Resource Efficient Management of Energy (REME)

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Program on Promoting Sustainability in the Textile and Garment Industry in Asia (FABRIC)

Guideline for Companies

Title of document **Resource Efficient Management of Energy (REME) – Guideline for Companies**	**Date** 2022/11/03
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Content Learning materials	**Guideline** • Number of pages: 45 • Annexes: 0
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Purpose This document has been prepared to guide Textile and Garments companies in using the GIZ Resource Efficient Management of Energy (REME) training material.	

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List of abbreviations used

BAT	Best Available Techniques
CbD	Clean by Design
EE	Energy Efficiency
EnM	Energy Management
EnB	Energy Baseline
EnMS	Energy Management System
EnPI	Energy Performance Indicator
ET	Energy Team
FABRIC	GIZ Project on Promoting Sustainability in the Textile and Garment Industry in Asia
FEM	Higg Facility Environmental Module
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
LU	Learning Unit
NDC	Nationally Determined Contributions
NPO	Non-Product Output
PaCT	Partnership for Cleaner Textile
PST	Partnership for Sustainable Textile
PV	Photovoltaic
RE	Renewable Energy
REME	Resource Efficient Management of Energy
SP	Session Plan
T&G	Textile and Garments

1 About this guideline

The objective of this document is to provide guidance to factories in the textile and leather sectors with the implementation or upgradation of Resource Efficient Management of Energy (REME), on how to best integrate the newly compiled GIZ Energy Management training/course into their energy management activities. The GIZ REME training/course was prepared under the project *Promoting Sustainability in the Textile and Garment Industry in Asia* (FABRIC). The materials are primarily intended to guide factory personnel from textile and garment factories to increase their knowledge on energy efficiency, renewable energy, and energy management, and implement energy management at the factory level. While the materials refer to international energy efficiency/ management reference standards, the materials are not meant to ensure factories´ conformance to any such specific standards, but to enhance their ability to relate to the requirements of these standards as well as to act towards achieving legal compliance and conformance to customer expectations.

The materials under the GIZ REME training/course into are based on learning needs of service providers and textile and garment factories in Bangladesh, Pakistan, and Vietnam. Additional modules may be included or linked over time to cater to additional sectors of the apparel industry.

The master materials are managed by the GIZ, which also looks after the review and updating of learning materials.

1.1 Overview of guideline and training materials

The guideline provides explanation of the steps a company must take to improve energy performance and implement an energy management system using the REME training material. Relevant training material is referred to in each step; the training material contains worksheets, handouts, presentations, recorded video lectures of master training program, as well as reading materials to provide a ready reference for the different steps of implementing energy management system elements and good energy management practices.

The REME training material consists of ten topic-specific modules, of which three modules are further subdivided into submodules called *learning units (LU),* along the six steps of the “Resource Efficient Management of Energy” (REME) cycle of change and closely follow the structure and content of the ISO 50001:2018 Energy Management System and Higg Facility Environmental Module (FEM) Energy and GHG section.

You may refer to the REME Guideline for Trainers and Facilitators for details on how to use the material in a training setup.

The training materials are available in English as well as Vietnamese via following links:

- Learning program on Energy Efficiency in Textile and Garment Factories — Asia Garment Hub
- learning Program on Energy Efficiency in Textile and Garment Factories (veecom.vn)

1.2 How to use this guideline

Section 2 of this guideline explains the seven steps companies should take when implementing programs on energy management system, energy efficiency and renewable energy using the REME toolkit. Each step description contains suggestions regarding specific factory-level applications that you can consider when designing your energy program.

Section 3 of this guideline provides additional links and references that may help you get further insights when assessing, improving, and evaluating energy performance or implementing energy management system.

2 Implementing Resource Efficient Management of Energy (REME)

2.1 Why implement Energy Management System

2.1.1 Compliance with national and international law standards, codes

Energy management is no more a company level issue but a global challenge. Global efforts on energy and climate mitigation impact companies in form of national, regional, and global market requirements. Some of these requirements become an obligation for the companies and even take place in the buyers' code of conduct making it a case for staying in business. Agenda 21 of Earth Summit of Rio in 1992 first time referred to energy in multiple chapters but not as a main subject of interest. Kyoto Protocol (2005) set binding obligations on industrialized countries to reduce emissions of greenhouse gases and later Paris Agreement 2015 was adopted by 196 Parties at COP 21 with a goal to limit global warming to well below 2 degrees Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Countries announced their Nationally determined contributions (NDCs) that are at the heart of the Paris Agreement and the achievement of these long-term goals. These NDCs also translate into national laws and regulations which company must comply with.

Apart from these obligations, many independent organizations are working on climate mitigation, prominent among them are Sustainable Apparel Coalition (SAC), Green Peace International, Partnership for Sustainable Textiles (PST), Partnership for Cleaner Textiles (PaCT) led by International Finance Corporation, and International Standards Organization (ISO). ISO has contributed big with its famous standard ISO50001 Energy Management System and many other related standards on energy and energy performance improvement.

2.1.2 Respond to customer demands

Textile and Garment buyers have announced ambitious science-based targets on energy and climate and assigned targets to their suppliers i.e., textile and garment companies. These targets not only require companies to reduce energy use, but also require reducing greenhouse gas emissions and add renewable energy to the energy mix.

SAC, with its Higg Index, tries to bring together requirements of most textile and garments brands and buyers into the Facility Environmental Module (FEM) and addresses energy in the section of Energy & GHG section.

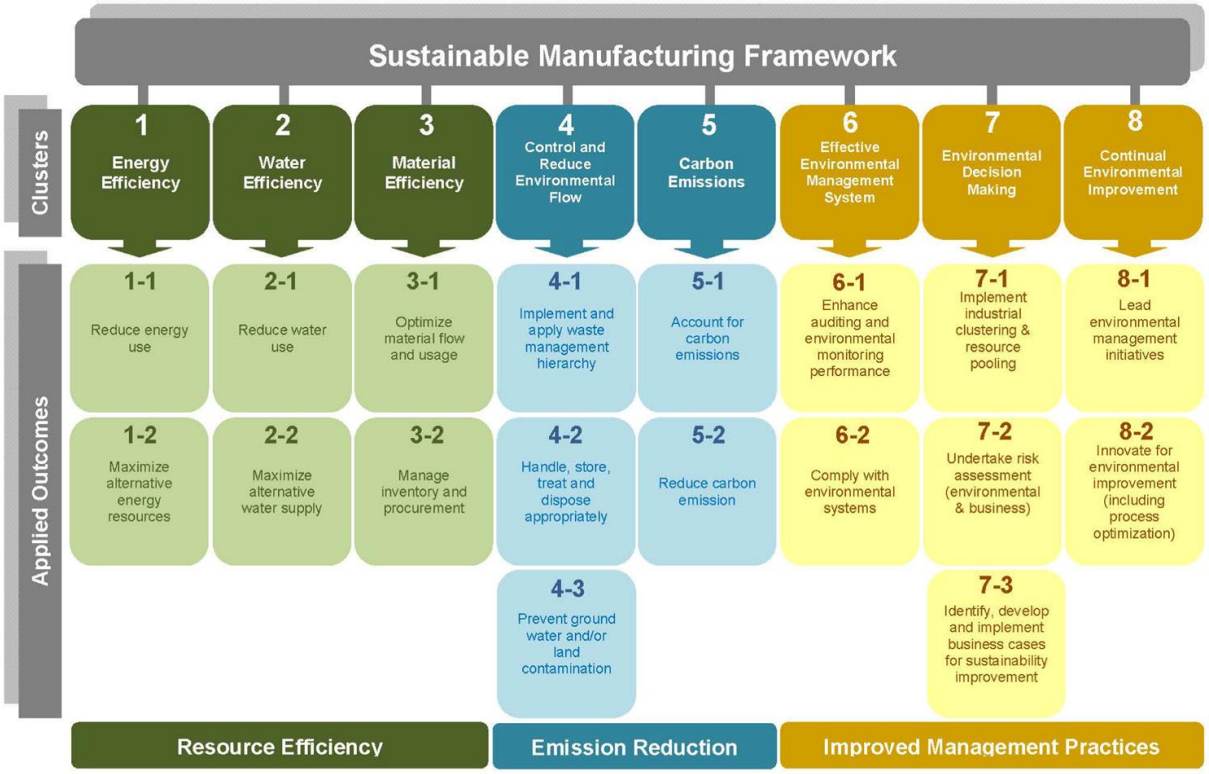
2.1.3 Ensure alignment with company's management system

Energy is not an isolated subject and must be addressed in integration with other sustainable production aspects like air emissions, environmental management systems, water use, and material efficiency. Given the growing complexity and need to address climatic impacts, the management of energy requires a systematic and comprehensive approach, either through setting up a separate energy management system or integrating energy management aspects into the company`s existing management system in line with ISO 9000 (quality), ISO 14000 (environment), OHSAS 18000/ISO45000 (occupational safety and health) and/or ISO26000 (Corporate social responsibility).

This link is created in the Capability Framework for Sustainable Manufacturing of Sports Apparel and Footwear[1] (2012) and presented in following diagram.

[1] Sustainability | Free Full-Text | Capability Framework for Sustainable Manufacturing of Sports Apparel and Footwear | HTML (mdpi.com)

Figure 1: Sustainable Manufacturing Framework



2.1.4 Reduce production costs

Energy can represent a considerable part of the production inputs and costs for companies, such as in the textile and leather industry; both for thermal and electrical energy uses. Implementation of any measures that reduce the input, waste, or emissions will bring cost savings to companies, and, at the same time, reduce their environmental impact. These measures eventually reduce the environmental management costs, for example lesser investments or efforts for abatement of GHG emissions may be required if emissions in energy input and use are reduced.

