MAKING MODERN LIVING POSSIBLE

Smart savings in automated systems

Select the right drive components and cut costs

VLT®
THE REAL DRIVE

Cut costs, conserve resources and protect the environment

Energy prices have been increasing for many years, stimulating the desire to reduce energy consumption in industrial, mercantile and commercial applications. If this can be achieved, users can keep their operating costs constant or even reduce them, despite rising prices. Mechanical engineers and plant engineers can achieve competitive advantages by reducing the energy consumption of their facilities, with a corresponding reduction in energy costs.

In addition to purely commercial reasons, there are social reasons – climate change – for using available resources as effectively as possible in order to drastically reduce CO_2 emissions.

There are also political initiatives to promote energy-efficient technology. For instance, the EU's "Energy-using Products" Directive (EuP, 2005/32/EC and 2008/28/EC) specifies requirements for the environmentally-compatible design of energy-using products. This directive implements the EU's "integrated product policy" (IPP), which takes into account the entire life cycle of electrical equipment, from production to disposal.

Electric drive technology as a key technology

Electric drive technology is a key technology for enhancing energy efficiency. It is currently the most effective way to achieve a distinct, rapid reduction in energy consumption. For example, the energy consumption of motors in refrigerators, air conditioning equipment and many drive systems used in industrial applications can be optimised by operating them with speed control. In the industrial sector alone, EU estimate that a 15%-plus reduction in the amount of energy consumed by electric motor-drivensystems can be achieved. However, caution is necessary, because no matter which measures users take, their benefits must always be analysed before they are implemented.

The rule is: energy savings are desirable, but not at any price.

Quick, easy and inexpensive
Our objective must be to achieve significant energy savings in both new and existing systems and machines. As a rule, the first thing that operators as well as mechanical engineers and system builders want are measures that can be implemented easily, quickly and, above all, inexpensively.

Smart savings
There is potential for saving energy in almost all areas. Whether building automation, conveyor systems or chemical processes, the difficulty lies in identifying potential and in finding the most cost-effective way in which to exploit it. When taking action to exploit potential for savings, operators/users must pay particular attention to the benefits such action will achieve. Pumps and fans in particular offer incredible potential for savings.

Although their electrical energy consumption levels are amongst the highest in industrial applications, in the case of centrifugal pumps and fans, energy consumption falls in proportion to the speed cubed. A quick and easy solution would be to fit all pumps and fans with frequency converters and to control their speed. The fact that price trends are making converters more and more attractive also favours taking such an approach.

However, caution is necessary, because not all pumps and fans are suitable for speed control. Furthermore, the cheapest frequency converter will not always offer the most cost-effective solution.

Although in many applications the use of frequency converters will result in energy savings, in some cases it will not, and converters can even be counterproductive. Estimates indicate that speed control is economically advisable in approximately 50% of all electric drives. Alongside the type of application, the extent of the savings is determined by the hidden costs generated by the converters used. For example, in many cases the premium paid for a more efficient device will pay for itself in just a short time.

Therefore, issues of commerce and logistics have to be considered, in addition to technical aspects, before an investment decision is taken, in order to avoid uneconomical and counterproductive action. To strike the correct balance between costs and efficiency, users favouring this approach need to make their selection not on the basis of which frequency converter is the cheapest, but based on which option offers the most cost-effective and efficient solution throughout the entire life cycle.

Today, frequency converters represent the best available technology and their use is becoming more and more widespread. Of the 75 million or so motors installed in Europe, approximately one in eight now has a variable speed drive.

Savings, but not at any price

Concentrating on action which is cost-effective and sensible

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A considerable amount of energy can be saved by implementing speed control on electric motors. So that such action achieves the required results, users and system builders have to take a number of important points into account.

Estimating potential savings
Regardless of whether a machine or system is new or existing, operators need to start by ascertaining the equipment's "current state". This includes calculating the energy consumption, clarifying which processes are suitable for speed control and analysing where reasonable savings could be made. This approach will also highlight synergies. As a result, operators will be able to identify possible solutions and can also subsequently verify whether the action taken has had the desired effect; in other words, if the potential for savings has been fully exploited.

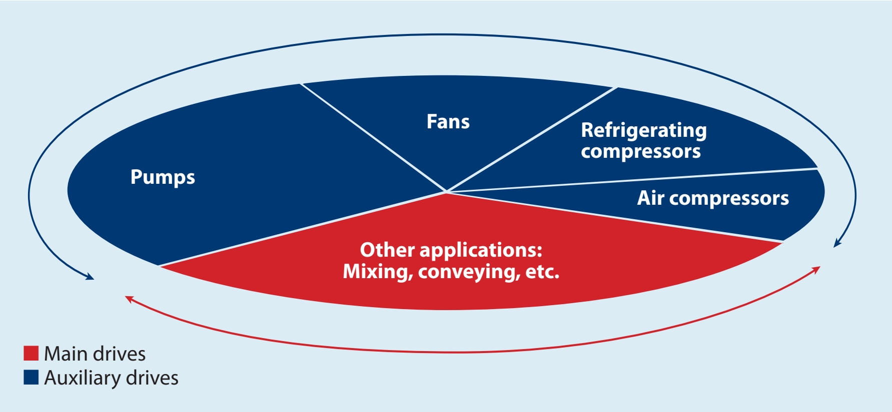
Analysis of the system layout
The most important starting points for an effective analysis of the current state are:

Efficiency
The easiest way to save energy is to use components which are more efficient.

Control of process variables
The most effective way to optimise processes is to control pressure, flow, speed, etc. If just two-step control has previously been used, its energy efficiency should be compared to that offered by speed control.

