SOLUTIONS FOR MOTOR-DRIVEN SYSTEMS

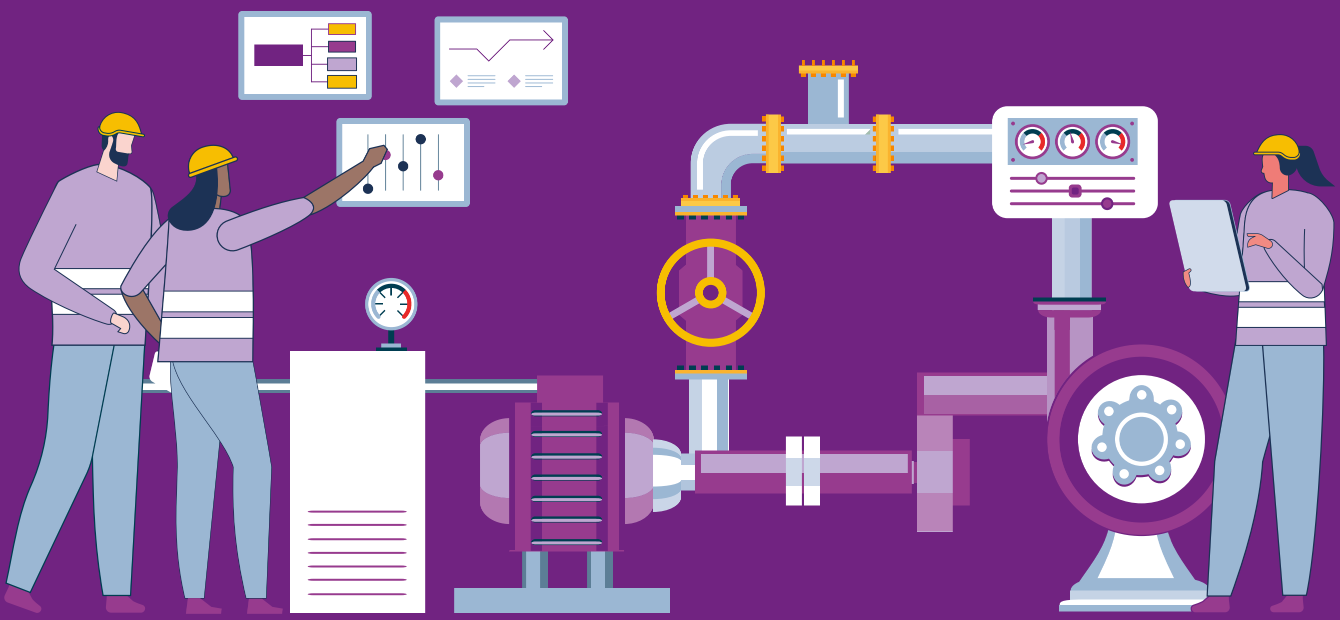
BROCHURE

INDUSTRIAL ENERGY ACCELERATOR

UNIDO

Efficiency Solutions for Motor-driven Systems

Energy Efficiency Solutions Series



Introduction

Just like an orchestra, an electric motor-driven system is only as efficient as the sum of its parts. One flat note, such as a leaky pipe or a faulty compressor, can ruin the overall performance of the system. That's why it's critical for companies to apply a systemic approach when identifying opportunities for efficiencies. Assessing an entire system can help to uncover inefficiencies beyond the electrical motor, often enabling benefits well beyond reduced energy consumption.

There is no shortage of resources available for industrial managers looking to make their company more energy efficient. In fact, there is so much information it can often be difficult to know where to start or what is worth researching further. This kit provides an overview for leadership teams on how to achieve more efficient motor-driven systems. Inside you will find insights from UNIDO's global experts as well as external links to recommended manuals and technical guides. The introductory video, case studies and this brochure are perfect starting points for generating awareness about the benefits and opportunities that optimized motor-driven systems can provide for your organization.

Did you know?

Electric motor systems account for about 60 per cent of global industrial electricity consumption and close to 70 per cent of industrial electricity demand.[1]

What are motor-driven systems?

