Rapid diagnosis of low hanging fruits in low-carbon energy investment

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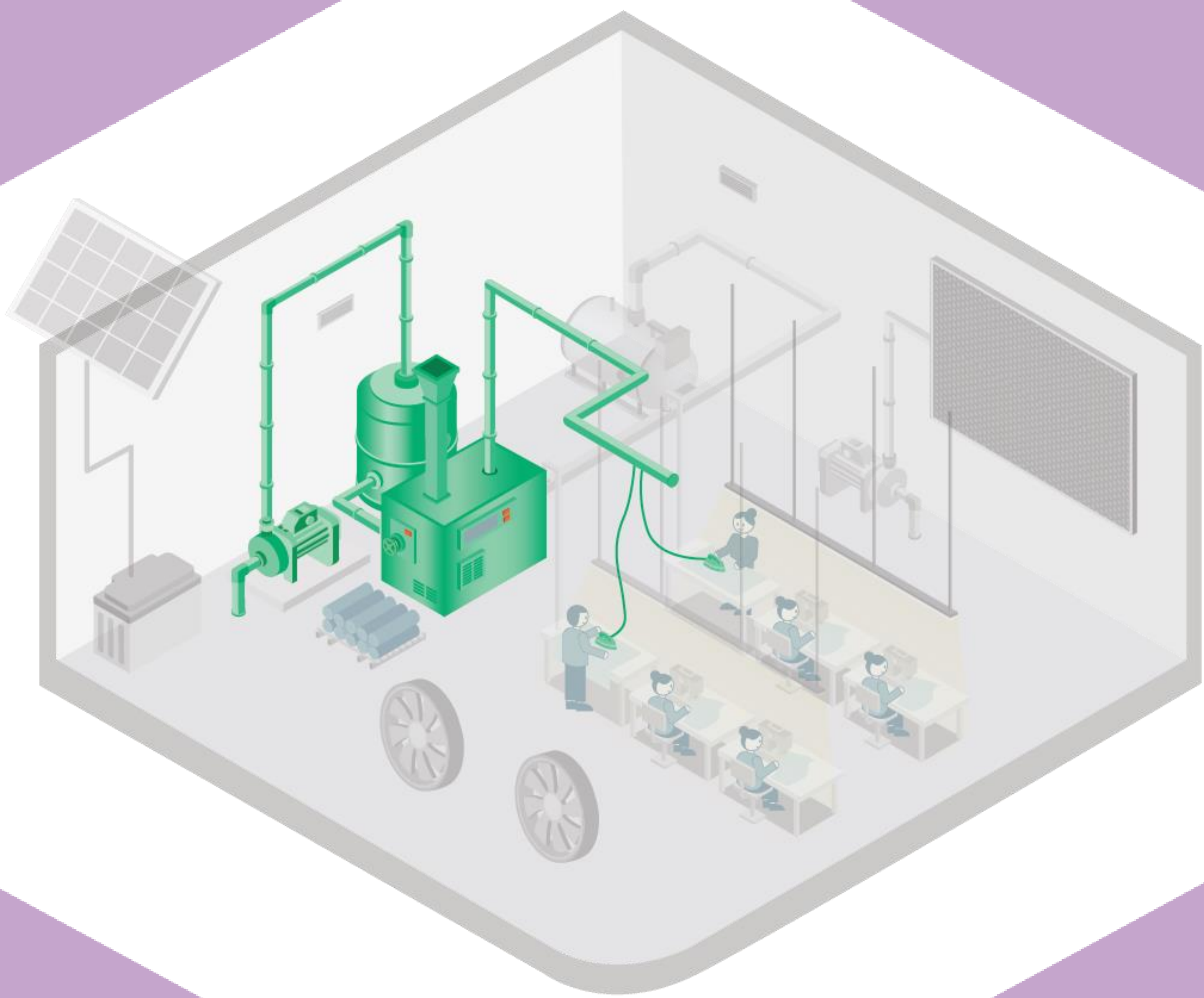


Chapter 1:

Boiler and Steam System

Introduction

A boiler is an enclosed vessel that provides a means for combustion heat to be transferred to water until it becomes heated water and steam. The hot water or steam under pressure is then usable for transferring the heat to the process. Water is a useful and cheap medium for transferring heat to a process. When water is boiled into steam, its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment that must be treated with the utmost care.

Boiler and Steam System

Following extensive energy audits in various Cambodian garment factories, nine key recommendations have emerged to enhance boiler and steam systems, as outlined in Annexure 1.

Recommendation 1:

Optimize the boiler processes

Issue: During the energy audit, several crucial observations were made regarding the factory's energy infrastructure. The factory utilizes wood-fired boilers for steam generation, and it was observed that the exhaust flue gases had elevated O2 levels, causing significant heat loss and reduced boiler efficiency. Additionally, uninsulated pipelines in the steam distribution system were identified, contributing to heat loss. The factory also utilizes electric steam boilers for ironing, and the study revealed that these boilers frequently operate at higher pressures than necessary, resulting in inefficiencies and energy waste.

Intervention: It was recommended for factories to install an O2 monitoring system in boilers, install a float-level switch, and optimise boiler pressure as needed.

Ironing machine designed for 0.2MPa

Impact: Implementing the recommended measures is expected to result in significant savings in fuel consumption, estimated to reduce it by more than 52,200 kWh of electric, 25.10 tonne of LPG and 43.56 tonne of wood, and calculated to be 52.22 tons of oil equivalent (toe) annually, as shown below*:

52.22 toe/y
Reduction in Equivalent Consumption

4,193 USD/y
Monetary Saving

46 tCO_2/y
GHG Emission Reduction

*The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 2:

Reduce the heat loss by using small wood logs

Issues: Presently, the factory utilizes large forest wood logs as a fuel source for its boiler. This choice of fuel presents certain challenges, primarily linked to incomplete combustion, which is signified by elevated carbon monoxide (CO) levels and higher oxygen (O2) levels. The use of larger wood logs leads to an inefficient air-fuel mix, resulting in incomplete fuel combustion within the boiler. It is crucial to understand that this incomplete combustion not only impacts boiler efficiency but also poses potential health hazards for the employees working in the boiler section. Hence, exploring alternative, more efficient fuel sources for the factory's heating needs becomes a primary objective.

Intervention: It was recommended that small wood logs (maximum size 30 to 50 mm), be used for better combustion and to reduce heat loss due to incomplete combustion.

Firewood logs

Impact: Implementing the suggested measures is anticipated to yield substantial wood consumption savings, estimated to reduce it by over 30.93 tonnes, equivalent to approximately 14.01 tonnes of oil equivalent (toe) annually, as shown below*:

14.01 toe/y
Reduction in Equivalent Consumption

972 USD/y
Monetary Saving

31.17 tCO_2/y
GHG Emission Reduction

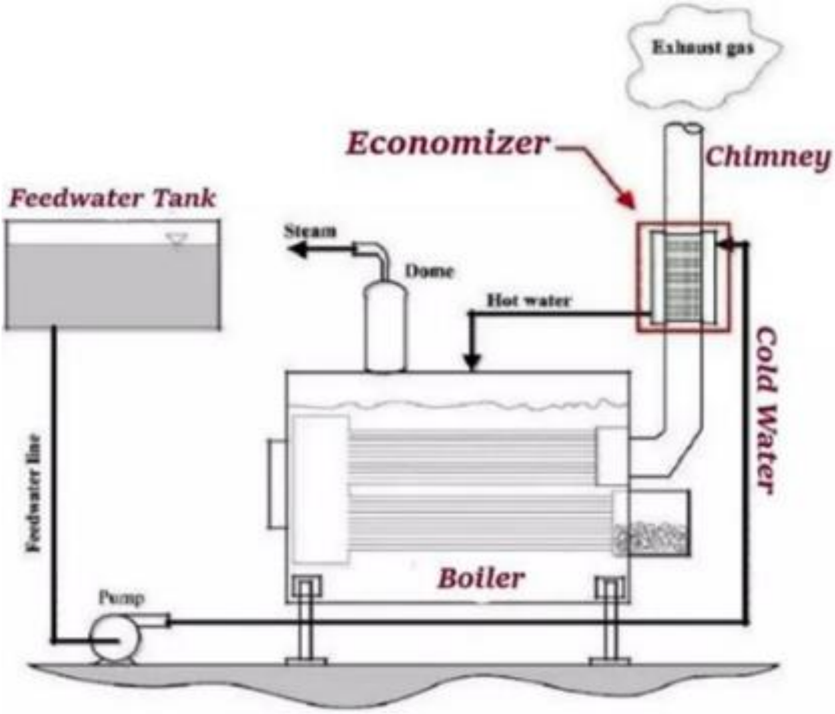
* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 3:

Installation of economizer to increase the feed water temperature

Issues: The wastage of flue gas temperature in the boiler highlights the need for installing an economizer. An economizer can recover this lost heat from the flue gas, improving energy efficiency and reducing operational costs, making it a sensible and cost-effective addition to the boiler system.