System layout
Many systems are not necessarily planned from the point of view of the most efficient design or even the optimum energy solution. All types of pipe, for example, offer potential for optimisation. The route taken by the pipes, the type of distributor and the valves used should be selected so that back pressure is as low as possible.

Compressed air
Compressed air is a simple but expensive means of power transmission. In many cases it is more energy-efficient to use a direct motorized actuator instead. As a general rule, operators should keep air pressure as low as possible. Reducing the pressure by just 1 bar will result in energy savings of approximately 7–8%. Leaks too are expensive: depending on system pressure, a hole just 1 mm in diameter will generate additional consumption of between 1500 and 5000 kWh – per year!

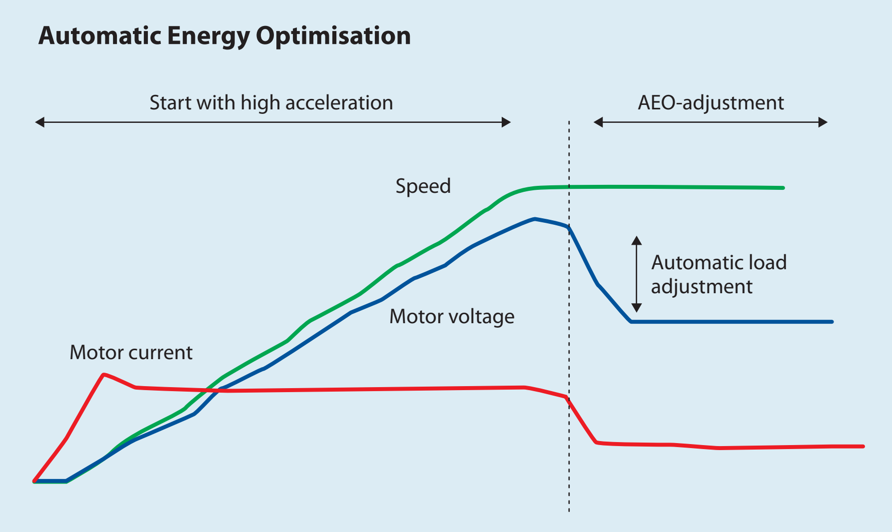


Auxiliary drives consume the highest proportion of energy. Source: Franhofer ISI, Karlsruhe (EU-15)

Calculating prevailing energy consumption
The time during which prevailing energy consumption can be calculated is determined by the application. In the case of defined technical processes, reliable consumption data is usually available after a number of full process sequences have been completed. Evaluating the consumption profile of applications which depend upon climatic conditions is more complex. The required delivery rate of a waste water pump, for example, is directly linked to prevailing rainfall levels.

Testing applications with variable load torque
In the case of applications with variable torque – which include pumps and fans, for example – users have to define the purposes for which control could be used. They also have to identify the peak efficiency of their fans, pumps and compressors and use this information to specify the optimum control range. Finally, the effects on the system have to be checked.

Consideration of the drive train
Users can only achieve maximum savings by giving consideration to the whole of the drive train. They therefore have to check whether efficient motors are being used, what types of gear are in use and if cable lengths have been optimised. Furthermore they have to clarify whether all necessary EMC measures have been taken and that the solution does not overload the mains supply. It is also important to determine losses and the air conditioning required to deal with such losses in the electrical cabinet or electrical operating area.



Appropriate control strategies are the key to maximizing energy efficiency in operation. Danfoss converters feature proven AEO control.

Specialists help to save
Users also need to include existing converters in the analysis. The general conditions on the site which favoured their use originally might have changed. The analysis will also show whether investments are proving worthwhile.

Smart saving requires that users always assess the advantages and disadvantages of a specific technical solution. In so doing it is important to bear in mind that in most cases the quality of a technical solution increases in line with its price. As the vast majority of today's users cannot possibly be familiar with every last detail of all technical devices, it is perfectly reasonable to seek advice from experts where necessary and to discuss all technical advantages and disadvantages with them.

Your knowledge counts. Only those with detailed systems and specialist knowledge can estimate the overheads involved in implementing specific energy-saving measures and reduce unnecessary design reserves.

Motors: Potential for savings and future development

Energy-efficient three-phase induction motors have been available in Europe since 1998. Classification has taken the form of efficiency classes eff1 to eff3. This voluntary agreement is being superseded by the international standard IEC 60034-30.

Geared motors
The use of energy-efficient electric motors to operate gears has become the standard. Depending upon the manufacturer, users can choose between various efficiency classes as appropriate for their drive motors.

However, a motor's efficiency class is based solely on the motor and not on the combination of gear and motor.

There is massive potential with regard to the choice of gear type. Helical gears and bevel gears are, as a rule, much more efficient than worm gears. Operators who choose to use equally compact bevel gears as an alternative to worm gears will initially face higher investment costs.

However, thanks to increased efficiency and reduced edge wear, these costs usually pay for themselves relatively quickly. Geared motors are absolutely ideal for operation on frequency converters. As well as optimising electric motor operation, converters enable operators to do away with mechanical variable speed gearings.

	Power	MPES	Alternatives to MPES
As of 16/06/2011	0.75 – 375 kW	IE 2	–
As of 01/01/2015	0.75 – 7.5 kW	IE 2	–
	7.5 – 375 kW	IE 3	IE 2 + converter
As of 01/01/2017	0.75 – 375 kW	IE 3	IE 2 + converter

PM motors
Permanent magnet motors are highly efficient synchronous motors. Compared with asynchronous motors offering similar rates of efficiency (e.g. IE 3), the dimensions of PM motors are much more compact.

