Tha Bar Wa
A sustainable future for industry

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GRANTS PROGRAMME

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Prepared for the Food and Beverage Industry of Myanmar
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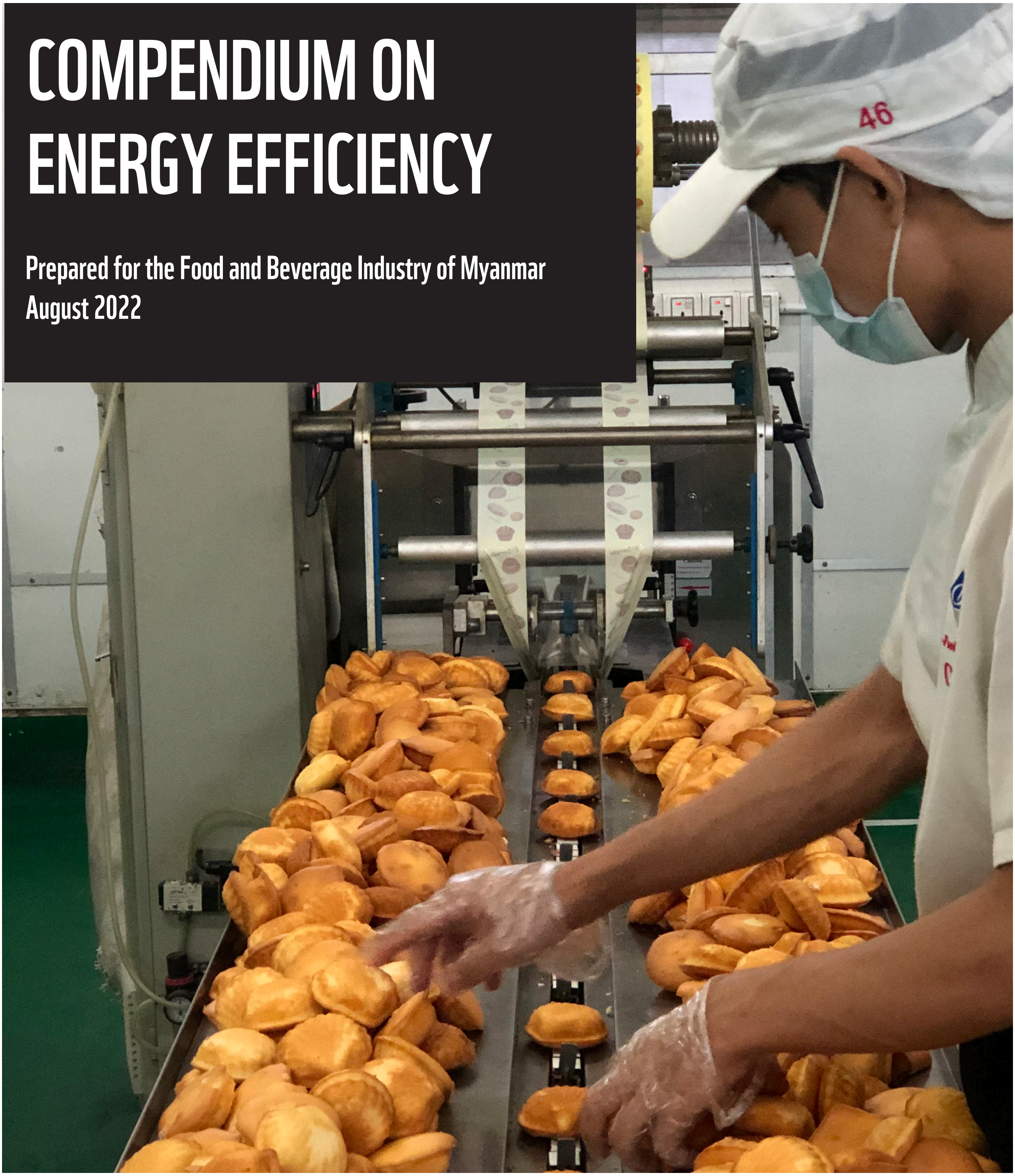

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Key Terms

Average Load: The mathematical average power (usually expressed in kilowatt - kW) drawn by a piece of electrical equipment over a specific period of time.

AHU: An air handling unit, commonly called an AHU, is the composition of elements mounted in large, accessible box-shaped units called modules, which house the appropriate ventilation requirements for purifying, air-conditioning or renewing the indoor air in a building or premises.

Blowdown: Boiler blowdown is water intentionally wasted from a boiler to avoid concentration of impurities during continuing evaporation of steam. The water is blown out of the boiler with some force by steam pressure within the boiler.[1]

Best efficiency point (BEP): The point along a pump performance curve where efficiency is the highest. In other words, BEP is the point at which the pump efficiency peaks. In any pumping system, operating at or around BEP of the pump is desired.[2]

Clamp-on meter: A clamp-on meter is an electrical test tool that combines a basic digital multi-meter with a current sensor. Clamps measure current. Probes measure voltage.

Condensate: The liquid formed when steam passes from vapor to a liquid state. In a heating process, condensate is the result of steam transferring a portion of its heat energy, known as latent heat, to the product, line or equipment being heated.

Cooling load: The amount of energy that would need to be removed from a space (cooling) by refrigeration equipment to maintain the temperature within an acceptable range.

Emissions: The discharge of harmful solid, liquid, or gaseous pollutants into the environment. Some activities that produce emissions include burning fuel or discharge from industrial processes and equipment.

Exhaust gas: Exhaust gas, also known as flue gas (as it comes out of a chimney or flue), is emitted because of the combustion of fuels such as natural gas, gasoline, diesel fuel, fuel oil, biodiesel blends or coal.

FD fan: A forced draft (FD) fan is a type of pressurized fan that gives off positive pressure within a system. FD fans force outside air into a heating system

Flash steam: Flash steam is produced when high pressure condensate is discharged to a lower pressure. The word 'flash' describes the way it is formed.[3]

Greenhouse gas emission: The emission into the earth's atmosphere of any of various gases, especially carbon dioxide, that contribute to the greenhouse effect

Impeller: An impeller (or impellor) is a rotor used to increase the pressure and flow of a fluid.

ISO 50001 Energy management systems: An international standard created by the International Organization for Standardization (ISO). The standard specifies the

[1] Wikipedia, Boiler blowdown: LINK.

[2] Pumps&Systems: LINK.

[3] Forbes Marshall, What is Flash Steam: LINK.

requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy security, energy use and consumption.[4]

ISO 50002: Another international standard created by the ISO. ISO 50002 specifies the process requirements for carrying out an energy audit in relation to energy performance. It is applicable to all types of establishments and organizations and all forms of energy and energy use.[5]

kWh: The kilowatt-hour (kWh) is a unit of energy equal to one kilowatt of power sustained for one hour and is commonly used as a measure of electrical energy.

Load: This is a component of a circuit that consumes electrical power or energy. In a factory setting, a motor is a common example of an electrical load. The amount of load is usually expressed in terms of power drawn by the circuit in kW.

Lux level: Lux is a standardised unit of measurement of light-level intensity. "Lux" is the unit of illuminance, measuring luminous flux per unit area.

Simple payback period: Simple payback period refers to the amount of time it takes to recover the cost of an investment. Simply put, the payback period is the length of time an investment reaches a break-even point.[6]

Pressure drop: It is defined as the difference in total pressure between two points of a fluid-carrying network. A pressure drop occurs when frictional forces, caused by the resistance to flow, act on a fluid as it flows through a tube.[7]

PVC curtain: Curtain made up from polyvinyl chloride (PVC). PVC strip curtains are often used at loading docks to prevent the escape of air-conditioned air, which can help manage utility costs and can help keep outdoor debris from getting in.

Rated load: A rated load is the load a machine/equipment is designed to carry as mentioned on the name plate of the equipment.[8]

Renewable energy: Energy from a source that is not depleted when used, such as wind or solar power.

Return on Investment (RoI): Also called "return on costs." A ratio between net income and investment. It is a performance measure used to evaluate the efficiency of an investment or compare the efficiency of several investments.[9]

Specific energy consumption (SEC): The ratio of kWh of energy consumed to the unit weight of the product produced by this energy consumption. It is represented by kWh per kilogram(kWh/kg) or ton (kWh/ton)

Throttling: Flow, which is forced to pass through a restricted area using a valve, where the velocity increases.

[4] ISO 50001 Energy Management Systems: LINK.
[5] ISO 50002 Energy Audit: LINK.
[6] Payback Period, Investopedia: LINK.
[7] Wikipedia, Pressure drop: LINK.
[8] Wikipedia, Rated load: LINK.
[9] Wikipedia, Return on Investment: LINK.

Variable frequency drive (VFD) or variable speed drive (VSD): A variable frequency drive, is a type of motor drive used in electro-mechanical drive systems to control alternating current (AC) motor speed and torque by varying motor input frequency.[10] A variable speed drive works similarly, but varies the speed of both AC motors and direct current (DC) motors by varying the voltage to the motor.[11]

V-belt: It is a flexible machine element that transmits power between a motor to the driven machine wheel.

[10] Wikipedia, Variable frequency drive: LINK.

[11] Quantum Controls. What are the differences between a variable frequency drive (VFD) and a variable speed drive? LINK.

Executive Summary

This document, prepared as part of WWF-Myanmar's Tha Bar Wa (TBW) project, which means "nature" in English, seeks to provide to small and medium enterprises (SMEs) within the food and beverage (F&B) industry a good understanding of energy usage in F&B enterprises, identifying areas of high energy usage as well as some directional guidance on steps they may take to improve energy efficiency within their own enterprises. Such information would also be beneficial for other stakeholders such as service providers and industry associations.

Another objective of this document is to share the TBW project's lessons learnt with public and private sector stakeholders who may be designing or implementing similar projects on energy efficiency in the future.

This report will cover:

- **An overview of the F&B industry in Myanmar.** In this section, the relevance of the F&B sector in the country is highlighted and provides justification for the sectoral choice made by the TBW project.
- **What is energy efficiency and why is it important for the F&B industry?** This section briefly explains the concepts of energy efficiency and the relevance for the F&B sector.
- **How to improve energy efficiency in your business.** This section provides the basic steps that an F&B SME could take in order to become more energy-efficient.
- **Good practices for energy efficiency.** This section describes the practices commonly seen in enterprises that have already taken steps to achieve energy efficiency, as well as those practices that help to sustain a focus on energy efficiency over time. These practices can serve as a benchmark for SMEs starting their journey towards becoming more energy-efficient.
- **Energy efficiency case studies from the F&B sector.** This section lists out specific energy efficiency case studies and aims to motivate interested SMEs by highlighting tangible benefits that similar SMEs have achieved.
- **Overview of equipment used in the F&B industry**. This section delves deeper into the utilities and equipment commonly used within F&B SMEs and provides specific technical guidance on relevant energy efficiency actions that SMEs can implement for their own operations.
- **Food and beverage sub-sector process mapping.** This section looks at the typical processes for different kinds of F&B sub-sectors, such as bakery, dairy, or fish processing, and highlights key points where there may be opportunities to improve energy efficiency.
- **Energy efficiency-related lessons learnt from TBW project.** This section is mainly helpful for stakeholders, such as consultants, non-governmental organizations, or industry associations, to improve the design and implementation of new energy efficiency-based projects in Myanmar.
- **Resources.** Finally, this section provides some preliminary information about technology or solutions providers in Myanmar that SMEs may contact to procure energy-efficient equipment. This section also has links for interested readers to deepen their knowledge on the subject of energy efficiency.

Overview of the Food and Beverage industry in Myanmar

Before discussing the details of the F&B industry in Myanmar, it is important to understand the landscape of industrial enterprises throughout the country. According to Myanmar's Department of Industrial Supervision and Inspection (DISI), in 2020, there was a total of 51,330 registered private industrial enterprises currently operating in Myanmar.[12] Figure 1 shows the distribution of these industrial enterprises by sector. The F&B industry is the largest sector, comprising 55.3 percent of all registered private industrial enterprises. The second largest industrial sector is "miscellaneous industries," which includes 7,440 registered private industrial enterprises and accounts for 14.5 percent of registered enterprises, followed by construction materials (9.4 percent) and mineral and petroleum products (7.1 percent).[13]

Because agriculture has traditionally been Myanmar's primary economic sector, contributing 30 percent to GDP[14] and employing 56 percent of the labour force, most manufacturing activities are also related to agriculture, whether it's for agricultural inputs, equipment, or post-harvest processing. As noted above, since the F&B industry makes up more than half of all registered enterprises in Myanmar, it is clear that F&B enterprises in Myanmar make an important contribution to the national economy.

