Technical Brief on Sustainable Energy

MOTORS AND PUMPING SYSTEMS

switchasia

Funded by the European Union

SWITCH GARMENT

PROMOTION OF SUSTAINABLE ENERGY PRACTICES IN THE GARMENT SECTOR IN CAMBODIA

AFD AGENCE FRANÇAISE DE DÉVELOPPEMENT

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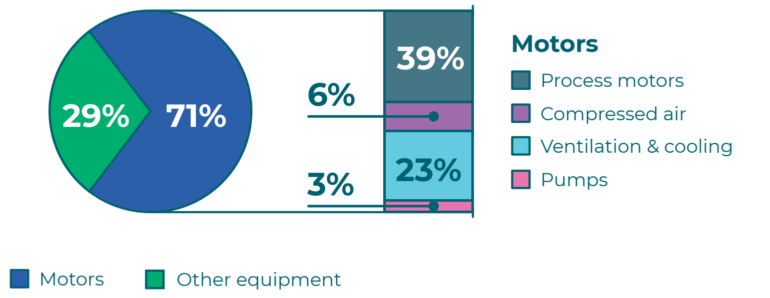
MOTORS AND PUMPS USE IN INDUSTRY

Motors convert electricity into mechanical force, powering process machines in factories, including pumps, fans, air conditioning and more (see related Technical Briefs).

Pumps are not only used for **sanitation**, but also in all **processes** and **utilities requiring water**. They use electric motors to operate,

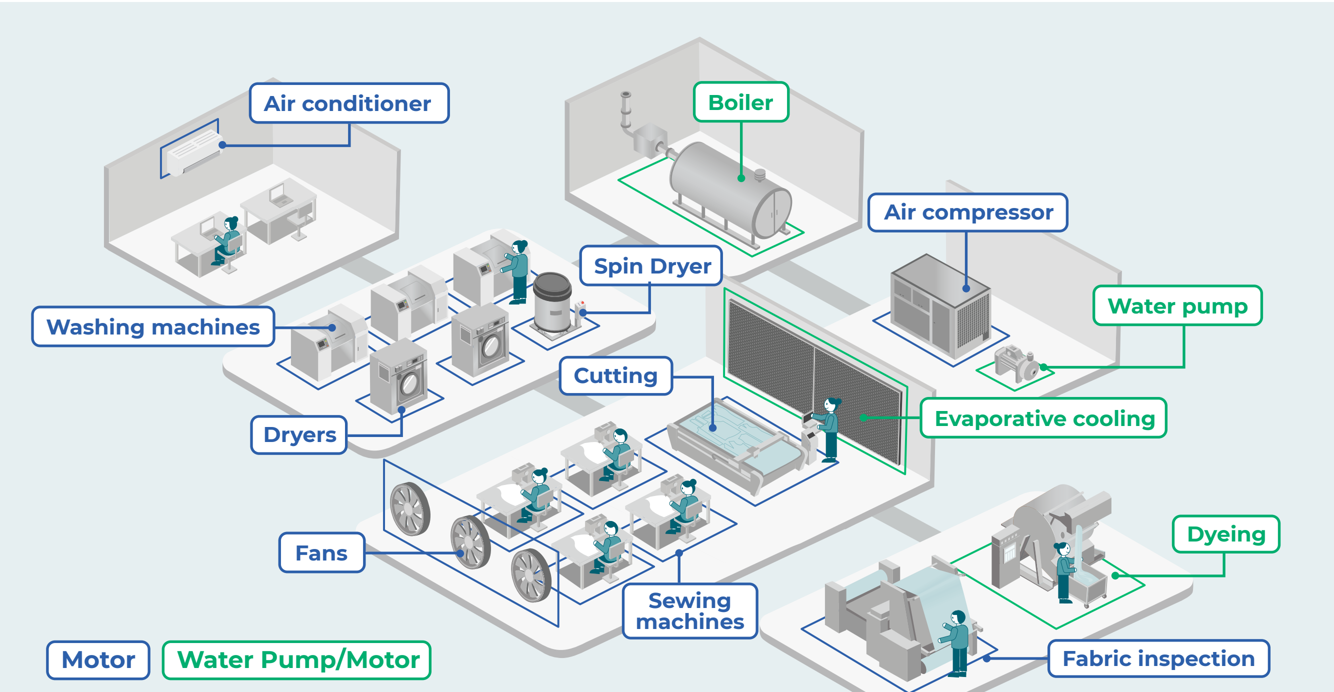
Motors are the biggest electricity consumer in the garment industry, accounting for over **71%** of the total electricity consumption.