Intervention: The waste heat in flue gases can be recovered by incorporating an economizer before the ID fan. Economizers must be sized for the volume of flue gas, its temperature, the maximum pressure drop allowed through the stack, the type of fuel used, and the quantity of energy that needs to be recovered.



Economizer

Impact: Implementing the suggested measures is anticipated to yield substantial wood consumption savings, estimated to reduce it by over 17.7 tonnes, equivalent to approximately 8.01 tonnes of oil equivalent (toe) annually, as shown below*:

8.01 toe/y	**742 USD/y**	**18 tCO_2/y**
Reduction in Equivalent Consumption	Monetary Saving	GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 4:

Reduce the heat loss due to moisture by using dried firewood

Issues: Utilizing moist or wet wood for burning in a boiler leads to a range of issues, including reduced combustion efficiency, increased emissions, creosote buildup, diminished heat output, potential damage to equipment, resource waste, and regulatory non-compliance.

Intervention: To mitigate these concerns, it is imperative to ensure that wood fuel is adequately seasoned and dried to the appropriate moisture content (moisture<20%). Implementing moisture control systems, adhering to best practices in wood fuel storage and handling, and prioritizing combustion efficiency measures are essential for enhancing boiler performance, reducing emissions, and maintaining compliance with environmental regulations and air quality standards.

Firewood

Impact: Implementing the suggested measures is anticipated to yield substantial wood consumption savings, estimated to reduce it by over 29.9 tonnes, equivalent to approximately 13.3 tonnes of oil equivalent (toe) annually, as shown below*:

13.3 toe/y

Reduction in Equivalent Consumption

885 USD/y

Monetary Saving

30.5 tCO_2/y

GHG Emission Reduction

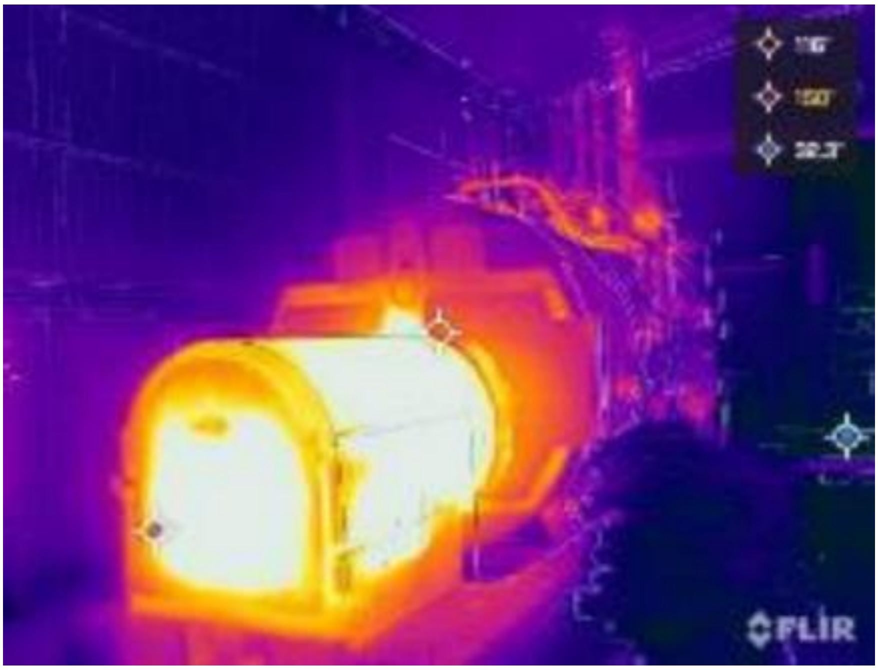
*The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 5:

Boiler insulation front surface to avoid heat loss

Issues: In the boiler system, notable variations in curing oven surface temperatures across different zones underscore significant energy inefficiencies. These discrepancies reveal substantial energy wastage stemming from radiation and heat losses from the boiler's surface, contributing to reduced operational efficiency and increased energy costs.

Intervention: It’s recommended to do the relining of the furnace, use a nano protective coating, and insulate the curing oven with an aluminium foil air bubble insulation sheet to reduce radiation losses and improve the working condition. And insulate the boiler during shut-down or maintenance periods either with glass wool or prefabricated insulation blocks.



Temperature profile of boiler

Impact: Implementing the suggested measures is anticipated to yield substantial wood consumption savings, estimated to reduce it by over 11.4 tonnes, equivalent to approximately 6.72 tonnes of oil equivalent (toe) annually, as shown below*:

6.72 toe/y

Reduction in Equivalent Consumption

640 USD/y

Monetary Saving

9.1 tCO_2/y

GHG Emission Reduction

*The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 6:

Insulation Pipelines

Issues: Uninsulated pipelines within a boiler system network led to a range of issues, including substantial heat loss, increased energy consumption, operational inefficiencies, a lack of temperature control, compromised reliability of heat and steam supply, and potential safety hazards for personnel working in the vicinity.

Intervention: Addressing these concerns through proper insulation measures enhances energy efficiency, reduces costs, ensures consistent system performance, and compliance with safety standards.

Impact:

Uninsulated fuel gas duct

Jacket insulation

Implementing the suggested measures is anticipated to yield substantial wood consumption savings, estimated to reduce it by over 3.47 tonnes, equivalent to approximately 1.54 tonnes of oil equivalent (toe) annually, as shown below*:

1.54 toe/y

Reduction in Equivalent Consumption

113 USD/y

Monetary Saving

3.5 tCO_2/y

GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 7:

Installation of condensate recovery system

Issues: The absence of a condensate recovery system in a boiler setup leads to significant issues, including the wastage of valuable energy and water resources. Without this system, the heat energy contained in the condensate is lost, resulting in lower energy efficiency and increased operational costs. Additionally, the continual loss of water resources places strain on water supplies and adversely affects environmental sustainability.

Intervention: Installing a condensate recovery system is crucial not only for improving energy efficiency and reducing operational expenses but also for conserving water resources, reducing the environmental impact, and promoting responsible resource utilization, making it a key component in a sustainable and cost-effective boiler operation.

Condensate discharges out

Impact: Implementing the suggested measures is anticipated to yield substantial wood consumption savings, estimated to reduce it by over 23.51 tonnes, equivalent to approximately 10.46 tonnes of oil equivalent (toe) annually, as shown below*:

10.46 toe/y

Reduction in Equivalent Consumption

783 USD/y

Monetary Saving

24 tCO_2/y

GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 8:

Optimization of combustion efficiency

Issues: In the context of garment factories, common issues arise in the wood-fired steam boiler system. These issues include excess air leading to additional fuel consumption due to air infiltration through compromised doors and FD fans, often caused by broken locks and improper damper wane closure. Furthermore, while belt drives are installed to prevent stress on induced draft fans, discrepancies in the speed of the ID fan and the size of the connected motor's pulley have been observed.

Intervention: It was suggested to install a VFD for the ID fan for precise control and flexibility. And install an inlet guide vane control (IGV) to regulate the air flow rate. The new IGV can be used for capacity regulation as per requirement, which minimises the present pressure drop. Additionally, the factory should install an Air Fuel Ratio Controller to enhance combustion control with various burner control boxes, allowing for multi-element control, fan speed monitoring, and oxygen trim for improved burner efficiency.