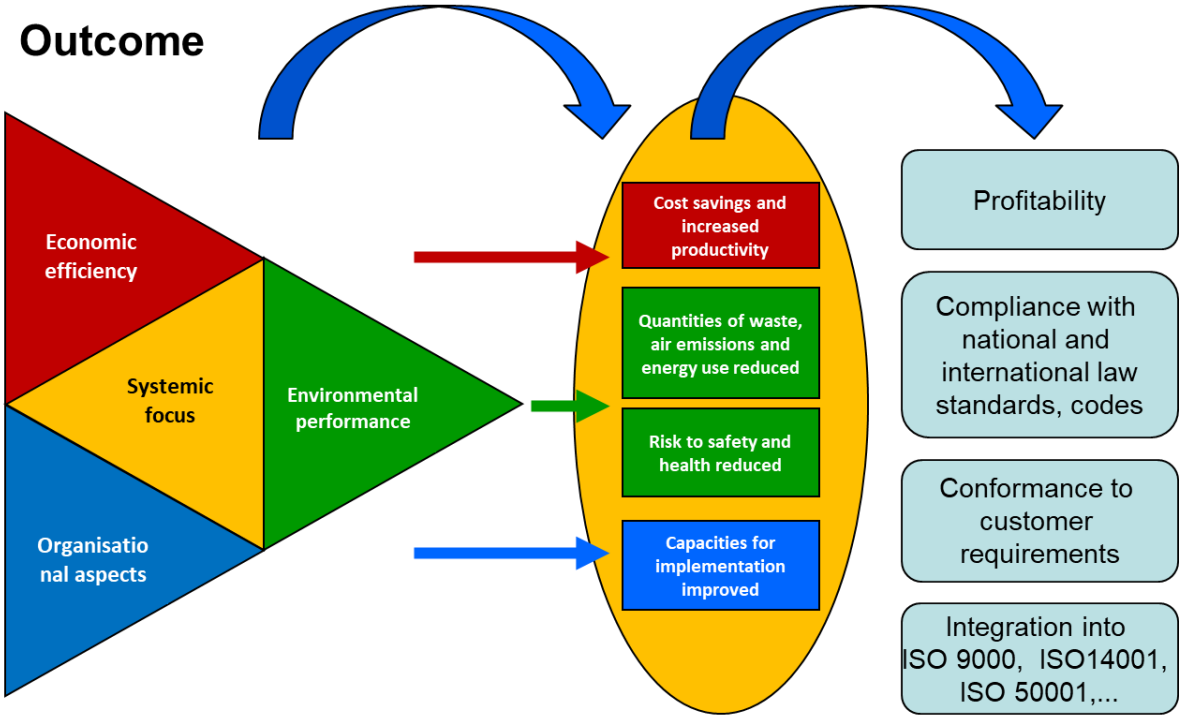
2.1.5 Reduce risk of adverse impacts on environment and workers' health & safety

Energy utilities often have the characteristics and hazards that can harm the environment or the health and safety of humans. Examples are uninsulated hot surfaces, uncovered electrical wires or connections, or emission of smoke and other pollutants due to inefficient burning or contaminated fuel. Such incidences/accidents can create substantive additional costs for companies in terms of lost materials, damaged equipment and facilities, image loss and compensations or fines to be paid. The sound management of energy does not only reduce the environmental, health & safety risks, but also the overall business risk.

Following figure summarised the outcomes of a sound energy management system [2].

[2] Four-wins by PREMAnet e.V

Figure 2: Outcomes of energy management



2.2 REME Implementation Steps

In line with the PLAN-DO-CHECK-ACT cycle, common to many management systems, the process of implementing of energy management in this handbook follows a cycle of change, consisting of six main steps which is presented in following schematic diagram followed by the table summarising tasks to be performed at each step and relevant REME modules.

Figure 3: REME Cycle of Change

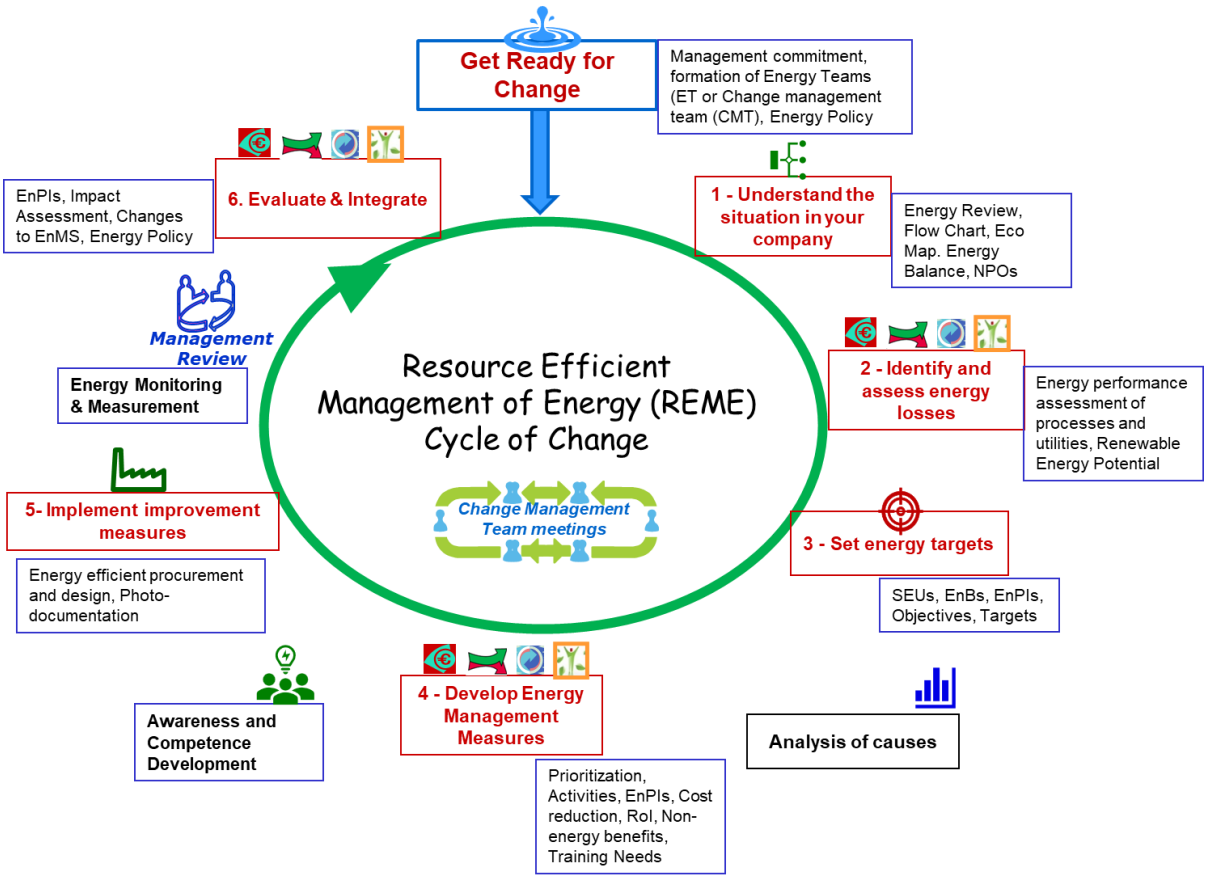


Table 1: REME Steps and their description

REME Steps	Description	Relevant REME Modules
Step-0: Get ready for change	☐ Obtain management commitment ☐ Create in-house awareness and willingness to change ☐ Constitute your change team ☐ Define the scope ☐ Conduct initial review	Module 1 Module 2
Step-1: Understand and review the situation in your company	☐ Develop energy assessment plan ☐ Analyse material and energy flows in your enterprise and identify NPOs ☐ Develop Company-wide energy balance and GHG emissions	Module 3 (optional) Module 4 Module 5
Step-2: Identify and assess energy losses	☐ Develop energy balance of processes and utilities and measure waste streams ☐ In-depth energy performance assessment of manufacturing processes and utilities ☐ Assess renewable energy potential	Module 6 Module 7

REME Steps	Description	Relevant REME Modules
Step-3: Set energy targets	☐ Identify Significant Energy Uses (SEUs) ☐ Develop Energy Baselines and EnPIs using Energy Balance results ☐ Develop energy objectives and targets	Module 5
Step-4: Develop energy management measures	☐ Prioritize NPOs and energy wastes ☐ Identify root causes of NPOs and energy wastes ☐ Identify, select, and prioritise possible energy management measures ☐ Relate measures with objectives, targets, and EnPIs ☐ Prepare action plan with specific measures	Module 8
Step-5: Implement improvement measures	☐ Implement action plans and test good practices ☐ Assess training needs and train your staff and workers	Module 9 Module 10
Step-6: Evaluate and integrate	☐ Review and report results ☐ Integrate results into your company and plan next (cycle of) steps	Module 9

2.2.1 Step-0: Get ready for change

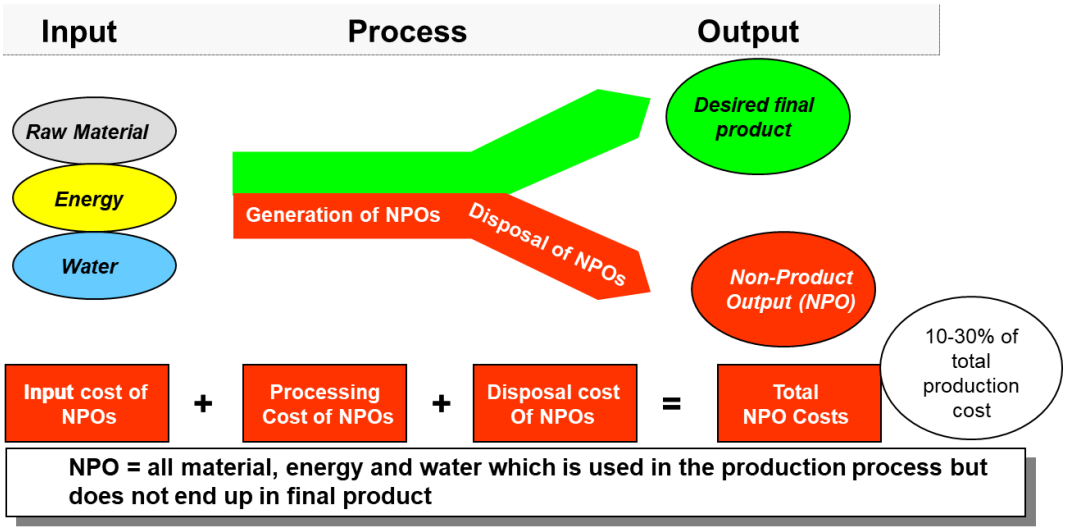
Step-0: Get ready for change		
Tasks	**Modules**	**Learning materials**
• Obtain management commitment • Create in-house awareness and willingness to change • Define scope for energy management • Constitute your change management team or energy team • Conduct initial review of EnMS	• Module 1: Introduction to energy management • Module 2: Setting the framework for Energy management in your company	• Presentation of Module 01 LU1.1 • Presentation of Module 01 LU1.2 • Recorded lectures of Module 01 (03 videos) • Presentation of Module 02 • Recorded lectures of Module 02 (02 videos) • Espire EnMS Maturity Matrix • Carbon Trust Energy Management Self-Assessment Tools

Task 0.1: Obtain management commitment

- The commitment from the top decision makers is a pre-requisite for implementing any major change in an organization. Accordingly, incorporating energy management into strategic and operational planning, day-to-day management and decision making at all levels your organisation will require the full support from the top management. This may manifest itself in various forms, for example:
    - A policy or management statement indicating the organization's commitment towards chemical management is formulated
    - A clear mandate to the team or persons tasked with implementing energy management is given
    - Resources (facilities, personnel, time, funding) are provided to the change team involved.
- Understanding the organizational context is very important to gain management commitment. It is critical to link any improvement activity with interests of the organization and its stakeholders. These stakeholders may be internal (shareholders, management, workers etc.) or external (Regulatory bodies, customers, society etc.). Module 01 explains the context for textile and garments industry in detail. Also refer to section 2.1 of this document for a summary.
- One key aspect, however, is to link the activities with costs, and hence the starting point would be identification of Non-Product Outputs (NPOs) as depicted in the NPO arrow[3] in following figure.