Enterprises across Myanmar are classified in three sizes: small, medium, and large.[15] As shown in Figure 2, the F&B industry is mostly comprised of small enterprises (63

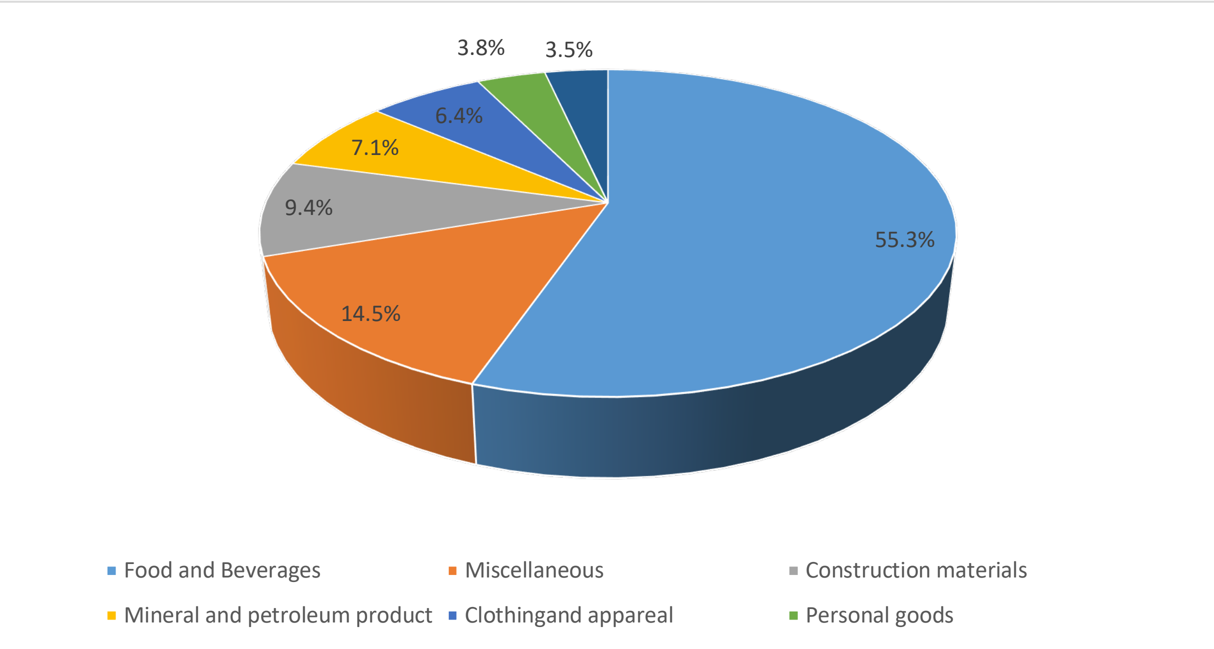

Figure 1: Industrial Enterprises in Myanmar by Sector (based on number of enterprises registered with DISI)

[12] Registered private industries as per Directorate for Industrial Supervision and Inspection (DISI), 2020
[13] Ibid. DISI, 2020
[14] Ministry of Agriculture, Livestock, and Irrigation (2018), Myanmar agricultural and development strategy and investment plan (2018-19).
[15] Definitions of enterprise classifications can be found on the Government of Myanmar's website.

percent).[16] This value is broadly in line with average national figures for all private enterprises; 59.3 percent are registered as small businesses. However, this national average is greatly affected by the size of the F&B sector, which makes up 57 percent of all small enterprises.[17]

The large share of F&B-related small enterprises has important environmental ramifications, as these enterprises often have both limited ability and/or motivation to effectively log energy consumption and production output quantity-related data and to implement advanced environmental impact assessments and plans related to their enterprise activities. The sheer number of these small F&B industry enterprises can have a cumulatively negative impact on the environment without proper safeguards in place.

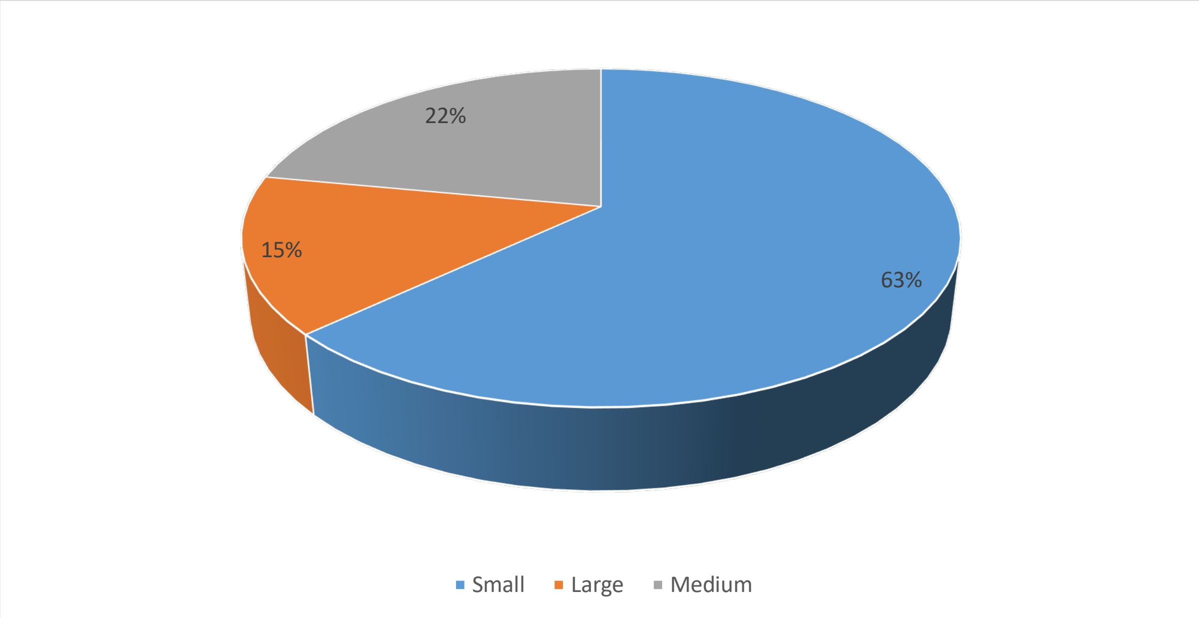

Figure 2: Food & Beverage Enterprise Distribution by Size across Myanmar

While industrial activity is distributed across the entirety of Myanmar, the two major centres of industry are Mandalay and Yangon, with 8,193 and 7,489 registered private enterprises, respectively (see Table 1). As compared to the rest of the regions in Myanmar, only Yangon and Mandalay have significant proportions of enterprises located within officially designated industrial zones. In general, in Myanmar, there is a shortage of officially designated areas for industrial zones to accommodate all industries, with limited space in existing zones and not enough zones throughout the country, although the government is planning to allocate new areas as industrial zones. Over time, many SMEs have evolved from being informal and often run from the home, and, as such, the government is developing plans to move a significant proportion of these SME industrial activities away from residential areas and into existing or future designated industrial zones. It is also important to note that while Mandalay and Yangon have the highest number of industrial enterprises, they do not have the most F&B manufacturing

[16] DISI figures for registered food & beverage enterprises (DISI), 2020
[17] Ibid. DISI, 2020

enterprises. The regions with the highest number of F&B manufacturing enterprises include Ayeyarwady (4,339), Sagaing (3,264) and Bago (3,033), while Chin, Rakhine, and Ayeyarwady have the highest percentage of F&B manufacturing enterprises as compared to other sectors (88 percent, 83 percent and 76 percent, respectively).

Table 1: National distribution of total number of enterprises and food and beverage enterprises in Myanmar (DISI, 2020)

Region	Total Number of industrial enterprises	Food and Beverage manufacturing enterprises	Percentage of food and beverage
Mandalay	8193	2952	36%
Yangon	7489	2360	32%
Ayeyarwady	5692	4339	76%
Sagaing	5012	3264	65%
Bago	4670	3033	65%
Shan	4515	2617	58%
Magway	3701	2579	70%
Mon	2742	1145	42%
Rakhine	2304	1909	83%
Taintharyi	1886	1013	54%
Kachin	1822	1276	70%
Kayin	1193	434	36%
Chin	811	714	88%
Union Territory (Naypitaw)	688	472	69%
Kayar	612	275	45%
Total	**51,330**	**28,382**	**55%**

In summary:

- The F&B sector makes up the largest share of Myanmar's total industrial enterprises, at 55.3 percent.
- The F&B manufacturing sector is made up primarily of SMEs. Out of all F&B manufacturing enterprises, 63 percent are categorized as "small".
- F&B manufacturing enterprises are widely distributed across all regions of Myanmar.

What is energy efficiency and why is it important for the F&B industry?

Energy efficiency and energy conservation are related and often complimentary or overlapping ways to avoid or reduce energy consumption. Energy efficiency has the goal to use less energy to perform the same task or achieve the same result, thereby achieving the maximum results or effects from each unit of energy used.[18] Energy efficiency is one of the easiest and most cost-effective ways to combat climate change, reduce energy costs for consumers and improve business competitiveness.[19]

Energy conservation is the conscious decision and practice of using less energy. This involves a change in behaviour and habits of a factory's staff, including practices such as turning off appliances that are not in use. Energy efficiency, on the other hand, involves using technology or practices that give the best performance with the least possible energy usage. For example, a factory might use LED lamps instead of incandescent lamps or optimise the fuel-to-air ratio in an oven to consume less fuel for the same output. As SMEs are often less energy-intensive, they have larger energy-efficiency potential compared to larger enterprises in more energy-intensive sectors.

Both energy efficiency and energy conservation measures can help to directly lower an enterprise's energy requirements, and the quantum of lowering of energy requirements is called "energy savings". Energy savings may also be expressed in monetary terms or cost savings.

Energy efficiency and energy conservation can both reduce costs for consumers and also potentially reduce greenhouse gas emissions associated with energy use. Production of many forms of energy at energy production sites, like a thermal power plant, results in carbon dioxide gas emissions from the burning of fuel. Thus, the lowering of energy consumption by an SME requires less energy to be produced at primary production sites. So, when SMEs achieve energy efficiency, not only do they save money, but they also contribute to a substantial reduction in carbon emissions into the atmosphere.

Overall, energy efficiency has five main benefits:

- It reduces energy costs, both for industrial enterprises and for the consumer.
- It reduces greenhouse gas emissions by reducing the quantity of energy required to achieve a specific outcome.
- It offers a cheaper, quicker and cleaner option compared to other emissions-reduction solutions such as carbon capture. Efficient energy use saves money and has a low technology risk. Many energy efficiency solutions also have a short payback period, or break-even point, compared to other emissions-reduction solutions, like using a renewable energy source.
- It is low risk, as energy-efficient technologies are mature and proven.
- In addition to energy, cost and carbon savings, energy efficiency often leads to improved **quality**, increased **production** and enhanced **comfort** conditions for

[18] U.S. Department of Energy. Energy Efficiency. Office of Energy Efficiency and Renewable Energy. LINK.
[19] Ibid, footnote 5, page 8

the workforce. Comfort conditions may be enhanced through the optimisation of illumination levels and ambient temperatures at the workplace.

By implementing energy efficiency measures, thereby reducing their energy consumption, F&B businesses can cut costs, increase profit margins and improve competitiveness. SUSTENT Consulting Private (Pvt.) Limited (Ltd.)'s experience helping enterprises to improve energy efficiency has shown that even low- and no-cost actions, such as raising energy conservation awareness among employees by promoting the utilisation of daylight or switching off lights when not in use, can usually reduce energy costs by at least 10 percent and produce quick returns, thereby enhancing profitability.

Within the F&B industry, food processing (especially milling sugar and rice) has high electrical and thermal demands.[20] For sugar mills, this is particularly focused on thermal energy, whilst for rice mills, the main energy load is both thermal and electrical. Both sugar and rice milling operations often utilise old, unimproved processing systems, leading to quality losses of 15-20 percent as well as energy losses.[21] Other food processing industries, especially those related to processing animal products such as dairy or fish, require significant amounts of energy for heating and/or cooling processes.

Since energy costs can be a significant portion of an industrial F&B SME's operating costs (and most F&B enterprises are small-scale—63 percent—as noted above), energy efficiency should be an important focus area for industry leaders and business owners. For, as noted above, energy efficiency yields important cost savings and can even be achieved with a low cost of investment (as will be discussed below).

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[20]Electrical and thermal energy demand are the measure of the amount of electrical energy and heating energy, respectively, needed in the industry for operation.

[21] Saving Energy and Costs: Taking action in Myanmar's Food and Beverage sector- Carbon Trust. LINK.

How to improve energy efficiency in your business

Energy conservation and energy efficiency are two strategies to reduce energy consumption within an industrial F&B enterprise. To develop a clear approach to improve both energy conservation and efficiency, an F&B enterprise must first map out how energy flows through the enterprise and where there are losses of energy. After having identified the losses, an enterprise can initiate actions to reduce those losses and thereby achieve improved energy efficiency. However, for these energy efficiency improvements to make a reduction in business costs over time, it is important to permanently sustain them.

There are some basic steps any enterprise may take, whether it's in the F&B industry or in any other industry, to start the process of adopting energy efficiency in its factories. By following these steps, any factory manager can start the journey towards energy efficiency.

1. **Energy policy** and action plan– as set up by the management of the enterprise

   1.1. At the beginning, the enterprise's management team should define a clear policy and action plan towards achieving energy efficiency in the factory. This also means that the management team will be committed to supporting the staff and be willing to make process changes required to enhance energy efficiency.

   1.2. Enterprise managers should spread awareness on energy efficiency among factory staff, clearly highlighting objectives around energy savings. The energy action plan should include setting realistic and achievable targets.

2. **Create an energy efficiency team** - including a team leader

   2.1. Making process improvements to achieve energy efficiency is not simply a job for one person from the maintenance department! A cross-functional team involving production, management, maintenance, and other responsible persons is needed to effectively implement energy efficiency practices in a factory.

   2.2. Management should select one person as "Energy Efficiency Team Lead." This person should have the capacity to mobilise other staff, understand the technical aspects of energy efficiency and also have adequate time to carry out energy efficiency tasks.

   2.3. Management should then capacitate the team. Training programmes or online courses can be used to help team members understand energy efficiency and fill any knowledge gaps.

3. **Monitor current energy use** – establish a baseline and monitor consumption

   3.1. The enterprise should then collect data by monitoring energy consumption. This data can be maintained monthly in a excel sheet or record book. The enterprise should monitor energy consumption data both at the plant/factory level as well as the equipment level, identifying which pieces of equipment and processes consume the most energy within the plant.