Present door position and suggested door position

Impact: Implementing the recommended measures is anticipated to yield substantial energy savings, estimated to reduce electricity consumption by over 3,279 kWh, liquid petroleum gas (LPG) by 2.8 tonnes, wood consumption by 206.1 tonnes, and calculated to be equivalent to 95.12 tonnes of oil equivalent (toe) annually, as detailed below*:

95.12 toe/y

Reduction in Equivalent Consumption

11,400 USD/y

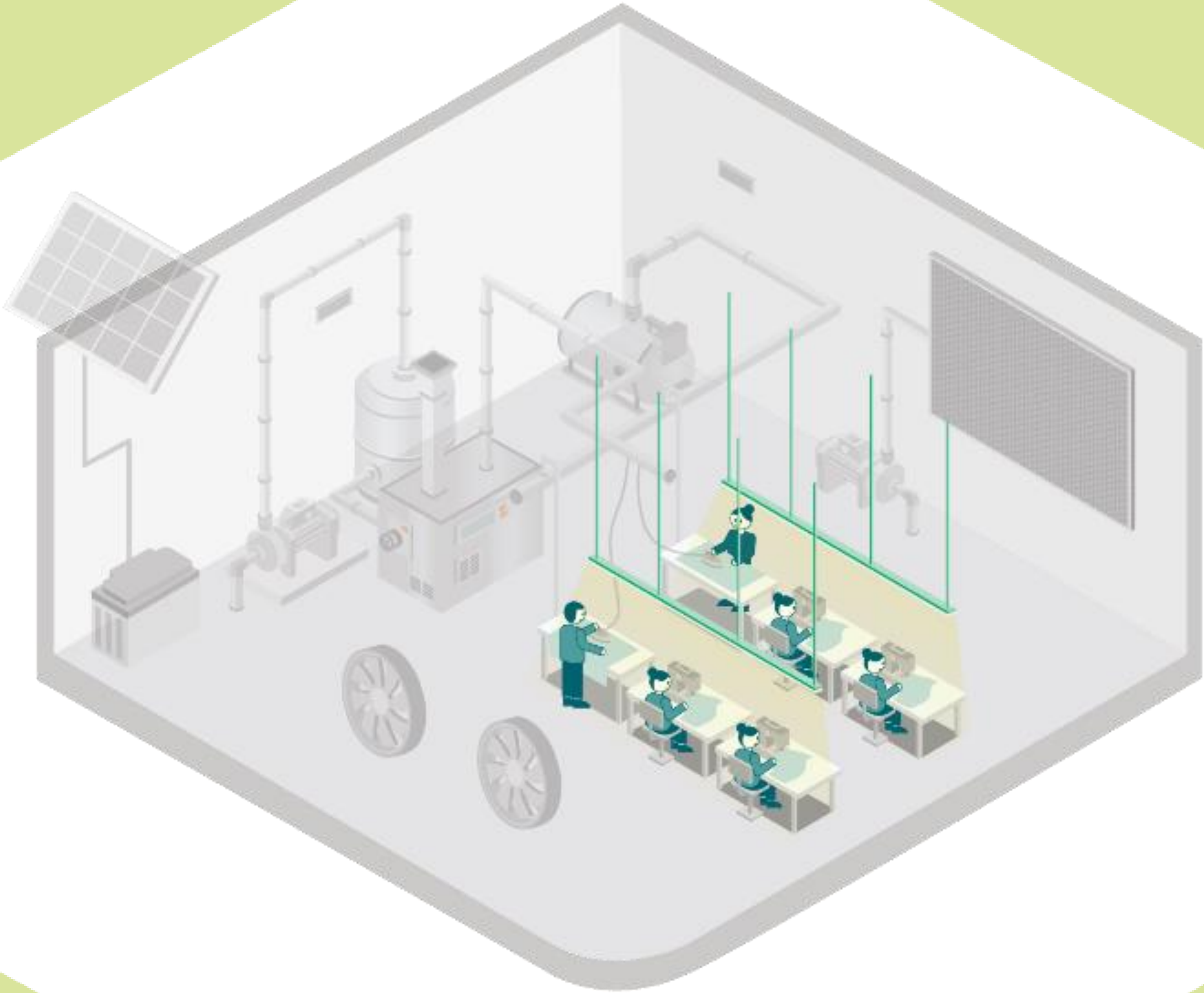
Monetary Saving

96.8 tCO_2/y

GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

2 LIGHTING SYSTEM



Chapter 2:

Lighting System

Introduction

Most natural light comes from the sun, including moonlight. Its origin makes it completely clean, and it consumes no natural resources. But man-made sources generally require the consumption of resources, such as fossil fuels, to convert stored energy into light energy.

Lighting System

Following extensive energy audits in various Cambodian garment factories, five key recommendations have emerged to enhance lighting systems, as outlined in Annexure 2.

Recommendation 1

Installation of solar lights for outdoor lighting

Issues: Some factories have not yet adopted any renewable energy technologies. The absence of solar lighting systems in a garment factory results in increased energy costs, heightened environmental impact from carbon emissions, and missed opportunities for energy efficiency and cost savings. Installing solar lighting not only reduces reliance on conventional energy sources but also aligns with sustainability goals, lowering operational expenses and enhancing the factory's eco-friendliness.

Intervention: Factories are encouraged to consider the implementation of solar lighting, especially for outdoor illumination, in order to enhance the contribution of renewable energy sources to the overall energy mix. This initiative not only reduces the reliance on artificial lighting and conventional electricity but also promotes sustainability and energy efficiency.

Outdoor Solar Light

Impact: Implementing the suggested measures is anticipated to yield substantial electricity consumption savings, estimated to reduce it by over 2,744 kWh, equivalent to approximately 0.23 tonnes of oil equivalent (toe) annually, as shown below*:

0.23 toe/y
Energy Saving

395 USD/y
Monetary Saving

24 tCO_2/y
GHG Emission Reduction

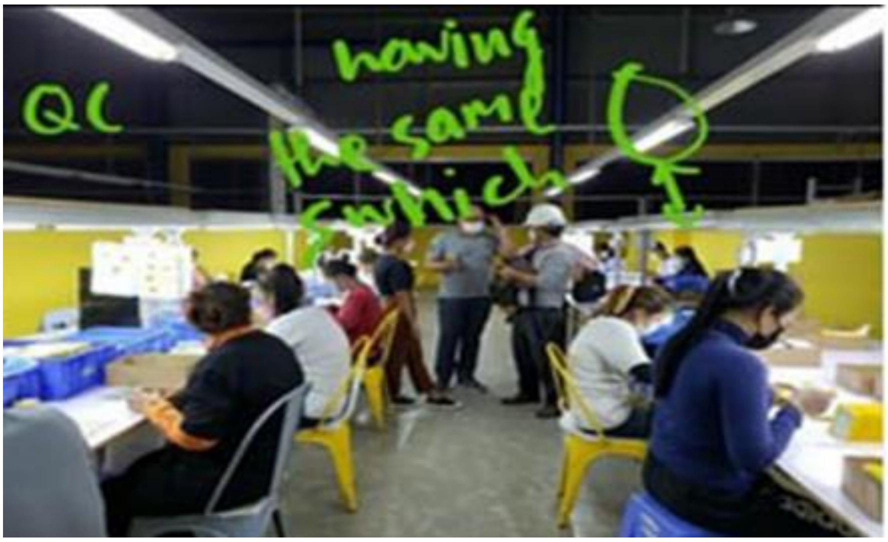
* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 2

Installation of local level lighting control

Issues: Throughout the audit period, it was noted that the process section is equipped with shared lighting control switches, leading to a situation where lights remain illuminated even in the absence or partial utilization of workstations. The absence of dedicated ON/OFF switches at individual workstations contributes to increased electricity consumption.

Intervention: The recommendation for the factory is to install a local-level lighting controller in the process section to enable the efficient switching off of point-of-use lighting.



Common lighting system

Impact: Implementing the suggested measures is anticipated to yield substantial electricity consumption savings, estimated to reduce it by over 1,500 kWh, equivalent to approximately 0.13 tonnes of oil equivalent (toe) annually, as shown below*:

0.13 toe/y
Energy Saving

270 USD/y
Monetary Saving

0.9 tCO_2/y
GHG Emission Reduction

*The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 3

Switch off light in non-operational area

Issues: During the audit period, it was noted that a few areas of the factory can reduce illumination level: the area between the sewing lines and finishing section.

Intervention: It is recommended for factories to switch off lights in non-operational areas where lighting can be reduced.

Proposed de-lamping area

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 2,074 kWh equivalent to 0.18 tonne of oil equivalent (toe) annually, as shown below*:

0.18 toe/y
Energy Saving

290 USD/y
Monetary Saving

1.35 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

3 SPACE CONDITIONING SYSTEM

Chapter 3:

Space Conditioning/Ventilation system

Introduction

A space conditioning system is a system that provides heating or cooling within or associated with conditioned space in a building and may incorporate components such as chillers or compressors, fluid distribution systems (e.g., air ducts, water piping, refrigerant piping), pumps, air handlers, cooling and heating coils, air- or water-cooled condensers, economizers, terminal units, and associated controls.