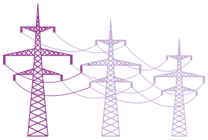
Motors convert electric energy into mechanical motion. They vary vastly in size and can be found everywhere, from micro motors in computer hard drives and small motors in domestic appliances to huge motors used by oil rigs, which can consume the energy equivalent of a small city. Despite differences in size and type, all electric motors work in much the same way: an electric current flows through a wire coil in a magnetic field to create a force.

More than 30 million new electric motors are sold each year for industrial purposes alone. They are responsible for driving both core industrial processes, like presses or rolls, as well as auxiliary systems like compressed air generation, ventilation and water pumping.

Motors need to be connected to a chain of equipment in order to deliver the final motion required. This includes equipment for supplying power, starting the motor and varying its speed, as well as motor-driven equipment such as pumps, fans, conveyors, compressors and specialised production machines.

1 Fleiter & Eichhammer 2012, Energy efficiency in electric motor systems: Technology, saving potentials and policy options for developing countries, UNIDO.

Components of a motor-driven system

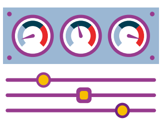


Power supply

The primary function of a power supply is to transmit an electric current from a source such as an electrical outlet, a battery, generator, alternator or a renewable source such as a solar power converter, into a motor system.

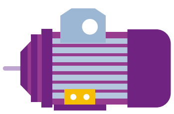
Power equipment

Transformers, switchgears and cables are electric apparatuses that transfer electrical energy from a source like a generator to an end use application such as an electric motor. The power equipment is designed to maximise the energy transfer in a safe and effective way.



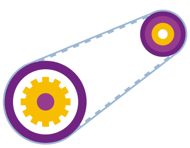
Controls

When an electric induction motor is directly connected to the electrical supply, it will operate at a fixed speed depending on the nature of the load. A soft starter may be used to control the high start up currents. When a variable speed is desired, an electronic control unit called a variable speed drive may be used to control the motor speed and torque, as well as to soft start the motors.



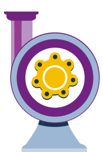
Motor

An electric motor is the device which converts electrical energy into mechanical energy to enable motion.



Mechanical transmission

A transmission is a device in a motor system such as a direct coupling, a gearbox, a belt, a pulley or a chain and sprocket arrangement, which can be used to vary the final speed and torque of the mechanical load application such as a fan or pump. Electromagnetic clutches and disc brakes are also other examples which aid in rapid stopping of the motorised power.



Driven equipment

Driven equipment simply refers to the machinery which is being powered by the electric motor to produce the final motion. This could be an air or water pump, a fan, a gas compressor, a conveyor to move materials, or some type of production machine.

Mechanical controls & process components

The remainder of the process can include components such as pipes, throttles and valves which transport liquids and gases.

Optimized motor-driven systems

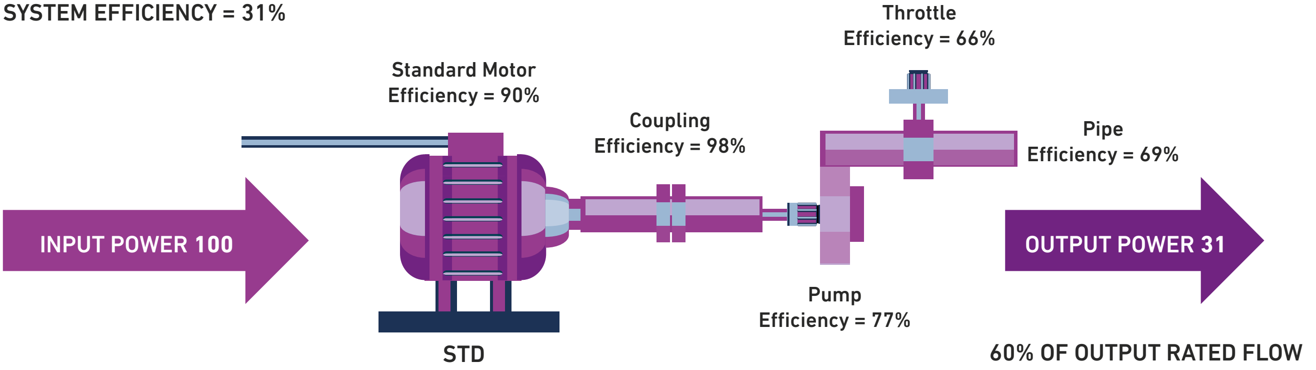
What is meant by 'system' optimization?