IEC 60034-30	eff Classes
IE 1 (standard efficiency)	Comparable eff2
IE 2 (high efficiency)	Comparable eff1
IE 3 (premium efficiency)	Approx. 10-15% better than IE 2
IE4 (super premium)	–

For the purpose of seeing the Eco-design Directive 2005/32/EC implemented, the EU has concluded an agreement on the introduction of minimum rates of efficiency (MPES) for three-phase induction motors. The Directive comes into force in June 2009.

Speed control: High potential – quick to implement

Falling prices for permanent magnets used are making PM motors attractive even for applications with low dynamic requirements. Whether replacing three-phase induction motors with PM motors makes economic sense is determined by numerous factors.

When carrying but the necessary investigations, in addition to the costs incurred for procurement, conversion and energy, of course operators also need to consider maintenance and replacement motor concepts.

Implementing speed control on load machines often brings with it energy benefits with which can be seen directly on users' electricity bills. The advantages of using speed control include:

Energy savings
The extent of the energy-saving potential varies dependent upon the load's torque characteristics. In the case of a constant torque characteristic the saving is at most proportional to the reduction in torque and speed at the shaft; in the case of a quadratic torque characteristic, savings increase with the speed reduction cubed.

Cos φ adaptation
Many frequency converters correct the cos φ to close to 1, thereby reducing inductive reactive power consumption. This also cuts losses on incoming cables.

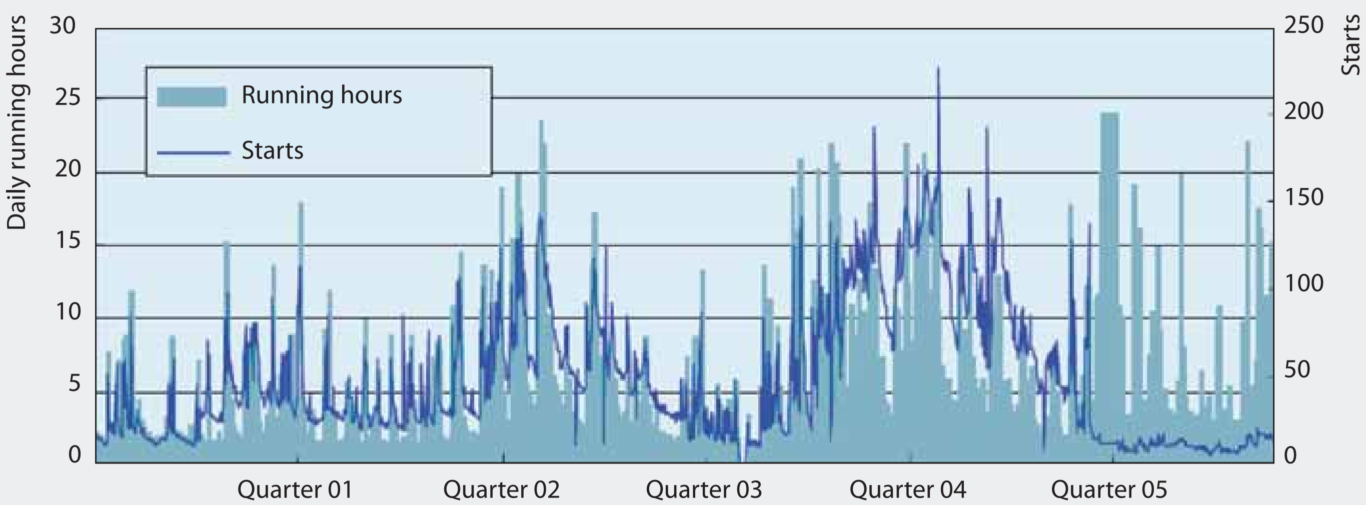
Optimised part-load operation
Usually, rates of efficiency for three-phase motors are only specified for the nominal point. If a motor is running directly on the mains at part load, constant mechanical and electromagnetic losses will cause its efficiency to deteriorate significantly.

Depending on the quality of the control method, frequency converter operation always ensures optimum magnetization of the motor. Accordingly, the reduction in efficiency at part load is not as significant. Noticeable improvements are typical on motors rated at and above 11 kW.

Automatic energy optimisation
In applications in which there are no rapid load changes, operators can use automatic energy optimisation (AEO). The converter runs motor magnetisation down to a minimum, thereby saving energy. The functions have proved their worth in all types of slow control, such as those typical of pumps and fans.

Reduction in starting operations
In many applications speed control can reduce the number of starts. Every time an electric motor starts up under uncontrolled conditions, additional energy is required to get the motor going and re-accelerate the loads. The energy consumption for starting is usually 5–10% of overall energy consumption in the case of pumps, although there are examples of up to 40% being required for starting. Furthermore, current peaks and mechanical stresses caused by jerky starting are reduced.

Speed control also brings about other advantages thanks to the reduction in the mechanical stress to which the system and its component parts are exposed, as well as by means of the integrated software function modern frequency converters feature.



Practical example: The introduction of variable speed drives in the fourth quarter significantly reduced the number of starts and therefore the mechanical stress to which the system was exposed.

Constant torque applications

Today there are already many instances of frequency converters being used for speed control in conveying systems. They optimise energy consumption depending on the load to be transported and the required speed.

Constant torque applications include those where the load does not change significantly with the speed, for example conveyors, lifting gear and mixers.