Space Conditioning System

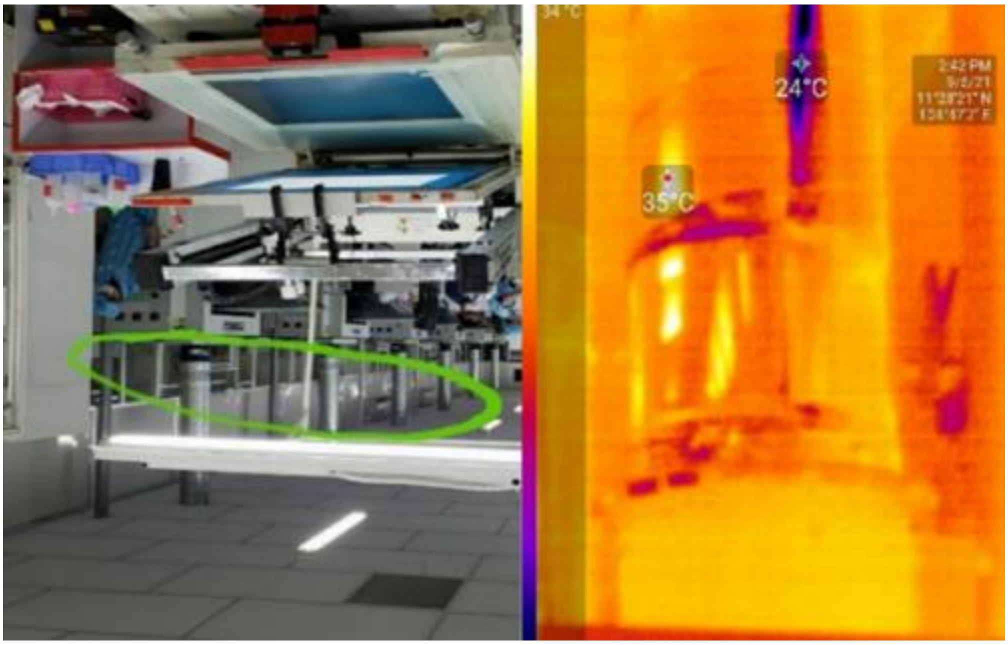
Following extensive energy audits in various Cambodian garment factories, six key recommendations have emerged to enhance space conditioning / ventilation systems, as outlined in Annexure 3.

Recommendation 1

Insulating hot pipe surface to avoid heat dissipation in the work space

Issues: The factory has installed exhaust pipes in auto printing machines to remove the heat generated. The hot surfaces of these exhaust pipes are exposed to the air-conditioned workspace, dissipating a significant quantity of heat.

Intervention: It is recommended to provide suitable insulation on the outer surface of the exhaust pipes to avoid heat dissipation inside the air-conditioned workspace. Insulation of the hot pipe surface will not only reduce energy consumption but also improve the comfort level and working conditions of the section.



Thermal image of exhaust pipes

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 970 kWh equivalent to 0.08 tonne of oil equivalent (toe) annually, as shown below*:

0.08 toe/y
Energy Saving

200 USD/y
Monetary Saving

0.6 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 2

Building optimization

Issues: The factory installed a false ceiling to improve worker comfort, but this increased air-cooling demand necessitates full-capacity air coolers and pumps. Exit doors, often opened, release hot and dusty air, violating garment industry regulations and allowing the factory to close them during working hours. Another point is that the factory offers various ventilation systems for the process section hall, but workers experience discomfort due to increased roofing temperatures above 40 ^{O}C due to a lack of insulation.

Intervention: Recommendations include lowering the false ceiling height to 3.5 metres, installing thick PVC strip curtains at exit doors to enhance air cooler system performance and decrease energy consumption, and installing insulation for the roofing, specifically aluminium foil air bubble insulation, to enhance comfort, operational efficiency, and reduce cooling requirements.

PVC strip curtain

Roofing Insulation

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 5,863 kWh equivalent to 0.5 tonne of oil equivalent (toe) annually, as shown below*:

0.5 toe/y
Energy Saving

821 USD/y
Monetary Saving

3.8 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 3

Switch off identified air cooler fans

Issues: The factory installed air cooler fans near the washing machines, and all the washing machines are located near the exit doors. It was observed that relatively few employees work in this area, and the number of air-cooling fans is more than required, causing waste of energy.

Intervention: It is recommended to reduce the operation of the air cooler fans or turn off at least three numbers of air cooler fans.

Air cooler fans in washing area

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 9,360 kWh equivalent to 0.8 tonne of oil equivalent (toe) annually, as shown below*:

0.8 toe/y
Energy Saving

1,404 USD/y
Monetary Saving

6.1 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 4

Operate the cooling water pumps and optimise the water circulation system

Issues: The factory has installed water pumps, but it was observed that some were running and others were on standby. At the same time, it was also observed that water pumps operate continuously despite having no control over their operation, and the valves in the water pipeline were fully open.

Intervention: It was recommended to install a relative humidity sensor controller for pumps to monitor conditions and adjust pump operation. This sensor sends feedback when humidity exceeds set levels, reducing energy consumption and running pumps until the desired conditions are met. And it is recommended to fully close the valve.

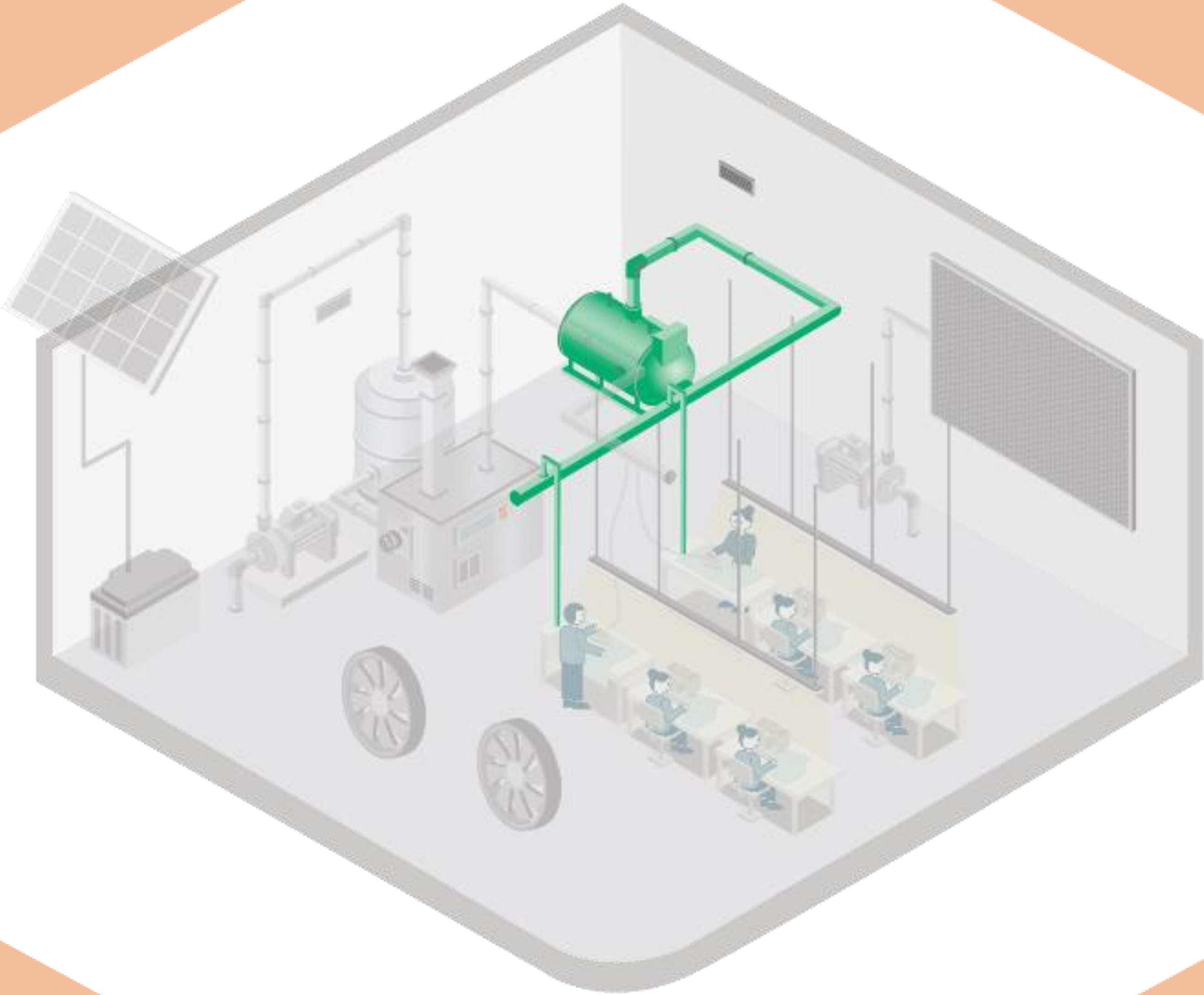
Water Pumps System

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 2,408 kWh equivalent to 0.21 tonne of oil equivalent (toe) annually, as shown below*:

0.21 toe/y	**413 USD/y**	**1.6 tCO_2/y**
Energy Saving	Monetary Saving	GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

4 AIR COMPRESSOR SYSTEMS



Chapter 4:

Compressed Air System

Introduction

Air compressors account for a significant amount of electricity used in the industry. Air compressors are used in a variety of industries to supply process requirements, to operate pneumatic tools and equipment, and to meet instrumentation needs. Only 10-30% of energy reaches the point of use-end, and balance 70-90% of energy of the power of the prime mover being converted to unusable heat energy and to a lesser extent lost in form of friction, misuse and noise.

