THE GENERAL SECRETARIAT OF THE NATIONAL COUNCIL FOR SUSTAINABLE DEVELOPMENT MINISTRY OF ENVIRONMENT

CASE STUDY ON IMPLEMENTATIONOF BEST PRACTICES OF OPTIMIZING THE FOOD PROCESSING EQUIPMENTINFOOD AND BEVERAGE INDUSTRY IN CAMBODIA

FOR IMPLEMENTATION OF OUTPUT 1.1.4:

AWARENESS RAISING AND LESSON LEARNED DISSEMINATION WITH FOCUS ON RESOURCE EFFICIENCY IN CAMBODIA

UNDER THE FRAMEWORK OF THE UNIDO PROJECT
LOW CARBON DEVELOPMENT FOR PRODUCTIVITY AND CLIMATE CHANGE MITIGATION THOUGH THE TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGY (TEST) METHODOLOGY

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CASE STUDY ON IMPLEMENTATION OF BEST PRACTICES OF OPTIMIZING THE FOOD ROCESSING EQUIPMENT IN FOOD AND BEVERAGE INDUSTRY IN CAMBODIA

I. Introduction of Transfer of Environmentally Sound Technology (TEST)

In the last three decades, a number of conceptual ideas and tools have been created to assist industry with being more manageable and sustainable in its production and more efficient in its utilization of resources. These incorporate pollution prevention, waste minimization, cleaner production, eco-efficiency, and eco-innovation; with a particular depend on waste, energy, and materials. These conceptual ideas and tools have the shared objective of bringing two apparently clashing purposes together, financial profit and environmental improvement. The term Resource Efficient and Cleaner Production (RECP) is to the appropriated adaption of cleaner creation methods to speed up the use of preventive environmental techniques to processes, products and services, with the purpose of improving material and energy efficiency and diminishing dangers and risks to people and the environment. Resource efficiency approaches are looked for as building blocks of the Circular Economy (UNIDO, 2018). The approach anticipated in these guidelines, which it is called the TEST approach, builds on all the concepts and tools mentioned above. TEST stands for Transfer of Environmentally Sound Technologies in which is an integrated approach that provides industries and small and medium enterprises (SMEs) with a combined set of tools to initiate a cycle of continuous improvements within their business operations to manage the transition towards a sustainable production. By combining combines internationally proven preventive environmental practices in Resource Efficient and Cleaner Production (RECP), the core elements of an Environmental Management System (EMS) and an Energy Management System (EnMS), which include exploring new eco-efficient technologies and an effective and supportive information system for material and energy flows based on Material Flow Cost Accounting (MFCA). TEST integrates all levels of the business management through creative thinking and effective collaboration. The project participant's companies applying TEST methodology follow the learning cycle "Plan-Do-Check-Act" to evaluate their processes and facilities to determinate improvement measures and feasible technologies as shown in the table 1

Table 1: TEST methods and their tools

TEST Methodology	TEST Integrated tools
Build on "one-stop improvement" approaches to resource efficiency in the system	Resource Efficient and Cleaner Production
Facilities creative thinking and effective collaboration through teamwork	Material Flow Cost Accounting/ Environmental Management Accounting
Match the needs of an enterprise within its operating framework conditions and enhance organizational learning	Environmental/Energy Management System
Address all levels of a business (operational, managerial, and strategic). Follow the learning cycle in line with ISO standard PLAN-DO-CHECK-ACT.	Corporate Social Responsibility

On the other hands, the effectiveness of TEST integrated approach contributes to the Sustainable Development Goals (SDGs) 6: Clean Water and Sanitation, 9: Industry, Innovation and Infrastructure, 12: Responsible Consumption and Production, and 13: Climate Action as shown in the figure 1 below.

Figure 1: TEST towards to achieve SDGs

II. Support mechanisms through policies and alignment with relevant ministries

Cambodian industry is highly energy inefficient, with energy consumption per unit of outputbeing higher than in many countries in the region and more than double that of the developed countries. Moreover, through the industrial production process and activities, there has been generate a lot of solid waste, hazard waste, wastewater pollution significantly into the environment and atmosphere. For instant, the food and beverage (F&B) sector will generate around 2,410,034 tons of waste in 2020, mostly in the form of industrial wastewater (IWW).[1] Garment waste represents 70% of industrial waste going to landfill and includes textile, footwear and leather offcuts and rejects. To cope with those issues, the current UNIDO's project called TEST project is designed with the purposes to analyze energy consumption data and trends, and identifies Significant Energy Users (SEU) to recommend potential energy saving practices, opportunities, and technological improvements.