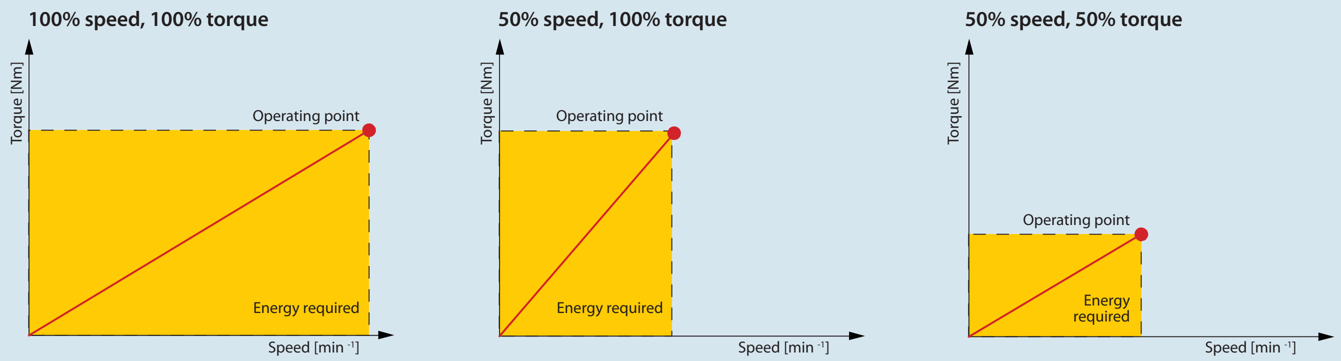
A motor block on a conveyor, for example, will always weigh the same, regardless of whether the conveyor is running at low or high speed. The torque required to move this motor block is always the same. Although friction and acceleration torques will vary depending on the operating state, the torque requirement for the load remains constant.

The power required by a system of this type is proportional to the torque required and to the speed of the motor.

Savings in energy can be achieved directly if the speed can be reduced at constant load. It is often the case that the quantity of goods to be transported on a conveyor is not constant. Adapting the speed of the belt to the quantity of goods to be transported not only enables those goods to be processed without interruption, but also leads to a reduction in the energy required.

Even if it is not possible or desirable to adapt the speed, most frequency converters will still bring about reductions in energy consumption, since they regulate the motor's output voltage depending on load. So, for example, a frequency converter will often supply power to a 400 V motor which is idling with just 380 V at an output frequency of 50 Hz. As the load rises it will then increase the voltage.

The benefits of this type of control are dependent upon the quality of the converter. However, the savings in energy which can be achieved by means of this functionality are not sufficient on their own to justify investing in a frequency converter.



In many constant torque applications, optimising torque and speed can increase energy efficiency.

Variable load torque applications

Variable torque applications often involve pumps and fans. However, a distinction has to be made in the case of pumps. Although the most popular types of centrifugal pump have a quadratic torque characteristic, eccentric, vacuum or positive displacement pumps have a constant torque characteristic.

The number of pump and fan applications is huge. Electric motors account for approximately 70% of all power consumed by industrial applications in the entire EU (15). Pumps and fans have a significant share, with consumption levels equating to approximately 37% of this figure. However, in industrial, mercantile and commercial applications, the EU-wide figure is actually approximately 40%.

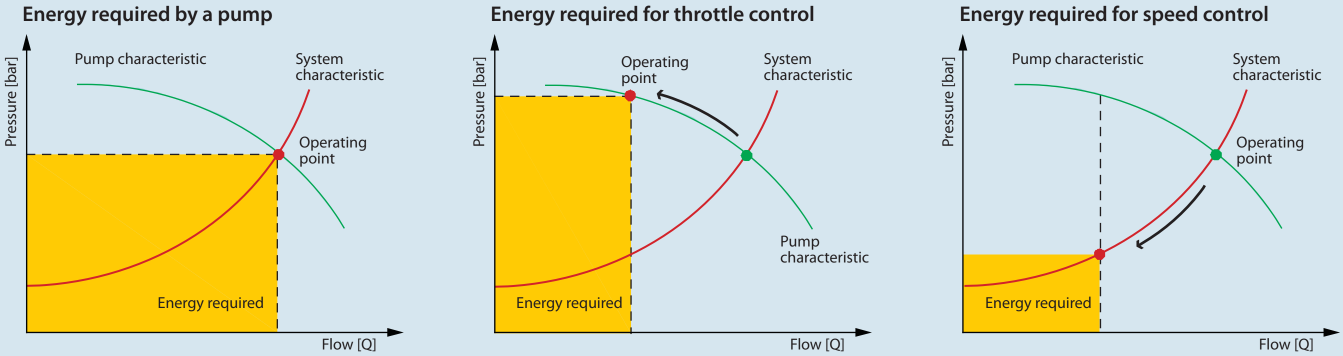
Speed control is a simple yet very effective way of saving energy where fans, pumps and compressors with variable load torques are concerned. Reducing the speed generates a cubic reduction in energy requirements. This significant potential for savings makes all applications with variable torque characteristic ideal candidates for the implementation of energy-saving measures.

To avoid surprises where speed control for pumps and fans is concerned, operators need to take account of the fact that changes in speed alter the operating point and, as a result, affect the efficiency of fans, pumps and compressors, when planning their projects.

Running fans, pumps and compressors in conjunction with converters produces a speed range in which the system saves energy. It is in this range that the machine should clock up most of its running hours. If the difference between the maximum power required and average part-load operation is too great, systems should be cascaded. It is often the case that investments pay for themselves relatively quickly when existing systems are converted, too.

When pumps are cascaded, one speed-controlled pump covers the base load. If consumption increases, the frequency converter will switch in more pumps one after the other. The pumps accordingly operate at maximum efficiency whenever possible. Pump control ensures that the system is always as energy-efficient as possible. The same system can be used in a similar way for fans.