Electricity consumption in the Cambodian Garment Industry



Source: *Energy efficiency NAMA in the garment industry in Cambodia*

Machines Using Motors and Pumps in Garment Factories



Note that all pumps are run by an electric motor.

Importance of investing in Efficient motors

Motors Lifetime costs

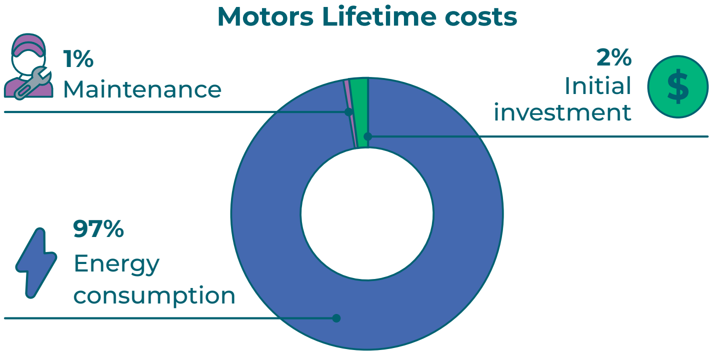


Chart source: *Energy Efficiency Opportunities for Electric Motor Driven Systems, International Energy Agency, 2011*

Energy consumed by motors represents the most **important share** of its total lifetime cost (97%).

A single motor may not seem significant, but when combined, total consumption of all motors represents the **largest area of consumption** in a factory.

Therefore, investing in **energy-efficient motors** is essential. While initial investment may be higher, considerable **energy and cost savings** are realized during their lifetime.

Main Categories of Motors

1

Various types of motors are used in the garment sector, depending on the specific technical requirements of the machines (speed, torque, controllability, precision, noise, etc.). Primary motor classification include:

Electric Motors

Alternative Current (AC)

For high power machines with little precision.
Cheaper, reliable but less efficient

Compressor, conveyor, fans and air conditioners, hydraulic or irrigation pumps.

Synchronous

Precise speed control.

Synchronous clocks, timing devices, robotics.

Asynchronous (induction)

Simple design, reliability, and cost-effectiveness.

Appliances, pumps, fans, and HVAC systems.

Direct Current (DC)

For precision and stability.
Efficient, but more expensive and require more maintenance.

Process machines, sewing machines, fans.

Brushed

Simple and easy operation.

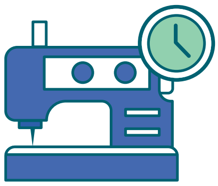
Small appliances, power tools.

Brushless (BLDC)

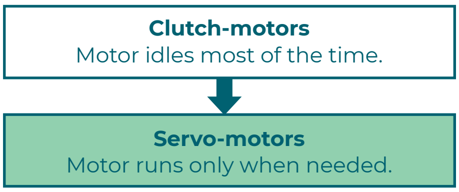
More efficient and durable than brushed.

HVAC systems, industrial machinery.

Motors for sewing machines



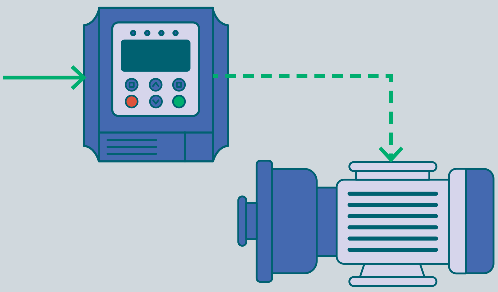
Avoiding idle time (needle time is only 20-30%), switching to servo-motors in sewing machines can **reduce consumption up to 80%**, with the benefit of reducing heat production, **improving workers thermal comfort** and lowering cooling needs.