   3.2. This recorded monthly energy consumption data should also be correlated to monthly fluctuations of production quantity, allowing the enterprise to determine the ratio of energy consumption per unit of production, which is called specific energy consumption (SEC). By monitoring this ratio, the company can establish an SEC baseline each month.

3.3. The company should regularly analyse SEC fluctuations and take necessary action when SEC increases, with the goal of achieving the lowest possible SEC every month.

4. **Identify improvement opportunities** – for energy conservation and efficiency

4.1. The enterprise can start identifying and implementing simple measures that can be implemented at low or no cost, such as arresting compressed air leakages, switching off the lights during lunch hours or when not needed to complete necessary tasks, etc.

4.2. Analyse the possibility to invest in energy efficiency technologies or renewable energy, such as solar heating for generating hot water for sanitary purposes, waste biomass as fuel, solar photovoltaic (PV) systems, etc. While these measures might initially cost more, they will eventually yield better energy cost savings.

5. **Fix the Basics**

5.1. Upgrade equipment, including by installing low-energy lighting, insulating exposed heating and/or cooling surfaces, reducing compressed air leaks and investing in low-loss equipment and/or high-efficiency motors (which will all be further discussed in the Overview of Equipment Used in the F&B Industry section).

5.2. Enterprise owners and managers should work to educate and motivate staff to assure support for the implementation of the energy action plan. This could include awareness training sessions and putting posters on the importance of energy conservation throughout the factory.

6. **Optimize through Automation and Regulation**

6.1 Set up automated systems that control heating, cooling, and humidity settings within efficiency tolerances defined in step three, Monitor current energy use.

6.2 Integrate a lighting control system, motor control system, and variable speed drives (VSDs) for each key industrial process.

7. **Consider carrying out an energy audit** - using external experts

7.1. Enterprises that are serious about cost savings through energy efficiency should conduct an energy audit every one-to-two years, based on the size of the industrial plant, to receive expert advice on energy-saving opportunities.

7.2. The enterprise should then implement the recommendations in the energy audit report to improve energy performance and gain benefits from saving energy.

8. **Continual improvement**

8.1. Reset targets for energy efficiency and resume the above steps for continual improvement to a factory’s energy efficiency

Sustaining an enterprise’s energy efficiency is an ongoing and cyclical process, shown in Figure 3.

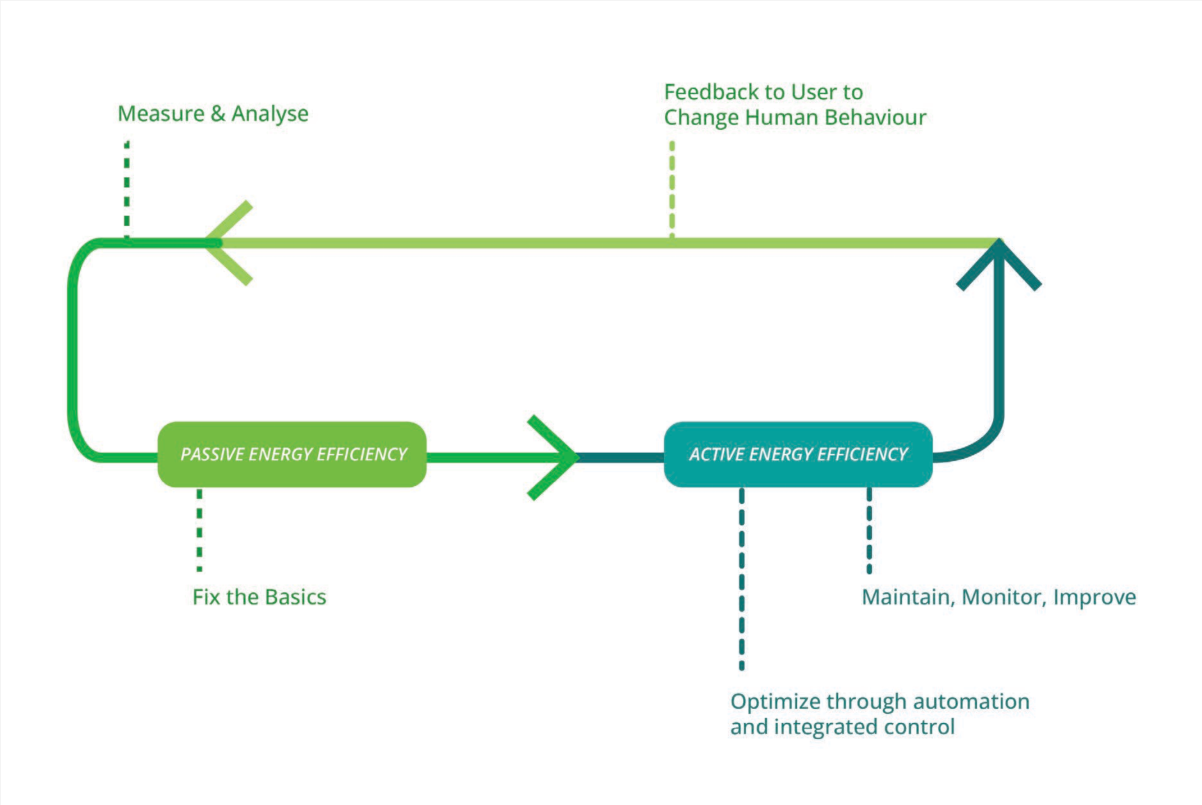


Figure 3: Recommended cyclical approach to achieve energy efficiency[22]

As noted in the process to achieving energy efficiency in an enterprise, conducting an **energy audit** is one of the main steps to achieving energy efficiency. ISO 50002, which is an international standard created by the International Organization for Standardization (ISO), specifies the process requirements for carrying out an energy audit in relation to energy performance. ISO 50002 defines an energy audit as the systematic analysis of energy use and energy consumption of audited objects with the goal of identifying, quantifying and reporting on opportunities for improved energy performance.[23] An energy audit is usually conducted to understand the energy utilisation of a given facility/plant and then to identify opportunities for improving overall energy savings.

In general, there are many reasons to undertake an energy audit, including to:

- Improve energy performance and minimise the environmental impacts of an enterprise's operations.
- Identify behaviour-change opportunities for enterprise personnel by evaluating current operations and maintenance practices.
- Identify technical opportunities for energy savings by evaluating significant energy-consuming equipment or utilities including motors, compressors, boilers, refrigeration units, furnaces or any other energy-consuming equipment.

[22] Source: Adopted from Schneider Electric's The successful energy management life cycle approach
[23] International Organization for Standardization (ISO) 50002: 2014(en). LINK.

- Provide clear financial information demonstrating the benefits of energy savings opportunities.
- Prioritise energy savings opportunities (least costly/most financial benefit) to help top management make decisions on process improvements and technology investments, as well as to develop an action plan.
- Gain a greater understanding of the enterprise's energy usage patterns and how they might fluctuate depending on production quantity.
- Identify potential for using a renewable energy supply or cutting-edge energy efficiency technologies.
- Achieve compliance with any national or international legal energy-related requirements and comply with or work towards corporate social responsibility goals.
- Contribute to the process for certification to a formal energy management system in accordance with ISO 50001 guidelines, which demonstrates an enterprise's credibility to outside parties or might be a legal or contractual requirement depending on the industry.[24]

The type of energy audit to be performed depends on the type of industry, the depth to which final audit is required by legal or contractual agreements, and the potential and magnitude of cost reduction desired by the enterprise. Energy audits can be classified under the following types: Walk-through Audit, Targeted Energy Audit and Detailed Energy Audit.

1. **Walk-through Audit:** This type of audit does not require much measurement or data collection, taking a relatively short period of time and providing more general results outlining broad opportunities for energy efficiency. The economic analysis in a walk-through audit is typically limited to calculations of the simple payback period, which refers to the amount of time it takes to recover the cost of an investment by reaching a break-even point.
2. **Targeted Energy Audit:** This involves detailed surveys of the target subjects (specific processes or equipment) and analysis of the energy flows and costs associated with them. Recommendations for actions to be taken to achieve energy savings for those specific targets are the outcome of a targeted energy audit.
3. **Detailed Energy Audit:** This is a comprehensive audit and results in a detailed energy efficiency implementation plan for a whole facility/plant, as it analyses the energy use of all major equipment. This audit will consider the integrated effects of various processes and offers the most accurate, detailed calculations of energy savings and the cost to achieve them.

To have a plan for comprehensive energy reduction for the whole enterprise, a detailed energy audit is recommended. An overview of the procedure for a detailed energy audit is shown in Figure 4**.** Overall, there are three main steps for a detailed energy audit

[24] ISO 50001. LINK.

(excluding the post-audit activities), each of which has several sub-steps. These three main steps are energy audit planning, execution and reporting.

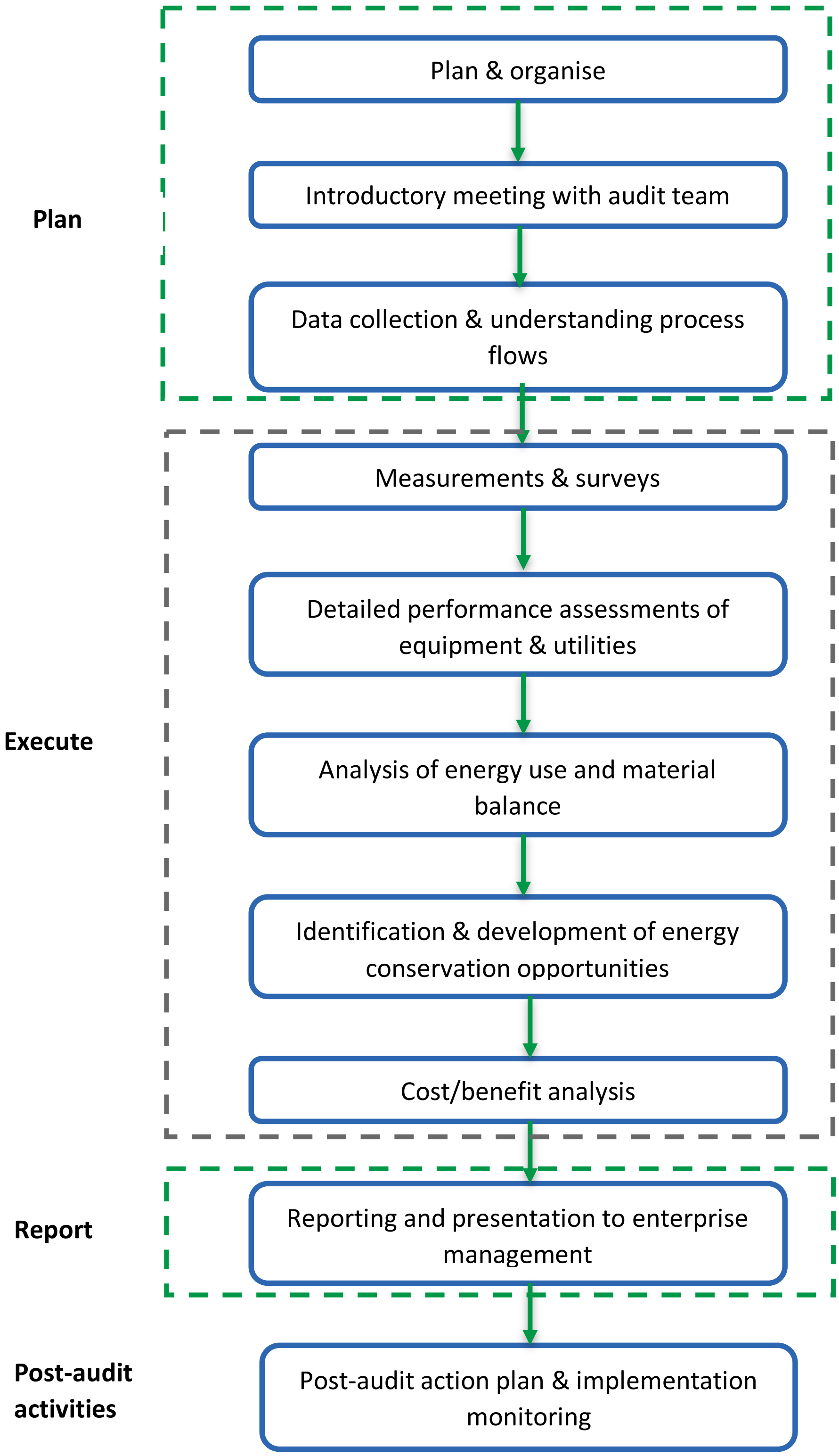


Figure 4: Steps for a typical detailed energy audit process

Good Practices for Energy Efficiency

As noted above, energy efficiency is a continuous process that involves participation from employees at all levels of an enterprise. As a general guide to enterprises in all sectors, the following are some good practices to improve energy efficiency.

Establish an Energy Policy

An enterprise should consider establishing an energy policy, which is either standalone or part of its environmental policy, if it has one. An energy policy and accompanying action plan should have clearly defined strategic objectives and achievable targets that reflect the enterprise's goals.

Use Awareness Tools

Among employees, an enterprise should generate awareness on energy usage and any other energy-related issues. Tools to raise awareness include posters in the enterprise, newsletters or pamphlets.

Conduct Training Programmes

An enterprise should conduct training programmes on energy efficiency, which should be scheduled once a month to strengthen the skills of the employees. The enterprise should consider testing the knowledge of their employees before and after trainings.

