SWITCH GARMENT

PROMOTION OF SUSTAINABLE ENERGY PRACTICES IN THE GARMENT SECTOR IN CAMBODIA

MODEL GREEN FACTORY PROGRAM

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About Switch Garment

The “Promoting Sustainable Energy Practices in the Garment Sector in Cambodia”, called Switch Garment, is a four-year project started in May 2020 and funded by the European Union SWITCH-Asia Programme. Switch Garment is jointly implemented by the Global Green Growth Institute (GGGI), Geres, and Textile, Apparel, Footwear & Travel Goods Association in Cambodia (TAFTAC). The objective of this project is to increase competitiveness of the Cambodian garment industry through investment in sustainable energy technologies and practices. Ministry of Environment (MOE) and Ministry of Industry Science Technology and Innovation (MISTI) are two government counterparts of the Project.

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MODEL GREEN FACTORY PROGRAM

2024

Developed by Global Green Growth Institute (GGGI) with the inputs and extensive review provided by Geres, Textile Apparel, Footwear & Travel Goods Association in Cambodia (TAFTAC) and Cambodian Garment Training Institute (CGTI). Thanks to the strategic guidance and technical inputs provided by Ministry of Environment (MOE) and Ministry of Industry Science Technology and Innovation (MISTI).

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Foreword

Cambodia pursues the development of its energy sector without any major policy or technology disruptions. Global climate change is concerned all over the world which is caused by greenhouse gas emissions and the depletion of the natural resources.

The industry sector is one of the key elements to support the economic growth of Cambodia due to a well-run investment of manufacturers such as textile, apparel & footwear, food and beverages, brick manufacturing, cement, and another sector. Most of these manufacturing sectors are owned by foreign investors, and they have been using energy on machinery in specific processes (steam boiler, generator, etc...). Therefore, the total energy consumption is the sum of the energy necessary to run different equipments.

According to the Cambodia Energy Sector Modelling Tool, the key policy of electricity will be used in Cambodia to ensure the sustainability of energy efficiency, then fuel switch to a low carbon source, and decarbonization of electricity production as of 2050.

Currently, the General Department of Science, Technology and Innovation of the Ministry of Industry, Science, Technology & Innovation has achieved the formulation of the Energy Tech Roadmap which is a comprehensive policy document navigating the effects of the dynamic landscape of energy technology in our pursuit of socioeconomic development and sustaining energy consumption in the future. It is established to be served as a stepping stone and guide us through the web of opportunities brought on by the energy transition.

In alignment, this Model Green Factory Program developed by Global Green Growth Institute (GGGI), in cooperation with GERES and Textile Apparel, Footwear & Travel Goods Association in Cambodia (TAFTAC) is a tool and technique to guide and simplify the energy efficiency implementation of any manufacturing operated in Cambodia through standard, management, action, reporting and training. In addition, the Model Green Factory Program represents TAFTAC's commitment and the practical support provision to the factories in order to ensure green and sustainable energy technologies and practices.

The comprehensive Energy Tech Roadmap and Model Green Factory Program 2023 would be the most significant and worthwhile players to drive their best in the textile and garment to mitigate the greenhouse gas emissions from 4%-10% by 2030 in Cambodia.

Seizing this opportunity, I am elated to wish the Switch Garment Project as well as all the concerned parties involved in this particular project a success onward, and widespread uses across the manufacturers in Cambodia.

Phnom Penh, 15 August 2023

Senior Minister

Ministry of Industry, Science, Technology & Innovation

***Kitti Settha Pandita* CHAM Prasidh**

Preface

The Model Green Factory Program (MGFP) is developed by European Union (EU) -Switch Garment project team as a regulatory guideline document and a voluntary supporting tool to Textile, Apparel, Footwear & Travel Goods Association in Cambodia (TAFTAC) member factories for going green. MGFP aims at guiding factories in the garment industry become greener by introducing sustainable energy interventions, sustainable waste management, gender, and social inclusion. This voluntary program will commence with piloting the energy component first which will eventually encompass the sustainable use of resources including management of waste and water in the garment industry. This guiding document will help the relevant stakeholders in implementing the MGFP led by TAFTAC in collaboration with Cambodian Garment Training Institute (CGTI). I am delighted to be the government counterpart to support this initiative.

The key mandate of Ministry of Environment (MoE) is to ensure environmental protection of the country while ensuring economic development. The industrial sector is one of the significant sectors that has contributed to Cambodia's steady economic growth at an average of 7 percent annually for more than a decade prior to COVID. This is the industrial sector's largest employer representing 10% of the country's GDP and 56% of its exports in 2022. The sector also supports some 770,000 jobs, mostly women, and the livelihoods of over 2.5 million people in the country. Overall, the garment sector has supported the livelihood of at least 2.5 to 3 million people including both direct and indirect beneficiaries from the sector. However, like other industries, the garment industry is also impacting the environment through energy consumption (i.e. GHG emissions), waste water and solid waste from discarded clothes, leathers, rubber and raw material residue and sludge. The garment industry consumes 700,000 tons of wood/year for heating purposes. Therefore, greening the industries specially the garment industry is critical for implementation of the Cambodia's Roadmap for Sustainable Consumption and Production 2022 to 2035 and thereby, achieving the Cambodian Sustainable Development Goals in overall.