Variable Speed/Frequency Drives

Variable frequency or speed drive (VFD or VSD) is a **motor speed control** device. It can be useful for specific **process operation** and **energy savings:** by adjusting to actual speed requirements, VFDs can reduce energy consumption drastically.

VFD can be used to control fans air flow or pumping water flow.



Energy Efficency Class

There are **5 energy efficiency classes** in electric motors: **IE1 to IE5.** Switching to higher class motor can lead to significant savings.

Energy efficiency class are defined for **motors, drives and power systems:**

- IE (motors) – CEI 60034-30-1:2014
- IE (VFD) – CEI 61800-9-2 : 2017
- IES (Power Systems) – CEI 61800-9

IE Class	Efficiency Class
IE 1	Standard Efficiency Motor (SEM)
IE 2	High Efficiency Motor (HEM)
IE 3	Premium Efficiency Motor (PEM)
IE 4	Super Premium Efficiency Motor (SPEM)
IE 5	Ultra Super Premium Efficiency Motor (USPEM)

Energy Savings in Motors

2

Maintenance	Modification	Habits	Optimization

Investment	Labour Time	Savings

1. Change to More Efficient Technologies

1. Upgrade to energy efficient motors with **higher energy class** (see p.2)
2. **Replace** clutch motors with **servo-motors** on sewing machines (see p.2)
3. Use **brushless direct current motors (BLDC)** for fans and air conditioning.

2. Habits to reduce consumption

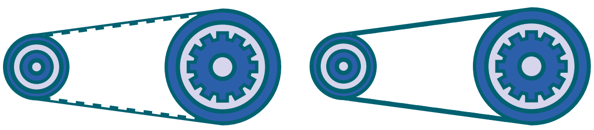
1. **Switch-Off unnecessary equipment.**
2. **Avoid motors running idle** by **sensitizing** operators not to continuously push the operating pedal (e.g. blowers for ironing):

To go further, install sensors to stop motors when unnecessary.

4. Provide regular maintenance

1. Properly **lubricate** motor ball bearings, and replace them when worn or damaged.

2. Ensure **motors and electric system do not overheat**, which can reduce efficiency and shorten their lifespan:
   - Do **thermal camera checks** regularly on all electrical systems to **detect** overheating (lose connection, undersized cables, phase unbalance, motor overheating, etc.)
   - Maintain **effective motor cooling** by keeping the outer frame fins free of dust and ensuring the cooling fan operates properly to maintain a constant airflow.
   - Keep **phase unbalanced under 1%** for three-phased motors.
3. Improve **mechanical transmissions** by:
   - Replace conventional V-belt with high torque belt and conventional flat belt with cogged flat belt.
   - Adjust belt tensioning.
   - Adjust and secure mechanical transmission alignments.



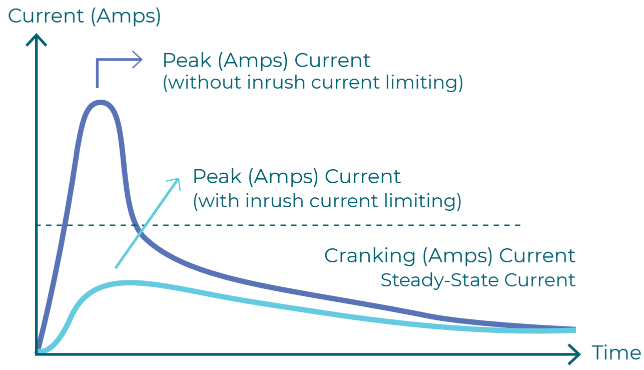
Cogged V Belt **Standard V Belt**

4. To maintain motor efficiency at previous levels, in case of **motor rewind**, ensure it is done by a **qualified professional.** However, in most cases, motor rewinding results in efficiency losses.