An efficient electric motor and the use of variable speed drives is of little value if pipes are blocked in a pump system, or if there are leaks in a compressed air system. Similarly, if a motor is idly running and not providing a mechanical end use benefit, then energy will be wasted, regardless of the equipment's efficiency rating. System optimization approaches address the entire motor system, from the power supply to the mechanical controls and everything in between. A motor is considered just one of many opportunities for optimization.

Comparison of a typical pump system versus an optimized system

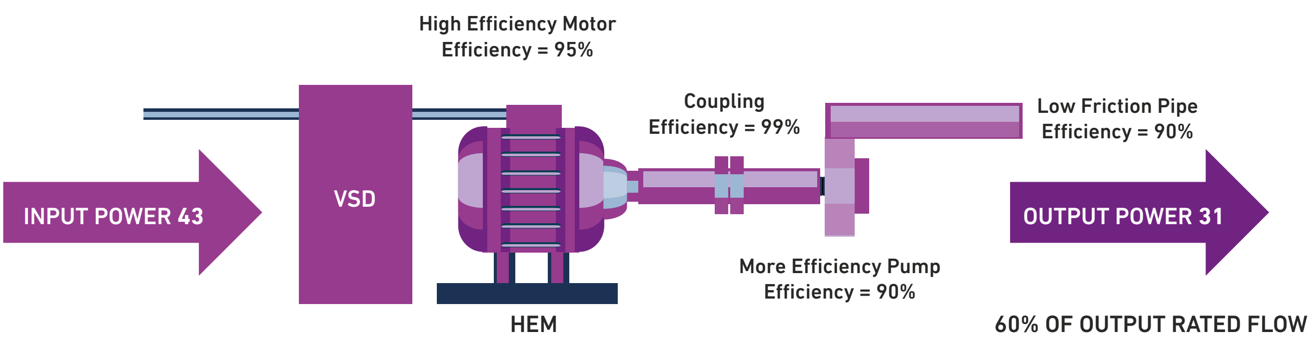
CONVENTIONAL PUMPING SYSTEM

SYSTEM EFFICIENCY = 31%



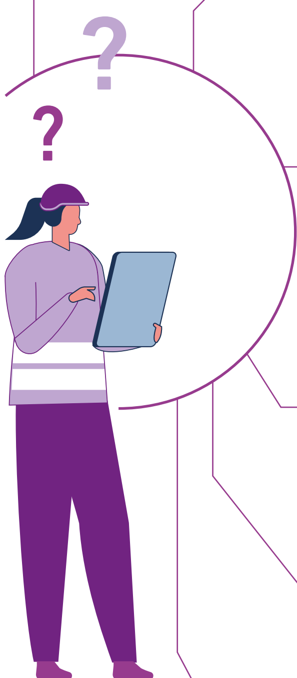
ENERGY EFFICIENT PUMPING SYSTEM

SYSTEM EFFICIENCY = 72%



Source: de Almeida, A & Ferreira, F & Both, D 2004 "Technical and Economic Considerations to Improve the Penetration of Variable-Speed Drives for Electric Motor Systems," IEEE Industrial and Commercial Power Systems Technical Conf. (ICPS'04), Conf. Rec., pp. 136-144.

Questions to ask when assessing the efficiency of a motor system



1. Is all of this water, air or energy actually needed to achieve the desired outcome?

2. Is each component in the system optimized to provide the best overall system efficiency? Are all the components necessary? Is there newer technology which can be applied to improve the performance of key components as well as the overall system performance?

3. Are there possibilities for energy recovery in the motor system, such as using gravity to provide energy storage (e.g. as in cranes or lifts) or kinetic energy (e.g. regenerative braking in vehicles)?

4. What are the operational set points for the system being assessed? How were they determined? Are they valid for all operating conditions?

5. Is there a difference in the understanding of how much energy is needed between the engineering team and the plant management team? How can everyone get on the same page?

6. Is there a single set of appropriate metrics used across all departments to monitor the energy performance of critical and large motor systems?