Depending upon the manufacturer and design, appropriate cascade controllers are built into devices as standard or are available as external assemblies.



Reducing the speed generates a cubic reduction in energy requirements. In many applications the use of frequency converters to control fans and centrifugal pumps can therefore pay for itself in less than 2 years.

Particulars of fans, pumps and compressors

Swirl flaps, throttles or three-way valves are often used on most pumps or fans to regulate the pressure or volumetric flow of an application. If a centrifugal pump is controlled using a throttle valve, throttling moves the machine's working point along the pump characteristic. The reduction in energy requirement achieved is minimal compared with the pump's nominal operating point.

If a pump is speed-controlled , the operating point moves along the system characteristic. The energy requirement is reduced by the power of three in comparison to throttle control. So at half speed, for example, the pump only needs an eighth of the power. This applies equally in the case of fans and for all pumps with variable torque characteristic.

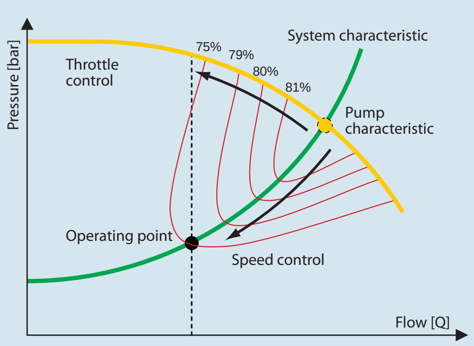
In addition to the pump and system characteristics the graph below also shows the efficiency limits. From these we can see that in the case of both throttle control and speed control, the operating point moves out of the optimum efficiency range.

In the case of speed control the effect of the change in efficiency is evident from the specific energy consumption curve on the graph (only valid for a selected pump).

At approximately 32 Hz the additional pump losses start to exceed the savings. Accordingly, the optimum energy efficiency frequency in the system considered is 38 Hz. If the pump was not speed-controlled, the energy balance would be even worse.

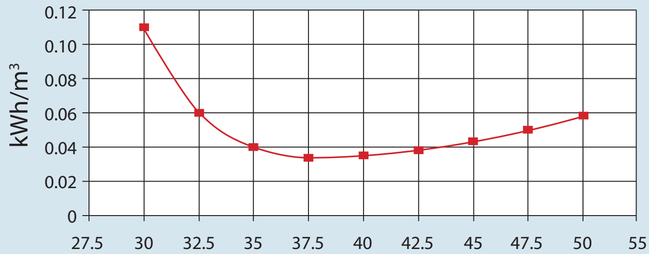
Experience shows that fans, pumps and compressors in particular often do not (cannot) work at the optimum operating point. Air conditioning systems, for example, have to work at higher cooling capacities in summer than in winter. However, as the system has to be dimensioned in line with the maximum power required, it is forced to operate at part-load a lot of the time.

Some manufacturers of fans, pumps and compressors have started to take this into account. They are designing their units so that optimum efficiency is achieved at approximately 70% of delivery rate.



In addition to the pump and system characteristics, the graph also shows a number of efficiency limits. Both throttle control and speed control cause the operating point to move out of the optimum efficiency range.

Specific energy consumption for frequency control



The curve shows the energy consumed by a selected pump under speed control. At approx. 32 Hz the additional pump losses start to exceed the savings. Accordingly, the optimum energy efficiency frequency in the system considered is 38 Hz. If the pump was not speed-controlled, the energy balance would be even worse.

Consider the power losses

Close inspection saves hard cash

At first glance a comparison of efficiency rates does not suggest any real difference between different devices. Devices with identical power and identical efficiency often exhibit different losses.

The frequency converter efficiency is calculated from the ratio between power output and power input. It is usually expressed as a rounded percentage, i.e. without decimal places. In the worst-case scenario, therefore, converters with the same efficiency rate will differ by at least 1%.

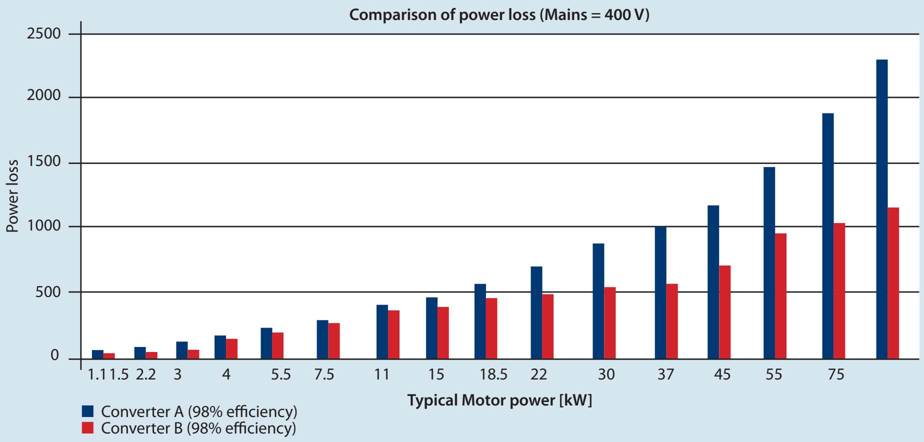
In order to be able to compare the efficiency of various converters, the user must know the conditions under which they were calculated by the manufacturer. In the case of converters, a distinction is usually made between standard overload (110%) and high overload (160%). The rated current of the device is also considered, along with part-load operation and measuring tolerances effective during the calculation of efficiency rates.

Power loss data for a device is much more easily available. The device's operating mode and rated current are, of course, influential here. Since operators and system builders use this data as a basis for an electrical cabinet's air conditioning requirement, though, it can be considered relatively reliable.