3. Use electronic controls

Electronic controls stabilize current and optimize motors performance and durability:

- Install **harmonics filters.**
- Use **slip energy recovery (SER)** systems for induction motors
- Install motor **starters (ramp up)** to avoid high peak consumption during motor startup:

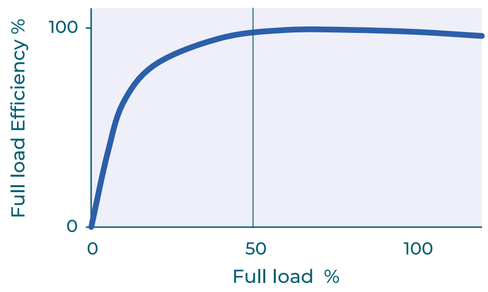


- Install **voltage surge protection** for unstable power grid. Note that motors operating outside of their nominal voltage lose efficiency.
- Use **capacitor banks** to improve power factor if it falls below 0.95.

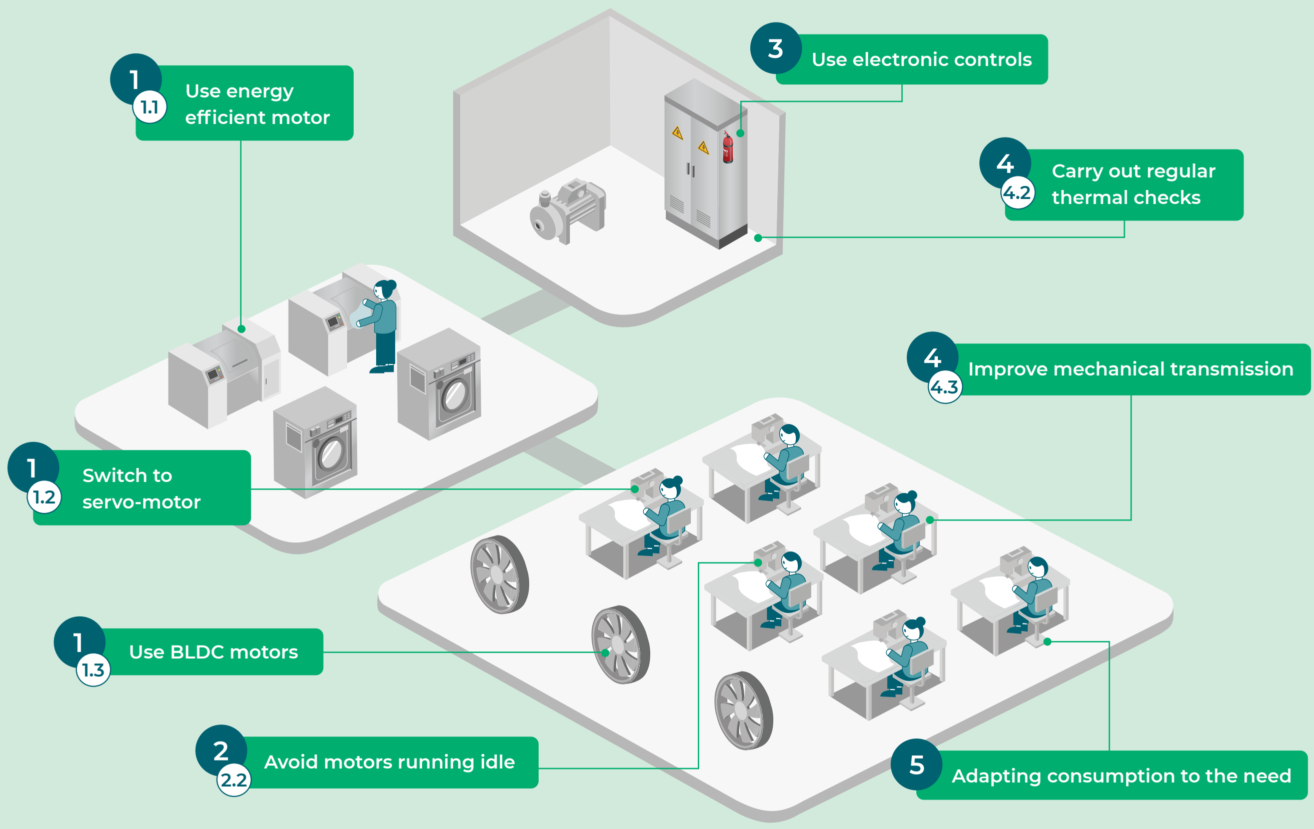
5. Adapting consumption to the need

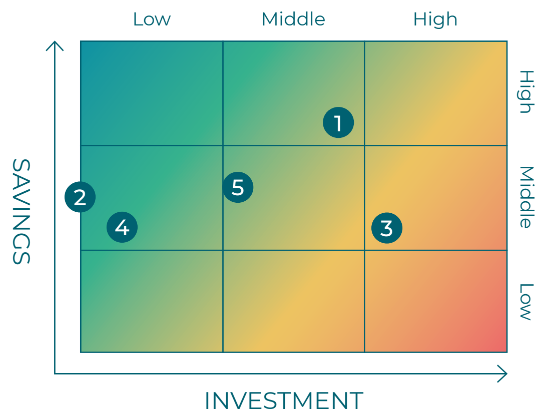
1. Use **variable frequency drives** (VFD) to modulate motor speed to the **actual needs** instead of running 100% all the time. The resulting savings can be significant. It is often applied to fans, pumps or compressors.

2. Motor with **loads under 50% should be replaced by smaller motors.** This is called **downsizing.** Indeed, when motor load falls under 50%, the overall efficiency of the motor drops drastically, especially for motors with little nominal capacity.



Summary & Recommendation





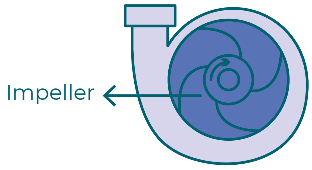
1. Change to more efficient technologies
2. Habits to reduce consumption
3. Use electronic controls