To address these challenges, the EU Switch Garment project has been promoting the sustainable energy practices in the Garment Sector in Cambodia. The MGFP with the primary focus on sustainable energy practice will promote

the use of sustainable energy resources i.e. renewable energy and energy efficiency among member factories of TAFTAC which will set a great precedent in the region.

I would like to appreciate the efforts made in by the project implementing partners, including GGGI, TAFTAC and Geres, in developing this framework. The partnership and contribution from the Directorate of Policy and Strategy, Ministry of Environment and the Ministry of Industry, Science, Technology & Innovation (MISTI) have been invaluable. I extend my appreciations to the EU for financing the Switch Garment project. I would like to encourage garment factories and relevant stakeholders to use the MGFP as a tool to promote our collective efforts to achieve the target of National Energy Efficiency Policy and thus help promoting environmental sustainability in Cambodia.

Phnom Penh, 09 October 2023

Minister

Ministry of Environment

Dr. Eang Sophalleth

Reading Guide

This guideline is prepared as a guiding tool to help implementation of Model Green Factory Program (MGFP) hosted by Textile Apparel Footwear & Travel Good Association in Cambodia (TAFTAC). The objective of MGFP is to support the participating factory to review their energy consumption profile, enhance capacity and then to encourage sustainable energy implementation. Overall implementation of the Program will follow multiple phases, completion of which will earn them a formal recognition from TAFTAC. The guideline has four chapters.

Chapter 1 of the guideline provides an overall introduction to the MGFP. This chapter set the foundation of the program by explaining the key challenges to be addressed by sustainable energy interventions in garment sector. Chapter 1 also discusses the overall goal of the program and the methodology to achieve the goal.

Chapter 2 explains overall implementation mechanism of Model Green factory Program (MGFP). Starting with implementation principles this chapter provides a detailed break-down of all the phases and associated activities. All the key indicators for each phase are elaborated in detail for ease of reference for the participating factories. Finally, the application and certification process of MGFP is also discussed.

Chapter 3 provides a detailed outlook of Monitoring, Reporting and Evaluation (MRV) of the MGFP. This explains how TAFTAC will monitor the progress of the participating factories against set indicators for each phase of the Program.

Chapter 4 introduces typical sustainable energy conservation measures and good practices in garment industry as experienced during 50 energy audits conducted under Switch Garment project. Energy conservation measures for different industry utility systems and process systems have been explained along with indicative investment ranges.

Acronym

AC	Alternative Current
BLDC	Brushless Direct Current
BOP	Best operating practices
CGTI	Cambodian Garment Training Institute
DC	Direct Current
ECM	Energy Conservation Measure
EE	Energy Efficiency
FD	Forec Draft Fan
GGGI	Global Green Growth Institute
GHG	Green House Gas
HSD	High Speed Diesel
ID	Induced Draft Fan
IE	International Efficiency
IPCC	Intergovernmental Panel on Climate Change
ISO	the International Organization for Standardization
kJ	Kilo Joule
LED	light emitting diode
MGFP	Model Green Factory Program
MRV	Measurement Reporting and Verification
PR	Public Relation
SEC Specific	Energy Consumption
TAFTAC	Textile Apparel Footwear & Travel Good Association in Cambodia
ToR	Term of Reference
USD	American dollar
VFD	Variable Frequency Drive

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1. INTRODUCTION

1.1. Rationale

The global textile and garment manufacturing sector or "Fashion Sector" is estimated to be responsible from 4% to 10% of all global greenhouse gas emissions. Mitigating carbon emissions from the fashion sector is key to the overall global goal averting catastrophic climate change by limiting global temperature rises to 1.5 degrees by 2030 as modeled by the United Nations Intergovernmental Panel on Climate Change (IPCC). The global fashion sector is the largest emitter of water pollutants and textiles are also one of the largest sources of industrial waste.

Global fashion sector is lucrative and highly competitive. Supply chains for textile goods have evolved into enormous, complex sourcing networks where materials, labor and manufacturing facilities can be flexibly taken online and offline from all corners of the earth deliver products to consumers rapidly and at the lowest cost possible. To ensure maximum value and secure business from buyers, agents and factory groups can switch goods manufacturing from one factory to another and one country to another to maintain minimum costing to buyers. While this low-cost seeking supply regime is effective for meeting the demands of modern consumers, it also represents one of the most wicked challenges to global environmental sustainability.

The barriers associated with reducing the carbon footprint in countries of Cambodia's garment and textile sector is emblematic of the overall challenge of reducing carbon emissions of global fashion supply chains.