Beside this, the Royal Government of Cambodia has formulated, developed, and implemented a series of national policies, strategies, action plans, and programs in order to ensure holistic social development and sustainable development, to promote green environment and renewable energy, to encourage efficient use of energy and to minimize detrimental environmental effects resulting from energy supply and use, and to encourage private investment on the green business, etc. The table 2 the briefly description of the Cambodia's policies, law, strategies, action plans, guidelines, other programs on/related to the promotion of renewable energy, power sector, green environment, waste management, and green industry, etc.

Table 2: List of policies, law, strategies, and action plans

No	Name	Period	Remark
1	Power Sector Strategy	1999-2016	
2	Cambodia's Law on Electricity	2000	
3	Renewable Electricity Action Plan (REAP)	2002-2012	
4	National Policy, Strategy and Action Plan for Energy Efficiency	2013	
5	National Policy on Green Growth	2013-2030	
6	Strategic Plan for Green Growth	2013-2030	
7	National Strategic Development Plan (NSDP)	2019-2023	

[1] The Economic, Social and Environmental Impacts of Greening the Industrial Sector in Cambodia, GGGI, 2018

8	Cambodia Climate Change Strategic Plan (CCCSP)	2014-2023	
9	Climate Change Action Plans (CCAPs)	2014-2018	
10	Intended Nationally Determined Contribution (INDC)	2015	
11	Environment and Natural Resource Code	-	Draft
12	National Energy Efficiency Policy	2018-2035	
13	Sub-decree on energy efficiency standards and labeling for electrical appliances and equipment	-	Draft
14	National Waste Management Strategy and Action Plan	2018-2030	
15	National Policy on Solid Waste Management in Cities	2018	Official in Khmer version
16	Sub-decree on Solid Waste Management in the Cities	2015	Official in Khmer version
17	Sub-decree on Plastic Bags Management	2017	Official in Khmer version
18	Guideline on E-Waste Management	2017	
19	Sub-decree on E-Waste Management	2016	
20	Water Resources Management Law	2007	
21	Sub-Decree on Water Pollution Control	1999	

Government has a critical role in accelerating the energy transition. Government has the responsibility to enact an enabling policy framework that provides long-term certainty for the private sector and ensures a positive environment for the energy transition. The roles of the main actors in the power sector and wastewater management are set out in the below table 3.

Table 3: The roles of the main actors in the power sector and wastewater management

No	Ministry/Institute's Name	Duties
1	Ministry of Economy and Finance (MEF)	Involves in allocating the budgets.
2	Ministry of Mines and Energy (MME)	Is responsible for developing policies and strategies, power development plans, overseeing the electricity trade with neighboring countries, major investment projects and management of the rural electrification sector.
3	Ministry of Industry, Science, Technology and Innovation (MISTI)	Is responsible for developing policies and strategies related to green industry and involves in providing drinking water in 11 provincial capitals and for approximately 60 medium sized and small towns.
4	Ministry of Public Works and Transport (MPWT)	Involves in wastewater management.
5	Electricité du Cambodge (EDC)	Involves in generating, transmitting and distributing electricity throughout Cambodia. Its main functions are supplying electricity, developing the transmission grid and facilitating import and export of electricity to and from neighboring countries.
6	Electricity Authority of Cambodia (EAC)	Is the power sector regulator, and is responsible for granting licenses, approving and enforcing performance standards, and determining tariffs, rates and charges for electricity. The EAC may grant various types of electricity license, including licenses for generation, transmission, distribution, retail, or a combined license.
7	Ministry of Environment (MoE)	Reviews and approves Environmental Impact Assessments (EIAs) and Environmental Management Plans (EMP) for all energy and water related projects, etc.

8	National Council for Sustainable Development (NCSD)	Is a cross-sectoral and multi-disciplinary body with the mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programs related to climate change in Cambodia. The NCSD aims to improve the coordination of climate change activities in Cambodia and to support a stronger, comprehensive and effective climate change response.
9	Ministry of Water Resources and Meteorology (MOWRAM)	Issues water licenses for hydropower projects.
10	Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries (MAFF)	Is responsible for the management of wood-fuel and the production of crops as a source of renewable energy.
11	Ministry of Rural Development (MRD)	Involves in master plans and water supply and sanitation management in rural areas and towns.
12	Ministry of Interior and municipalities	Involve in master plans, operation and maintenance wastewater treatment system.