Strive for high performance

The efficiency of a motor-driven system depends upon several integrated factors

Energy requirements of end-use application

It is important to understand, and where possible, quantify the actual end-use power and energy demand of the application. In many cases the end-use requirement is over specified to provide for a "just in case" scenario.

Efficiency of the end-use device

For each motor, consider the efficiency of the equipment and mechanical load that it is driving such as the fan or pump. Are they correct for the actual end use application? Do they need to be repaired or replaced?

Motor quality

Efficient motors are typically constructed with superior materials. This includes larger magnetic circuits with high-grade magnetic steel and thinner laminations, a larger copper or aluminium cross-section in the stator and rotor windings, tighter tolerances as well as better quality control and optimized design.

Motor size

Getting the motor size right is one of the many ways to maximise efficiency. Motors should run primarily in the 65 per cent to 100 per cent load range. Consider replacing motors which are consistently running at less than 40 per cent load with smaller sized motors.

Motor controls

When used correctly, electronic motor controls such as variable speed drives can save significant amounts of energy, reduce wear on the mechanical system, and improve performance.

Power quality

Optimal energy performance is achieved when fed by a pure sinusoidal wave at 50 or 60 hertz depending on location.

Distribution network

Ensuring that transformers are operating at the correct voltages is an important cost effective way to minimise energy losses in the distribution network.

Mechanical transmission

Adequate transmission design, use of high efficiency equipment, appropriate lubrication as well as maintenance and manufacturing techniques can help to prevent significant power losses when mechanical power is transferred from the motor to the final end-use.

Maintenance practices

Regular maintenance such as inspection, cleaning, lubrication and tool sharpening is essential to maintain peak performance of mechanical parts and to extend their operating lifetime.

Load management

Load management allows utilities to reduce demand for electricity during peak usage times, which can help to reduce costs by eliminating the need for peaking power plants.

ADDITIONAL RESOURCES

READ

- UNIDO 2012, **'Energy efficiency in electric motor systems: Technology, saving potentials and policy options for developing countries'.**
- A. De Almeida et al 2019, **'New technology trends and policy needs in energy efficient motor systems - A major opportunity for energy and carbon savings'**.

WATCH

- Topmotors Webinar 2020, **'New global motor standards move the market'**.

The benefits

There is a huge, untapped potential for energy efficiency in electric motor-driven systems. Around 25 per cent of motor-driven electricity consumption could be saved with low-cost investments. This would reduce total global electricity demand by about 10 per cent.[2]

In UNIDO's experience, on average, motor-system optimization can reduce an individual plant's energy consumption by up to 30 per cent. Most motor optimization investments show payback times within three years.

Other organizational **benefits include**:

- Cost savings related to reduced energy consumption
- Lower total life cycle cost of motor systems
- Reduction in carbon emissions
- Improved final product quality
- Improved operational reliability and control
- Peak power reduction
- Ability to increase production without requiring additional, and possibly constrained, energy supply
- Lower acoustic noise and improvement of the process control
- Less wear maintenance needs of the mechanical components
- Monetized specific savings goals
- Lower maintenance
- Improved production processes
- Improved environmental performance
- Improved workplace conditions
- Enhanced corporate reputation

Furthermore, the optimization of motor-systems within industrial organizations provides multiple benefits that extend far beyond the more direct energy and corresponding system improvements. With existing technologies and practices, efficient industrial electric motor-driven systems have the potential to reduce global electricity consumption by up to 4.8 exajoules. This would dramatically reduce emissions worldwide and save industry between USD $72 – 108 billion annually.[3]

Electric motors and the systems they drive are the single largest electrical power consumers—more than twice as much as lighting, the next largest energy-consuming product.[4]

"Our energy savings through motor system optimization have enabled many advantages for our company. The results speak for themselves. The training gave us the confidence to look further for more energy saving opportunities, such as implementing a solar system which we are specifically designing for our plant's lighting needs."