1.2. Goals

The goal of the MGFP is to ultimately provide a country level, multi-stakeholder platform for constructive engagement for sustainability in the Cambodian fashion sector. The MGFP represents TAFTAC's commitment to building awareness amongst its membership about the business case for operationalizing factory sustainability and providing practical support to factories to make investment commitments. Recognizing that all factories are unique, the MGFP provides an accessible "onramp" to greening any manufacturing operation by establishing a minimum standard for operationalizing sustainable energy technologies and practices. Each enterprise that completes full certification level in the MGFP will receive not only recognition of this accomplishment, but also tangible outputs that supports factories to implement appropriate sustainable energy technologies and practices in their operations and improve the level of "green value addition" that can be offered to buyers.

1.3. Strategy

1.3.1. Strategic Energy Management Mainstreaming

Fundamentally, the TAFTAC MGFP program is designed to work with all factories regardless of their progress level in adopting or implementing sustainability goals. The MGFP seeks to first help factories establish their baseline for adoption of sustainable energy and practices and then establish a hands-on advisory partnership to enable practical actions towards improving operational energy performance. The key objective of the MGFP is scaling up the adoption of sustainable energy measures in the Cambodian garment factories and improving energy performance. Improving energy performance could include capital investments, but the emphasis in the MGFP certification scheme is to reward factories that show documented progress towards sustained operationalization of energy management. The underlying philosophy is that if a factory commits to mainstreaming good energy management practices into operations, sustainable energy technology investments will become easier as knowledge and decision confidence improves.

1.3.2. Standards Centric

The MGFP program activities are aligned with internationally recognized standards to

support and facilitate business positive compliance requirements required by buyers and government.

ISO 50001

Core to the MGFP is the integration of the ISO 50001 energy management system standard. The sustainable energy measures performance assessment follows the ISO 50002 energy audit standard framework which is part of ISO 50001. Output from the ISO 50002 compliant sustainable energy measures performance assessment is used to establish and drive the ISO 50001 compliant energy management system which the MGFP activities will guide the factory to develop which will be tailored to its business situation.

MRV – IPMVP and Gold Standard

The MGFP provides simple measurement, verification, and reporting (MRV) tools for factories to plan and track performance of sustainable energy measures investments. These MRV tools provide the documentation expected of buyers and factory decision makers to understand investment performance for sustainable energy technology upgrades. As a basic standard, MRV tools provide a MRV plan for basic SE technology investments that are compliance with the International Performance Measurement and Verification protocol. Additional tool features will allow the factory to also plan investment performance verification and generate reporting documentation that is compliant with internationally recognized standards to mobilize climate finance including carbon credits.

1.3.3. Results Orientation

The MGFP works with enterprises to first establish and understand their baseline for sustainable energy measures and then develop a customized action plan to improve operational energy performance through a program of systematic trainings that are practical and results oriented. Through the one-year program, the factory will join a series of hands-on trainings that support the factory to take confident action to develop a sustainable energy measures action plan that suits their business situation and guide implementation with results that are measurable and documented for recognition through international, industry recognized environmental sustainability schemes. At the end of the MGFP each factory will have tangible outputs to support factory competitiveness in providing greater "green value addition".

- ISO 50002 Compliant sustainable energy measures Baseline Performance Assessment
- ISO 50001 Compliant sustainable energy measures Management System
- Sustainable Energy Action Plan

Note that the MGFP will help prepare the factory for achieving sustainable energy goals that are directly related to their respective brand's requirement as well as to the national targets.

2. IMPLEMENTATION OF MGFP

2.1. Implementation Principles

The MGFP emphasizes five compliance areas described as by the "S.M.A.R.T." framework i.e. [S]tandards, [M]anagement, [A]ction, [R]eporting, [T]raining described as follows:

- **[S]tandards:** Establish minimum energy performance standards for basic energy technologies
- **[M]anagement:** Mainstream strategic energy management in Cambodian garment factories
- **[A]ction:** Establish basic best operating practices (BOPs) to operationalize energy management
- **[R]eporting:** Normalize enterprise energy reporting to promote a culture of continuous improvement
- **[T]raining:** Emphasize regular training to enable continuous energy performance improvement

2.2. MGFP Implementation Phases and Related MRV

The Program will be implemented in 3 different phases, namely Onboarding, Readiness and Operationalization.