Monitor and Access Energy Data

An enterprise should monitor energy consumption data, both at the enterprise level and at the equipment level. Energy monitoring should be done over a longer period of time to show trends, which will help sustain the improvements made towards energy efficiency, help model energy consumption and requirements for the future and identify opportunities for further reduction.

Conduct Regular Energy Audits

An enterprise should conduct regular energy audits, which are necessary to identify energy savings options and help the enterprise focus on priorities that would give the best return on investment. An enterprise should implement the findings from the energy audit based on their potential impact and payback period.

Set Targets to Optimize Energy Use

An enterprise should set energy-use targets by identifying the most energy-consuming operations and processes and then planning its energy efficiency interventions based on which processes would have the biggest impact on energy savings and the largest return on investment. The targets should be defined in terms of SEC and must be different for thermal and electrical energy (in enterprises where both types of energy are used).

Employ Renewable Energy Options

An enterprise should consider employing renewable energy options such as solar heating for generating hot water for sanitary purposes, waste biomass as fuel, PV systems, etc. These solutions will result in high energy savings while reducing the release of pollutants into the atmosphere and water.

Sustain Achieved Improvements

An enterprise should consider pursuing ISO 50001 certification, which demonstrates that the enterprise uses a specific energy management system. Establishing and maintaining ISO certification requires regular follow-ups and monitoring by top management. Putting such a system in place helps sustain the energy efficiency improvements in the long term and also promotes continual improvements.

Energy Efficiency Case Studies for the F&B Industry

This section provides nine case studies of energy efficiency implementation that gave real benefits to enterprises within the F&B industry. These examples are drawn from the TBW project and SUSTENT Consulting Pvt. Ltd.'s work with the F&B industry in the Yangon region of Myanmar, India and Central Asia (Tajikistan and Uzbekistan).[25] The case studies described here are organized in ascending order of simple payback period. First, we provide examples of immediate payback period, followed by those examples where the payback period is longer. Usually, those initiatives that have a shorter payback period are also easier to implement.

[25] For all calculations in all case studies, monetary benefits are converted to MMK (Myanmar kyat) using the following rates: 1 USD= 10,810 UZS (Uzbekistan Som), 1 USD= 9.88 TJS (Tajikistan Somoni), and 1 USD= 1848 MMK.

Case study 01

Energy Savings by Using Daylight

A fruit processing enterprise in Tajikistan was using electric lighting despite ample sunlight available within the work area. This was due to limited awareness on the benefits of energy conservation among workers.

BEFORE

Image 1, Before: Lights were on in the daytime despite ample available daylight

During the daytime, despite ample natural light, light bulbs were turned on, which led to significant wasting of electricity. Eighteen LED bulbs were kept on during the day.

The awareness level among workers was very low regarding energy conservation

AFTER

Image 2, After: Switched off lights after raised awareness among workers

The project raised awareness among the workers, and managers instructed them to switch off the lights when not required. Training on the importance of energy conservation and how to do it was given to the workers.

A "nodal person" among the workers was appointed, and this person was given the responsibility to switch off the lights during the day and when not in use.

Monetary Savings[4]	Energy Savings	Cost Investment	Payback Period
213,145 MMK	1,628 kWh	No Cost	Immediate

Case study 02

Compressed Air Leakage Reduction

A milk processing enterprise in Uzbekistan was using compressed air for pneumatic operation of their machines. A compressed air leakage test found that 25 percent of the compressed air leaked from the system. The company brought an end to the leakages by changing the system's pipe joints, where the leaks were occurring.

BEFORE

Image 3, Before: Pneumatic machine where major compressed air leaks were found

On performing the compressed air leakage test, the team observed that 25 percent of the compressed air leaked from the compressed air pipeline.

This led to unnecessary energy loss and higher energy consumption.

Additionally, these leaks reduce the life of the compressed air system as they require continuous motor operation.

AFTER

Image 4, After: Pneumatic machine after compressed air leaks were stopped

The compressed air leakage in the pipeline was fixed both by closing the valve when the machine was not in use and by using spare pipe to replace the leaky pipe joints.

Company personnel was made aware of the cost of compressed air leakages.

The maintenance team was trained to perform regular leakage tests on the compressed air system and stop the leakages as soon as they were discovered.

Monetary Savings[2]	Energy Savings	Cost Investment	Payback
88,853 MMK	1,155 kWh	No Cost	Immediate

Optimising Operations of an Air Compressor that had Accumulated Dust

A potato manufacturing enterprise in Tajikistan was operating an air-compressor unit with accumulated dust in its filter. The enterprise cleaned the filter and added regular cleaning to its preventive maintenance plan for the compressor.

BEFORE

Image 5, Before: Air compressor with accumulated dust

The compressor was placed outside in a shed where dust in the air was common, and the team observed accumulated dust in its filter. This dust led to higher energy consumption for the same output. In addition, no ducting was done to displace heat from the compressor, increasing the temperature of inlet air and also leading to higher energy consumption.

AFTER

Image 6, After: Cleaned air compressor

The enterprise cleaned the air filter and added regular cleaning to the maintenance schedule. The maintenance team now cleans the air filter every 15 days.

The enterprise also ensured sufficient ventilation in the compressor room.

Finally, the enterprise is considering either providing an exhaust duct to expel heat directly out of the room or installing a ventilation duct to provide cooler fresh air.

Monetary Savings[2]
315,073 MMK

Energy Savings
1,326 kWh

Cost Investment
No Cost

Payback Period
Immediate

Energy Savings by Replacement of Incandescent Bulbs

A milk processing enterprise in Uzbekistan was using inefficient lighting inside its cold storage room, unnecessarily keeping the lights on all the time and using incandescent bulbs. These inefficient lights were not only consuming a higher amount of energy but were also heating the inside of the cold chamber, increasing the cooling load on the chiller.

BEFORE

Image 7, Before: Incandescent bulb inside cold storage

Image 9, Before: Thermal image of incandescent bulb showing high surface temperature

AFTER

Image 8, After: LED lights are installed inside the cold storage unit

Two incandescent bulbs (150 watts [W]) provided lighting in the cold storage unit. This led to higher energy consumption, not only by the bulbs themselves but also by the chillers, due to the increased cooling load required to mitigate the additional heat generated by these bulbs.

Lights were switched on at all times in the cold storage unit, even when people were not inside.

Incandescent bulbs were replaced with LED lights (15 W)

Energy consumption was reduced, not only by using more energy-efficient bulbs but also by reducing the cooling load.

Switching off the bulbs when not in use led to additional energy savings.

Monetary Savings[2]
164,781 MMK

Energy Savings
2,124 kWh

Cost Investment
13,636 MMK

Payback Period
1 Month

Case study 05

Replacement of a Diesel Boiler with a Biomass Boiler

A milk processing enterprise in Yangon, Myanmar was using an old, uninsulated, energy-inefficient diesel boiler with leaky steam distribution lines that was therefore consuming a large amount of diesel fuel. The enterprise replaced the diesel boiler with a biomass boiler that uses rubber tree sawdust briquettes, which saves significant energy, thereby reducing costs.

BEFORE

Image 10, Before: Inefficient diesel boiler

The old diesel boiler used a large amount of fuel, consuming 180 litres of diesel in 12 hours (costing about 15 USD/hour). Thus, this boiler was inefficient compared to others used for similar operations, resulting in a high operating cost for the enterprise.

AFTER

Image 11, After: Biomass boiler (picture for illustration purposes)

The enterprise installed a new energy-efficient biomass boiler, which reduced operating costs and used less energy. The new boiler consumes 66,000 kilograms of biomass briquettes per year—only costing about 4 USD/hour.

Monetary Savings
13,50,00,000 MMK

Fuel Savings
54,000 litres of diesel

Cost Investment
1,85,00,000 MMK

Payback Period
2 Months

Case study 06

Using a Polyvinyl chloride (PVC) Curtain in a Cold Storage Unit to Prevent Heat Gain within the Unit

A meat processing enterprise's cold storage unit in Tajikistan was gaining heat when loading and unloading goods. To mitigate this issue, the enterprise installed a PVC curtain at the door.

BEFORE

Image 12, Before: Cold storage door without curtain

The main door to the cold storage unit did not have curtains installed, resulting in cold air leakages as well as warm air infiltration from outside.

This led to higher energy consumption by the chillers in the unit in order to maintain the required temperature inside.

AFTER

Image 13, After: Cold storage door with PVC curtain

PVC curtains were installed both to avoid leakages of cold air and to prevent warm air infiltration, which resulted in energy savings.

Monetary Savings[2]	Energy Savings	Cost Investment	Payback Period
196,958 MMK	1,620 kWh	28,057 MMK	2 Months

Case study 07

Fuel Savings within a Steam Boiler, Thanks to the Installation of Adequate Insulation

A jam-producing enterprise in India has a steam boiler that runs on Liquid Petroleum Gas (LPG). The surface of this boiler and its steam pipeline had no, or worn out, thermal insulation.

BEFORE

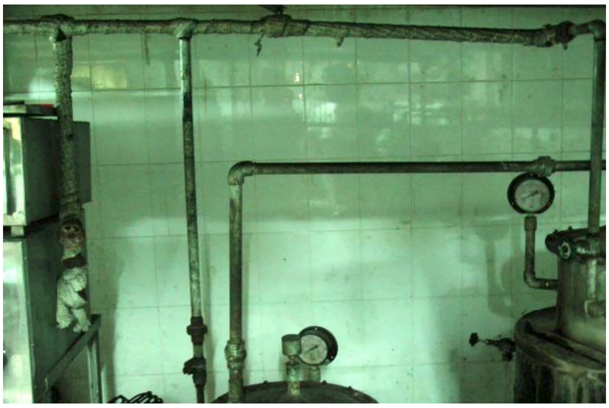


Image 14, Before: Uninsulated steam pipeline

AFTER

Image 15, After: insulated steam pipeline

The LPG-run boiler had inadequate insulation, both on its surface and along its steam pipeline.

Heat loss from the exposed surface area on the boiler and steam pipeline resulted in higher fuel consumption.

Adequate insulation on the steam pipeline and boiler surface was applied with steel cladding, which is a protective metal coating on insulation material that prevents moisture from penetrating the insulation.

With the new insulation, the surface temperature of the steam pipeline and boiler surface was reduced, limiting heat loss and resulting in cost savings through energy conservation.

Monetary Savings[2]	Fuel Savings	Cost Investment	Payback Period
123,941 MMK	**735 kg/year**	**51,286 MMK**	**5 Months**

Case study 08

Replacement of an Old Steam Generator with a New, Energy-efficient Steam Generator

A food processing enterprise in Tajikistan was using an old and inefficient electrically-operated steam generator of 50-kW capacity. The enterprise replaced this old steam generator with a new, energy-efficient steam generator capable of delivering the same quantity of steam but only using 35 kW of power.

BEFORE

Image 16, Before: 50kW Old steam generator without insulation

To generate steam, the food processing enterprise was using an old and inefficient electric steam generator with a 50-kW capacity.

The body of the steam generator had no insulation and was rusted, consuming significant time and energy to generate steam.

AFTER

Image 17 After: 35kw New efficient steam generator

The enterprise procured a new energy-efficient electric steam generator with 35-kW capacity to replace the old one.

Now, it can generate the same amount of steam in less time and with less energy consumption.

Monetary Savings[2]
3,064,904 MMK

Energy Savings
24,480 kWh

Cost Investment
3,366,802 MMK

Payback Period
13 Months

Case study 09

Energy Savings with Steam Condensate Recovery

A medium-scale dairy enterprise in India was using a coal-powered boiler that emitted significant steam. The enterprise then installed a condensate recovery system to utilise both the escaped heat and water that was going down the drain as feed water for the boiler. By using this water preserved by the new system in its boilers, the enterprise was able to reduce both water and coal consumption.

BEFORE

Image 18, Before: Condensate going down the drain

There was no steam condensate recovery system in place within the enterprise's coal-powered boilers.

Instead, condensate from steam was drained to an effluent treatment plant (ETP), thus wasting both heat and water.

AFTER

Image 19, After: Condensate recovery system

The enterprise installed a steam condensate recovery system pressure-powered pump package unit (PPPU), consisting of steam/condensate traps and a condensate pipeline to recover the condensate. The PPPU uses the condensate as boiler feed water, which increases the inlet temperature of feed water to the boiler, resulting in energy savings. A reduction in the use of coal has additional benefits: reduced handling of a difficult-to-manage fuel and lower particulate and other emissions into the environment.

Monetary Savings[2]
30,790,523 MMK

Coal Savings
300 tonnes/yr.

Cost Investment
22,306,616 MMK

Payback Period
9 Months

Overview of Equipment Used in the F&B Industry

F&B enterprises use various types of equipment for processing, and each piece of equipment is supported by multiple engineering utilities such as air compressors, pumps, motors, boilers, etc. This equipment and associated utilities are typically the drivers of high energy consumption within the enterprise, so it is important to closely monitor their energy use and efficiency to achieve long-term cost-savings. The following table, which was prepared using data from TBW energy assessment reports, shows the common equipment/utilities used in various F&B sub-sectors.