The diagram below compares power loss on two different converters. The efficiency data for most power ratings is identical here.

What, then, is the significance of this across the device's entire service life? If we assume a service life of 60,000 hours and motor operation of 90%, the total power loss for the 75 kW converters used in the diagram will be 124,740 kWh and 66,528 kW respectively.

Although both devices exhibit the same efficiency, one consumes approximately 58,000 kWh more! This difference is not as marked in part-load operation. However, the trend is still clearly in evidence.



It is very difficult to make a direct comparison between different frequency converters due to fundamental differences in underlying data such as rated currents and overload capability. Power loss is a better basis for comparison.

Taking filters into account in respect of efficiency and performance

Frequency converters generate electromagnetic interference on account of their operating principle. Every frequency converter has an EMC filter to limit this interference. These filters can be built into a device or connected externally upstream of it. A combination of internal and external filters is also possible.

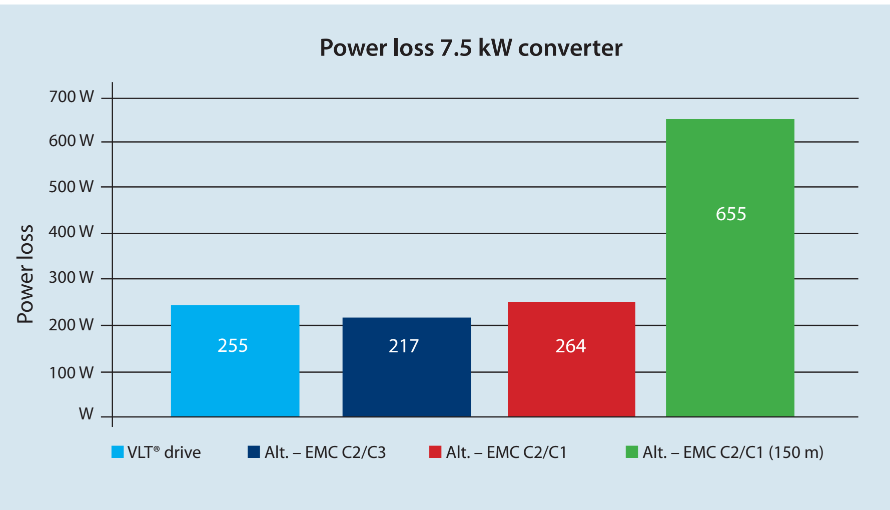
Sine-wave or dU/dt filters can also be used on the motor side. Frequency converters work with a high switch frequency in order to generate the corresponding frequency's output voltage.

The first consequence of this is that the output voltage is no longer sine-shaped. Dependent upon motor cable length and motor insulation, this voltage can damage the insulation. This is problematic in particular in the case of older motors. Motor-side filters limit the rate of voltage rise to which the motor insulation and the amplitude of voltage peaks is exposed, protecting the windings against flashover.

The major advantage of frequency converters with external filters is their price. These devices are cheaper and often more compact than devices with integrated filters. A disadvantage is the additional mounting space required. Furthermore, all external filters always generate additional losses. This is just as true of EMC filters as it is of motor-side sine-wave or dU/dt filters. These additional losses also need to be taken into account when deciding upon the electrical cabinet's air conditioning. Losses from inverters with built-in filters are usually included in the power loss figures specified by the manufacturer.

When comparing the efficiency of two frequency inverters, you therefore need to consider whether they both have the filters integrated into them and whether (as far as the EMC filter is concerned) they comply with the same standards. If not, in the case of converters without filters, this will lead to a reduction in the overall efficiency achieved by the filter and the converter, increased losses and higher energy costs.

Cutting costs by purchasing EMC filters which are not of the requisite quality or doing without them completely as well as by omitting the necessary motor filters can incur significant costs for retrofitting, additional losses and air conditioning.

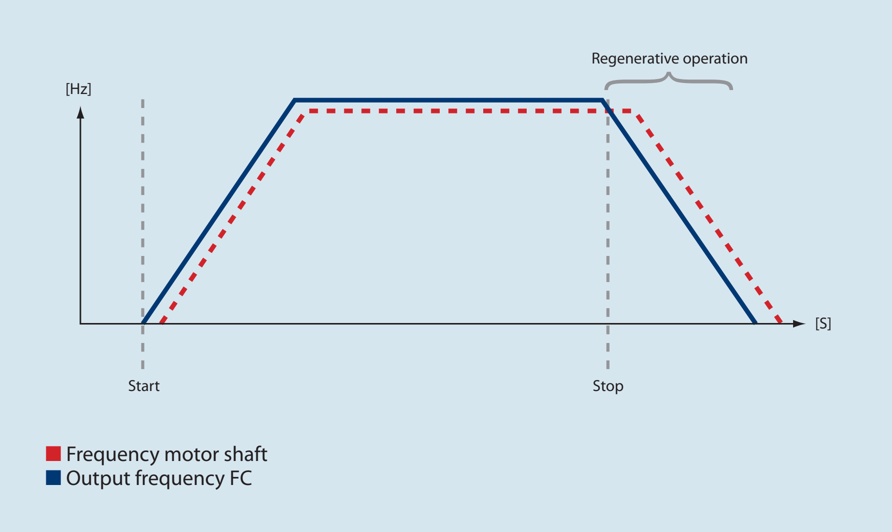


External filters generate additional losses. Therefore, when setting up frequency converter projects, it is important to ensure that the devices used have all the necessary filters built in prior to commissioning.