Air Compressor System

Following extensive energy audits in various Cambodian garment factories, nine key recommendations have emerged to enhance Compressed Air Systems, as outlined in Annexure 4.

Recommendation 1

Installation of auto drain valve for air receiver tank

Issues: During the audit period, it was found that the air receiver tank installed for the air compressor did not have an automatic drain valve to remove condensate instantly. Currently, factory personnel drain the receiver tank manually prior to starting the compressors. However, after a few hours of compressor operation, the receiver tank will be filled with condensate. With condensate, the receiver tank's available volume decreases, resulting in frequent loading and increased power consumption. Also, the water from the receiver tank will carry forward to the dryer, increasing the dryer load.

Intervention: It was recommended that the air receiver tank be equipped with an automatic drain valve. It instantly removes water condensate, reduces the air dryer, and lowers the energy consumption of the air compressor.

Air receiver tank-sewing section

Example of audit drain valve

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 2,332 kWh equivalent to 0.2 tonne of oil equivalent (toe) annually, as shown below*:

0.2 toe/y

Energy Saving

321.83 USD/y

Monetary Saving

1.52 tCO_2/y

GHG Emission Reduction

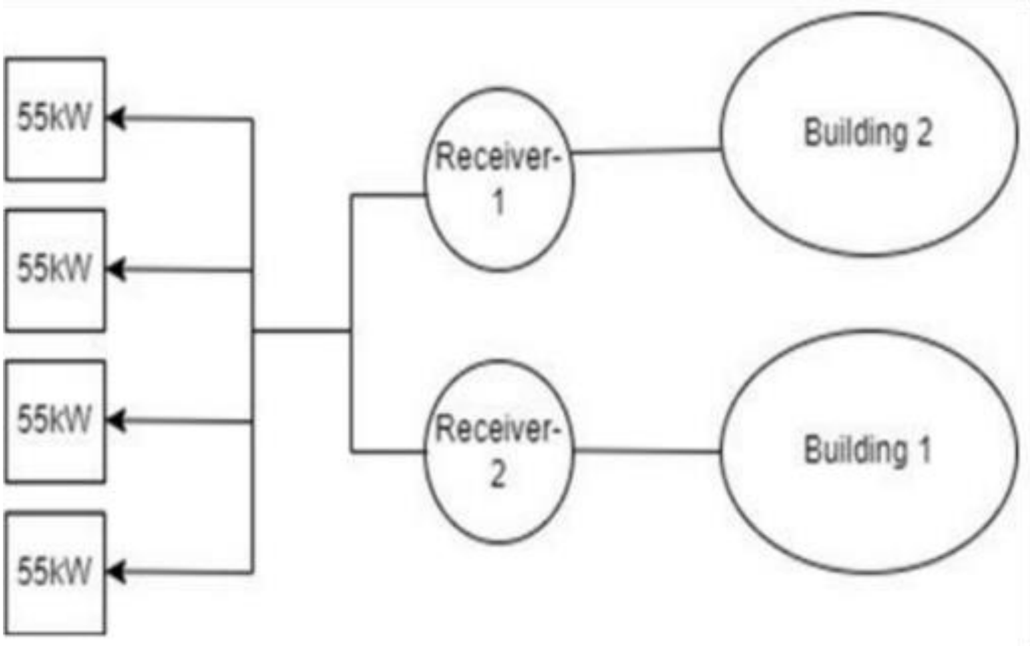
* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 2

Centralised air distribution system

Issues: The factory's compressor, which is energy-consuming and outdated, consumes power during unloading but fails to deliver air, leading to high leakage and high-power consumption.

Intervention: It is proposed to centralise the entire air distribution network for both factories by looping all compressor pipelines into a single system. The other two compressors can serve as standby compressors.



Example-Proposed compressed air system

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 41,040 kWh equivalent to 3.53 tonne of oil equivalent (toe) annually, as shown below*:

3.53 toe/y
Energy Saving

5,746 USD/y
Monetary Saving

26.7 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 3

Provide pressure regulation for the sewing area compressor

Issues: Compressed air is used in printing and fabric cleaning lines. The cleaning lines are equipped with an air blow gun, and it was observed that there was increased leakage at pipe joints, valves, and other locations. The majority of flexible lines are incapable of withstanding high pressures, and the set pressures on sewing machines were discovered to operate at a higher pressure than needed. Another problem observed is that the increased air pressure requirements of other equipment such as heat transfer and cutting machines, as well as the high air leakage in the compressed air line, lead to the tapping lines being under extremely high pressure.

Intervention: To cut down on air consumption, it is recommended to install a pressure regulator and set it to the needed level for the sewing lines and the cleaning lines. And reduce the pressure setting to unload and load as needed.

Compressed air tapping for sewing machines and cleaning lines

Issues: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 10,383 kWh equivalent to 0.89 tonne of oil equivalent (toe) annually, as shown below*:

0.89 toe/y
Energy Saving

1,422 USD/y
Monetary Saving

6.7 tCO_2/y
GHG Emission Reduction

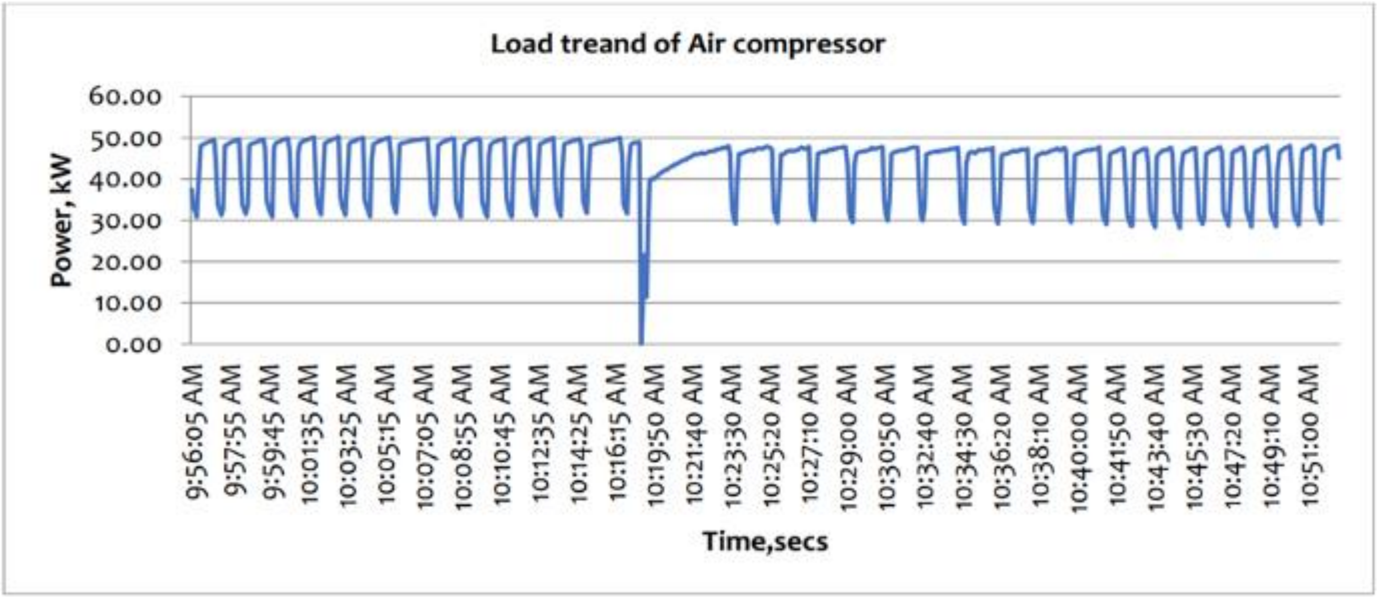
* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI

Recommendation 4

Installation of VFD for compressor

Issues: During the study of the air compressor, it was observed that there is continuous loading and unloading of the air compressor based on the set pressure. Due to continuous loading and unloading, specific energy consumption will be on the higher side. And during the unloading period, the compressor consumes power but does not deliver air.

Intervention: The recommendation is to install a VFD, set the compressor's maximum running frequency as needed to reduce unloading power consumption, and operate the compressor speed reduction at a compatible speed.



Example-Load trend of air compressor

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 13,010 kWh equivalent to 1.12 tonne of oil equivalent (toe) annually, as shown below*:

1.12 toe/y
Energy Saving

1,820 USD/y
Monetary Saving

8.5 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 5

Better use of compressed air equipment

Issues: The factory has installed air compressors with variable-frequency drives. It was observed that the compressor operates at a reduced speed due to low demand, resulting in wasted power consumption during the unload period. Additionally, it was noticed that the factory has installed a new, efficient absorption dryer in series with the faulty and old refrigerant dryer, causing a pressure drop. And the air is leaked at various machines like hot stamps, auto cutting, and Kaigu Heater M/C Bldg.