Table 2: Common equipment/utilities observed in F&B sub-sectors

Sub-Sector	**Lighting**	**Air compressor**	**Boiler**	**<u>AHU</u>**	**Motor/ Pump**	**Air conditioner**	**Chiller**	**Oven**	**Diesel Generator**	**Cold storage/ refrigeration**	**Cooling tower**	**Fan/ blower**
Bakery	√	√	√	√	√	√	√	√	√		√	
Dairy	√	√	√		√	√	√		√	√		
Edible oil	√	√	√	√	√	√			√			
Food processing (Snacks, such as chips)	√	√	√		√	√		√		√		√
Preserved fruits	√	√	√	√	√	√				√		
Fish processing	√	√	√	√	√	√	√			√		√
Vinegar processing	√	√	√	√					√		√	
Tea leaves	√	√		√	√							
Rice milling	√	√	√		√	√						√
Sugar processing	√		√	√	√							

Lighting, air compressors, boilers, AHU and motors/pumps are most the commonly used equipment and utilities within F&B sub-sectors. General best practices and improvement options for this equipment are provided below, with the goal of offering guidance and demonstrating the benefits to F&B enterprises. However, please note that this list is not a substitute for a detailed assessment carried out by an energy auditor. Each enterprise must exercise care in selecting its own best, specific, data-driven improvement options, as the actual situation of equipment and/or utilities on the ground may vary.

Lighting

Lighting is used in industries to illuminate work surfaces according to the requirements of the task to be performed. There are various "lux level" requirements for different tasks. For example, a high lux level is required when workers are filling and packaging bottles and a low lux level is required within the corridors of the enterprise. Some best practices for energy savings within lighting systems are given below:

Image 20 Switching off the lights when not required is one of the most simple yet effective ways of saving energy

- Switch off all unnecessary lights. When feasible, turn off the lights beside windows. Turn off the lights when you leave at night.
- Make the most of daylight, e.g., by putting polycarbonate sheeting in the roof as a skylight. Window and skylight cleaning will allow more natural daylight to reach the workspace.
- Instead of brightly lighting an entire room, focus the light where you need it to directly illuminate work areas.
- Paint ceilings and walls white and use light-coloured flooring materials.
- Install occupancy sensors for restrooms, offices, and other rooms within the facility. Determining which lights are the most appropriate candidates for an occupancy sensor depends on how much electricity the light uses, the traffic within the area and how often lights are left on. Occupancy sensors can conserve more than 20 percent of the annual energy usage of an individual lighting system, depending upon the area.
- Use light timers and photo sensors, which reduce the use of artificial lighting during periods when natural sunlight from exterior windows or skylights is adequate.
- Use LED bulbs instead of incandescent bulbs.

Compressed Air System

Compressed air is used in almost all types of industries. Compressed air is utilised to power a variety of equipment, such as pneumatic tools, monitoring instruments for process control, conveyor belts, etc. and is often preferred because of its convenience. Normally, air compressors are an overlooked area for energy savings as the general perception is that air is free and naturally available all around us. However, air compressors are a costly source of power, about eight to 10 times the cost of electricity.[27] Given this high cost, better maintenance practices and elimination of air leakages would help improve the performance of compressed air systems, resulting in cost savings. Some best practices for saving energy in air compressors are given below:

[27] Chicago Pneumatic. The cost of compressed air. LINK.

- Recover heat waste from an air compressor. More than 80 percent of the electricity supplied to the compressor can be recovered if the enterprise utilises the heat generated from cooling the compressor.[28] For example, hot air can be used to produce hot water, which can be further used for process heating or washing purposes. Water-cooled air compressors can provide hot water, at about 75 degrees Celsius, which can be used in other enterprise processes, thereby saving energy that would be spent heating water. A generic compressed air system is shown in Figure 5.[29]

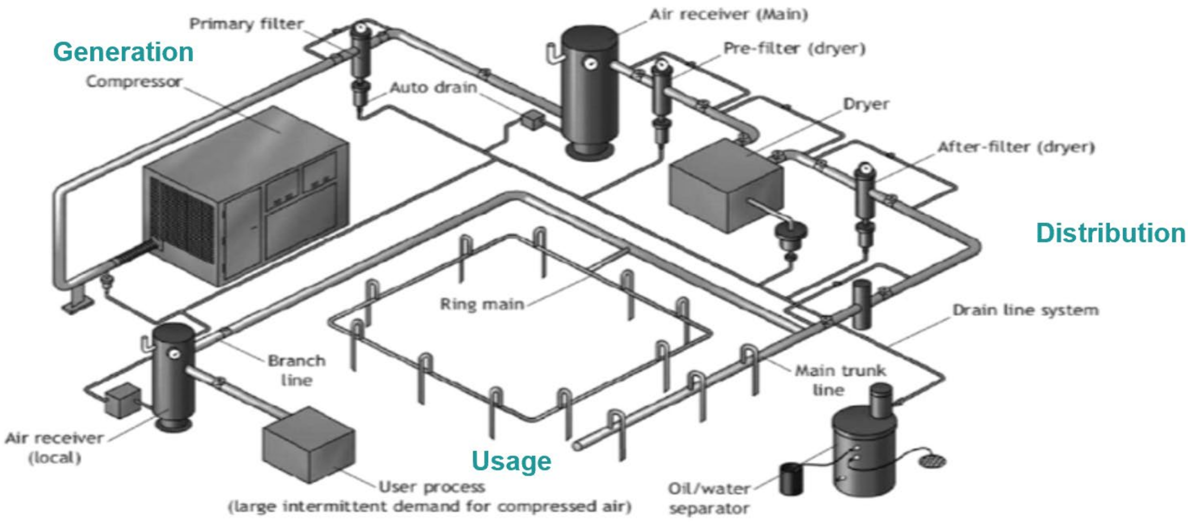


Figure 5: A generic compressed air system

- Utilise colder intake air for an air compressor, as every 4-degree-Celsius rise in inlet air temperature results in increased energy consumption of 1 percent.[30] As compressors require less energy to compress cooler and denser air, an enterprise may use inlet air from outside, which is cooler than the air in the compressor room. To provide better ventilation for cool air intake, an enterprise may invest in a separate compressor room or make arrangements for ventilation in the existing room. Typical results are energy savings of about 5 percent, with payback periods of less than a year for compressors under continuous operation.
- Repair compressed air leaks. In a typical industrial plant without a leak detection and repair programme, air leaks contribute to 25 to 40 percent of utilised air.[31] A leak detection and repair programme can reduce leaks to only about 10 percent of air compressor demand. Air leaks occur mainly in the following areas:
    - Couplings, flexible hoses, rubber and plastic tubes, and fittings
    - Pressure regulators
    - Pipe joints and thread sealants

[28] Moskowitz, Frank. Heat Recovery and Compressed Air Systems. Compressed Air Best Practices. LINK.
[29] Source of figure: The Chemical Engineer. LINK.
[30] Government of India. Compressed Air System. Bureau of Energy Efficiency. LINK.
[31] Marshall, Ron. Protect Profits with Compressed Air Leakage Best Practices. Compressed Air Best Practices. LINK.

- Reduce line pressure to the minimum required. As a rule of thumb, 1 percent savings can be achieved with every 0.1 bar reduction in pressure for screw compressors,[32] which is a common kind of compressor used by industrial enterprises.
- Segregate high- and low-pressure requirements. If several appliances require high-pressure air, but others require low-pressure air, consider using a smaller, separate high-pressure compressor.
- Design for a minimum pressure drop in the distribution line. A properly designed system should have a pressure loss of less than 10 percent of the compressor's discharge pressure, measured from the receiver tank output to the point-of-use.[33]
- Start with an energy audit, then make an air compressor efficiency-maintenance program as part of your continuous energy management program.

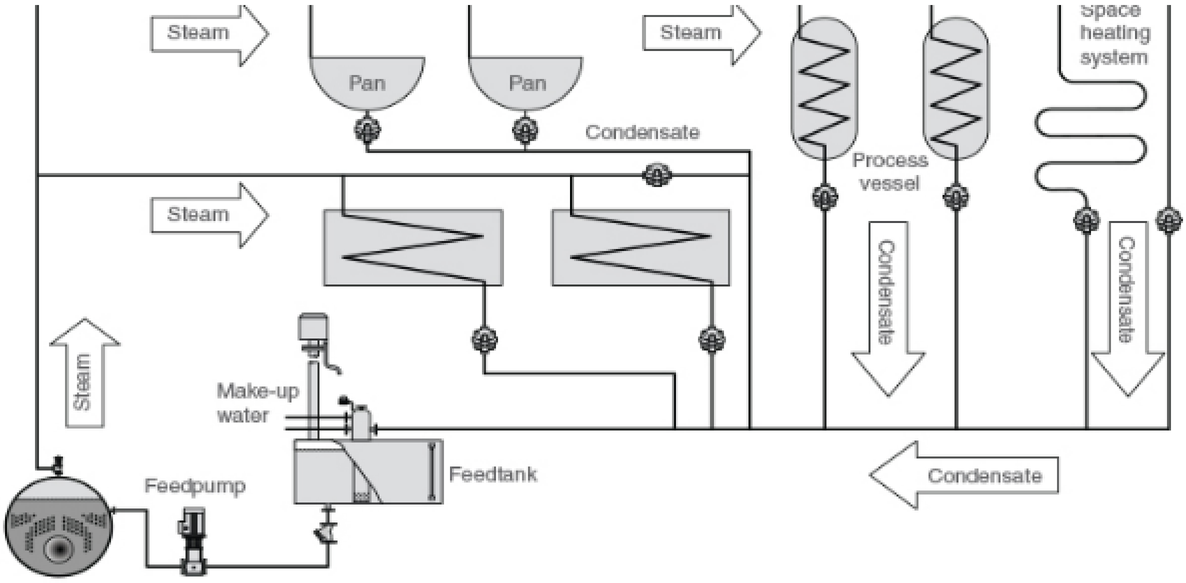
Boiler and steam pipeline system

Boilers are used in various industrial units to convey heat through steam for different processes such as cooking rice, boiling milk or sterilisation of containers prior to packing. Steam is commonly used as the heating medium due to two main reasons. First, steam is generated from water that is usually readily available and inexpensive. Second, steam can store a large quantity of heat at a temperature that can be conveniently used for heat transfer. Boilers require various types of fuel, namely coal, oil, gas or biomass, to generate steam, depending on the availability of fuel and its cost. A generic steam distribution system is found in Figure 16.[34] Some best practices for energy saving in boiler systems are given below:

- Insulate exposed pipelines, the body of the boiler and its door with tightly wound glass wool fortified with ceramic ribbon and waterproof cladding.
- Regularly check the oxygen content in the boiler's exhaust gas. To maintain optimum oxygen levels in the exhaust gas, regularly adjust the damper of the FD fan based on exhaust (flue) gas analysis. Best performance is obtained by installing an automatic air control system that will adjust the supplied air volume depending on the residual oxygen content in the exhaust gas.
- Install a condensate recovery system to conserve and recirculate condensate from steam.
- Optimise blowdown (release of hot water) by measuring the boiler water's conductivity and installing a system that automatically controls blowdown.
- Recover heat from flash steam (which is low pressure and forms from blowdown or returning condensate). A flash tank acts as a separator, allowing the remaining liquid to separate from flash steam. Low-pressure steam can then be used for process applications such as producing hot water.

[32] Air Compressor Guide. Why Am I Wasting Money on Compressed Air? LINK.
[33] Compressed Air Best Practices. Distribution Piping: Understanding Pressure Drop. LINK.
[34] Wermac. Steam Distribution System. LINK.

Figure 6: A generic boiler and steam distribution system



- Recover lost stack gas. A boiler's stack or chimney allows the gases produced after fuel combustion to be exhausted into the atmosphere. The energy lost through the boiler stack is a function of exhaust gas temperature and excess air at the stage of fuel combustion. Typically, stack gas loss contributes to about 15 percent of a boiler's energy loss. Energy from the stack can be recovered for preheating combustion intake air or preheating feed water before it enters the boiler. When water is pre-heated (utilising the energy in the stack gases) it needs less energy to be heated to form steam, thereby saving energy and making the boiler more energy-efficient.

- Use the warmest air possible for combustion intake. As a rule of thumb, a 1 percent increase in boiler efficiency is possible for each 20-degree-Celcius increase in intake air temperature for combustion. This air could be sourced from the area just below a facility's roof, which will be warmer due to air temperature stratification.

- Key parts of the boiler, including fireside surfaces, waterside surfaces, the burner assembly and the stack, should be regularly maintained. This maintenance would include visual inspection for leaks or cracks in insulation and cleaning, as necessary.

- Seals, feed water pumps and safety valves should be systematically checked for water leaks and repaired, if necessary

- Eliminate steam leaks. Significant energy savings can be realised by locating and repairing leaks in live steam lines and in condensate return lines. By wasting steam through leaks in steam lines, increased boiler steam production is required to meet the system's needs. In leaky condensate return lines, additional feed water is required to make up for condensate losses, as more energy is needed to heat this new, cooler feed water than what would be necessary to heat the preserved, warmer condensate. In this case, the need for water treatment also increases, as additional water is required to top up the system. Leaks most often occur at the fittings in the steam and condensate pipe systems. Energy and cost savings from the elimination of leaks depend on a boiler's efficiency, the number of hours the leaks occur, the boiler's operating pressure and the enthalpies of the steam and boiler feed water (where enthalpy is a measure of the energy content of the steam and feed water).