Regeneration and Active Front End – Rarely to be recommended

The thought of being able to use the regenerative energy generated during operation of an electric machine on a frequency converter is very tempting. The energy arises because the driven three-phase induction motor is running faster than the mains from which it is drawing its power; this happens primarily when the motor is decelerating.

In most cases the user conducts this energy to brake resistors, where it is converted into heat. It might be more sensible to feed this energy back into the mains or make it available to other machines.



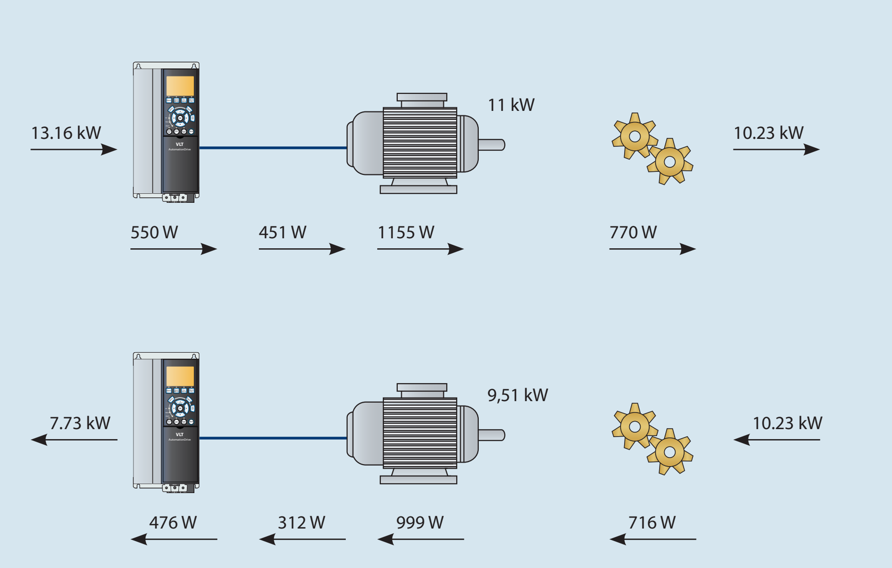
Two technical solutions are common in practice:

Load sharing/Capacitive clamp coupling
Many converters are able to couple their DC link to intermediate circuits on other devices, thereby making any regenerative energy generated directly available to other devices. However, a number of boundary conditions have to be taken into account. Provision needs to be made, for example, to ensure that a short circuit in one device will not be harmful to the other devices. Users must of course also give consideration to what happens if all interconnected devices output regenerative energy at the same time.

Regeneration
A frequency converter's regenerative input modules use a controlled rectifier to feed regenerative energy back into the mains. Most applications run primarily in motor operation.

The energy gained by means of regeneration is often less than the additional losses generated by the controlled rectifier in motor operation. It is for this reason that regenerative converters are often only worthwhile at higher power ratings, with consideration given to the load cycle and numerous boundary conditions, such as frequent braking, for example.

Operators should carry out thorough investigations prior to investing in capacitive clamp couplings or regenerative systems. They usually overestimate the amount of energy generated. In order to evaluate cost efficiency, it is essential to calculate the proportion of the operating cycle during which the system runs in regenerative operation and to estimate the system's average brake energy. In most cases the use of brake resistors is more advisable, in both economic and ecological terms, than using the energy generated in braking operation.



If you are considering implementing regeneration in a drive system, please note that losses still occur in the system with this solution. Even in the unlikely case that the maximum mechanical energy is available at the shaft, these losses will significantly reduce the energy which can be regenerated.

System optimisation:
Consideration of the overall system and sources of potential

In a drive system approximately 10% of potential savings can be achieved by using more efficient motors. Speed-controlled operation opens up potential savings of approximately 30%. However, the biggest potential savings of approximately 60% can be achieved by optimising the overall system.

In the case of every measure, therefore, operators must always consider the effect on the overall system. It is for this reason that they should always check whether different energy-saving approaches can be combined. These include selecting the best layout for pipes when carrying out conversion work, and the option of using software functions in modern frequency converters.

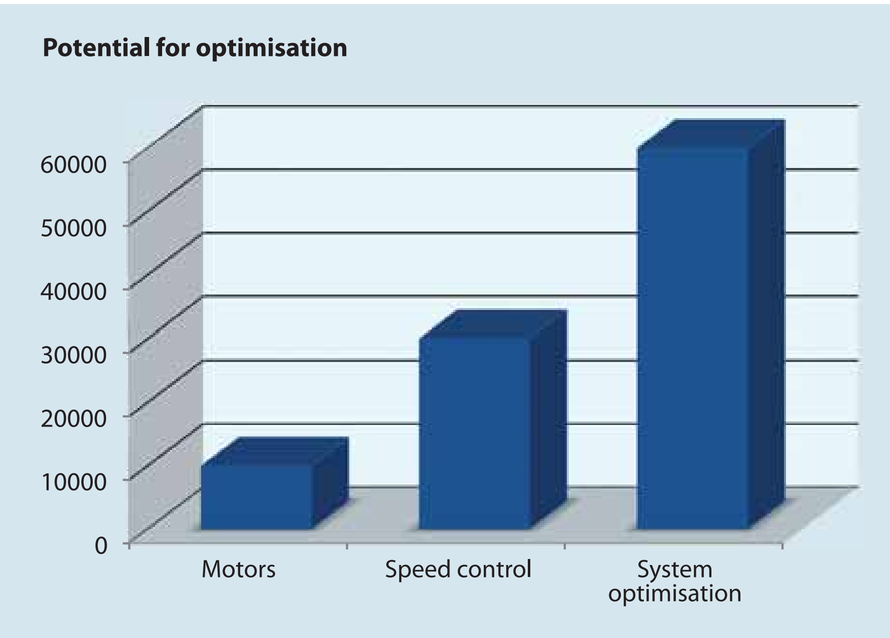
The potential savings in the source of energy used vary greatly from sector to sector. For example, the need for process heat is often much higher in the industrial than the mercantile sector.