[3] PREMA Good Housekeeping Guide

Figure 4: Non-Product Output Concept



Task 0.2: Create in-house awareness and willingness to change

- The implementation of any change requires the buy-in of those who need to contribute or may be affected. This primarily is the case with the people working in your organisation.
- According to Gleicher Formula for Change, the willingness to change will depend on following factors,

Table 2: Elements of change

the degree of dissatisfaction with the current situation	For change to take place and the necessary motivation to develop, there must be a sufficient degree of dissatisfaction with the status quo; otherwise, energy for change cannot be mobilised (no pain no change!). If painful pressure in the company (losing money, pollution is too high etc.) is not high enough, little can be moved, even if there is strong external influence by consultants or external funds.
the clear or publicly announced desired state (situation) in the future	A change process will only be successful if there is a clear perception of what the situation could look like once the change has been successfully implemented, i.e., the future situation (joint figure building: WE go through six clearly defined steps, starting with the flowchart and finishing with the evaluation and integration into everyday procedures etc., energy management system as Higg FEM or ISO50001 implemented).
the first practical steps into the direction of the desired future state (situation)	There are clear, manageable, and realistic action plans which soon can lead to first successful measures.
the 'costs' of change (both financial and emotional)	For change taking place, the first three factors must be stronger than the costs of change. These can be either material (e.g., investments) or immaterial costs (e.g., fear, anger, uncertainties).

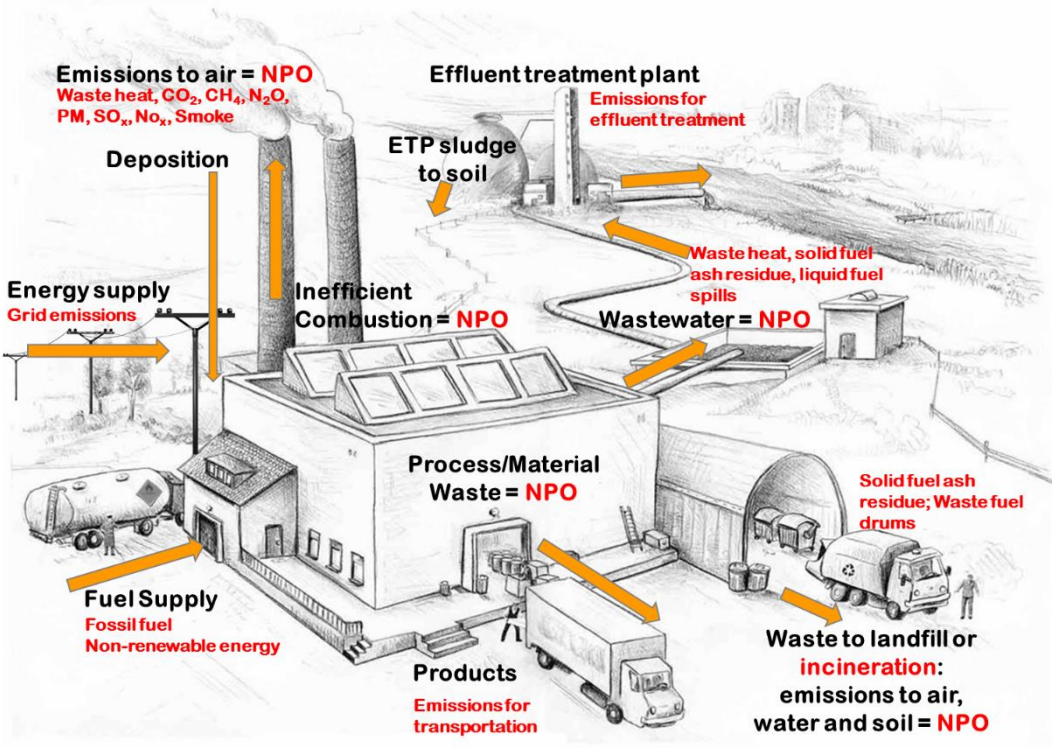
- What can be done?

- Prepare the stakeholders in your organisation (company, unit, area). Your management plays a crucial role in communicating and leading => Why, what, how.
- Link every improvement measure with energy and cost benefits to build a business case for top management
- Initiate and implement improvements measures during the initial stage, which are easy to implement and yield quick and visible results. This will raise the readiness for change and create the necessary dynamics for continuing the change.

Task 0.3: Define scope for energy management

- As with any other management systems, a company which wants to implement an energy management system, needs to clearly define the scope of the system by mentioning and documenting the boundaries of the organisation to which the EnMS applies. Depending on the manufacturing processes the scope and boundary may include either the entire organisation or specific operating units. At a minimum, it is recommended that all production facilities and units using energy are included into the scope along with all energy inputs. Pay special attention to aspects such as energy purchase and emissions due to energy generation and use. When defining inclusion of processes and facilities, ensure you have the authority to control energy efficiency, energy use and energy consumption of these processes and facilities
- Here it is important to define if any processes or facilities are excluded and the reason for their exclusion. You must not exclude an energy type within the scope and boundaries. Some sub-contractor activities can be excluded from scope, e.g., boiler owned and operated by a sub-contractor; in such case, Steam purchased from sub-contractor shall be considered as energy source.
- For this purpose, refer to task 0.1 where you identified company level aspects and define which of the aspects shall be part of the scope. Following figure presents major aspects of concern for factories on energy.

Figure 5: Factory level aspects of Energy



Task 0.4: Constitute your change management team (CMT) or Energy Team (ET)

- The implementation of energy management also implies the establishment of an organisational structure (roles & responsibilities). At the beginning, it is important that a team is formed which will receive a clear mandate (terms of reference, job description) from the management. The ET must be relevant to the defined scope and boundaries of EnMS as defined in Task-3.
- The core Energy Team (ET) will be responsible for supervising the implementation of the energy management steps. A sub-team can assist the core team on specific areas and functions per a plan. The assignments may be system-wide to follow the flow of a process from the input through to the output phase, or it may be divided by phase, or it may be divided by departments. The composition should also suit the culture of the organization.
- It helps, if following functions/departments in the organisations are represented in the team:

Table 3: Typical roles of energy team members

Function/department	Roles and responsibilities
Engineering / Energy / Utilities / EHS	Monitor and maintain energy performance, develop energy balance, prepare relevant drawings such as process flow diagrams, eco-maps, control charts, check Sheets, prepare material balances; carry out benchmarking; set objectives and targets; develop performance indicators; generate and evaluate technical options; prepare implementation plans; implement energy management measures; carry corrective actions if required; support training of line workers.
Purchase	Ensure energy efficient procurement.

Human Resources	Define competency requirements and job descriptions for various roles in energy management. Develop training programs based on a needs analysis. Integrate the Energy Management System (EnMS) into reward, discipline and appraisal systems.
Maintenance	Implement preventive maintenance for key equipment. Track equipment performance, cost efficiency, etc.; maintain logs and inventory on equipment, machine parts, etc., maintain or improve energy performance through maintenance.
Legal/compliance	Check requirements on compliance to all applicable regulations and laws, update legal documents, communicate risks of non-compliance.
Finance	Evaluate energy management measures for economic feasibility; prepare budgets for energy measures; track data on costs incurred and benefits accrued in EnMS program.
Production / Quality	Implement controls in production processes to ensure that optimum energy performance is achieved, and product quality is maintained.

- Experience shows that such teams should not be simply formed based on one person from each department. A needs analysis should drive the selection of members. Smaller organizations with less resources may seek external assistance. An external consultant need not be a professional consultant; but someone from your supply chain, either upstream or downstream, may also fulfil this role.
- Be aware that as the scope of the tasks change, so may change the team. Evolve the composition of the team to match the dynamic nature of the task. In larger firms, there may be different levels of teams, and different teams in operation at the same time.
- Ensure that the team members have enough work-time available for energy activities otherwise they may consider this as additional burden and hence may not be able to commit to the process.

Task 0.5: Conduct initial review

- As a preparatory step for the implementation of energy management, it will be helpful, if your energy team gets a quick idea of the situation and challenges at hand. For this purpose, your team can conduct already a comprehensive self-assessment, for example using the ISO50001 Energy Management System or Higg FEM Energy and GHG section.
- Alternatively, the team can carry out a preliminary assessment, using the EnMS Maturity Matrix tool to identify and document areas of special attention. The interactive approach of the EnMS Maturity Matrix tool allows the involvement of the organisation`s staff at all levels and can contribute to creating awareness and change readiness in the organisation.
- Example of tools available:
    - Espire EnMS Maturity Matrix
    - Carbon Trust Energy Management Self-Assessment Tools

2.2.2 Step-1: Understand and review the situation in your company

Step-1: Understand and review the situation in your company		
Tasks	**Modules**	**Learning materials**
• Develop energy assessment plan • Analyse material and energy flows in your enterprise and identify NPOs • Develop Company-wide energy balance and GHG emissions	• Module 3: Energy Assessment (optional) • Module 4: Analysing and documenting process and energy flows	• Presentation of Module 03 • Recorded lectures of Module 03 (01 video) • Presentation of Module 04 • Recorded Lecture of Module 04 (01 video) • Presentation of Module 05 (Slides related to Energy Balance) • Clean by Design (CbD) 10 best practices assessment tool • HO 120001 - The Textile Company – Energy Assessment Query • HO 130001 - Elements of a process flow chart • HO 130002 - The Textile Company - Walkthrough – Story • HO 130003_Example Energy Balance

Task 1.1: Develop energy assessment plan

- You will now take the first steps towards energy management in your company creating the foundation for your energy management system. While completing the tasks and corresponding activities, you will find answers to questions such as
    - What types of energy do we use in our company?
    - Where are these energy types used and in what manner?
    - How energy move through our company, and which are the significant energy uses?
    - What types of environmental emissions are caused by our energy portfolio?
- Energy review is a major requirement in ISO50001 and Higg FEM Energy & GHG section, and provides basis for identification, mapping, improving, and monitoring energy performance. Module 3 (Energy Assessment) guides on conducting an energy review or an energy audit (as per ISO50002). If you plan to conduct energy review or energy audit using in-house team, you may refer to the presentation and training exercise of Module 03 in detail. In case you plan to hire services of an external expert, it is recommended to get a basic overview of the module presentation so that you can define the terms of reference and deliverables for the expert experts.
- Consider the national, regional or export market regulatory requirements, as well as requirements of your buyers (e.g., Higg FEM)

- Typical tasks of energy assessment are presented in following figure.