Motors

Electric motors are used to provide motive power to equipment such as processing equipment, air compressors, pumps, blowers, etc. It is important that industrial enterprises accurately define their processing needs to enable proper selection of a motor for a particular application. Some best practices for saving energy in motors are given below:

Image 21: Picture of an induction motor for illustration purpose

- Make a list of all existing motors used in the enterprise. Note down the motors' parameters, including rated power, hours of operation, age of each motor and efficiency class.
- Using a clamp-on meter, measure each motor's actual load to identify the percentage of actual power as compared to rated power.
- Select the appropriate size of motor for more efficient operations. Motors should be sized to operate within a load window of 65 to 100 percent of their rated load.[35] However, the common practice of motor over-sizing results in less efficient operation. For example, an over-sized motor operating at a 35 percent load is less efficient than a smaller motor that would operate between 65 and 100 percent with the same load.
- It is a common practice for enterprises to rewind a motor when it burns out due to electrical failures, disruption to power supply or insulation breakdown. Such failures are typically caused by contaminants, abrasion, vibration or voltage surges. However, rewinding reduces motor efficiency by 1 to 3 percent.[36] Therefore, rewinding a motor more than three times in the lifetime of the motor is not cost efficient, regardless of the type or size of motor or the context. Given

[35] Government of India. India Guide Books. Bureau of Energy Efficiency (BEE). LINK.
[36] Government of India. India Guidebooks. Bureau of Energy Efficiency (BEE). LINK.

the increased energy inefficiency of a rewound motor, purchasing a new motor provides more cost savings in the long term.

- Install Variable Frequency Drives (VFDs) on valve-controlled fans and pumps that operate in a range of conditions. To know the exact economic benefits of installing VFDs, information on the frequency of an enterprise's fan and pump operations is necessary. As a rule of thumb, a VFD-supplied air flow of 50 percent reduces electricity consumption by 70 percent as compared to controlling air flow with a valve.[37]
- Use an energy-efficient V-belt. V-belts have a trapezoidal cross section that create a wedging action on pulleys within a motor to increase friction and power transfer capacity. V-belt drives can reach a nominal efficiency of 93 percent.[38] Regularly check the tension of the belts to maintain efficiency.

Refrigeration and air conditioning

Refrigeration is the process of removing heat at a low temperature level and rejecting it at a relatively higher temperature level. Refrigeration, including equipment for freezing to temperatures below 0 degrees Celsius, and/or air conditioning is accomplished by various methods, such as through a vapor compression system, absorption system, or steam-jet refrigeration cycle. Based on the experience of SUSTENT Consulting, the most used refrigeration systems are vapor compression, followed by absorption. The means of achieving higher energy efficiency in both refrigeration and air conditioning systems are similar, hence the opportunities for energy efficiency in these systems are presented together.

The required elements making up a complete refrigeration and air-conditioning system are refrigerating equipment (such as mechanical compression refrigeration, evaporative cooling, absorption refrigeration, vapour compression refrigeration or vapour absorption refrigeration), fans, pumps, cooling towers, filters, air-handling units, and ducting. Depending on the process, all or some of the equipment mentioned may be required. Some best practices for saving energy in refrigeration and/or air conditioning systems are given below:

- Mount blinds outside windows in addition to inside to prevent warming.
- Turn off unused devices, as they produce additional heat.
- Close doors in air-conditioned rooms and cold storage units.
- Turn off air conditioning when no cold air is needed.
- If possible, increase an air conditioner's temperature to 25 degrees Celsius, and no lower; every increased degree of room temperature saves up to 6 percent of air conditioning-related electricity[39]

[37] Government of India. India Guidebook. Bureau of Energy Efficiency. LINK.
[38] Grainger. Types of Belt Drives and How They Improve Efficiency. LINK.
[39] Wibberly, Alana. 2016. What's the Best Temperature for my Thermostat? SmartEnergy. LINK.

- Cold air should be directed so that it is blown where specifically needed (using the unit's "flapper position").
- Select an air conditioning unit and refrigeration system appropriate for the room size and temperature.
- Carry out an energy audit and develop a regular maintenance plan to maintain air conditioning and refrigeration devices according to the manufacturers' recommendations.

Pumps

Many industrial processes, including those in the F&B industry, involve transportation of fluids, and a pump is the only mechanical means available to facilitate this transportation. Because a pump is incapable of transporting fluid on its own, it needs a "prime mover" in order to function. The prime mover can either be an electric motor, a diesel engine, or a steam/gas-powered turbine. To power a pump, all prime movers consume energy, either in the form of electric power or non-renewable petroleum products like diesel, oil or gas. Some best practices for saving energy in pumps are given below:

Image 22: Picture of a pump for illustration purpose

- Operate pumps near their best efficiency point (BEP).
- Minimize throttling and pump losses by modifying the pumping system to minimise pipe bends.
- Incorporate basic, key instruments in pumping systems, such as pressure gauges or flow meters.
- Using VSDs or sequenced control of multiple units, adapt the pumping system to a wide range of operational loads.
- Install and use booster pumps for smaller loads requiring higher pressures.
- Repair seals to minimize water lost in the pumping system through leaks/dripping.
- In a system with multiple pump operations, seek to carefully combine them to avoid throttling.

- Replace old pumps with energy-efficient pumps. A pump's efficiency may degrade by 10 percent to 25 percent in its lifetime.[40] This degradation is primarily driven by process changes that may have caused a mismatch between the pump's capacity and its operation.
- To improve the efficiency of oversized pumps, install VFDs, downsize or replace the pump's impeller or replace the bigger pump with a smaller pump.
- Reduce system resistance by conducting a pressure-drop assessment and pipe-size optimization.
- Regularly check for vibrations in the system to predict bearing damage, misalignments, unbalance, foundation looseness, etc.
- In operations that require continuous or near-continuous operation, install an energy-efficient pump.

Chiller

Commonly used to cool both products and machinery, chillers, which circulate chilled water or liquid through processing equipment, are used in a multitude of different applications in F&B enterprises.

Image 23: Picture of an Air-cooled Chiller for illustration purpose

The function of a chiller is to move heat from one location (processing equipment or product) to another place (usually the air outside the manufacturing facility). It is very common to use water or a water/glycol solution to transfer the heat to and from the chiller, which may require a reservoir and pumping system. Some best practices for saving energy in chillers are given below:

- If possible, increase the chilled water temperature set point (the minimum temperature needed to adequately cool the machine or product).

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40 Electrical Engineering Portal. 2014. 14 Energy Efficient Improvement Opportunities in Pumping Systems. LINK.

- For water used in the chiller's condenser, use the lowest temperature that the chiller can handle, as reducing condensing temperature by 5.5 degrees Celsius results in a 20- 25 percent decrease in compressor power consumption.[41]
- Regularly clean dirty heat exchangers, as a 1-millimetre scale build-up on condenser tubes can increase energy consumption by 40 percent.[42]
- Use water-cooled, rather than air-cooled, chiller condensers, as water-cooled condensers utilise less energy, allowing the refrigeration system to operate at lower head pressure, making it more efficient to operate than an air-cooled chiller.
- In operations that require continuous or near-continuous operation, install energy-efficient chiller motors.
- Install a control system to coordinate multiple chillers operating simultaneously or sequentially.
- Operating multiple chillers simultaneously might result in lower loads and potentially less efficiency. Study part-load characteristics and cycling costs to determine the most efficient mode for operating multiple chillers.
- As with motors and pumps, avoid oversizing chillers and, instead, match the size of chiller to the connected load.
- Starting with an energy audit, establish a regular chiller efficiency maintenance program as a part of your continuous energy management program.

Ventilation and exhaust system

Any F&B enterprise engaging in processing activities will require ventilation or an exhaust system for heat, particles from processing, smoke or noxious gases from processing machines. Some best practices for saving energy in ventilation or exhaust systems are:

- For exhaust fans, install occupancy sensors or timers for restrooms, offices, and other rooms that are not used continuously, so that fans are used only when needed.
- Switch off fans/blowers if not needed for operations (e.g., during break time).
- Install VFDs on air handling/processing equipment that operates under a range of conditions.

Cooling tower

[41] Latest Energy Saving Ideas for Chiller Systems. LINK.
[42] Energy Conservation in Refrigeration & HVAC System. LINK.

A cooling tower is a device that rejects waste heat into the atmosphere through the cooling of a water stream to a lower temperature (part of the hot water evaporates into the air, thereby transferring the heat). Some best practices for energy-saving in cooling towers are given below:

Image 24: Picture of a cooling tower for illustration purpose

- Analyse cooling tower and chiller performance data to determine the optimum water temperature.
- Use VSDs for cooling tower fan control. VSDs increase or decrease the speed of the fan based on the water temperature requirements.
- Turn off unnecessary cooling tower fans when loads are reduced.
- Install interlocks to prevent fan operation when there is no water flowing to and from the cooling tower.
- Periodically clean cooling tower water distribution nozzles, which may become plugged, or install new nozzles to obtain a more uniform water pattern.
- If possible, follow the manufacturer's recommended clearances around cooling towers and relocate or modify structures, signs, fences, dumpsters, etc. that may interfere with air intake or exhaust.
- Divert clean, air-conditioned-building exhaust to the cooling tower when the weather is hot.
- Assess whether cooling tower cold water basins are leaking, and re-line them (with epoxy coating) as necessary.
- Check water overflow pipes to ensure proper operating levels, adjusting the overflow pipe if necessary.
- Shut off process loads that are not in service to reduce the cooling tower’s operating load.
- Utilize blowdown for other operations. Remember, the blowdown does not have to be removed at the cooling tower. It can be removed anywhere in the piping system.

- Start with an energy audit, then make a cooling tower efficiency-maintenance program as part of your continuous energy management program.

Diesel generator (DG) sets (also called gen-sets):

When gaps exist between the demand and supply of electric power, the role of DG sets cannot be overemphasized in order to ensure continuous processing operations in an F&B enterprise. Some best practices for saving energy in DG sets are given below:

Image 25: Picture of a diesel generator for illustration purpose

- Regularly measure fuel consumption per kWh of generated electricity. Take corrective action in case this shows a rising trend, including preventive maintenance or replacing an old DG set with a new, efficient DG set if the payback period is attractive (under three years).
- Clean air filters regularly.
- Use waste heat from DG sets to generate steam, hot water, or power for an absorption chiller.
- Insulate exhaust pipes to reduce DG set room temperatures, especially when the DG set shares a room with other equipment or products.
- Start with an energy audit, then make a DG set efficiency-maintenance program as part of your continuous energy management program.

Food and Beverage Sub-sector Process Mapping to Identify Energy Efficiency Opportunities

General, simplified process mapping of some food and beverage sub-sectors are provided below. The data for these process maps was extracted from enterprise energy assessments carried out under the TBW project.

For each sub-sector, basic process flows, along with resource mapping diagrams, are given along with a breakdown of energy consumption. The symbol in the process flows and resource mapping diagrams shows the "hot spot" for energy efficiency in that particular process or step, and enterprises should focus their efforts on these hot spots to have the greatest reduction of energy consumption.

- **Bakery**

A simple resource mapping and process flow diagram for a typical bakery process is given in below, in Figure 7.

Resources		**Process**		**Wastes & Hazards**
Flour, Sugar, Eggs, and Butter	→	**Raw material**	→	Fine flour and sugar dust
		↓		
		Weighing		
		↓		
Electricity	→	**Mixing**	→	Residual flour
		↓		
Hot Water	→	**Dough making**	→	Heat loss
		↓		
Electricity and LPG	→	**Baking**	→	Fine flour dust and heat loss
		↓		
		Cutting	→	Cut pieces (ends and edges) of bread and cake
		↓		
Electricity and compressed air	→	**Packaging**		Plastic waste and compressed air leakage
		↓		
		Dispatch		

Figure 7: Process flow and resource mapping diagram of a bakery enterprise

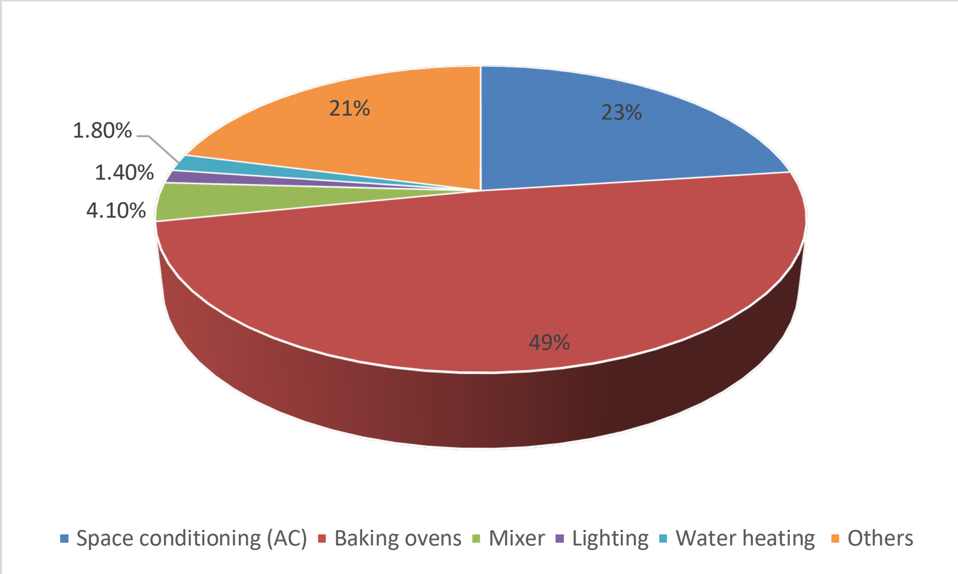

Figure 8: Energy consumption breakdown of a bakery

Figure 8 shows the typical energy consumption breakdown of a bakery enterprise assessed by the TBW project. Together, baking ovens and water heating (to make dough) consume 72 percent of energy in the factory, with baking ovens making up about half of all energy consumption. In certain bakeries, gas is used in place of electricity to heat the ovens. Commonly found energy-saving opportunities for bakeries include installing more energy-efficient ovens, LED lighting (and turning lights off when not in use), air compressors and motors.

- **Dairy**

Figure 9 shows a simple resource mapping and process flow diagram for a typical dairy enterprise that processes fresh milk.