Myo Nyunt Aung, Plant Manager Proven Technology

2 IEA 2011, **'Energy Efficiency Policy Opportunities for Electric Motor-Driven Systems'.**

3 **IEE, Egypt 2016.**

4 CLASP, **'Motors'.**

UNIDO's 'systems' approach

Not all of the electric energy that goes into a motor is converted to usable mechanical energy. Some of this energy is lost as heat during the conversion process, in the magnetic materials or through friction from inefficient motor bearings and via lubrication. Such losses occur at each step in the electric motor system, which compound along the way and can result in significant overall inefficiencies. As a result the energy savings opportunities from system optimization are far greater than from individual components. **Typically, component approaches can result in energy savings of 3 to 5 per cent. Whereas a systems approach can result in energy savings of between from 10 to 50 per cent**. For this reason, UNIDO has long championed a 'motor-systems' approach to achieving efficiency rather than focusing on the maintenance of individual components.

ADDITIONAL RESOURCES

- UNIDO 2018, **Manual for industrial motor systems assessment and optimization.**
- UNIDO 2016, **Energy efficient electric motors systems.**
- UNIDO 2016, **Manual for industrial pump systems assessment and optimization.**
- EMSA 2018, **Energy audit guide for motor-driven systems. Recommended steps and tools.**

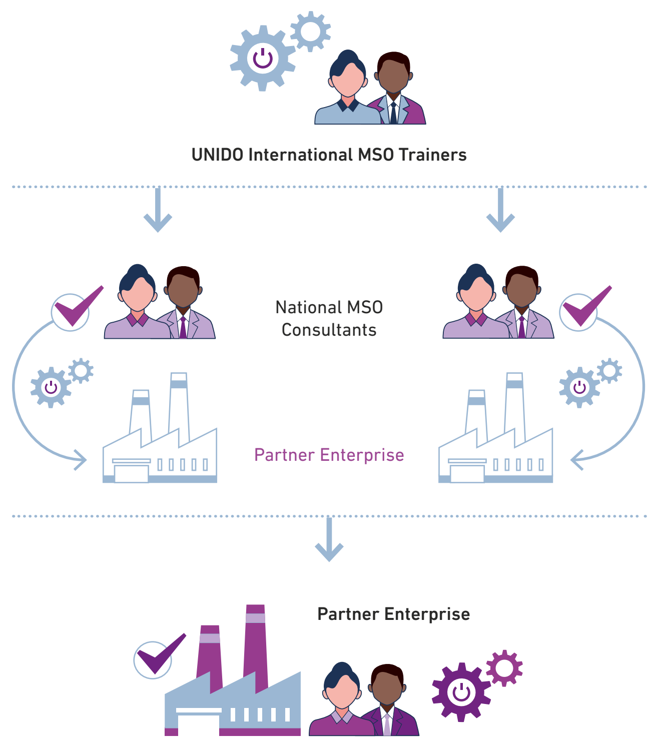
UNIDO case studies

Myanmar
Proven Technologies - optimization of compressed air system

Egypt
Evergrow Company - installation of variable speed drives

A hands-on experience

UNIDO's Motor Systems Optimization (MSO) Capacity Building and Implementation Programme brings international experts together with national trainees, vendors and host companies, creating a ripple effect of knowledge sharing, simultaneously fostering demand and supply in national markets for energy efficiency services. The MSO programme takes participants beyond the classroom into industry where they implement real-life projects in partner enterprises.



Broken into two user streams, which include advanced training to qualify MSO experts as trainers and assessors, this unique programme is designed for a variety of motor-driven systems.

The UNIDO Motor-driven Systems Optimization (MSO) Training Programme

A systemic approach for efficiency

Four training programmes for the optimization of motor-driven systems:

- Fans
- Compressed Air
- Pumps
- Motors

PREPARATION (2-3 MONTHS) → **USER TRAINING** (2 DAYS)

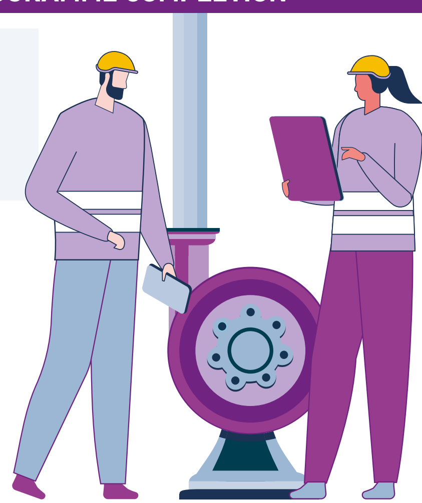
Targeted to facility engineers, operators and maintenance staff of enterprises, as well as equipment vendors and service providers.