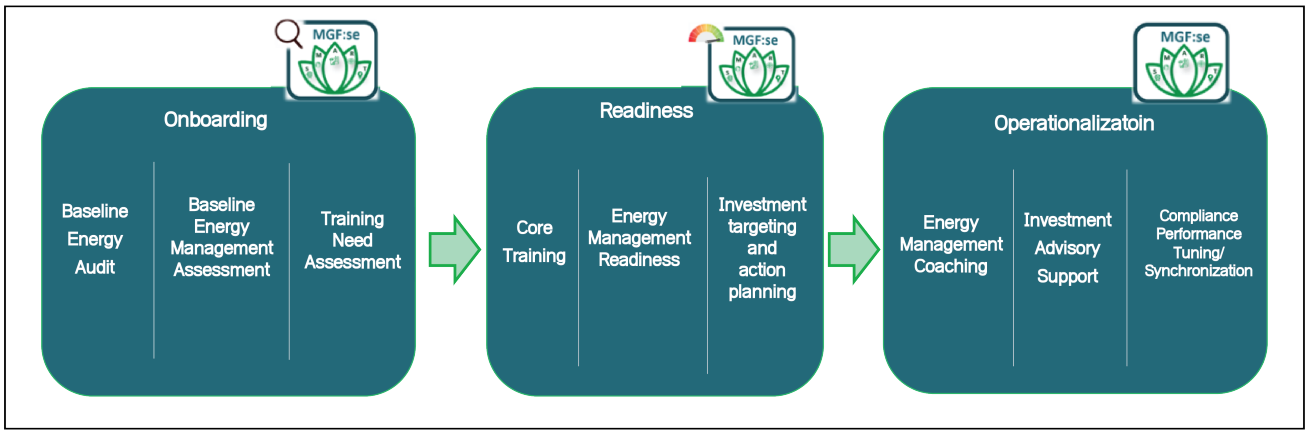


Figure 1: Phases of TAFTAC Model Green Factory Program

Factories interested in taking part in MGFP will start with some preparatory activities. Such activities will include the followings (foundation phase):

- **Application to TAFTAC:** Factories will apply to TAFTAC for participation in the Program. TAFTAC will make application form available to the factories. An application fee might be applicable for program participation.

- **Establish program committee and Green Team:**

Establish program committee: Interested factories will form a committee to coordinate overall program activities. Factories will assign someone as the Energy Manager who will act as the focal point for MGFP. Energy Manager should preferably have an orientation around sustainable energy initiative. Otherwise, a plan to train the energy manager can be considered. The program committee may consist of the followings:

- One Executive Member
- Factory General Manager
- Energy Manager

Green Team: A team of 3 members led by the energy manager will be responsible to monitor day to day energy management of the factory. They will meet bi-weekly to report their findings and action plan. The team will be trained by TAFTAC/CGTI.

- **Agree on Meeting and Training**

Commit to quarterly committee meetings: The program committee will meet on quarterly basis to discuss the progress of MGFP implementation. Meeting Minutes will be shared with TAFTAC.

Training: Factories will assign at least one preferably two staffs to join all trainings under MGFP.

- **Data Collection:** Factories will keep some basic information ready with them. Information may include the list of equipment, use of electricity, use of diesel, use of wood and other utility data, etc. Data collection template can be collected from TAFTAC/CGTI.

Application form and data collection templates are in Annex-I.

Foundation Phase Indicators:

- Application to TAFTAC Submitted
- Committee and Green team formed
- Agree on Meeting and Training

Once the foundation phase is completed a factory will start the onboarding phase under MGFP.

Phase I: Onboarding

In the phase of Onboarding, the factory will conduct following sustainable energy activities:

- **Energy Assessment:** One energy auditor (trained and approved by CGTI) will be hired by the factory to conduct an energy assessment. The cost of an energy assessment will vary depending on size of the facility, scope of work, and expertise level of the auditor (local or international). The cost is typically between USD 500 and USD 5000. The assessment will find out possible improvement measures along with financial indicators. The assessment will also guide the factories on how to manage the overall energy system. A factory which has already completed an energy audit in last 3 years may not need to do it again. TAFTAC/CGTI will help the factories in preparing the ToR, hiring and conducting energy audits.

- **Training Need Assessment:** This is a self assessment by the factories with the help of TAFTAC to identify the need for capacity building/training of factory staff around sustainable energy concept.

- **ISO 50001 and ISO 140001:** Registration for these standards is recommended. The cost of an ISO certification is about USD 5000. The Energy Management Awareness (ISO 50001) takes two days of training at cost of USD 190 per day, based on CGTI quotation.

Phase I: Onboarding Indicators

- Baseline Energy Audit Completed
- Training Need Assessment Completed
- Registration for ISO 50001 energy management completed (recommended)
- Registration for ISO 14001 environmental management completed (recommended)

Phase II: Readiness

Phase II involves following readinesses activities:

- **Sustainable Energy Action plan:** Based on the energy audits under Phase I, all the factories will require to prepare a simple sustainable energy action plan, with specific timeline for implementation of audit recommendations. An indicative investment plan i.e. how much to be invested for which measures might also be included. The plan should also include a detailed energy management plan as suggested by the energy audit report.

- **Training Action Plan:** Based on the assessment, a training plan will be prepared and included in the aforementioned sustainable energy implementation action plan. At least two staffs need to be trained to act as energy manager of the factory. TAFTAC/CGTI will guide the factories in developing the capacity required for implementing MGFP.

- **Management Approvals:** Sustainable energy action plan (including training plan) has to be approved by the factory management.

- **Training on ISO:** Two factory staff are recommended to get training on ISO 50001 and ISO 14001.

Action plans will be reviewed and agreed by TAFTAC/CGTI.

Phase II: Readiness Indicators

- Sustainable Energy Action plan developed
- Training Action Plan developed
- Management Approvals on technology investment roadmap
- Training on ISO 50001, ISO 14001 completed (recommended)

Phase III: Operationalization

Under Operationalisation phase following activities have to be implemented:

- **Sustainable Energy Action Plan:** The Action Plan approved under phase II starts being implemented under Operationalisation phase. In this phase, factories will establish an energy management committee led by a trained energy manager. Energy manager will be responsible in implementing energy management plan as approved by factory management. Proper reporting system has to be in place. In terms of implementing energy conservation measures at least 2 Low cost / no cost measures have to be implemented (as agreed with CGTI). The action plan should also include an indication for using efficient equipment in case of procuring new equipment. Finally, a long-term investment plan in implementing long term measures has to be adopted and approved by the management.