Resources		Process		Wastes & Hazards
Milk	→	**Raw material**		
		↓		
Electricity	→	**Chilling**	→	Cold loss
		↓		
Electricity and steam	→	**Pasteurization**	→	Heat loss
		↓		
Electricity	→	**Cooling**	→	Energy loss (Heat)
		↓		
Electricity	→	**Packaging**	→	Plastic waste
		↓		
Electricity	→	**Cold storage**	→	Heat loss
		↓		
		Dispatch		

Figure 9: Process flow and resource mapping diagram for a dairy enterprise `

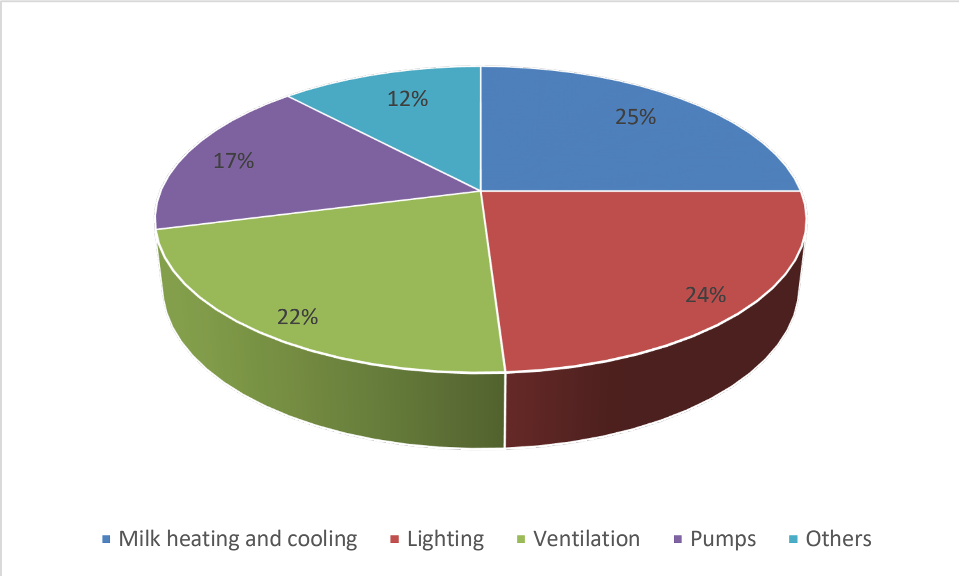

Figure 10: Energy consumption breakdown of a dairy company

Figure 10 shows the typical energy consumption breakdown for a dairy company assessed by the TBW project. Milk heating and cooling are the most energy-consuming processes, taking up a quarter of all energy. Other energy-consuming equipment and processes are lighting and ventilation, which each consume about a quarter of the facility's energy. In addition to electrical energy, diesel and coal are also used for generators and boilers for steam generation, which is used to heat milk. Commonly found areas with energy saving opportunities in dairy are lighting, boiler and steam distribution, air compressors, cold storage and motors.

- **Fish processing**

Figure 11 shows a simple resource mapping and process flow diagram for a fish processing enterprise.

Resources		**Process**		**Wastes & Hazards**
Fish	→	**Raw material**		
		↓		
Electricity	→	**Removal of head and fins**	→	Fish head and fins
		↓		
Electricity	→	**De-boning**	→	Bone
		↓		
Water	→	**Washing**	→	Waste water
		↓		
Electricity	→	**Forming into blocks and freezing**	→	Energy loss (Heat)
		↓		
Electricity	→	**Packaging**	→	Plastic waste
		↓		
Electricity	→	**Cold storage**	→	Energy loss (Heat)
		↓		
		Dispatch		

Figure 11: Process flow and resource mapping diagram for a fish processing enterprise

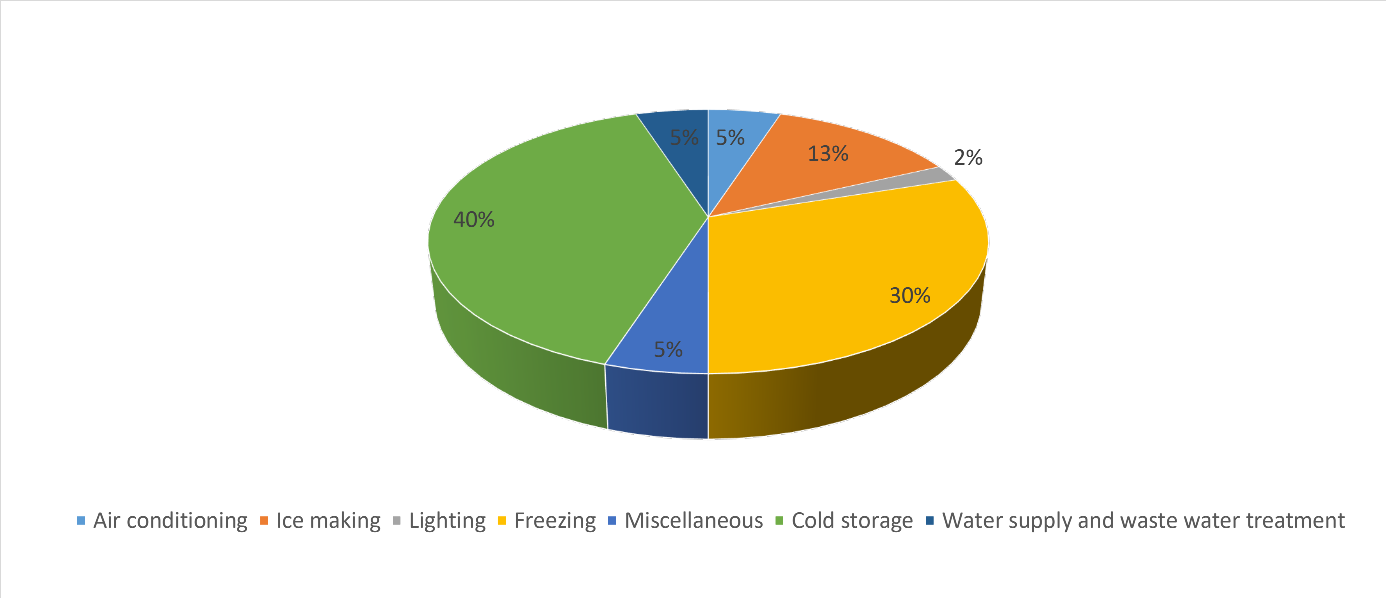

Figure 12: Energy consumption breakdown of a fish processing company

Figure 12 shows the typical energy consumption breakdown for a fish processing company assessed by the TBW project. Cold storage, including freezers, are the main energy consuming areas, using 70 percent of a fish processing facility's energy. Commonly found areas with energy saving opportunities in fish processing are cold storage, chillers, lighting, air conditioning and motors.

- **Edible oil processing**

Figure 13 shows a simple resource mapping and process flow diagram for an edible oil processing enterprise.

Resources		**Process**		**Wastes & Hazards**
Oil seed	→	**Raw material**		
		↓		
Electricity	→	**Seed cleaning and drying**	→	Seed shell and dust
		↓		
Electricity and Steam	→	**Grinding**	→	Water and heat loss
		↓		
Hot Water	→	**Filtering**	→	Heat loss
		↓		
Electricity	→	**Storage**		
		↓		
Electricity	→	**Packaging**	→	Plastic waste and heat loss
		↓		
		Dispatch		

Figure 13: Process flow and resource mapping diagram for an edible oil processing company

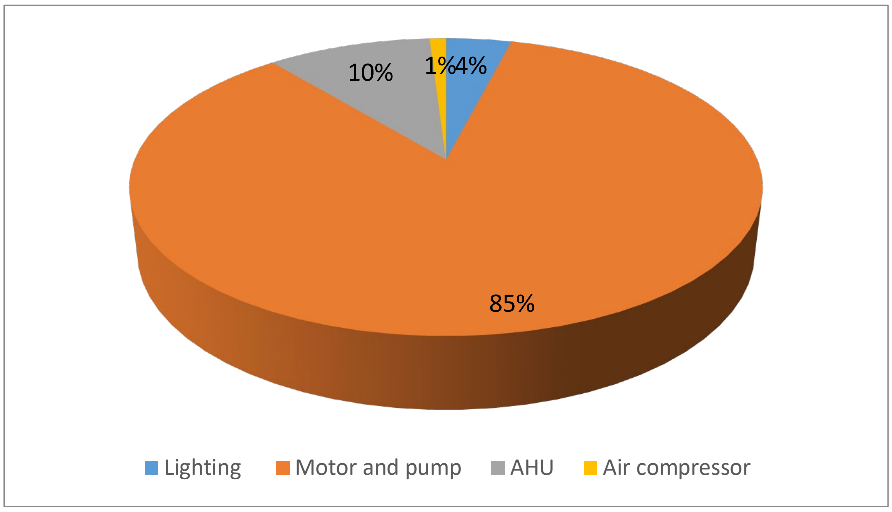

Figure 14: Energy consumption breakdown of an edible oil processing company

Figure 13 shows the typical energy consumption breakdown for an edible oil processing enterprise assessed by the TBW project. Motors, which power machines like grinders, and pumps, which are used in the transportation of water and oil, are the main energy consuming area, eating up 85 percent of energy in a factory. In addition to electrical energy, diesel and coal are also used for generators and boilers for steam generation (used in the grinding process). Commonly found areas with energy saving opportunities in the edible oil industry are motors (which take up the most energy), lighting, boilers and steam distribution.

Energy Efficiency-related Lessons Learnt from the TBW Project

Throughout the duration of the TBW project, which worked with F&B enterprises in the Yangon, Mandalay, and Bago parts of Myanmar, the team faced various roadblocks like COVID-19 lockdowns, travel restrictions and political turmoil in Myanmar, which significantly affected the work. The TBW team adapted as best it could to each situation and was able to carry out project work with the aim of achieving maximum results. Some of our key lessons learnt during the project are mentioned below.

Data-sharing: Enterprises were generally very sensitive regarding the confidentiality of their resource-consumption data and were thus reluctant to share it with the TBW team. To remedy this issue, the TBW team worked to gain the trust of the enterprises before they provided access to their data. Post-energy assessment, additional visits to the enterprises to better understand their issues and provide assistance on energy-related issues helped the team to earn participating enterprises' trust. During such visits, the TBW team (and consultants) sought to highlight simple, practical measures that could help the enterprise save energy. After these visits, enterprises were more amenable to sharing data. Therefore, a key lesson learnt is to prepare a project plan that allows the team to start by delivering some simple and small benefits to the enterprises and then gradually seek and collect enterprise-level data from them. In other words, considering the hesitance of enterprises, future project designs should not expect fast data collection at project start-up.

From an enterprise data availability perspective, an important lesson learnt was that many enterprises do not do any tracking or monitoring of basic energy data, so they were unable to provide accurate information even when they were willing to pass it on to the TBW project team. To remedy this issue, the project team helped enterprises develop basic data collection systems, such as noting down monthly electricity bill information and monthly production data. In future projects, the project team should provide more training to enterprises on how to collect and record energy consumption data. In addition to this training, it would be helpful if data monitoring and collection templates could be provided to the enterprises. Ideally, at least three months' data should be available before the first on-site assessment is carried out.

The eLearning app developed by the TWB project has an easy-to-use data monitoring tool, which would be useful for future projects to promote tracking energy (and other resource) consumption and factory production data using a smart phone.

Implementation of energy-saving practices within enterprise activities: Sixty-four percent of the enterprises targeted by the project implemented the recommended no-cost and low-cost measures. However, given the constraints emanating from the COVID-19 pandemic and political situation, many enterprises were unable to implement any measures requiring a high-cost investment. Another project implementation challenge was the energy shortages and fluctuations in energy prices throughout the duration of project.

The project team was not able to actively support implementation of energy efficiency measures within the enterprises, due to travel restrictions. The TBW project team believes that many more simple and low-cost measures would have been implemented if the team and consultants had had the opportunity for more active interaction with the enterprises. Hence, another key lesson learnt is that while energy efficiency can be achieved through (often expensive) technology changes, there are many low-cost energy saving opportunities that can be implemented by simply being on the ground to promote better awareness and improved practices. More time, continuous implementation support and mentoring to enterprises are required if investment-based energy efficiency measures are to be fully implemented and sustainable.

It was observed that once the enterprises received an assessment report containing energy-saving opportunities and recommendations for saving, they were interested in learning about the payback period and willing to work towards implementation by aligning with an action plan. Most of the enterprises committed to following up on and implementing all recommendations, even for the high-cost investments, once their economic situation improves and stabilizes. Therefore, a lesson learnt is that projects should adapt to context constraints and continue factory energy assessments, even during crisis situations, while clearly recognizing that the enterprises may not be able to afford to make investments immediately. The full list of recommendations, even including higher-cost investments, may be helpful for an enterprise's future planning.

One of the simple and low-cost practices implemented by several enterprises was to install sub-meters for monitoring actual energy consumption changes related to their implementation of energy-saving measures. Twenty-seven percent of the enterprises who documented specific energy consumption noted that they saw decreasing energy usage after following certain recommendations. Therefore, another lesson learnt is that installing sub-meters to track energy usage data provides a clearer picture of benefits to the enterprises.

The project provided support to one factory so that they could successfully apply for a results-based financing grant that would cover 30 percent of the cost of replacing existing equipment with new, energy-efficient machines. After installing the new equipment, enterprise staff praised the project for its support and shared their experiences and the benefits of energy efficiency investments with other business owners. A lesson learnt from this initiative is that even during a crisis period, future projects and participating enterprises should try to achieve at least one complete set of implementation actions to demonstrate that significant, positive impact is achievable when making certain operational changes and investments. This can then provide motivation to others to pursue energy-saving initiatives.