Figure 6: Typical tasks of an energy assessment

1- Define Audit and Energy objectives

2- Determine scope and criterion of the audit

3- Define energy audit tasks and responsibilities among auditors and facility

4- Formulate audit team based on identified tasks and required competencies

5- Secure top management support; break ice with key personnel (remember the formula for change)

6- Establish communication protocol

- Among auditors
- Between auditors and facility

7- Ensure access to

- Audit areas, processes, facilities
- Relevant personnel, systems and equipment (e.g. ensuring that measurement points are accessible)
- Documents, drawings, test reports, records, manuals etc.
- Monitoring data, calibration records,

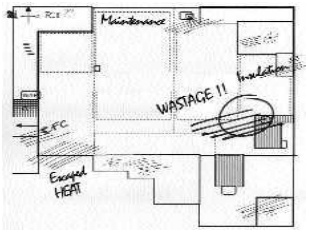
8- Define measurement requirements and develop a measurement plan

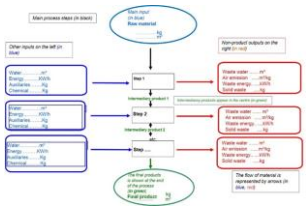
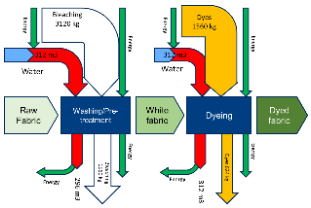
- Stage-1: Point source measurement using equipment
- Stage-2: Data logging over representative period and interval; also including data of variables like production, operating parameters etc.
- Stage-3: Preliminary data treatment / organization
- Stage-4: Calculation and data visualization

Task 1.2: Analyse material and energy flows in your enterprise and identify NPOs

- The analysis and documentation of the energy flows lay the groundwork for establishing energy management system framework for promoting responsible usage, preventing adverse impacts on environment, and reducing losses in your company. This also makes it easier for you to later identify and document energy losses and emissions related to entire range of production processes, products, non-product outputs (NPO) activities under the purview of your company as well as plan and monitor your improvement measures.
- The REME toolkit refers to the following three ways of documenting the energy flow:

Table 4: Methods of documenting energy flow

Function/department	Roles and responsibilities
Eco Maps 	• Create a facility plan that details the physical areas of the property including energy utilities and energy users. The simplest way is to use existing plans of your company. • Indicate and individually label all areas where energy is generated or stored (e.g., fuels) as well as released (GHG and air emissions). It is recommended that your facility plan clearly points out (a) Energy Utilities and Fuel Storages, (b) product storage areas (main stores, sub stores, temporary storage areas), (c) production areas, (d) areas with burning or combustion of fuels (resulting in environmental emissions), and (e) surrounding including water bodies, communities, and crops. • Practical tips: ○ Prepare or verify during an initial company/site walk-through

	○ Collect and fill in additional information, using guiding questions and observations on site ○ Involve your staff and workers in the preparation of the maps
Flow Charts 	• The process flow diagram represents a schematic of the production/process steps, different inputs, intermediary products, final product as well as non-product outputs (defines as inputs which do not end up in the final product). It will allow you to prepare mass and energy balance, and/or cost analysis as well as identify where you can encounter opportunities for cost savings. • Draw a general outline of your production process first. You can always prepare separate and more detailed diagrams for each production steps and process. • Include inputs, outputs, and non-product outputs. Here, start differentiating and detailing these. • Indicate quantities and/or value of inputs, outputs, non-product outputs as far as already known to you. In case of batch processes, in which the input and quantities may vary from product to product, you may develop flow charts of major product categories so that the flow chart represents majority of energy use. • Flow chart also helps identify which energy flows (inputs, uses, or wastes) are being monitored and where further monitoring is required.
Sankey Diagram 	• Sankey diagram is an extension to the Flow Chart. You can decide between two methods for developing a Sankey diagram ○ Use same methodology as in flow chart i.e., keep material and process flow as the main flow stream and show energy flows in line with process flow ○ Use energy as main flow commodity and show processes and facilities as energy users • In a Sankey diagram, the thickness of a flow arrow represents the quantity of flow i.e., thicker the arrow, bigger the quantity

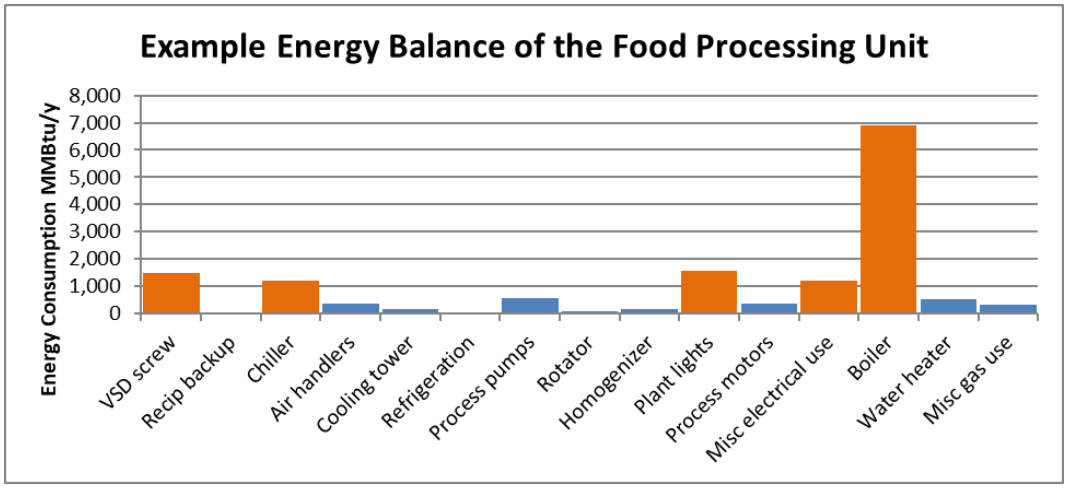
- Use these tools to identify areas for immediate improvement (NPOs or hot spots) and take immediate actions. As described in Step-0, such improvements motivate the management and factory staff and build trust in the process of EnMS.
- At this stage, you are only identifying (and quantifying) energy flows, but not analysing energy efficiency or energy performance of any specific production processes or energy utilities. This follows in next step.

Task 1.3: Assess and conduct Company-wide energy balance and GHG emissions

- The purpose of an energy balance is to look at energy consumption on a smaller (individual energy uses) scale. Using estimates and spot measurements of equipment loads, the energy consumed by each user can be found
  - Energy Consumption = Nominal equipment rating x Duty Factor x Load Factor x Operating Hours
- Individual loads are summed and compared to the plant energy input. Areas of significant energy use (SEUs) are identified. SEUs can be facilities, systems, processes, or equipment.

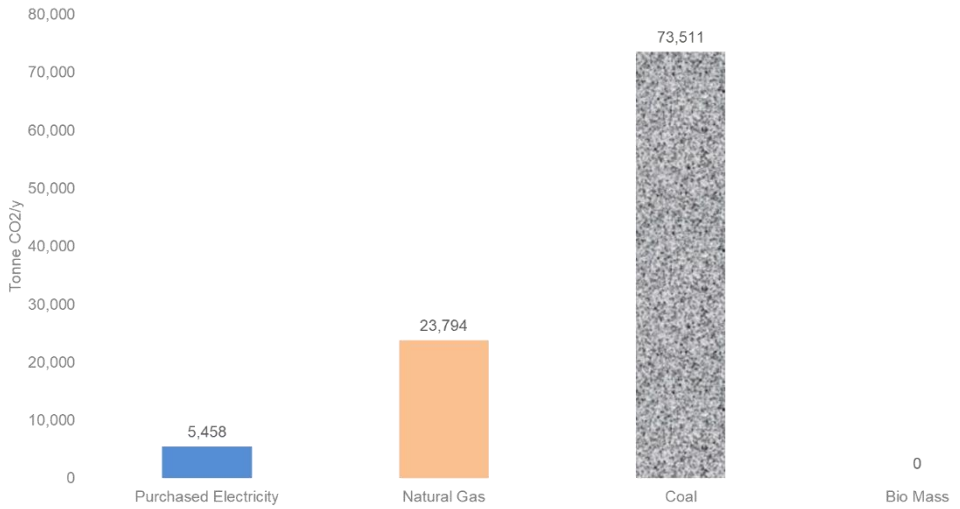
- This ensures that companies focus on biggest energy users first where bigger savings can be achieved. Once developed, the energy balance shall also help you identifying which energy flows must be measured and which not, helping in reducing effort of measurement and monitoring
- Following is one example of an energy balance [4].

Figure 7: Example Energy Balance



- Develop an inventory of GHG emissions using the energy balance, quantifying the GHG emissions for each energy type

Figure 8: Example GHG Emissions Inventory (GHG Balance)



[4] 2011 Georgia Tech Research Corporation and U.S. Department of Energy

2.2.3 Step-2: Identify and assess energy losses

Step-2: Identify and assess energy losses		
Tasks	**Modules**	**Learning materials**
• Assess and conduct energy balance of textile and garments processes and utilities • In-depth energy performance assessment of manufacturing processes and utilities • Assess renewable energy potential	• Module 6: Understanding processes and assessing energy performance of textile and garments factories • Module 7: Renewable energy potential in textile and garments factories	• Presentation of Module 06 LU6.1 and LU6.2 • Recorded Lectures of Module 06 LU6.1 (03 videos) • Recorded Lectures of Module 06 LU6.2 (02 videos) • Presentation of Module 07

Task 2.1: Assess and conduct energy balance of textile and garments processes and utilities

- Now that you have developed a company-level energy flow and energy balance, next step is to analyse the individual processes and utilities (SEUs) in detail, measure their energy performance, and identify and quantify energy losses. Start with developing process-wise detailed energy balance as presented in following diagrams.