Intervention: To prevent leakage, it's suggested to isolate machines, shift loads to one compressor, bypass faulty refrigerant dryers, and provide additional receivers to reduce energy consumption and unload time.

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 5,973 kWh equivalent to 0.51 tonne of oil equivalent (toe) annually, as shown below*:

0.51 toe/y
Energy Saving

836 USD/y
Monetary Saving

3.9 tCO_2/y
GHG Emission Reduction

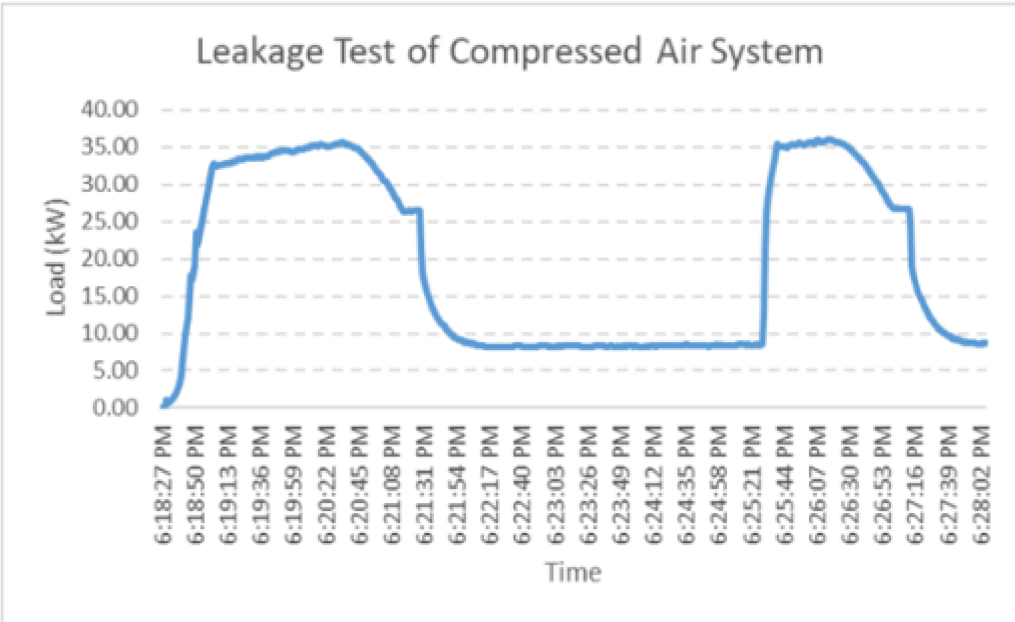
* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 6

Check and repair distribution leakages

Issues: The audit revealed that compressed air is wasted due to compressed air leakage, which was observed at various junction points, valves, and supply valves in the distribution network, with the receiver auto-drain valve being open. The rate increases with supply pressure and orifice diameter. The current hose can't withstand more than 0.60 MPa. This can affect system operations, operational efficiency, productivity, and compressor capacity, leading to higher costs and maintenance.

Intervention: It was recommended that by installing suitable application-specific nozzles, adopting suitable periodic maintenance practices, and undertaking a regular inspection of the distribution network, it would be possible to reduce the air leakages significantly. The permissible limit for leakage is about 10% of the total compressed air generated.



Example-Load profile of air compressor during leakage test

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 27,209 kWh equivalent to 2.34 tonne of oil equivalent (toe) annually, as shown below*:

2.34 toe/y

Energy Saving

3,833 USD/y

Monetary Saving

17.7 tCO_2/y

GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 7

Providing proper ventilation in air compressor room

Issues: During the audit of the air compressor, it was found that the air compressor temperature was higher than the ambient air temperature, resulting in higher energy consumption. Additionally, hot air from the cooler exhaust is not venting properly, causing higher energy consumption, potentially reducing the life of the equipment, and causing tripping.

Intervention: It is recommended to provide cool air intake through the installation of a proper exhaust duct for the hot air generated by the compressor cooler fan. With these measures, the factory can reduce the use of exhaust fans or limit the use of exhaust fans with proper temperature control.

Exhaust fans provided for compressor

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 9,238 kWh equivalent to 0.79 tonne of oil equivalent (toe) annually, as shown below*:

0.79 toe/y
Energy Saving

1,410 USD/y
Monetary Saving

6 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 8

Reducing delivery pressure of the air compressor

Issues: The audit of the compressed air system revealed that air compressors have higher pressure settings with cut-in and cut-off pressures, affecting compressor and motor life.

Intervention: So, it is suggested to optimize the pressure setting as needed by compressors for cut-off and cut-in.

Present pressure setting

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 5,610 kWh equivalent to 0.48 tonne of oil equivalent (toe) annually, as shown below*:

0.48 toe/y
Energy Saving

1,003 USD/y
Monetary Saving

3.6 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

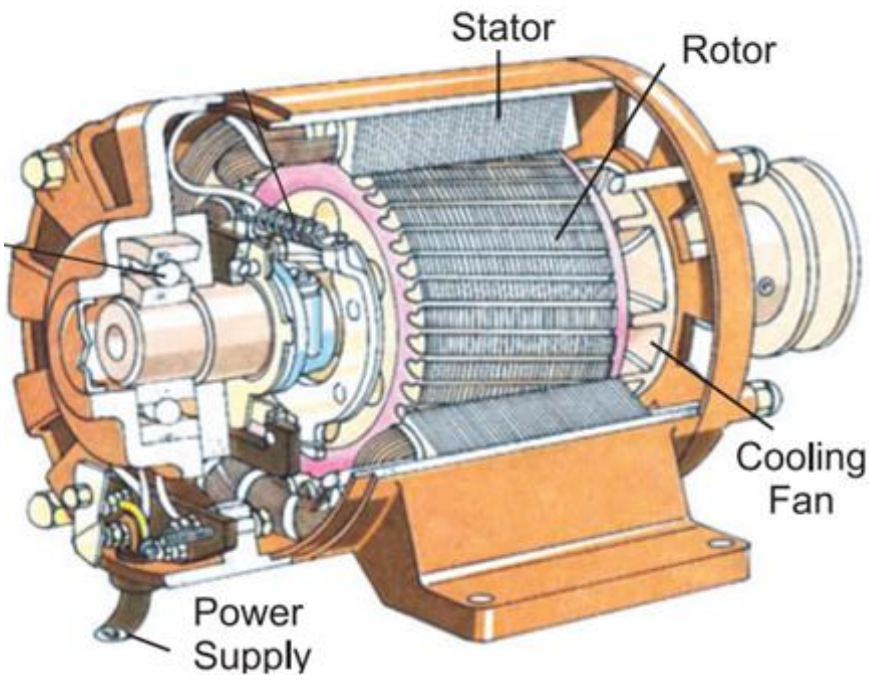
5 MOTORS

Chapter 5:

Motors

Introduction

Motors convert electrical energy into mechanical energy through the interaction between the magnetic fields set up in the stator and rotor windings. Electric motors can be broadly classified as induction motors, direct current motors, or synchronous motors. All motor types have the same four operating components: stator (stationary windings), rotor (rotating windings), bearings, and frame (enclosure). Mechanical energy is used to rotate the pump impeller, fan, and blower. Moreover, the energy generated by the motor could be used to drive compressors as well as lift materials. It is estimated that about 70% of the total electrical load is accounted for by motors only.



Motor

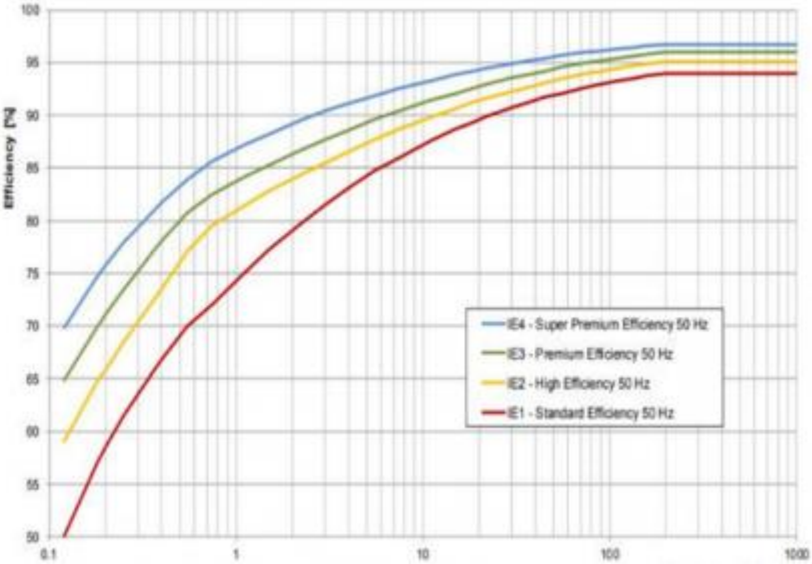
Following extensive energy audits in various Cambodian garment factories, three key recommendations have emerged to enhance Motos, as outlined in Annexure 5.