According to the above mentioned national regulations, laws, policies, etc. as well as following to all the relevant ministries and institutions' mandates and responsibilities related energy and power generation, waste management, and water supply and management, there are the fundamental ways and mechanisms in which allow for all stakeholders and private sector to access to water and energy consumption dramatically. In addition; so far, there were many supported activities and programs were provided and supported to those private sector and stakeholders for their businesses' program and activities as well. For example: Financial supports, capacity buildings, taxation reduction and exception for some imported equipment, issuing the licenses and certifications, and other services, etc. were provided.

III. Integrating the best practice pproach into the factory environmental roadmap

In 2013; as collaboration with 11 enterprises, the UNIDO project on low carbon development for productivity and climate change mitigation though TEST methodology in Cambodia has been applied various technology cases or approaches in which mainly focus on energy consumption to help those enterprises to reduce their energy consumption, to improve their business activities and productions, and to make a better surrounding environment.

50 factories in the first phase from the garment including laundry, textile, footwear, and the food and beverage sectors were selected as demonstration companies and will benefit from the comprehensive project technical support and other services, such as the provision of trainings both collectively and in-house on the TEST tools, followed by RECP assessment and energy audits of the production facilities, which will be carried out jointly by the factory's TEST team and project experts to identify or find out the causes of inefficiencies as well as recommended improvement measures. Moreover, there are a lot of technologies were selected and applied to deal with those causes as well as integrated into each factory environmental policy during the project implementation, and these technologies can be considered as the best practice approach to help each factory not only to achieve the environmental policy target but also can help each project participant's factory to reduce resources consumption, financing expenditure, and greenhouses emissions, etc.

The below five measures can be the best practices that every factory owner could consider and apply:

- ✓ Optimize Compressed Air Usage by Repairing the Compressed Air Leakage and Optimizing Compressor Operating
- ✓ Increase the boiler efficiency by cleaning both water and fire side and optimize air fuel ratio
- ✓ Opportunities of installing Solar PV with Li-Battery System

- ✓ Advantages of replacing AC in the embroidery room with evaporative cooling
- ✓ Optimize resistive ovens for cooking, drying and baking with steam from LPG

Note: There are more appropriate technologies can be used and applied to improve each company's business. Please consult with UNIDO's project team for more information.

IV. Overview of the food processing equipment

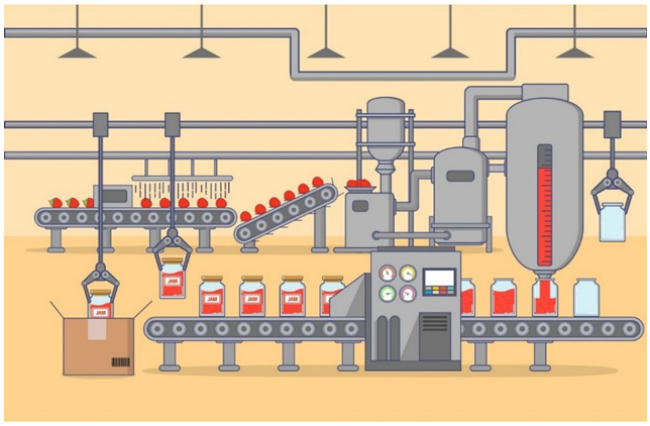


Figure 2: A complete automated food processing system for jam production[2]

Food processing equipment is an umbrella term referring to the components, processing machines, and systems used to handle, prepare, cook, bake, dry, store, and package food and food products. All food processing equipment, including pipes and instruments, should be easy to clean and disinfect, as well as simple to monitor. The equipment design and structures should not be exposed to machine-lubricating oil, metal debris, sewage, and other pollutants in order to prevent their transmission to the food. The contact surfaces of equipment used in processing foods should be smooth or corner smooth, with no blind angles and cracks to prevent the accumulation of food debris, dirt, and organic matter (Shan, 2016).