Figure 9: Energy balance of a process (Example)

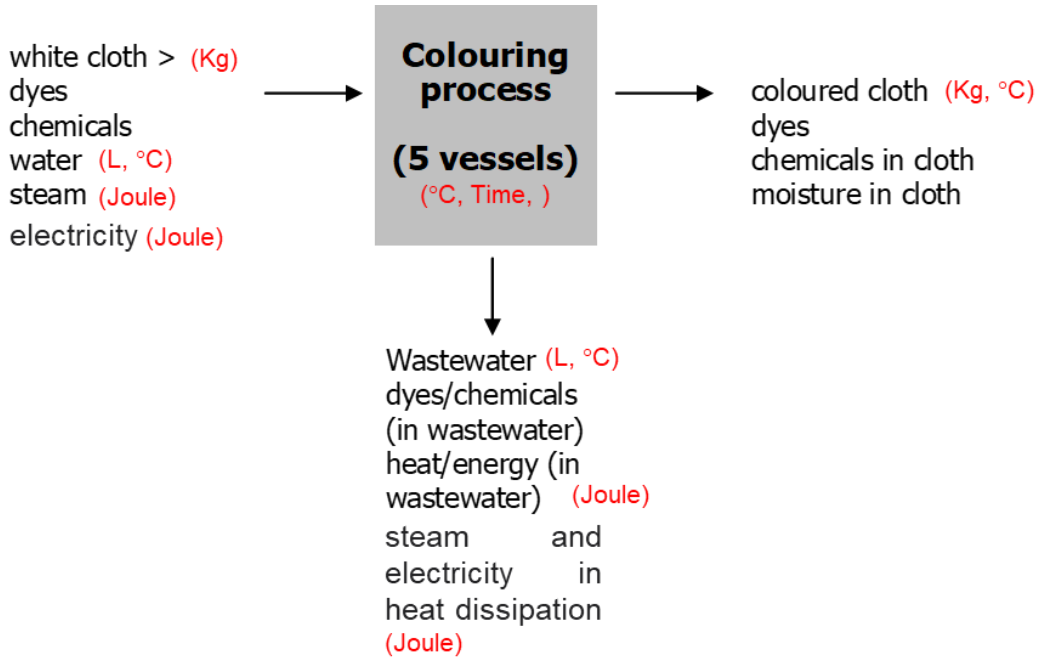
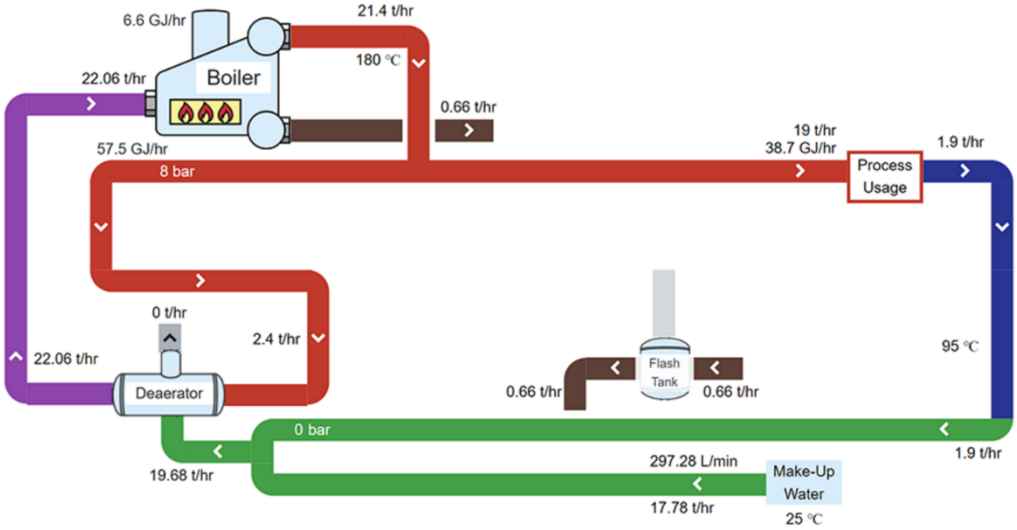


Figure 10: Energy balance of a steam system (example)



- If developed in detail, process-wise energy balance provides critical information on the type and manner of energy use, energy contained in the immediate product, and energy NPO i.e., energy in the waste streams or energy not ending up in final product. Here you may need to investigate following to improve energy performance.
    - Is right type and quality of energy supplied to the processes / utilities? (Example sub-questions)
        - Have we selected right fuel (considering calorific value, impurities, emissions etc.)?
        - Is correct power quality supplied (electric voltage, avoidance of harmonic distortion)?
        - Does energy supply match with energy demand (temperature of steam of oil compared to process temperature, pressure of steam or compressed air compared to required process pressure etc.)
    - Is the process operating at optimum parameters?
        - It is often observed that process parameters are defined without considering energy performance. Operators or supervisors may at times change the parameters to match production output rate resulting in increased energy demand.
        - Often pressures of steam or compressed air are set at higher values to compensate for condensation, leakages, or other network losses. It is advised to correct these issues and set pressures at optimum values.
        - Uninsulated surfaces of machines or networks of steam, thermal oil, chilled water may result in increased temperature demand
    - What is the energy content and quantity in waste streams, and how can this be recovered or reused?
        - You must first investigate if the waste energy can be eliminated altogether or reduced to minimum quantity before considering reuse or recovery options.
        - Waste heat can be recovered from hot air and water discharges by installing heat exchangers

- If hot air or warm water are free of contamination, their flow may be redirected to input of same or other processes for reuse. One common example is reusing non-contact machine cooling water.

- You may use checklists for energy performance at this step; some resources are listed in Section 3 Useful links and references.

Task 2.2: In-depth energy performance assessment of manufacturing processes and utilities

- Once you have developed energy balance of your significant energy uses, go ahead and measure energy efficiency and energy performance of the SEUs. Many tools are available at various online resources, some resources are listed in Section 3 Useful links and references.
- You may need aide of measuring devices (portable or fixed); commonly used devices are power quality analyser, flue gas analyser, thermal imaging camera, flow meters for water, steam and compressed air, pressure and temperature data loggers, and dewpoint tester for compressed air and chillers. Best measurements and logs are achieved if these devices are already installed in the network and data is logged for past. Since portable devices are usually not available in the factories, you may need to hire services of an external expert for the spot or short-interval measurements.
- In this task, the objectives are to (i) quantify all the energy streams of Energy Balance developed under Task 2.1, (ii) measure or calculate efficiency of the energy use, (iii) determine sources of inefficiencies, and (iv) calculate energy and monetary losses due to these inefficiencies.
- Following figures presents an example of basic efficiency assessment of a boiler.

Figure 11: Efficiency assessment of a boiler (example)

Steam Production		Specific Energy Consumption	
No. of Boilers	Total Steam Production	Specific Fuel Consumption	Hourly Fuel Consumption
1	66.00	2.63	0.72
	Ton/d	mmBtu/Ton	mmBtu/h

Net Energy Requirement	Daily Energy Input	Total Energy Cost	Steam Cost (Fuel only)
144.55	173.70	0.11	1718.58
mmBtu/d	mmBtu/d	MPKR/d	PKR/Ton

Overall Efficiency of Steam Boiler
83.2%

- For detailed guidance on efficiency and performance assessment of textile utilities, you are encouraged to refer to the presentation of Module 6 LU6.2, its recorded lecture and additional reference materials provided with the module.

Task 2.3: Assess renewable energy potential

- Factories and professionals (e.g., renewable energy technology vendors) often make a mistake of calculating renewable energy demand based on existing energy use; without considering energy losses in the factory. This may result in increased amount of investment and installing oversized systems. You are advised to first calculate energy losses, develop plan for reduction of losses, reduce your base energy demand, and then calculate potential for renewable energy.
- Common ventures of renewable energy for textile and garments companies may be.
    - Solar Photovoltaic system for electricity generation
    - Solar water heater to substitute heat from steam or other sources – works well for any uses up to 70 degrees Celsius and usually provides more energy content than solar photovoltaic system for same space utilization.
    - Replacing fossil fuel with bio-mass or other renewable fuels. Most common use of this is on steam boilers, water heaters and thermal oil heaters
- For such an investment grade measure, it is important that you conduct a detailed feasibility study with proper financial calculations.
- The module 07 presentation is only a summary of the prefeasibility study on renewable energy for Pakistan and Bangladesh; link for the study is provided in the Section 3 Useful links and references. Going through this study will help you comprehend the aspects to be considered when developing renewable energy projects.

2.2.4 Step-3: Set energy targets

Step-3: Set energy targets		
Tasks	**Modules**	**Learning materials**
• Identify significant energy uses (SEUs) • Develop Energy Baselines (EnBs) and Energy Performance Indicators (EnPIs) using Energy Balance results • Develop energy objectives and targets	• Module 5: Set energy targets	• Presentation of Module 05 • Recorded Lecture of Module 05 (01 video) • HO 130003_Example Energy Balance • HO 130004_EnPI Normalization_Data • HO 130004b_EnPI Normalization_Solution • HO 130005 - The Textile Company – Energy Baseline – Data • HO 130005b - The Textile Company – Energy Baseline - Solution

Task 3.1: Identify significant energy uses (SEUs)

- Step-3 overlaps with Step-1 and Step-2 to a great extent in following manner.
    - In step-1, meta-level significant energy uses are identified once the company-level energy balance is prepared. Usually here you can identify (i) which energy types have bigger share in energy mix, GHG emissions, and energy cost, and (ii) which departments consume most of the energy and of which type
    - In step-2, process-level significant energy uses are identified when process flows are quantified, and process-wise energy balance is prepared. Here we can identify (i) which users (processes and utilities) contribute significantly to the energy consumption and GHG emissions, (ii) which users display low energy performance resulting in energy losses.
- You must identify relevant variables that affect energy performance of SEUs. These may be climate conditions, type of raw material used for various products, quality of fuel etc. Following table presents basic assessment of variables affecting the SEUs.

Table 5: Example assessment of variables affecting SEUs

SEUs	MMBtu/y	Relevant Variables	Further Considerations
Boiler	6,909	Ambient Temperature, Production Volume, Fuel quality	Excess oxygen, water intake, and blow-down water quality monitoring missing
Plant lights	1,554	Day-light availability, Production Volume	Lighting control is centralised, and users have low control.