Recommendation 1

Installation of high efficiency class (IE3/IE4) motors

Issues: The motors installed in the factories are of standard efficiency (IE1 or equivalent). High- or premium-efficiency motors are usually manufactured from materials that incur lower energy losses compared with standard motors. Further to this, the operating efficiency of the motors decreases under partial load and overload conditions.

Intervention: The recommendation is to replace the existing inefficient motors with optimally loaded, energy-efficient Premium Efficiency (IE3) motors or super-premium efficiency class (IE4) motors of appropriate size.



Example-Motor efficiency chart

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 8,022 kWh equivalent to 0.69 tonne of oil equivalent (toe) annually, as shown below*:

0.69 toe/y
Energy Saving

1,161 USD/y
Monetary Saving

5.2 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Recommendation 2

Avoid idle operation with sensor or foot switch

Issues: The factory has installed steam-ironing tables. The ironing table has a suction/vacuum blower to remove hot and humid air. A foot-operated switch is also provided to control the suction blower's operation, but it was found that most machines bypass the foot switch for the operator's convenience. It causes an increase in suction blowers' idle operating time. Another point observed was that the idle operation of the reverse fan was higher.

Intervention: To prevent idle suction blowers, foot-operated switches or optical position sensors should be installed on ironing tables. The sensor monitors the ironing box's position, activating the suction blower if it's moved. And also, it was recommended to install a proximity sensor with a time delay for the reverse fan.

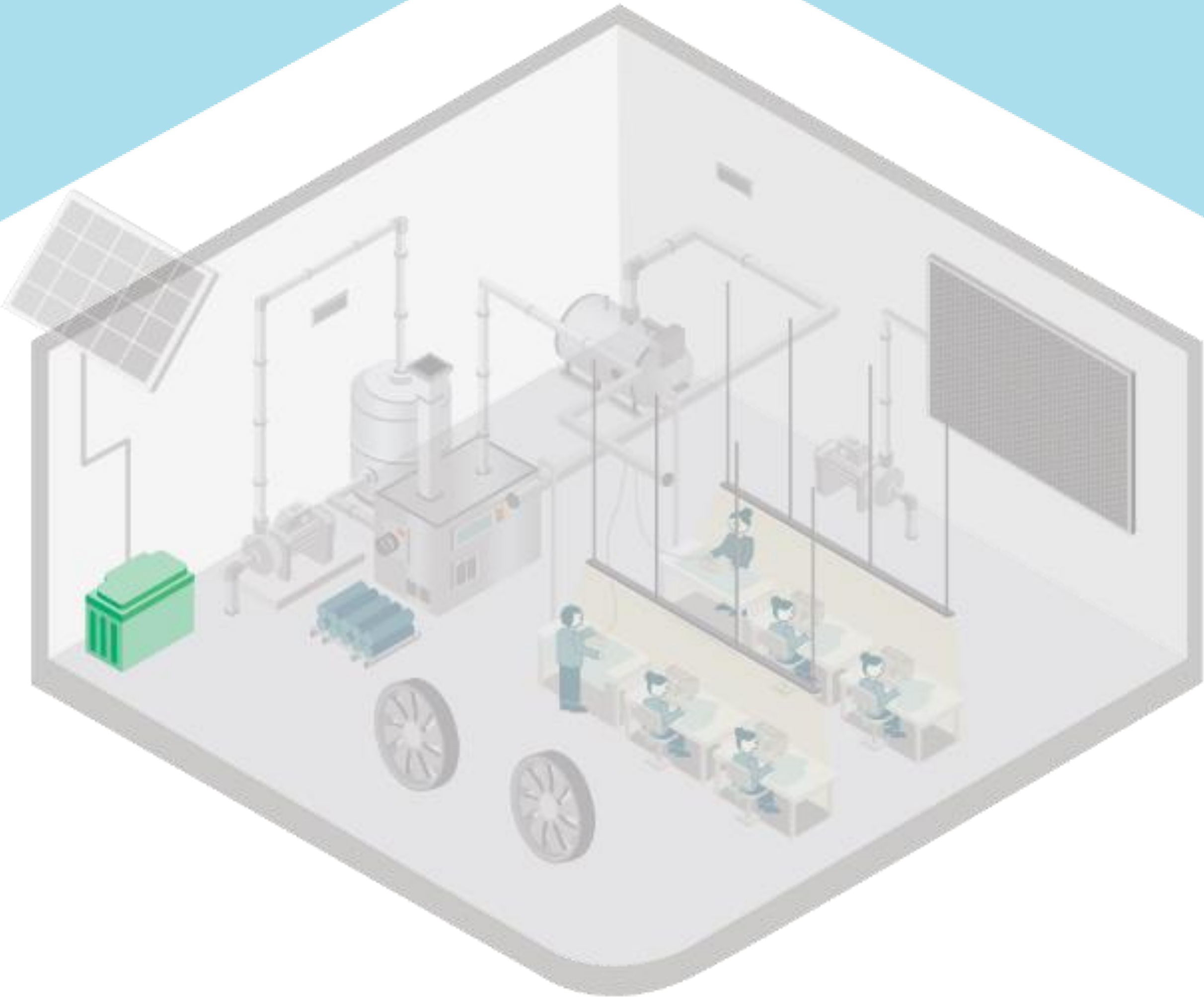
Foot operating switch for ironing table section blower

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 8,320 kWh equivalent to 0.72 tonne of oil equivalent (toe) annually, as shown below*:

0.72 toe/y	**1,190 USD/y**	**5.4 tCO_2/y**
Energy Saving	Monetary Saving	GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

6 ELECTRICAL SYSTEMS

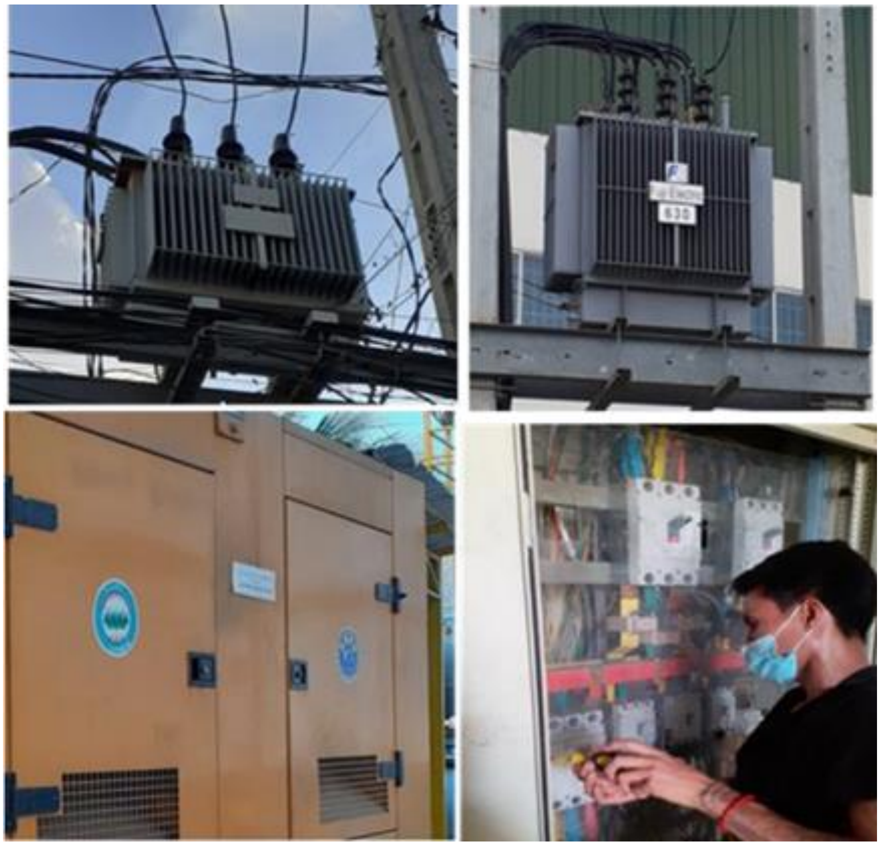


Chapter 6:

Electrical System

Introduction

An electrical system is the transmission of voltage from a power plant to a power storage point and distribution line that delivers the electricity to consumers. An example of a power system is the electrical grid, which provides power to homes and industries within an extended area. Electricity is used for lighting, heating, cooling, and refrigeration, as well as for operating appliances, computers, electronics, machinery, and public transportation systems.