- **Training Action Plan:** Factories will have their awareness and communication program operationalized. At least one management staff and two technicians will be trained on sustainable energy.

- **ISO Certification:** It is recommended for the factories to get certified for ISO 50001, ISO 14001.

Phase III: Operationalization Indicators

- Energy manager and green team formalized and appointed
- Energy Management Committee formalized and operationalized
- Energy management reporting operationalized
- Energy Management Plan adopted, demonstrated and reported
- Low cost / no cost measures implemented (Less than 2-year Payback)
- Long Term Investment Plan and Budget
- 3 staffs have been trained
- ISO 50001, ISO 14001 certified (recommended)

2.3. Application and Certification

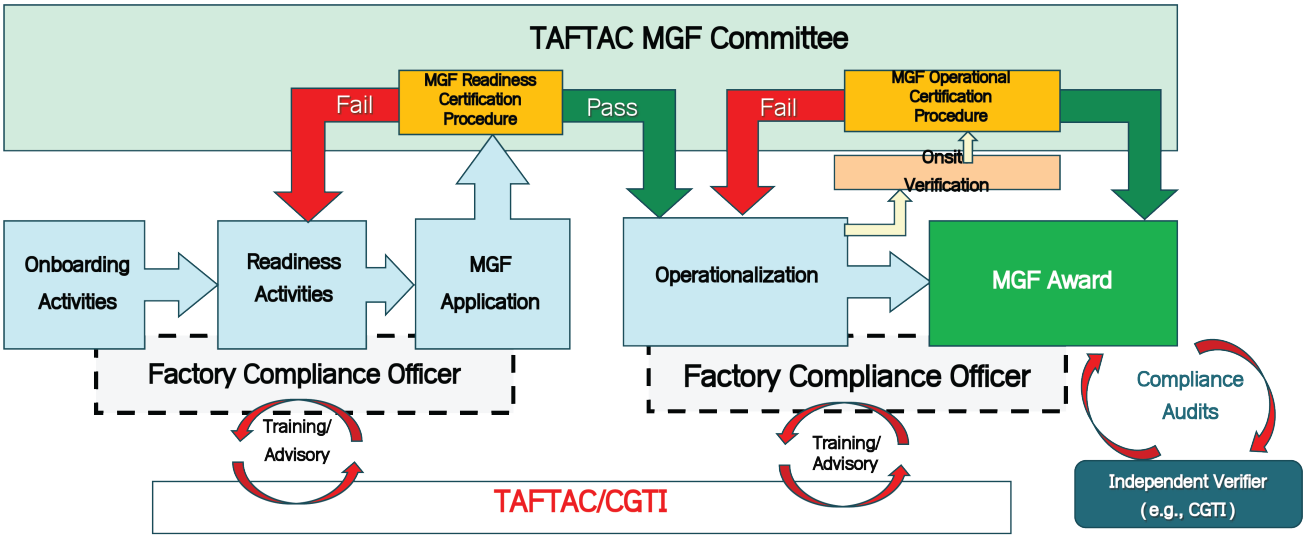


Figure 2: TAFTAC Program Certification Process

Factories interested in taking part in TAFTAC Model Green Factory (MGF) Program will have to go through several stages as explained below:

- **Step I:** Participation Application: As explained in earlier section, in the foundation stage factories will apply to TAFTAC for participation in the Program. TAFTAC will make application form available to the factories. An application fee might be applicable for program participation. Once the application is accepted the factory will be guided to complete the foundation step.

- **Step II:** Readiness Award Application: After the completion of foundation, onboarding and readiness phases a factory may apply for Readiness Award Certification to TAFTAC. TAFTAC will assess the application based on the indicators mentioned in the earlier sector for each phase. Factories awarded with Readiness Award may proceed to operationalization phase. In case of failure, the factory will have to follow TAFTAC recommendations to apply for the Readiness Award again.

- **Step III:** Operationalization Award Application: A factory awarded with readiness award is eligible to apply for operationalization award. Once a factory achieves all the indicators for operationalization phase may apply for the final award. TAFTAC will conduct an onsite verification using its inhouse team. TAFTAC may also appoint a third-party auditor to assess factory progress against such indicators. A factory may Pass, Fail or Pass with recommendations. The factory successfully passes the assessment will be granted the Operationalization Award. In case of failure a factory needs to implement the TAFTAC recommendations before applying for the award again. For the factories with 'Pass with recommendations' will be awarded once they implement said recommendations.

Certification for phase-II and Phase-III will initially be issued for one year and will be extended subject to yearly verification by CGTI/TAFTAC.