VSD screw compressor	1,498	Ambient Temperature, Relative Humidity, Production Volume	Compressed air flow rate and dewpoint monitoring missing
Misc. electrical use	1,203	Unaccounted loads	Too much unaccounted load. Need further investigation and monitoring.
Chiller	1,196	Ambient Temperature, Relative Humidity, Production Volume	Temperature controller malfunction, pending repair

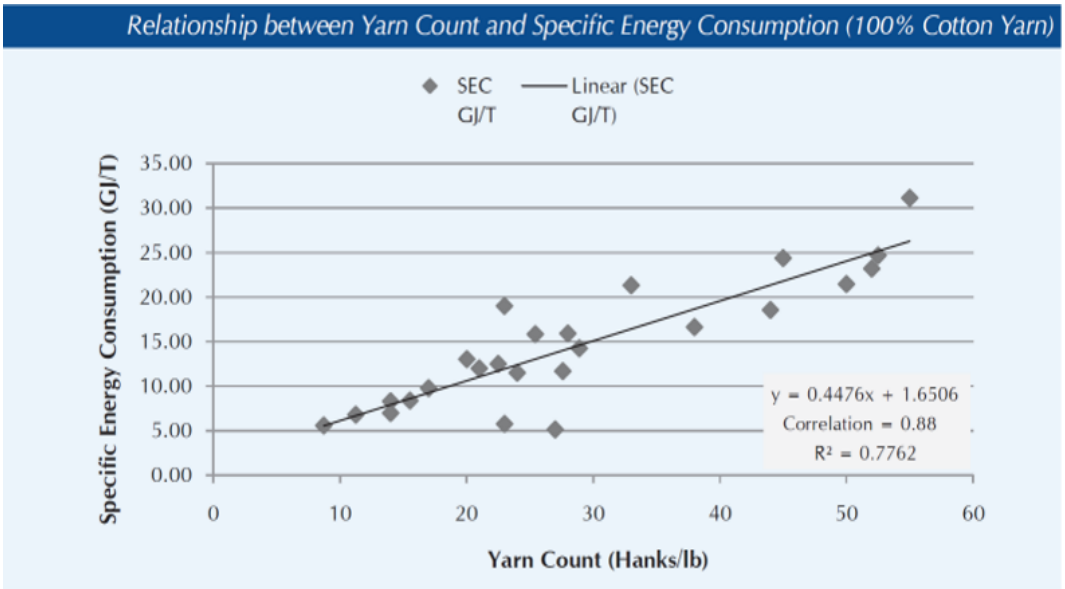
- ISO50001 requires organizations to develop a control plan for the variables that significantly affect SEUs so that the impact of these variables is measurable as well as under control.

Task 3.2: Develop Energy Baselines (EnBs) and Energy Performance Indicators (EnPIs) using energy balance results

- Energy Performance Indicators are measurable indicators related to energy efficiency, energy use and energy consumption e.g., GJ/Year, or GJ/kg-fabric. EnPIs must be appropriate for measuring and monitoring energy performance i.e., covering all energy sources and all SEUs
- EnPIs enable the organization to demonstrate energy performance improvement by comparing current values against baseline
- Energy Baselines (EnBs) are quantitative reference providing a basis for comparison of energy performance e.g., energy consumed in year 2020. EnB is based on data from a specified period and/or conditions e.g., January – December 2020.
- Baselines can be Absolute (e.g., 120,000 GJ/year) or Normalized (e.g., 6.5 GJ/Tonne-production). The decision to define absolute of normalized EnBs depends on the relevant variables that may significantly affect energy performance of the SEUs as defined in Task 3.1. Depending on the nature of the activities and complexity of variables, normalization can be a simple adjustment (e.g., GJ/year), or a more complex procedure (using regression or other statistical tools). Following is an example[5] of normalized EnB using regression.

[5] UNIDO Sectoral Analysis on Renewable Energy and Energy Efficiency, July 2019

Figure 12: Example of normalized energy baseline using regression



- In the module presentation and handouts, you will find examples and an exercise for normalizing EnBs which can be referred to at this stage.

Task 3.3: Develop energy objectives and targets

- Before defining energy targets for the EnBs, it is important to first develop energy objectives of the organization. These objectives may be derived from the task 0.3: define scope for energy management. The objectives may be (i) quantitative or (ii) qualitative
- Quantitative objectives may include
    - reducing energy consumption
    - adding renewable energy in the energy mix
    - reducing your GHG emissions
    - …..
- Qualitative objectives may include
    - ensuring compliance to legal or regulatory emission limits
    - maintaining or improving conformance level to ISO50001, Higg FEM or customer code of conduct
    - providing safe environment to workers and surrounding communities by reducing environmental impact beyond the regulatory emission limits
    - …..
- Similarly, targets may be set for various levels.
    - Targets for the energy objectives are set at organizational level. You must develop these targets either at this stage, or event at Step-0 if relevant information is available
    - Targets for SEUs are set against EnBs of the respective SEUs in line with the energy objectives. These targets contribute towards achieving the energy objectives. However, at this stage, you may not be able to define accurate targets as the action plans are not prepared. Once the action plans are prepared, you will be in a better position to define what is possible to achieve.

- Depending on the EnBs, the targets can be simple or complex. For a normalized EnBs, regression slope can also be used for forecasting, budget setting, and target setting. For the normalized EnB presented in task 3.2, if the target is to reduce energy consumption by 10%; the values of constants shall be reduced by 10% in the regression formula, i.e., Energy (y) = 0.447X*0.9 + 1.6506*0.9

2.2.5 Step-4: Develop energy management measures

Step-4: Develop energy management measures		
Tasks	**Modules**	**Learning materials**
• Prioritize NPOs and energy wastes • Identify root causes of NPOs and energy wastes • Identify, select, and prioritise possible energy management measures • Relate measures with objectives, targets, and EnPIs • Prepare action plan with specific measures	• Module 8: Developing Energy Management Measures	• Presentation of Module 08 • Recorded Lecture of Module 08 (03 videos) • HO 210001 - Impact Assessment • HO 210001b - Impact Assessment - Example • HO 210002 – The Textile Company - Evaluating Alternatives • HO 210002b - The Textile Company - Solution • HO 210003 - Action Planning • HO - Higg FEM Implementation Plan Template • HO 130002 - The Textile Company - Walkthrough – Story • HO 130005b - The Textile Company – Energy Baseline - Solution

Task 4.1: Prioritize NPOs and energy wastes

- At this stage, you have already calculated the energy losses and NPOs in the organization and understand their impact on energy consumption and manufacturing cost. To direct your efforts towards high impact areas, it is recommended to prioritize the energy wastes and NPOs systematically. One way is to develop a Pareto Chart and select those wastages which have highest impact on energy cost. However, cost reduction may not be your only objective as defined in Step-3. Thus, the energy wastes might have various impacts including customer compliance, legal compliance, working conditions and environment, GHG emissions, cleaner energy mix, product quality etc. Following figure presents an example of prioritizing the NPOs based on their impacts.

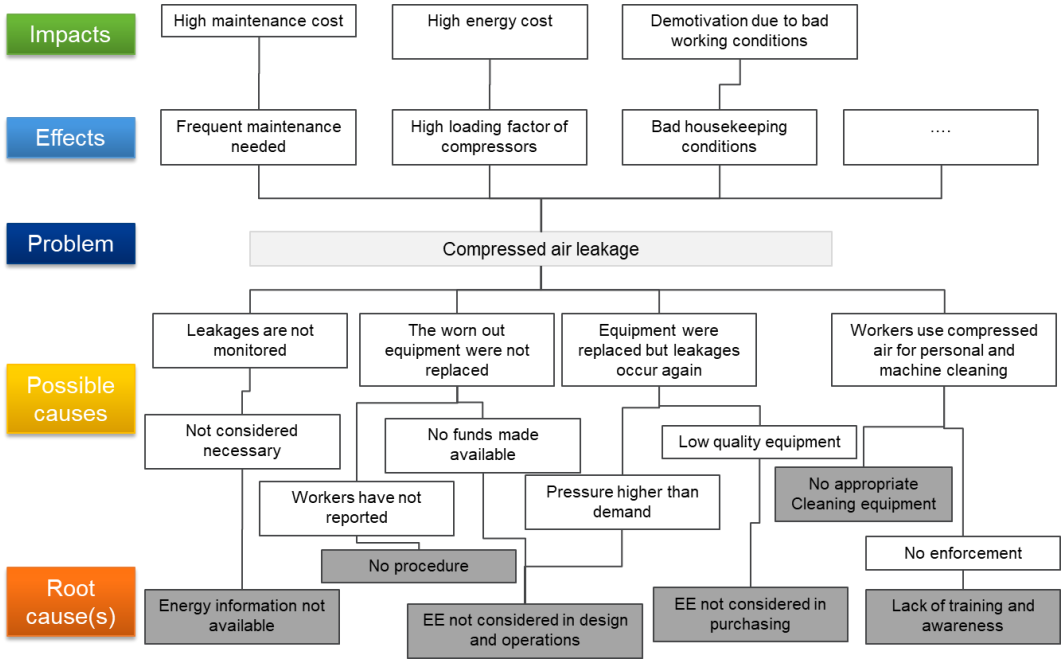
Figure 13: NPO impact assessment and prioritization (example)

Aspects	Identification of Impacts (High=3, Medium=2, Low=1, N/A=0)											
	Results in monetary loss	Causes air Emissions (PM, Sox, NOx, CO…)	Contributes to global Warming, Ozone depletion	Increases fossil fuel use	Effects health of staff/ worker	Contributes to emergencies (fire/,explosion)	Effects relationship with customers	Lead to legal consequences or public reactions	Affects quality/ productivity	Affects working conditions and environment	Increases use of natural resources	Total Impact
Very low condensate recovery	3	0	2	2	0	0	1	0	0	0	3	11
Low combustion efficiency of coal fired boiler	3	2	3	3	1	0	2	2	0	1	0	17

Task 4.2: Identify root causes of NPOs and energy wastes

- You may use any methods for root cause analysis including Fishbone, Mind map, problem tree analysis etc. Please consider using the method which you are comfortable with – simplicity is the key
- Properly analysing the situation will allow you to address the real causes in an effective and sustainable way. Technical cause of an energy waste is only one aspect, while there may be root causes hidden in the procedures, management system, procurement, human competence, or even top management commitment.
- It is also advised to extend your cause analysis diagram to conduct impact analysis of the energy loss as well, i.e., combining Task 4.1 and Task 4.2. This helps in visualising the business case of correction as well as prevention of the problem in a sustainable way.
- Following example of compressed air leakages (also presented in the module presentation) demonstrates the cause and impact analysis as presented in above points. Usual measure taken in the factories is to rectify the leakages, and the reasons for recurrence of leakages are seldom analysed. You can see in this example that there are other root causes as well which need to be dealt with otherwise the recurrence of the problem cannot be avoided.

Figure 14: Root cause and impact analysis - example of compressed air leakage



- Don't forget to validate the root causes with actual data before moving forward with developing solutions. You may refer to the energy data and other records (like, training, procurement, production etc.) to validate the root causes.