Electric System

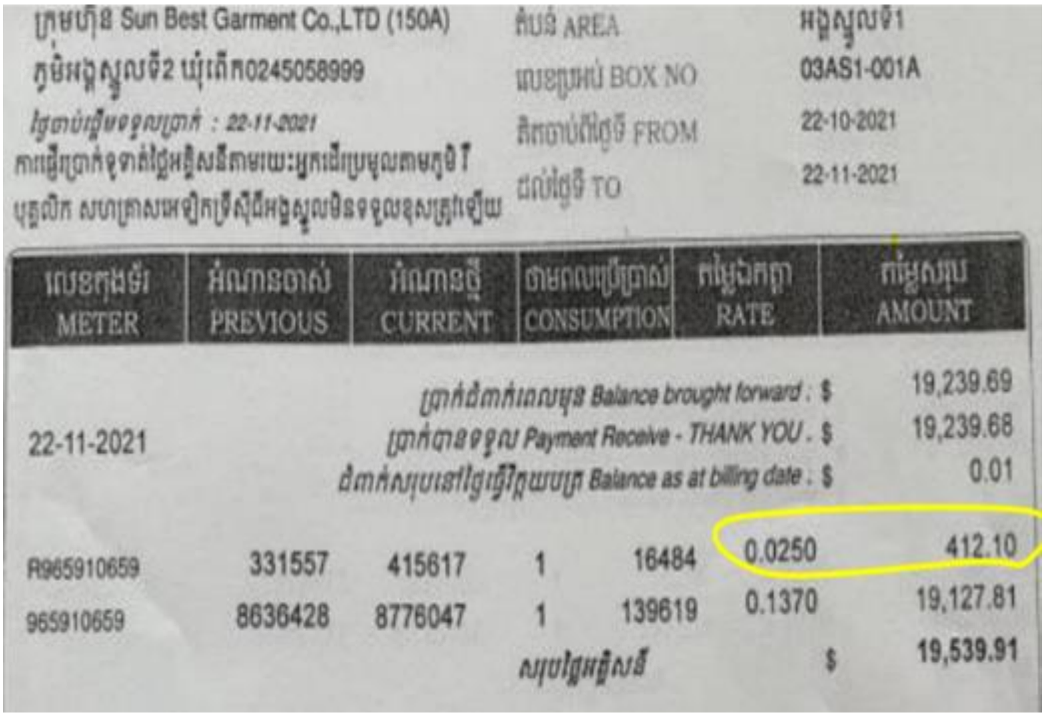
Following extensive energy audits in various Cambodian garment factories, four key recommendations have emerged to enhance Electrical System, as outlined in Annexure 6.

Recommendation 1

Improved the power factor at incomer level

Issues: The factory installed a capacitor bank with APFC to improve power factor and avoid penalties. The factory has been paying penalties for the power factor not maintaining a lag above 0.90.

Intervention: Replace faulty capacitors and the APFC, reconnect to the receiver, and operate the APFC in auto mode to avoid the PF penalty.


Sun Best Garment Co.,LTD (150A)
AREA
BOX NO 03AS1-001A
FROM 22-10-2021
TO 22-11-2021

METER	PREVIOUS	CURRENT		CONSUMPTION	RATE	AMOUNT
22-11-2021				Balance brought forward : $		19,239.69
				Payment Receive - THANK YOU . $		19,239.68
				Balance as at billing date . $		0.01
R965910659	331557	415617	1	16484	0.0250	412.10
965910659	8636428	8776047	1	139619	0.1370	19,127.81
				$		19,539.91

Example-Electricity bill

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 10,478 kWh equivalent to 0.9 tonne of oil equivalent (toe) annually, as shown below*:

0.9 toe/y
Energy Saving

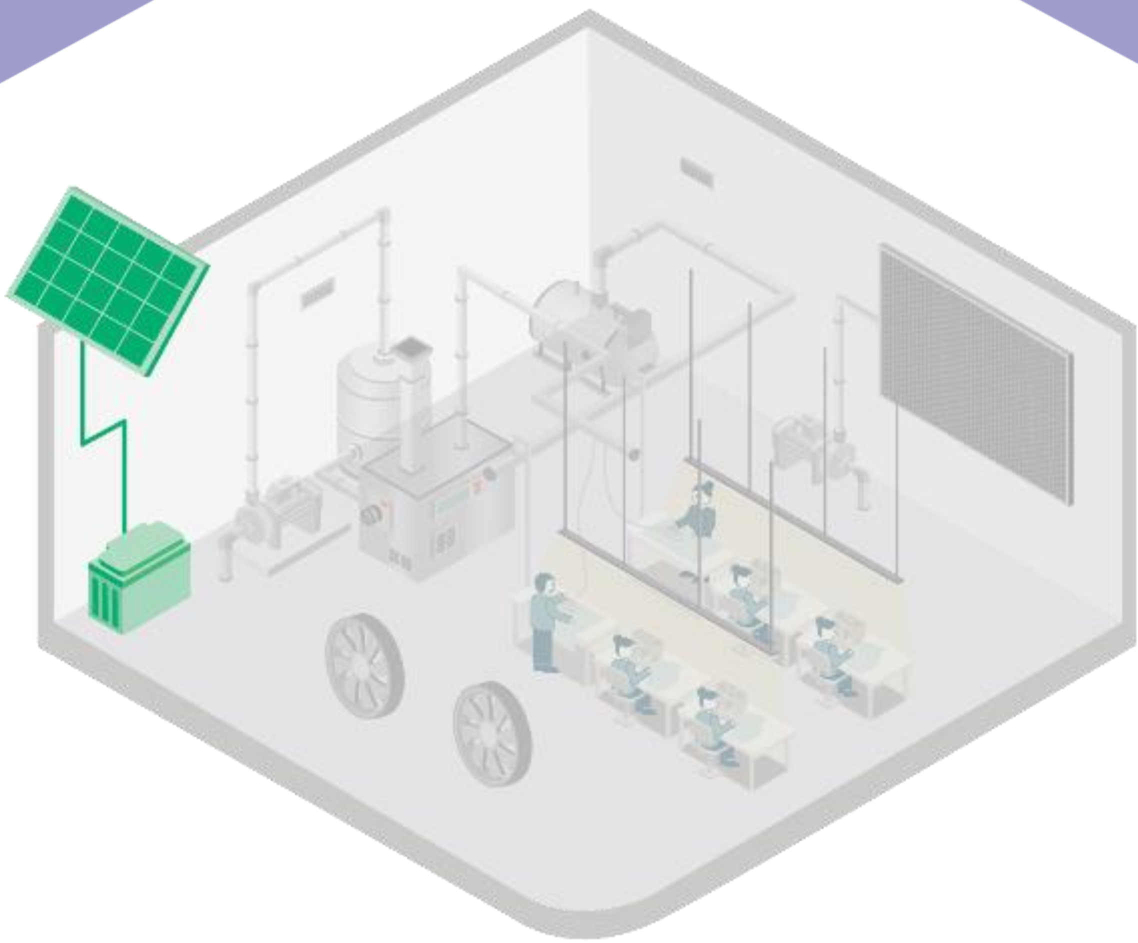
5,882 USD/y
Monetary Saving

7 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

7 RENEWABLE ENERGY



Chapter 7:

Renewable Energy

Introduction

Renewable energy is energy derived from natural sources and is energy that can be replenished repeatedly, so it is never depleted. Some examples include solar, wind, hydropower, and biomass, which are such sources that are constantly replenished. These types of energy sources are usually converted into electricity or thermal (heat)

Hydro Energy

Solar Energy

Renewable Energy

Biomass Energy

Wind Energy

Several audits conducted in various factories revealed underutilization of available natural energy sources to generate electricity within proximity to the facilities. A walk-through energy audit of the garment factory has consequently yielded two key recommendations for improvement, as detailed in Annexure 5.

Recommendation 1

Installation of solar water heater

Issues: The textile plant consists of room accommodations for staff. The rooms are equipped with instant geysers. The incremental power consumption of electrical heaters is between 1 and 15 kWh for 3 to 4 hours per day (in the evening). However, the electrical energy consumption is significant for hot water generation.

Intervention: The recommendation is to install a solar water heater and provide hot water to rooms for baths. A solar hot water tank can be integrated with a thermostat and backup electrical heaters for emergencies.

Solar Water Heater

Impact: Implementing the recommended measures is expected to result in significant savings in energy consumption, estimated to reduce it by more than 2,899 kWh equivalent to 0.25 tonne of oil equivalent (toe) annually, as shown below*:

0.25 toe/y
Energy Saving

406 USD/y
Monetary Saving

1.88 tCO_2/y
GHG Emission Reduction

* The data is a result of averaging walk-through 50 energy audit reports conducted by TERI.

Table: Summary