Following the TBW project team's advice, one enterprise replaced its diesel boiler with a biomass boiler, even though this recommendation was not originally included in the enterprise's assessment report. When the price of diesel increased, the TBW project team had contacted participating enterprises to enquire about how they were managing the situation. When the owner of this enterprise informed the team about high cost of diesel, they suggested replacing the diesel boiler with a biomass boiler to reduce energy costs, sharing the contact information of a supplier. The enterprise owner decided to invest in the biomass boiler and found that the huge amount of savings (reducing fuel costs by 70 percent) resulted in a very short payback period of only four months. After three months, the enterprise owner shared his positive experience with other business owners, using the project group chat (based on Viber). This resulted in two other enterprises also purchasing biomass boilers. The lesson learnt from this experience is that the project should facilitate opportunities for enterprises to share the effectiveness and benefits of energy-saving practices and technologies with other enterprises who might then implement recommendations after confirming the benefits with their peers.

Consultant team: One of the project's objectives was to capacitate local energy consultants to support SMEs. The project team provided training to select consultants who were then able to effectively work with target enterprises. However, due to travel restrictions from COVID-19 and political turmoil, the project team's consultant training and support could not be extended to include in-field assistance to newly trained consultants. Clearly, with more consultant in-field training, their ability to carry out future independent consultancy assignments in energy efficiency would have been further strengthened.

Vendor and technology suppliers: A list of vendors and suppliers identified during the project was provided to interested enterprises. While this list was useful to the enterprises to launch their improvements in energy efficiency, the situation on the ground changes over time. Therefore, future projects should conder updating the supplier list on a regular basis, as new vendors and products enter the market, some suppliers drop out of the market, and prices change.

Awareness and training: Training for enterprise workers has proved effective and helped raise awareness on energy efficiency issues within the enterprises. Such trainings provided by the consultants and the TBW team were important to drive behaviour-based changes. For example, after one awareness-raising workshop, three out of nine participating factories applied simple practices, such as turning off lights and closing doors to air-conditioned rooms. The project team identified these early adopters as champions, asking them to share their energy-savings benefits with other enterprises. These actions promoted healthy competition among enterprises, seeing who could save the most energy by applying these simple practices. As access to these types of training programs are limited in Myanmar, providing training and awareness-raising through projects such as TBW offer important and visible value for enterprise owners and managers. It is therefore important that these kinds of initiatives be part of future energy efficiency projects with SMEs.

Use of social media: Due to travel restrictions, the TBW team had to think outside the box and use social media and online meeting platforms to keep up regular engagement with enterprises. However, we believe that this engagement was not as effective as in-person visits to the enterprises would have been.

Resources

Below are some short lists of energy efficiency technology/service providers that are locally available in Yangon and Mandalay, Myanmar and can be explored by F&B enterprises.

Table 3: List of local technology suppliers

Product	Vendor Name	City	Address
Waste heat recovery systems	UEEG Ltd	Yangon	No. (320), Building-C, Pearl Condo, Kabar Aye Pagoda Road, Bahan Tsp: Yangon. No (6/773), Ward (29), Aung ThitSar St, North Dagaon Tsp, Yangon. Contact no.: 09-972721090, 09-965055682
	New Maxtherm Engineering Co, Ltd.	Yangon	No. 30/34 (A), 3rd Flr, 39th Street, Ward no. (8), Kyauktada Tsp; Yangon. No. 47, Development Zone (1), Yawatwinwon U Phoe Hlaing Road, Dagon Seikkan Tsp; Yangon. Contact no.: 09-261323235, 09-5117412
	Sann Shinn General Trading	Mandalay	78th Street, between 26th & 27th, Chan Aye Thar Zan Tsp; Mandalay. No. (F-4), 62nd Street, Panchan Road, Industrial Zone (1) Pyi Gyi Ta Gon Tsp; Mandalay. Contact no.:09-2020132, 09-796511188
LED lights	Kedia Light	Yangon	128-130, Upper Pansodan St., Mingalar Taung Nyunt Tsp., Yangon Contact No.: 01-242768, 09-6801525, E-mail: kedialit@myanmar.com.mm
	Everest Lighting	Yangon	7D, Pyay Rd., Hlaing Tsp., Yangon, Myanmar Contact no.: 01-513419, 09-799999567
	New Power International Co., Ltd.	Yangon	148, 29th St., Middle Blk., Pabedan Tsp., Yangon, Myanmar Contact no.: 01-253381, 01-252086
	Five Star	Mandalay	No.357, 83rd St, Bet 32nd & 33rd St, Chan Aye Thar San, Mandalay, Myanmar

Product	Vendor Name	City	Address
	Golden Power Technology	Mandalay	Address: A-2, 78th Rd, Bet 27th & 28th St, Mandalay, Myanmar Phone Number: (02) 098621013
	Super Power	Mandalay	Address: No(73/74), 68th St, Bet 33rd & 34th St, Mandalay, Myanmar. Phone Number: (02) 0991012336
Boiler	Perfect Boiler	Yangon	703, Level (7), Bldg (B), East Point Condo, Pazundaung Tsp., Yangon Contact no.: 01-201393, 01-8610423 E-mail: blueocean@myanmar.com.mm
	I.E.M Co, Ltd.	Yangon	15/28, East Race Course Rd., Tamwe Tsp., Yangon, Myanmar Contact no.: 01-540673, 01-546064 E-mail: iemyangon@gmail.com
	Deco-Land Co.,Ltd	Yangon	144/145, U Tayoke Gyi St., Ind. Zone (4), Hlaing Tharyar Tsp., Yangon, Myanmar Contact no.: 01-685064, 01-685279 E-mail: decoland@myanmar.com.mm
DG Set	Daewoo Generator	Yangon	Bldg.1, #11, 8th Mile, North of Myopya Housing, Mayangone Tsp., Yangon. Contact no.: 01-652990, 09-421005457 E-mail: kmldol@gmail.com
	Billion Power Co., Ltd. (Kenso)	Yangon	53, Pyay Rd, 9th Mile, Mayangone Tsp., Yangon Contact no.: 01-662268, 01-656120 E-mail: sales@kensopower.com
	Ever Seiko Co. Ltd.	Yangon	6, Shwe Marlar Yeik Mon, Baint Naung Rd, Yangon, Myanmar Contact no.: 01-501049
Cooling Tower	Liang Chi Enterprise (Myanmar) C., Ltd.	Yangon	133/B2, Mawyawaddy St., (5) Ward, Mayangone Tsp., Yangon, Myanmar Contact no.: 01-650206, 09-256266204 E-mail: liangchienterprise@gmail.com
	A R P T Co., Ltd.	Yangon	#7, Highway Complex, Narnattaw St., Sinmalike, Kamayut Tsp., Yangon. Contact no.: 01-2304065, 09-73066415 E-mail: airelated.myanmar@gmail.com
	Advance Cool Room Co.	Yangon	Ltd. 209/308, Kanaung Minthar Gyi St., Ind. Zone (2), Hlaing Thayar Tsp; Yangon Contact no.: 09-459001593, 09-459001595 E-mail: inquiry@advance-cool.com
Motors & Pumps	Kings Motor	Yangon	193, Anawrahta Rd.,, Lanmadaw, Yangon , Myanmar 01-210891, 01-224766

Product	Vendor Name	City	Address
	Aung Kyaw Win & Brothers	Yangon	163, 30th St., Upper Middle Block,, Pabedan, Yangon , Myanmar 09-5190894, 01-372895, 09-765190894
	Eco-Engineering Co., Ltd	Yangon	76, Hantharwaddy 22nd St., (6) ward, South Okkalapa Tsp., Yangon. Contact no.: 09-450020870, 09-253109080 E-mail: kmt.ecoengrg@gmail.com
	Han Sein Thant Engineering	Yangon	Bldg. 112, #28/29, 8th Mile Junction, Pyay Rd., Mayangone, Yangon, Myanmar Contact no.: 01-650488, 01-661030 E-mail: hst@myanmar.com.mm
	Star Soe Win	Yangon	No. 18/B, Ma Ouu Gone Lane Kyal, Tamwe Tsp., Yangon, Myanmar Contact no.: 09-428193486, 09-966629872
	Burco Marine Myanmar Co., Ltd.	Yangon	85, Aye Yeik Mon Rd., Ward (3),, Hlaing, Yangon , Myanmar 09-773926988,09-776028644,09-796721437
Capacitor banks	KTK Electrical Engineering	Mandalay	No. (901/46), 78th Street, between 42nd & Thate Pan St, Mahar Aung Myay Tsp; Mandalay. Contact no.: 09-977904549၊ 09-43143104
	IEM Company Limited	Yangon	No.(28), Waw Building, East Race Course Road, Tamwe Township, Yangon Contact no.: 01-8604425~29, 01-546064
Insulation	Asterism International Co., Ltd.	Yangon	222/A, Lanthit St., Insein Tsp., Yangon Contact no.: 01-3640649, 01-3647814, E-mail: asterism@asmbuilding.com
	Cool City Zone Co., Ltd.	Yangon	552, Lower Kyeemyindaing Rd., Pan Hlaing Qtr., Kyeemyindaing Tsp., Yangon Contact no.: 01-2315033 E-mail: ccz.myanmar@gmail.com
	Shwe Nagar	Yangon	22, Padinwun U Shwe Bin St., Ind. Zone (1), Hlaing Thayar Tsp., Yangon. Contact no.: 01-685985, 01-685990

Product	Vendor Name	City	Address
	Pro 1 Global Home Center	Mandalay	No. 8/6, Theik Pan Street, Btw 62nd & 63rd street, Chan Mya Thar Si Township, Mandalay Contact no.: 09 777000942, 09 777000695, 09 777000943, 09 777000944
Measuring Instruments	T.E.T Electrical Co.,	Yangon	No. 973, Than Thu Ma Road, (5) Quarter, South Okalar, Yangon Contact no.: 09 5024109, 09 43052695
	E MIN Myanmar (Testing & Measuring Tools)	Yangon	No.74 Ywarma Street, 9 Quarter, Mayangone, Yangon Contact no.: 09 266993007/08/09

Disclaimer: This supplier list has been compiled to provide a starting point of potential technology providers for TBW client companies. Neither the TBW project nor SUSTENT Consulting endorse, approve, or recommend any of the vendors listed here. The TBW client companies are strongly advised to explore beyond this list and to select vendors on their merit, using their own criteria.

Below are some useful links and sources for knowledge resources that can be useful for enterprises to better understand energy efficiency concepts.

- Tha Bar Wa website: https://www.wwf.org.mm/en/thabarwa/
- Tha *Bar Wa mobile application*. This app is available for android and IOS.
- Energy audit guidebooks from the Indian Bureau of Energy Efficiency (BEE) https://aipnpc.org/Guidebooks.aspx
- International standard on energy management system, ISO 50001. https://www.iso.org/iso-50001-energy-management.html
- International standard on energy audits, ISO 50002. https://www.iso.org/standard/60088.html
- Some selected YouTube videos that are relevant for F&B SMEs:
    - Energy efficiency in pumps: https://www.youtube.com/watch?v=0Kf0qW7qR9s&ab_channel=BureauofEnergyEfficiency
    - Installation of automation and control system for tea withering (reducing moisture content in tea leaves): https://www.youtube.com/watch?v=OUcvuoasqyA&list=PLzuBAPLvmzw5qIdcv3qZTMI97gUiHt4wC&ab_channel=BureauofEnergyEfficiency
    - Installation of waste heat recovery for compressors:
        - https://www.youtube.com/watch?v=yM3gLYSpwWA&list=PLzuBAPLvmzw5qIdcv3qZTMI97gUiHt4wC&index=3&ab_channel=BureauofEnergyEfficiency
    - Installation of waste heat recovery systems for chillers:
        - https://www.youtube.com/watch?v=zePaRJ7vGPQ&list=PLzuBAPLvmzw5qIdcv3qZTMI97gUiHt4wC&index=5&ab_channel=BureauofEnergyEfficiency
    - Application of Internet of Things (IoT, which refers to the incorporation of sensors and other devices that can report on equipment performance, online and in real time) in MSME processes:
        - https://www.youtube.com/watch?v=HaZ5TxQPk6E&list=PLzuBAPLvmzw5qIdcv3qZTMI97gUiHt4wC&index=7&ab_channel=BureauofEnergyEfficiency
    - Replacement of an old, traditional refrigeration system with an efficient direct-drive ammonia compressor:
        - https://www.youtube.com/watch?v=xDMnm0WcjoY&list=PLzuBAPLvmzw5qIdcv3qZTMI97gUiHt4wC&index=13&ab_channel=BureauofEnergyEfficiency
    - Replacement of conventional motors with energy-efficient motors:
        - https://www.youtube.com/watch?v=UTAJtFQb-0M&list=PLzuBAPLvmzw5qIdcv3qZTMI97gUiHt4wC&index=38&ab_channel=BureauofEnergyEfficiency

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WWF-Myanmar's Tha Bar Wa project is funded by the European Union under the SWITCH-Asia Programme. It promotes cleaner production within the food and beverage industry by promoting wastewater treatment plants, energy efficiency, and renewable energy. It also supports financial institutions to offer banking products designed specifically for cleaner production.

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2. Improving Operational Performance
3. Environmental Sustainability Performance Management of Supply Chains
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5. Technical Assistance Services for Green Finance
6. Training and Capacity Building for a Green Economy
7. Corporate Social Responsibility (CSR) with Environment Focus
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