2.4. Role of TAFTAC/CGTI:

TAFTAC will be responsible for overall management and implementation of TAFTAC Model Green Factory Program. An inhouse team will be set to provide one stop service for the factories related to the program. This team will provide training and necessary advisory services to the factories. TAFTAC generic roles will include:

- Making Application forms available and provide guidance is filling the application form
- Provide support related to energy audit

- Connecting factories with energy service providers
- Support in implementing energy measures
- Evaluating award application, conduct on-site visits and arrange third party evaluator and arrange certification ceremony
- With CGTI plan for implementing Training Action plan adopted by the factories
- Conducting Monitoring, Reporting and Evaluation (MRV) of MGFP
- Making communication and PR activities

Phase wise roles and responsibilities are mentioned in the table below:

Phase	TAFTAC/CGTI Role
Foundational	• Full time technical expert on call through "Factory Sustainability Help Desk" • Maintain resources website • Conduct two program intakes / year for MGFP • Sustainability regulatory compliance advisory • Close advisory support for ISO Certification
Onboarding	• On site energy audit & action planning advisory services • Performance roadmap development support • Support to use tools and resources for strategy development and compliance tuning • ISO Certification training
Readiness	• On staff–technical trainer for classroom and assignment tutorial support • Action plan development coaching • ISO Certification Training continue
Operationalisation	• Dedicated technical advisor on staff for implementation coaching • Compliance tuning support • ISO Certification Training continue

3. Measurement, Reporting, and Verification (MRV)

3.1. Introduction

Tracking of MGF program implementation progress is really important to achieve long term goal of the program. This will monitor the yearly progress of one factory moving towards different stages of the program. For example, if one factory qualify for readiness phase TAFTAC needs to monitor if they are implementing the measures as committed. The monitoring and reporting will continue even after passing the phase-III to ensure validity of the certification.

One the other hand its also important to monitor and collect the data related to energy/ emission saving achieved through implementation of the energy conservation measures. For example, if a factory replaces its existing lighting system with an energy efficient one the factory needs to know the amount of energy being saved. Its also important for the suppliers of the lighting system to know the savings before they claim their performance-based payment. Government authority may also need to know the progress as part of their national energy efficiency policy implementation.

Therefore, Monitoring, Reporting and Evaluation (MRV) scheme will have two components. One aims at keeping the track of MGF Program itself while other will monitor the progress of implementation of energy conservation measures. Both the components are explained in detail below:

3.2. MRV for MGF program

This component will follow simple strategy to follow the indicators for different stages of the program mentioned in the earlier sections. Therefore, to comply with each phase of MGF program a factory needs to achieve all the indicators properly. Indicators are summarised here below:

Phases	Foundation Phase	Phase I: Onboarding	Phase II: Readiness	Phase III: Operationalization
Indicators	• Application Submitted • Committee and Green team formed • Agree on Meeting and Training • Basic data collected	• Baseline Energy Audit Completed • Training Need Assessment Completed • Registration for ISO 50001 energy management completed (recommended) • Registration for ISO 14001 environmental management completed (recommended)	• Sustainable Energy Action plan developed • Training Action Plan developed • Management Approvals on technology investment roadmap • Training on ISO 50001, ISO 14001 completed (recommended)	• Energy manager and green team formalized and appointed • Energy Management Committee formalized and operationalized • Energy management reporting operationalized • Energy Management Plan adopted, demonstrated and reported • Low cost / no cost measures implemented (Less than 2-year Payback) • Long Term Investment Plan and Budget • 3 staffs have been trained • ISO 50001, ISO 14001 certified (recommended)

TAFTAC/CGTI will lead and conduct the MGF implementation MRV and approve certification and certification extension based on yearly compliance report.

3.3. MRV for Energy Conservation Measure (ECM)

Factories participating under MGFP will be monitored its progress against its Specific Energy Consumption (SEC). SEC defines amount of energy used by a factory to produce one unit of garment. If a factory use 1kJ of energy for producing 1 ton of garment then its SEC would be 1kJ/ton. This can also be expressed by energy used per 1000 pieces of product. For monitoring of ECM implementation following steps would be followed:

1. Submission of energy consumption data as per prescribed template shared by TAFTAC (Annex- II). This aims at collecting energy profile data i.e. amount of energy consumed, type of energy consumed, source of energy, production volume (under MGFP Phase-I)
2. Supporting document i.e. electricity bill for at least 1 year, HSD purchase directory, other fuel purchase directory (under MGFP Phase-I)
3. TAFTAC/ energy auditor will analyse the data to set a reference point (under MGFP Phase-II)
4. Energy efficiency profile of the factory will be monitored based on the set reference (under MGFP Phase-III)
5. A factory will submit similar information annually to help TAFTAC monitoring energy performance (under MGFP Phase-III)
6. MRV tool will be linked to TAFTAC website

Switch Garment project factories have already submitted required data for developing a baseline for SEC. Energy audit reports already have their reference SEC mentioned. Switch Garment team will also prepare an online monitoring tool where factories would be able to submit their energy data which can be accessed by factory and TAFTAC for investigating the energy profile improvement.