4. Provide regular maintenance
5. Adapting consumption to the need

Main Water Pumps used in the Industry

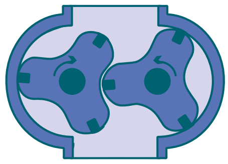
The **majority** of pumps used in factories are **centrifugal** for their simplicity, efficiency and cost effective investment and maintenance.

In some situation, **volumetric** pumps may be used to fill pressurized volumes (**Boiler systems**).

Centrifugal pump



Volumetric pump



Energy Savings in Pumping systems

Pumps being equipped with motors to operate, recommendations in p4-5 apply. This page presents additional energy savings measures specific to the pumps.

1. Provide regular maintenance

1. **Check and repair water leakage** to save energy and water.
2. **Purge** air from water network to optimize system performance.

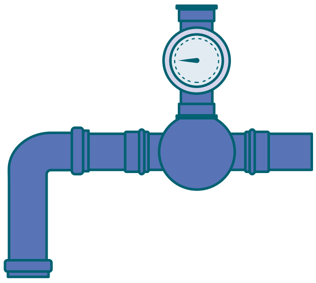
2. Optimize pumping system performance

1. Ensure pumps **efficiently deliver** the required pressure and flow. Replace the significantly underperforming ones.
2. **Inspect impellers** for wear and replace them if needed (corrosion can damage impeller, resulting in low performance).

3. **Optimize distribution system** by limiting directional change and use appropriate diameter to reduce pressure drops and consumption.

3. Monitoring and Control

Install **water meter** on pumps to monitor water consumption and detect issues.