Employed for food and food product applications ranging from bakery goods to beverages and dairy to produce, a wide range of food processing equipment is available to execute the various unit operations necessary during a complete production cycle, such as washing, separating, mixing, baking, freezing, and sealing. Depending on the demands of the operation (and the overarching food processing application), this equipment can be designed and constructed to handle solid, semi-solid, or liquid food products by batch or continuously. Some of the other design considerations include the food grade material used for construction, hygienic and governmental standards, sizing, cost, and integration of automation or analytical components. Each of these characteristics can influence the performance and efficiency of the equipment, but choosing the optimal design and construction is dependent on the specifications and requirements of the particular food processing application.

V. Types of Food Processing Equipment

While the wide range of food processing equipment available can be classified and categorized in several different ways, e.g., end product form, mode of operation, application, etc. The food processing production cycle can be broken into several stages, characterized by a specific function and during which individual unit operations are performed. For example, within the preparation stage, the primary function is to prepare the food material for further processing, and some of the unit operations performed include washing and separating. Other secondary functions provide support to the primary functions of the production cycle, such as material handling and system control operations, which convey food materials between process stations or maintain the required processing conditions and standards, respectively.

Some of the most common functions by which food processing equipment are grouped include[3]:

- Preparation equipment,
- Mechanical processing equipment,
- Heat processing equipment,
- Preservation equipment, and
- Packaging equipment.

[2] This figure is taken from https://www.thomasnet.com/articles/machinery-tools-supplies/overview-of-food-processing-equipment/

[3] This information is taken from https://www.thomasnet.com/articles/machinery-tools-supplies/overview-of-food-processing-equipment/

VI. Common problems and other possible risks for operation the food processing equipment

Using old and typical food processing equipment can be slow down and affect to production processes and productivities of food and beverage industry. Nevertheless, this problem will lead to cause more energy consumption and investment, which will result in wasting money on the electricity consumption and contributing to Greenhouse Gases emission in the country. To solve this common problem, the proper maintenance and operation of the electrical ovens or heaters, energy-efficient ovens, and other latest smart or modern oven appliances are highly needed for food and beverage industries.

The processes involved in the food and beverage industry often utilize flammable or toxic materials that present a risk to equipment and the health and safety of personnel, if left to accumulate and fail to maintain or operate. Ensuring all facilities are protected by flame and gas detection is a top priority.

VII. Best measures to improve the food processing equipment provided by the TEST project

The energy-inefficient food processing equipment is major financial investment, yet the measures for preventing this investment may be manifold according to the context and situation of each food and beverage industry. Proper maintenance and operation of the food processing equipment such as mechanical processing, heat processing, and preservation equipment, etc. are important with regard to efficiency and reliability. Without this approach, the daily food and beverage's production processes and activities can be very costing and waste lots of energy consumption. As the project implementation policy, all of the project participant's companies were given a free service for energy audit to look for the issues that happen around their factory (ies), especially, on the food processing equipment. In addition, the UNIDO project team will provide the measures or best approaches through TEST methodologies to minimize the costs, resources, and other fatalities with focusing on the energy efficiency to address all the finding issues. Therefore, the measures in each table below were used to cope with the finding issues around the food processing equipment such as heating system and/or ovens for cooking, drying, baking, etc.

Table 4: Replace electrical heater to steam based heating for shrinking machines

Amount of steam needed	91,934	kg/year
Steam cost	1,915	USD/year
Cost saving	8,006	USD/year
Total investment (estimated, detail quotation is needed)	8,006	USD/year
Payback period	0.25	Year
Wood needed for additional steam generation	90.35	m^3
GHG saving from additional wood consumption	85.83	tCO_2e/year
GHG emission from current electricity consumption	35.19	tCO_2e/year
GHG saving	(50.64)	tCO_2e/year

Table 5: Substitute resistive ovens for cooking, drying, and baking with steam from LPG

Electricity saving	1,201,082.60	kWh/year
Financial saving	19,347.24	USD/year
Investment cost	85,000.00	USD
Boiler 2 TPH and steam system	50,000.00	USD
Equipment modification	35,000.00	USD
Payback period	0.71	Year
GHG saving	505.16	tCO_2/year