4. TYPICAL ECMS IN GARMENT INDUSTRIES

Under phase I of the Model Green Factory program factories are expected to conduct energy audit by deploying certified energy auditors. The audit report will communicate possible energy conservation measures along with financial indicators. This section is to introduce typical energy conservation measures in garment industry as experienced during 50 energy audits conducted under Switch Garment project. Based on these energy audit reports, the investment range of recommended measures is divided into three categories namely low low-cost investment (up to 5,000 USD), medium-cost investment (5,000-20,000 USD), and high-cost investment (more than 20,000 USD). However, MGF Program will include all possible energy conservation and renewable energy measures even if it is not mentioned in the following charts.

4.1. Lighting System

Common Practice	EE Measure	Investment Range
• Conventional T8 Fluorescence lights	• LED lights • De-lamping and installation of either skylights or solar tube lights	Mostly low-cost
• Central lighting control restricting control of lighting system for a production line not in use	• Installation of local level lighting control in the process section	Low-cost

4.2. Compressed air system

Common Practice	EE Measure	Investment Range
• Compressor without variable frequency driver	• Inverter type screw air compressor performs two functions; one is to vary the speed of the air compressor based on the pressure of air in the receiver tank and another is that it reduces power consumption during unloading conditions by bringing the electric motor to halt. This will eliminate the idle operation of the air compressor and will save power consumption	Low/medium-cost
• The pressure setting of air compressor is on the higher side than the demand	• Optimise the setting as per demand will save energy	Mostly no-cost

• Most air distribution system is spoke type with pressure drop at the end of each line. Most factories utilize plastic tubes that cannot withstand the higher pressure and start leaking	• Design looped network to ensure same pressure in the system. Install pressure valves if high and low pressure required. With the looped system main compressor setting can be reduced	Low/medium cost
• Compressed air leakage in different junction points, instrument regulator valves, and supply valves in the distribution network. Compressed air leakage can lead to problems with system operations, which include the following: - Fluctuating system pressure can affect the functional efficiency of air tools and other air operated equipment, possibly affecting productivity as well - Excess compressor capacity may result in higher operating costs - Deteriorate service life and increased maintenance (including the compressor package) due to unnecessary cycling and increased operating hours Although leakages can occur in any part of the compressed air distribution system, the most common areas are couplings, hoses, fittings, pipe joints, quick disconnects, FRLs (filter, regulator, and lubricator), condensate traps, valves, flanges, packing, thread sealants, and point of use pneumatic devices. The leakage rate is a function of the supply pressure in an uncontrolled system and increases with higher system pressures.	• 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 in a similar factory is about 10-15% of total compressed air generated	Low cost

• Air receiver tank installed for the air compressor does not have an automatic drain valve to remove condensate instantaneously. 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 the condensate, the receiver tank's available volume decreases, resulting in frequent load unloading and increased power consumption	• Installation of Auto drain Valve for Air receiver tank. It instantly removes water condensate, reduces the load on the air dryer, and lowers the energy consumption of the air compressor	Low-cost

4.3. Boiler System

Common Practice	EE Measure	Investment Range
• Inefficient old boiler	• The efficiency of the boiler should be at least more than 70% • The boiler is to include an inlet water heat increase system (condensate recovery system, economizer or solar water heater) to maintain its efficiency • Pipes are to be insulated to reduce heat losses • Use dried and small wood logs	Low/medium-cost
• FD ad IF boiler fans are often blowing too much air and need to be optimized, this result in huge losses, wasting huge amounts of heat and wood	• Optimize forced and induction fan speed, either with VFD or mechanical air-flow controllers	Low-cost

• Drying wood; wet wood is often used, required strong fans and wasting huge amounts of wood	• Measure firewood moisture content, proposed cutting and drying of the wood • Use dried and small cut wood logs	Low-cost
• Return water temperature optimization. Even though many factories have a steam recovery system the return water is only about 35 Degrees Celsius	• The boiler is to include an inlet water heat increase system (condensate recovery system, economizer or solar water heater) to maintain its efficiency • Return steam pipe to end at the bottom of the return storage tank • Insulate storage tank • Temperature could be up to 50-60 degrees	Low-cost
• Condensate recovery/return system, some factories do not have steam recovery system and all steam is wasted	• Install economiser, guiding the feed-water through the boiler chimney to increase boiler feed water with another 10-15 Degrees. Optimum boiler feed water ~ 80 degrees Celsius	Low-cost
• All steam pipes should be properly insulated and not be welded on iron bars. Also return steam pipes should be insulated	• Pipes are to be insulated to reduce heat loss	Low-cost
• Safety of the boiler	• Many boiler are not up to standard, hire a consultant to estimate the real tonne/ hour steam requirement. For only ironing can consider using electric individual boilers units	Low/medium-cost
• Lack of proper insulation resulting in significant amount of energy being wasted through heat radiation	• Insulate the boiler with proper insulating material (ceramic wool or ceramic fibre)	Low-cost