Task 4.3: Identify, select, and prioritise possible energy management measures

- Once the causes are identified, you must develop solutions to all identified root causes.
- At this point, it is important to calculate energy performance improvement, cost savings, non-energy benefits and required investments for identified solutions. For investment grade solutions, it is recommended to assess feasibility using advanced tools like internal rate of return (IRR) or equivalent annual annuity (EAA) rather than basic pay-back calculations.
- Once you have assessed the feasibility, it is important to compare the alternative solutions using the financial feasibility results as well as their contribution to the energy objectives and targets.
    - There could be some solutions that bring great economic gains; however, you must not implement them if they don't match with energy objectives. Let's take example of switching to higher grade coal for steam which may result in improving boiler efficiency and provide great financial gains; however, if your energy objective is to decarbonise your company, you must opt for switching to a cleaner fuel (e.g., Agri-based biomass) or opting for renewable energy to generate heat.
- Here again, you must prioritise the energy management measures so that the efforts and resources are directed towards those measures first which contribute most towards achievement of objectives and targets. You may consider using the prioritisation matrix again which you used in Task 4.1

Task 4.4: Relate measures with objectives, targets, and EnPIs

- As mentioned in Step-3, you may only be able to set realistic energy targets for process-level SEUs once you have identified the solutions and measured their possible impacts. So now is the stage where you must relate energy management measures with objectives, targets, and EnPIs
- At this stage, you can use EnPIs for following purposes
    - Compare Energy efficiency, resource productivity and environmental/safety/health performance over time.
    - Highlight improvement and optimization potentials.
    - Identify and follow up on targets.
    - Discover market opportunities and cost-reduction potentials.
    - Involve, educate, and motivate staff.
    - Promote organizational learning.
    - Support decision-making by providing concise information about status and trends regarding resource use and performance.
    - Implement EnMS and/or generate information needed for your current EnMS.
    - Communicate your results to your stakeholders.
- Following table presents an example of specific energy targets set for a textile wet processing factory based on selected energy management measures

Figure 15: Example of specific energy targets set for a textile wet processing factory based on selected energy management measures

Resource	Key performance indicator			Projected Annual Saving	
	Current	Target	% Reduction	Quantity	Monetary (USD/y)
Electricity	1.153	1.145	0.7%	148,133 kWh	11,408
Steam	14.12	14.11	0.05%	131 Tonne	1,568
NG	0.318	0.313	1.8%	111,975 m^3	25,010
Water	86.40	85.2	1.4%	24,015 m^3	2,235
GHG	3.74	3.72	0.4%	310 TonneCO_2	
Total					40,221
Units for KPI: kWh/kg for electricity, kg/kg for steam, m^3/kg for NG, l/kg for water and GHG emission kg/kg					

Task 4.5: Prepare action plan with specific measures

- Various templates are available for developing action plans. Following figures presents some basic requirements of an action plan.

Figure 16: Template of action plan

Energy losses/ critical situation/ identified gap	Proposed measure	Results of proposed measures (Energy, GHG, USD, RoI..)	Necessary action/ activities for implementing measure	Person(s) Responsible	Deadline for completion	Targets/ EnPIs to be monitored
Hot water drained from rope dyeing machine	Install wastewater heat recovery system	Coal Reduction xx T/y Energy reduction at ETP xx kWh Investment xx USD Saving xx USD IRR xx %	Develop technical requirements Hire contractor Install system and conduct first trials Commission the system	Mgr Maintenance Mgr Prcurement Mgr Prooduction	dd/mm/yyyy	Total GHG emissions Energy consumption per production unit
↑ Issues to be addressed; ref. Eco-map, energy balance, energy audit…	↑ Mutually agreed and technically correct measures	↑ Measurable results of the interventions	↑ Work breakdown, division of measure into tasks /milestones			↑ Selected performance indicators

- You may use your own template, or the template recommended by your buyer, regulatory bodies or other subscribed standards or guidelines. Higg FEM also provides a detailed template for action plan, so if you already report on Higg FEM, then it is recommended to use that template. Higg FEM action plan template is also provided as handout with Module 08.
- You may even opt for a more detailed action plan specific to each energy objective; an example[6] is presented in following figure.

[6] 2011 Georgia Tech Research Corporation and U.S. Department of Energy

Figure 17: Action plan template specific to an energy objective (example)

Example Energy Management Action Plan	
Objective: Reduce natural gas use by 5% compared to baseline FY 2006	**Original Issue Date:** 12/22/11
Target: Reduce boiler natural gas use 2.5% compared to baseline FY 2006	**Revision Date:**
Energy Management Project: Preheat boiler combustion air from 90°F to 110°F	

Project Planning

Action Items	Person Responsible	Due Date	Required Resources/Comments
Assign project team	Management Rep.	2/14/11	Design, maintenance and procurement representatives
Collect data	Joe Mechanic	3/1/11	Assistance from maintenance
Design heat exchanger	Ima Engineer	5/8/11	Autocad access
Install system	Acme Contracting	6/14/11	Overhaul boiler during installation (See boiler plan)
Test and commissioning	Joe Mechanic and Ima Engineer	6/28/11	
Savings validation	Ima Engineer	7/1/11 – 6/30/12	Maintenance to collect data daily See Project Verification Plan

Target Verification Plan

Item	Information/Resource Requirements
Calculate EnPI in Btu/lb of product each month for baseline year	Boiler gas meter data and production and temperature data for FY 2006
Calculate EnPI in Btu/lb of product each month for 12 months after installation	Boiler gas meter, production and temperature data for 12 months after installation
Calculate average annual EnPI for each 12 month period	
Calculate percentage difference in average annual EnPI for baseline year and 12 months after installation	
Calculate average monthly savings for bottom up analysis	M&V requirements, documented savings
Actual Results/Comments: Based on production records and meter readings the project resulted in an energy savings of 300 Btu/lb based on production and a 1,570,000 Btu/hr (25.4 CFM) savings of natural gas.	
Prepared by: Earnest Brown	**Date: 12/22/2011**
Approved by:	**Date:**

2.2.6 Step-5: Implement improvement measures

Step-5: Implement improvement measures		
Tasks	**Modules**	**Learning materials**
• Implement action plans and test good practices • Assess training needs and train your staff and workers	• Module 9: Monitoring and measurement of results • Module 10: In-house Competence Development	• Presentation of Module 09 • Recorded Lecture of Module 09 (01 video) • Presentations of Module 10 LU10.1 and LU10.2 • Recorded Lectures of Module 10 (03 videos) • Espire EnMS Maturity Matrix • Carbon Trust Energy Management Self-Assessment Tools • Clean by Design (CbD) 10 best practices assessment tool • HO_Essential Client Briefing Form • HO_The Textile Company – Competence needs • HO_Modplan_Example

Task 5.1: Implement action plans and test good practices

- Refer to the formula for change presented in Step-0. Up to Step-4, you have (i) developed dissatisfaction to the status quo, and (ii) set vision of future state (i.e., set objectives and targets). Now you must start taking first concrete steps to ensure that the change starts taking place.
- At this stage, it is very important to engage all relevant personnel in the process to ensure ownership of the improvements. Module 10.1 explains strategies to engage employees in the change management and co-generate results. You may consider developing mini project teams and create competition among the teams.
    - Reaching out to key personnel in the factory to develop energy team is a challenging task. Keep the formula for change in mind and assess the resistance to change
    - Always try to put the key personnel in driving seat; this gives them motivation to improve and ownership of the process
- You must monitor the progress on action plan in an inclusive manner. Consider using visualisation tools like bulletin board presented in following figure to monitor the progress. You may also use the action plan to summarise the progress made and status updates as in following figure.

Figure 18: Improvement bulletin board for monitoring progress against action plan

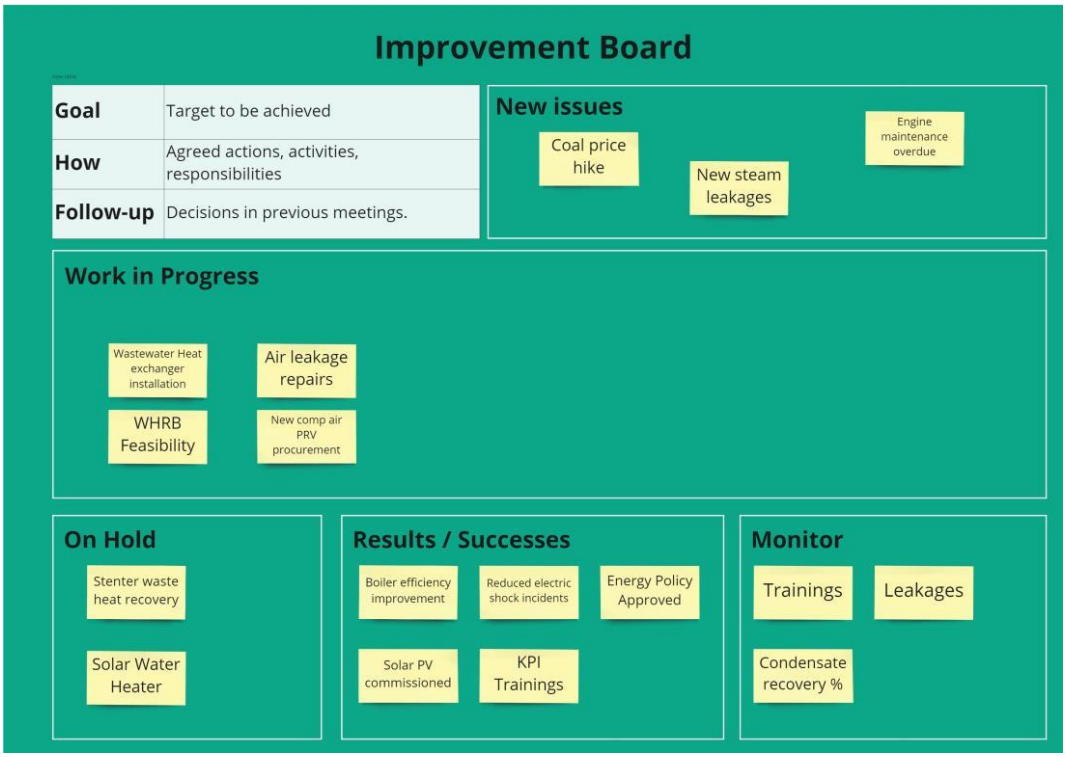


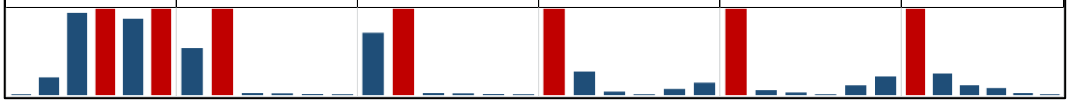
Figure 19: Monitoring status against action plan