EXPERT TRAINING

- **5-6 DAYS** — Theory & demonstration of industry assessment
- **3-6 MONTHS** — Individual industry assessments
- **3-4 WEEKS** — Reportings & presentations

PROGRAMME COMPLETION

- **1 DAY** — Revision & lessons learned
- **2-3 WEEKS** — Final assessment
- **1 DAY** — Graduation ceremony

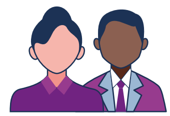


COMMUNICATION & DISSEMINATION

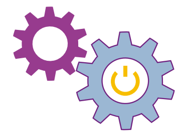
ACHIEVEMENTS

Since 2010, UNIDO has delivered its tailored energy system optimization training to industry and energy practitioners worldwide. This includes optimization of motor-driven systems, industrial heating and steam optimization processes as well as industrial cooling systems.

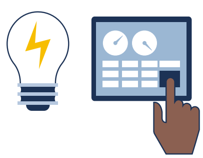
Energy system optimization **PROGRAMME IMPLEMENTED** in **18 COUNTRIES**



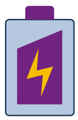
700+ EXPERTS QUALIFIED in different industrial energy systems



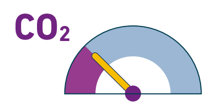
1,700+ ENTERPRISES received training



500+ ENTERPRISES supported with the implementation of energy system optimization measures and investments



Cumulative primary **ENERGY SAVINGS EXCEED 8,500 GWh**



MORE THAN 3.5 MILLION TONS of CO_2 EMISSIONS avoided, roughly equivalent to the emissions generated by over 750,000 passenger vehicles driven for one year[5]

5 United States Environmental Protection Agency, 'Greenhouse Gas Equivalencies Calculator.'

Your motor-driven systems questions answered

UNIDO has steadily grown its cohort of international and national motor-system optimization experts over the past decade. With collective experience in all of the world's major industrial countries and regions our team of specialized consultants have a long track record of leading organizational teams to achieve impressive energy savings. In this kit you will find a video featuring two of our experts answering common questions about motor system optimization.

Anibal De Almeida
Motor-driven Systems Expert

Over the years, Anibal has led numerous international projects and initiatives focusing on automation and energy efficient technologies with particular emphasis in advanced electric motors and drives. He is a Full Professor at the University of Coimbra, Portugal, where he is also the Director of the Institute for Systems and Robotics (UC). He holds a PhD in Electrical Power Systems from Imperial College, University of London.

Siraj Williams
Energy Management and Motor-driven Systems Expert

As a registered professional engineer, Siraj has been involved in industries related to electrical energy infrastructure and industrial energy consumption for over 25 years. In 2012 Siraj attended a UNIDO course on pump system optimization. Today Siraj is a UNIDO qualified expert and trainer in Resource Efficiency and Cleaner Production (RECP), Energy Management Systems (EnMS), Energy Performance Management and Indicators (EnPI), and also a systems expert in electric motors, compressed air and pump systems.

About the Energy Efficiency Solutions Series

The Industrial Energy Accelerator is a UNIDO-led network of international initiatives working to inspire global action on industrial energy efficiency. Throughout 2020, the Accelerator is drawing on its collective wealth of experience and expertise to produce a series of knowledge kits on industrial energy efficiency. These kits cover five key energy efficiency solutions: Energy Management Systems; Efficiency Solutions for Motor-Driven Systems; Efficiency Solutions for Industrial Heat; Efficiency Solutions for Industrial Cooling; as well as Energy Metrics and Performance Indicators. Through this series, the Accelerator aims to inspire and equip industry practitioners to take the first step towards enhancing their energy systems.

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NEXT STEPS

Visit our knowledge hub on our website (www.industrialenergyaccelerator.org) for more information on the processes and technology that will help you achieve your company's energy efficiency goals.

CONTACT

Rana Ghoneim, R.GHONEIM@unido.org,to find out how UNIDO'S Industrial Accelerator can help you.

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