4.4. Sewing Machine

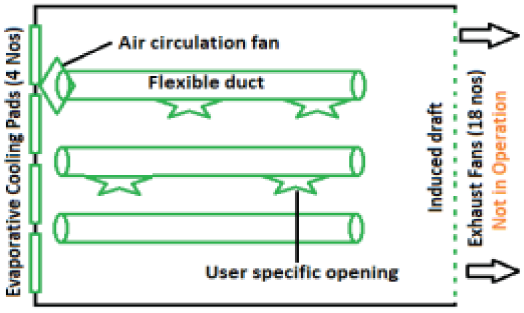
Common Practice	EE Measure	Investment Range
• Clutch type sewing machine: Production capacity of these types of sewing machines is very low and consumes more energy compared to the servo type sewing machines	• Replace the clutch type sewing machines with new energy efficient servo type sewing machines. These types of modern sewing machines use servo motor, which is operated only when the operator needs to sew. These machines have very good starting torque and immediately provide power to the machine's needle. A servo motor is a direct current (DC) machine - to run on an alternating current (AC) they need an electronic pack to convert the power supply	Low-cost

4.5. Motor

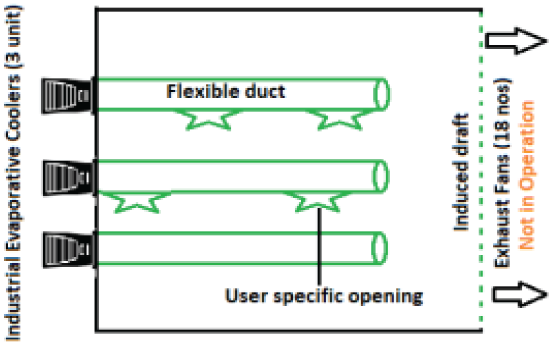
Common Practice	EE Measure	Investment Range
• The motors installed in the process as well as in the auxiliaries sections are out of standard efficiency class (IE1 or equivalent)	• Replace the standard efficiency class electric motors with premium efficiency class (IE3) or super-premium efficiency class (IE4) motors of appropriate size • All the motor in all the facilities with VFD system	Medium-cost

4.6. Ventilation System

Common Practice	EE Measure	Investment Range
• Circulation of cooling air in the workspace is maintained using wall-mounted air suction fans (induced draft exhaust fans) installed at the opposite end of the section. The existing arrangement of the evaporative air circulation may not be an effective method to cater to the cooling requirements in the large shed due to the poor residual static pressure of exhaust fans	• The performance of the evaporative cooling system can be improved by retrofitting with a ductable (flexible ducting) air distribution system and providing circulation fans at discharge. Alternatively, the existing evaporative cooling system can be replaced by industrial evaporative coolers with flexible ducting to provide application-specific cooling requirements	Low-cost



Illustrative view of proposed evaporative cooling system



Illustrative view of proposed evaporative cooling system

• Inefficiecnt/conventional exhaust fan	• Replace the existing air cooler fans by BLDC fans with auto control system. In comparison to a conventional Cooler fan, energy-efficient BLDC fans consumes 30~40% less power to deliver the same amount of air volume (m^3/min)	Medium/high-cost
• The plant's air cooler system is controlled manually	• Provide automatic control for the air cooler fans and pumps based on temperature and relative humidity (percentage) feedback from the production area	Medium-cost

4.7. Insulation

Common Practice	EE Measure	Investment Range
• Piping systems are not properly insulated can cause in energy loss as well as making work-space uncomfortable for workers	• 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 hot pipe surface will not only reduce the energy consumption but also improve the comfort level and working conditions of the section	Low-cost

4.8. Electrical System

Common Practice	EE Measure	Investment Range
• Present harmonics level at the incomer is higher than permissible limits of current harmonics based on the system design i.e. 15% as per IEEE519-19923 standard	• Install active harmonics filter at the incomer side will: - Improve Power Factor - Reduce Apparent Power (kVA) and distribution losses - Improve system reliability - Reduce capacitor and contactor failure - Reduce cable stress and improve current carrying capacity	Low/medium-cost

• The measured voltage at the incomer side is higher than the system-designed voltage level. At higher supply voltage the magnetisation losses especially in motor drives will be more and it causes additional energy losses in the system. Higher voltage may reduce the equipment's life	• Optimise the voltage by adjusting the tap position of transformer by lowering the tap position of transformer. This will save energy and equipment operating life	No-cost
• Power factor is often too low, either faulty or missing capacitor banks	• Capacitor banks should be checked regularly if working properly and if no capacity bank is installed its recommend and saving can be substantial with payback time below 1 year	Low-cost

4.9. Renewable Energy Measures

Considering renewable energy measures as sustainable source of energy for the factories:

Solar: Based on the space and strength available for the factory rooftop a factory can opt for installation of solar systems. The factory can invest in the solar system or they may opt for a lease-purchasing deal paying for the system over 10-20 years time based on the savings. There are several solar lease companies active in the Cambodian market. Savings under the current regulation are about 35% of the total electricity consumption. Currently the government is working on a revised regulation that could allow savings about 50-60%. In case the factory has larger funds available or even some lease companies are offering 100% solar system with battery backup.

Biomass: Increasing the share of sustainable and renewable biomass (ex: plantation traceable wood, agro-residues) for steam generation make significant reduction of CO2 emissions.

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