In most cases the biggest potential savings are to be found in the area with the greatest energy consumption. So industry accounts for approximately 43% of power consumption, but the mercantile, commercial and service sectors for "only" 23%.

Detailed systems and specialist knowledge is essential in order to identify the potential savings to be made in different sectors. Only those armed with such knowledge will be able to assess whether action can be taken to improve cost efficiency and, if so, which.

Regardless of whether a machine or system is new or existing, operators need to start by ascertaining the "actual status" of the overall system prior to taking energy-saving action.

This enables them to better identify possible solutions and subsequently verify whether the action taken has had the desired effect; in other words, if the potential savings have been fully exploited.



If system optimisation is not feasible, the use of frequency converters for speed control is a quick and effective option for saving energy, retrofit applications included.

Cost reduction throughout the entire life cycle

Frequency converters not only save hard cash where energy is concerned

Jethro Macey

Frequency converters have come to represent the best available technology and their use is increasingly widespread. Nevertheless, in addition to technical aspects, commercial and logistical issues have to be considered before an investment decision is taken, in order to avoid uneconomical and counterproductive action.

According to the latest research, initial costs account for only approximately 10% of overall life cycle costs. 90% of the costs incurred can be allocated to operating costs, for example expenditure on energy, maintenance and service. In addition, the initial costs of air conditioning systems, mains chokes and mains filters are a not insignificant cost factor.

LCC (Life Cycle Costs) and TCO (Total Cost of Ownership) are established methods of calculating overall costs. They take into account not only initial costs but also other expenses such as energy, repair and maintenance costs. Accordingly, a device which comes at a high initial cost can, considered over its entire service life, prove to be more cost-effective than a cheaper alternative.

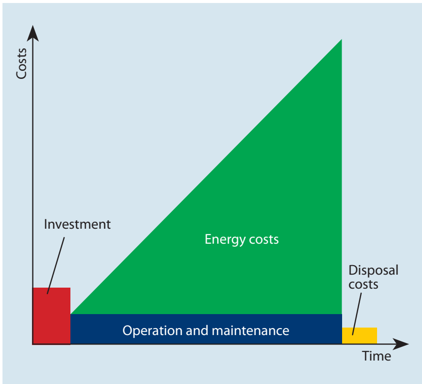
The availability of a product, for example, can also be included in the equation. The failure of a device in operation can incur costs due to production downtime, for example.

To guard against this scenario, operators need stocks of one or more replacement devices. One of the factors determining the amount of stock held is how quickly the manufacturer of a product can supply new devices when needed.

Proactive maintenance for lower costs and greater availability

Another attractive feature of modern frequency converters is their support for a multiplicity of functions, which enable operators to cut down on external components and their complex cabling. At the same time, the soft starting which is inherent in their operating principle protects motors and system components, thereby increasing service lives and reducing maintenance and service costs.

Extensive protective functions for motor and system display the current status for drive and system at all times. They protect the components and they can extend maintenance intervals by providing an early indication of wear, thus increasing system availability.



Initial costs usually account for only approximately 10% of overall life cycle costs. The higher initial costs of an energy-saving device often pay for themselves in next to no time.

90%

of the costs

incurred can be allocated to operating costs

Environmentally responsible

VLT® products are manufactured with respect for the safety and well-being of people and the environment.

All activities are planned and performed taking into account the individual employee, the work environment and the external environment. Production takes place with a minimum of noise, smoke or other pollution and environmentally safe disposal of the products is pre-prepared.

UN Global Compact
Danfoss has signed the UN Global Compact on social and environmental responsibility and our companies act responsibly towards local societies.

EU Directives
All factories are certified according to ISO 14001 standard. All products fulfil the EU Directives for General Product Safety and the Machinery directive. Danfoss Drives is, in all product series, implementing the EU Directive concerning Hazardous Substances in Electrical and Electrical Equipment (RoHS) and is designing all new product series according to the EU Directive on Waste Electrical and Electronic Equipment (WEEE).

Impact on energy savings
One year's energy savings from our annual production of VLT® drives will save the energy equivalent to the energy production from a major power plant. Better process control at the same time improves product quality and reduces waste and wear on equipment.

What VLT® is all about

Danfoss Drives is the world leader among dedicated drives providers – and still gaining market share.

Dedicated to drives
Dedication has been a key word since 1968, when Danfoss introduced the world's first mass produced variable speed drive for AC motors – and named it VLT®.

Twenty five hundred employees develop, manufacture, sell and service drives and soft starters in more than one hundred countries, focused only on drives and soft starters.

Intelligent and innovative
Developers at Danfoss Drives have fully adopted modular principles in development as well as design, production and configuration.

Tomorrow's features are developed in parallel using dedicated technology platforms. This allows the development of all elements to take place in parallel, at the same time reducing time to market and ensuring that customers always enjoy the benefits of the latest features.

Rely on the experts
We take responsibility for every element of our products. The fact that we develop and produce our own features, hardware, software, power modules, printed circuit boards, and accessories is your guarantee of reliable products.

Local backup – globally
VLT® motor controllers are operating in applications all over the world and Danfoss Drives' experts located in more than 100 countries are ready to support our customers with application advice and service wherever they may be.

Danfoss Drives experts don't stop until the customer's drive challenges are solved.

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