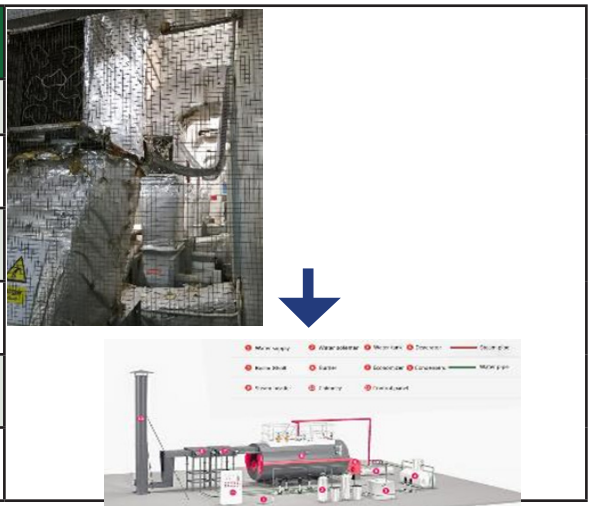
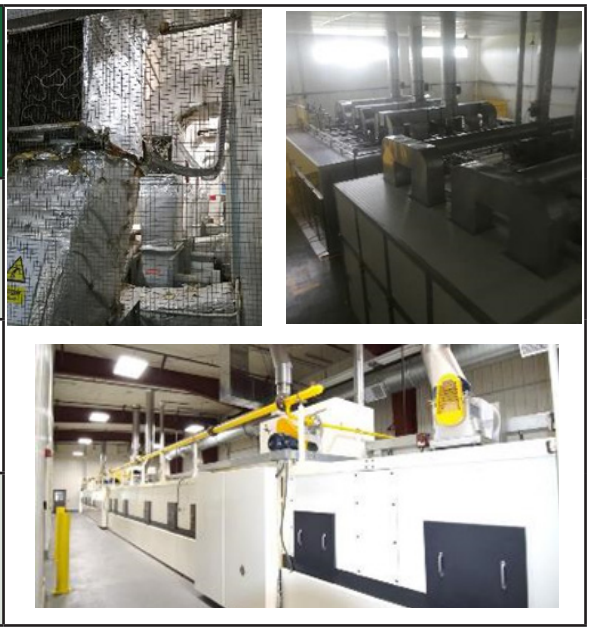


Table 6: Substitute resistive ovens for cooking, drying, and baking with LPG

Financial saving	116,605.30	USD/year
Investment cost	80,000.00	USD
Payback period	0.69	Year
GHG saving	709.62	tCO_2/year



VIII. Conclusion and Recommendations

The food processing equipment refers to the components, processing machines, and systems used to handle, prepare, cook, bake, dry, store, and package food and food products. All food processing equipment, including pipes and instruments, should be flexible to clean and disinfect easily, as well as simple to monitor. The equipment design and structures should not be exposed to machine-lubricating oil, metal debris, sewage, and other pollutants in order to prevent their transmission to the food.

Limited understanding of engineering principles through food processing equipment's operation and maintenance, there can generate very high risks that will impact to human health and safety of personnel. In other words, lack of food processing equipment's operation and maintenance is the waste of energy, costs, and resources. Therefore, to secure the food processing equipment safely and efficiently the energy efficiency approaches are crucially needed.

By joining with the UNIDO's TEST project implementation that led by the Ministry of Industry, Science, Technology and Innovation (MISTI), all of the project participant's companies will be offered a free energy audit that the owners of each company can be able to understand and know how their electricity consumption breakdown look likes and

[4] https://www.thermaxglobal.com/boilers-and-heaters/packaged-boilers/pdf/combipac.pdf
[5] https://betterwork.org/cambodia/wp-content/uploads/2013/05/Energy-Performance-in-the-Cambdia-Garment-Sector.pdf
[6] This information is retrieved from https://www.rasmech.com/blog/ways-increase-boiler-efficiency/

what the issues and their locations are. With that, those companies' owner will be able to build the concreted business plan holistically and can realize what challenges thee production processes' cycle are, and things they need to invest and improve as well as to enable their decision making quickly and in the right way.

As the UNIDO's project team had identified and provided various measurements or best approaches to minimize the costs, resources, and other fatalities with focusing on the energy efficiency for each participants' company to cope with the issues that happened around their food processing equipment. For example; as shown in table 6 above, the company owner just spent 80,000 USD in total investment on substituting resistive ovens for cooking, drying and baking with LPG, h e/she can save money around 116,605 USD/year and can contribute to reducing GHG emission around 710 tCO_2/year. Of course, this is a big contribution to the environment and the effort of the Royal Government of Cambodia to reduce GHGs emission as stated in the Nationally Determined Contribution Update (NDC-Update).

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