Resource Efficiency Measures	Status Visit-01; 15 Jul. 2021	Status Visit-02; 01 Sep. 2021	Supporting Documents
Use of Graded Coal for Steam Boilers and Oil Heaters	Trial to be conducted before 2nd monitoring visit	Trials are in process, we will compare data after completion of trials within next week.	
Reduction of Excess Oxygen at Steam Boilers and Oil Heaters	Oxygen sensors to be installed; manual control shall be applied	Procurement process initiated, Demand Raised.	Adobe Acrobat Document
Waste Heat Recovery from Stenters	no decision taken yet	Work in process, Currently working on PLEVIA system. Heat recovery system will be implemented step wise.	
Recovery and Reuse of Steam Condensate – Division-1	Thinking about heat recovery from condensate	Work in process, steam traps procurement initiated (getting quotations)	Adobe Acrobat Document
Insulation of steam and thermal oil network	Will start step wise insulation of steam/thermal oil valves	Working started	Adobe Acrobat Document
Install steam pressure and temperature gauges on all machines		Work in process, identifiction of critical points in process to install steam pressure and temperature gauges	

- Measure impact of all implemented measures on the EnPIs and compare with targets. Review if certain measures are not able to generate desired results and the reasons for this. Following figures presents example of monitoring against EnPIs

Figure 20: Monitoring progress on EnPIs (example)

	Key Performance Indicators (KPI's) - Calculated per kg of fabric produced				
GHG (From utilities) [tCO2]	Fresh Water [L/kg]	Process water [m³/kg]	Steam [kg/kg]	Electrical (total) [kWh/kg]	GHG (From utilities)[kg/kg]
8,298	134.67	125.40	8.18	5.24	5.07
8,384	142.27	130.00	7.11	4.31	4.29
8,704	126.06	113.90	6.77	4.28	4.14
8,724	125.96	113.80	6.72	4.26	4.11
8,674	125.86	113.70	6.82	4.36	4.05
8,724	125.76	113.60	6.92	4.46	4.03



- Similarly, you can review your improvements to energy management system using the EnMS Maturity Matrix. Display baseline and status on one common spider-web or pi-chart to display improvements. Refer to the presentation of Module 09 for further ideas.

Task 5.2: Assess training needs and train your staff and workers

- As you have started to implement the energy management measures, it is important that all persons doing work under the organization's control are aware of
  - the energy policy
  - their contribution to the effectiveness of the EnMS, including achievement of objectives and energy targets, and the benefits of improved energy performance
  - the impact of their activities or behaviour with respect to energy performance
  - the implications of not conforming with the EnMS requirements
- In addition, you must ensure that the key personnel at your facility responsible for energy management have the technical competence required to do their job. For this purpose, you must
  - determine the necessary competence of person(s) doing work under control of your organization. These may include any sub-contractors working at your site as well.
  - ensure that these persons are competent based on appropriate education, training, skills, or experience
- It is recommended to following when planning for awareness and competence development
  - Clearly identify your training target groups
  - Decide on training/awareness raising objectives
  - Define expected learning outcomes
  - Select training methods and identify resources needed
  - Assess requirements and availability of trainers
  - Set training course dates, duration, agenda and venue, frequencies

- Establish methods for evaluation and follow-up of training results

- Develop a training needs matrix to summarise the identified needs. Refer to presentation of Module 10 LU10.2 for examples.
- Selection of appropriate mode of delivery is critical to the success of any training program. Consider using methodologies that help engage learners through action and result oriented learning rather than mere classroom lectures. Experiential Learning Cycle (ECL) is a good methodology to teach adults in an inclusive manner.

2.2.7 Step-6: Evaluate and integrate

Step-6: Evaluate and integrate		
Tasks	**Modules**	**Learning materials**
• Review and report results • Integrate results into your company and plan next (cycle of) steps	• Module 9: Monitoring and measurement of results •	• Presentation of Module 09 • Recorded Lecture of Module 09 (01 video) • Espire EnMS Maturity Matrix • Carbon Trust Energy Management Self-Assessment Tools

Task 6.1: Review and report results

- Now that implementation of majority measures has completed, the management would desire to know the results of implementation and corresponding savings in energy and cost.
- As per ISO 50001, there are two perspectives addressed by the internal audit, (i) energy management system elements and processes, and (ii) energy performance improvement.
    - Energy management system audits should be carried out to:
        - determine conformance of an EnMS with the EnMS audit criteria
        - determine whether the EnMS has been properly implemented and maintained
        - identify areas of potential improvement in the EnMS
        - assess the ability of the internal management review process to ensure the continuing suitability and effectiveness of the EnMS
        - evaluate the energy performance of the EnMS of an organization
        - evaluate whether the EnMS continues to meet the needs of the business
        - identify areas of conformity and nonconformity with respect to implementation of the EnMS system, and to ensure that corrective action is implemented
        - provide a basis for identifying opportunities and initiating actions to improve the EnMS
    - Energy performance audits should be carried out to:
        - evaluate the current energy performance of the system
        - evaluate the current baseline(s) and EnPIs. Higg FEM requires factories to demonstrate continual improvements compared to baselines. This is only possible if factories maintain the record of EnPIs for at least 3 years.
        - evaluate the response and investigation of significant deviations in energy performance
        - evaluate energy performance in energy planning activities such as objectives and targets
        - review resourcing of action plans and method of verification of energy performance improvement

- determine effectiveness of communication of energy performance
- determine effectiveness of operation and maintenance controls
- review considerations in design and procurement processes
- review projected energy performance and actual vs expected energy consumption. Recall the financial feasibility assessment you conducted at Step-4 (Task 4.3) and analyse the results again using same method which you used in Task 4.3 to compare the projected savings with actual results.

- Following figure presents example results compiled for a textile company.

Figure 21: Impact assessment at a textile company (example)

Summary of achieved savings

Actual Resource Saving	Total Energy (MWh/y)	28,200.68
	Electricity (kWh/y)	256,455.60
	Coal (Tonnes/y)	35,017.82
	Water (m3/y)	49,470.00
Annual Emission Reduction	tonneCO	100,373.89
Monetary Savings	US $/y	5,344,561.00
Investment	US $	471,539.00
Actual Payback Period	Months	1.06

Key Performance Indicators

Resources	KPI Units	Baseline	Post Implementation	% Reduction
Water	liters/kg production	196.0	96.71	50.7%
Electricity	kWh_e/kg production	1.36	0.72	47.1%
Steam	kg/kg production	9.87	6.15	37.7%
Energy	GJ/kg production	0.06	0.02	66.5%
GHG	kg/kg production	6.79	1.40	79.4%

- Corrective and preventive actions must be taken after the internal audits to avoid recurrence of the identified non-conformances and energy losses

Task 6.2: Integrate results into your company and plan next (cycle of) steps

- Now everything is in its place! It is time to engage the top management again to review overall performance, integrate results into the company management system and plan next cycle of steps. This review and planning may take place once or twice a year to that plan for whole next year is in place with renewed commitment and allocation of resources.
- Present your results of internal audit and achieved savings during the management review with proposals for improvement in EnMS and energy performance.
- Following table presents a checklist[7] for preparing for management review.

[7] 2011 Georgia Tech Research Corporation and U.S. Department of Energy

Table 6: Typical checklist for management review

Types of Information Needed by Management	Potential Sources of Information
What is the status of the energy management system?	• Action items from previous management reviews from records of management review • Energy review – Current energy performance • Energy review - Current significant energy uses • Measuring and monitoring – EnPIs • Energy objectives, targets, and action plans - Status of action plans • Evaluation of legal and other requirements – Evaluation results • Nonconforming, correction, corrective, preventive action - Status of correction, corrective, and preventive actions
What strategic changes or modifications are needed to the program direction we are taking (e.g., a policy change), if any?	• Energy policy - Review of the energy policy • Objectives, targets, action plans - Review of the objectives and targets • Legal and other requirements - Review of changes to legal requirements • Energy review –Review of energy sources and potential for renewable energy sources or other technologies
What changes are needed, expected, or have resulted in terms of energy performance?	• EnPIs • Measuring and monitoring – Results of measuring and monitoring of key characteristics of energy performance • Objectives, targets, and action plans - Status of action plans
Are there any changes in external requirements that will affect the energy management system?	• Changes in legal requirements • Changes in other requirements • Changes in stakeholder expectations
Are there any changes internally that will affect the energy management system?	• Internal audit results • Energy review – Review and update • Design – Planned changes • Procurement – Planned changes
Do the current measures provide the correct information?	• Review of current EnPIs • Review of current baseline • Review of actual versus expected energy consumption achieved
Is there a need to change, add, or delete any current improvement objective?	• Prioritized list of opportunities

What resources are needed for the energy management system?	• Recommendations of employees and stakeholders for improvement • Future energy consumption of the SEUs • Internal audit Schedule • Projected energy performance for the following period
Is the energy management system suitable for the organization?	• Energy policy – Review of the energy policy • Internal audit results • Changes in stakeholders' expectations • Status of the action plans and the actual vs. expected performance of those plans • Current performance of the facilities, systems, processes, and equipment
Is the energy management system working?	• Status of the action plans and the actual vs, expected performance of those plans • Current performance of the facilities, systems, processes, and equipment
Is the energy management system providing continual improvement in energy performance?	• Achievement of the objectives • Management of the SEUs • Measurement of the relevant variables

3 Useful links and references

Best Available Techniques (BAT) reference document in the textile industry	https://eippcb.jrc.ec.europa.eu/reference/textiles-industry
Best Available Techniques (BAT) reference document on Energy Efficiency	Energy Efficiency | Eippcb (europa.eu)
Eco-Mapping	www.sia-toolbox.net/solution/eco-mapping
EMAS "easy" for small and medium enterprises – DG for the Environment	https://op.europa.eu/en/publication-detail/-/publication/a46da1ae-edee-47aa-b871-d13baa946379
IFC Environmental, Health, and Safety Guidelines on Energy conservation	IFC EHS guidelines on Energy conservation
IFC Environmental, Health, and Safety Guidelines for Textile Manufacturing	IFC Environmental, Health, and Safety Guidelines for Textile Manufacturing
ISO 50001:2018 – Energy management system, Requirements with guidance for use	ISO 50001:2018 – Energy management system, Requirements with guidance for use
ISO50002:2014 Energy Audits — Requirements with Guidance for Use	ISO50002:2014 Energy Audits — Requirements with Guidance for Use
ISO 50004:2014 – Guidance for implementation, maintenance, and improvement of an energy management system	ISO 50004:2014 – Guidance for implementation, maintenance, and improvement of an energy management system
Prefeasibility study by GIZ on Evaluating renewable thermal energy options for textile and garments sectors in Bangladesh and Pakistan	Evaluating renewable thermal energy options for textile and garments sectors in Bangladesh and Pakistan - Prefeasibility study — Asia Garment Hub
SAC Higg FEM – Energy and GHG	How to Higg Guide – Energy & GHG section
UNIDO Sectoral Analysis on Renewable Energy and Energy Efficiency (Ceramic, Dairy, Foundry, Pulp & Paper, and Textile Sectors)	unidogefpakistan.org.pk/sites/default/files/UNIDO Sectoral Report.pdf
Video of Napo in Shocking situations	Napo in... Shocking situations - YouTube