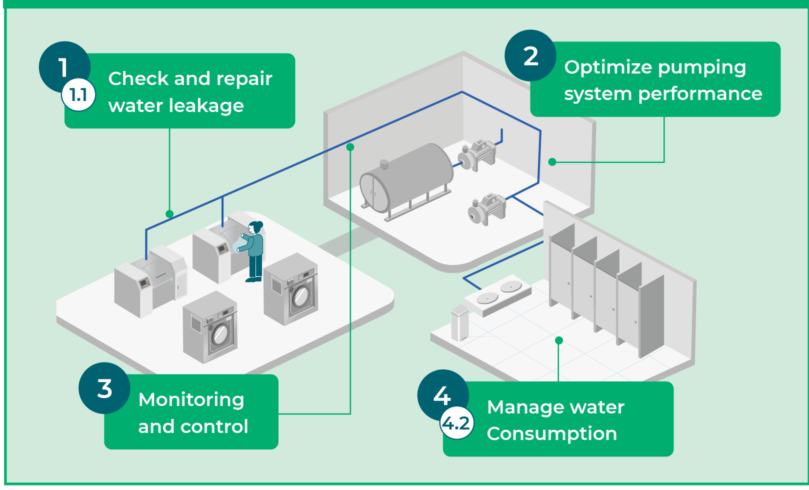


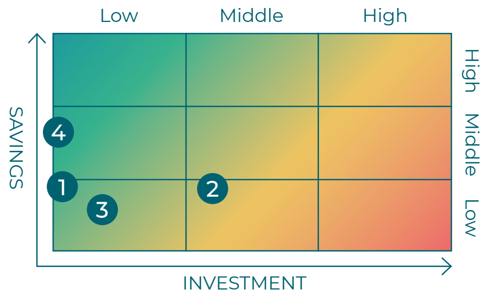
4. Habits to reduce consumption

1. **Turn off** unnecessary pumps
2. **Manage water consumption in the factory to save water and energy:**
   - Behavioral training.
   - Control of water level in washing machines and toilet tanks.
   - Procedures for water cleaning.

To go further, install automatic valves and taps.

Summary & Recommendation





1. Provide regular maintenance
2. Optimize pumping system performance
3. Monitoring and control
4. Habits to reduce consumption

Energy Management Steps

4

A step-by-step approach for investing in motors and pumping systems.

01. Current state of the installation

Inventory of the equipment and its use. Knowing the components and requirements of the installation will help pre-identify potential improvement and prepare further analysis of motors and pumps:

- Their capacity and quantity.
- Their type and location.
- Their efficiency.
- Type of mechanical transmission.
- Daily operating hour (h/day).
- Pumping and motorisation needs (pressure, water flow, electrical power, torque, rpm).
- Electronic controls installed.

02. Measurements

Taking detailed measurements of the installation is the starting point for improvement and assessing its performance.

Measure and document the following:

- Electricity and water consumption.
- Torque and rotational velocity.
- Pressure and water flow.
- Diameter of water piping and elbows.
- Voltage, current, power factor, harmonics.
- Water leaks in process machinery and sanitation.
- Motor and pump loads.
- Temperature of motors, connections, cables.

03. Data Analysis

Once measurement is done, the analysis of the consumption gives information on possible improvements:

- Calculate efficiency of motors/pumps by comparing electricity consumption with mechanical/water output.
- Calculate loads of motors and pumps.
- Calculate hydrodynamic losses in water networks.

04. Equipment & System Analysis

Analyzing the individual components to identify potential improvements on the installation, understand the actual lifetime of the products, and monitor their quality.

05. Implementation & Improvement

Based on careful assessment and evaluation, identify improvement options.

Considering the information gathered in this technical brief, propose improvement (technical improvement, possible investment, energy management, etc.), indicate the potential savings or impacts and set priority for the implementation of each improvement.

06. Verification & Monitoring

After implementation, start monitoring the efficiency and consumption of the system, and organize a maintenance plan for the system:

- Monitor energy consumption.
- Monitor water flow, temperature, voltage, current, etc.
- Estimate energy saving compared to previous system.
- Monitor water leaks.
- Organize a maintenance plan.

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Switch Garment, a project funded by the European Union SWITCH–Asia Grants Programme and jointly implemented by Global Green Growth Institute (GGGI) Cambodia, Textile, Apparel, Footwear & Travel Goods Association in Cambodia (TAFTAC) and Geres aims at 'Promotion of sustainable energy practices in the garment sector in Cambodia' ("Switch Garment"). The objective of this project is to increase the competitiveness and decrease the environmental impact of the Cambodian garment industry through sustainable production.

The VETHIC project (2022-2024), funded by Agence française de développement (AFD), aims to improve the environmental performance of the Cambodian textile sector by activating the levers of energy transition. The project is jointly implemented by Geres, TAFTAC, Cambodia Women for Peace and Development (CWPD), and Live and Learn Cambodia (LLC).

This document was developed with the inputs and extensive review provided by the partners GGGI and TAFTAC.

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