideline_cleaner_production_textile_2018**,** PDF:- 72 Pages

## 15.2. Optional reading materials

Two international standards that highlight best practices for EnMSs

**ISO 50001 of Energy Management**
The standard is designed to provide organisations with a framework for integrating energy performance into their operational management practices and promoting EE throughout the supply chain. The standard specifies requirements for measurement, documentation and reporting of food EE design and procurement processes. More detail can be found here.

**EN16001 of Energy Management Systems**
The European standard for best practices in energy management enables your organisation to develop and implement a policy, identify significant areas of energy consumption and target energy reductions. EN 16001 is usually used as best practice guidance before following the ISO 50001. More detail can be found here.

**A review of energy use and EE technologies for the textile industry by Ernest Orlando Lawrence Berkeley National Laboratory.**
This document provides information on the different energy-efficiency measures, reduction potentials and costs for spinning, weaving and wet processing activities. Click here for the document.