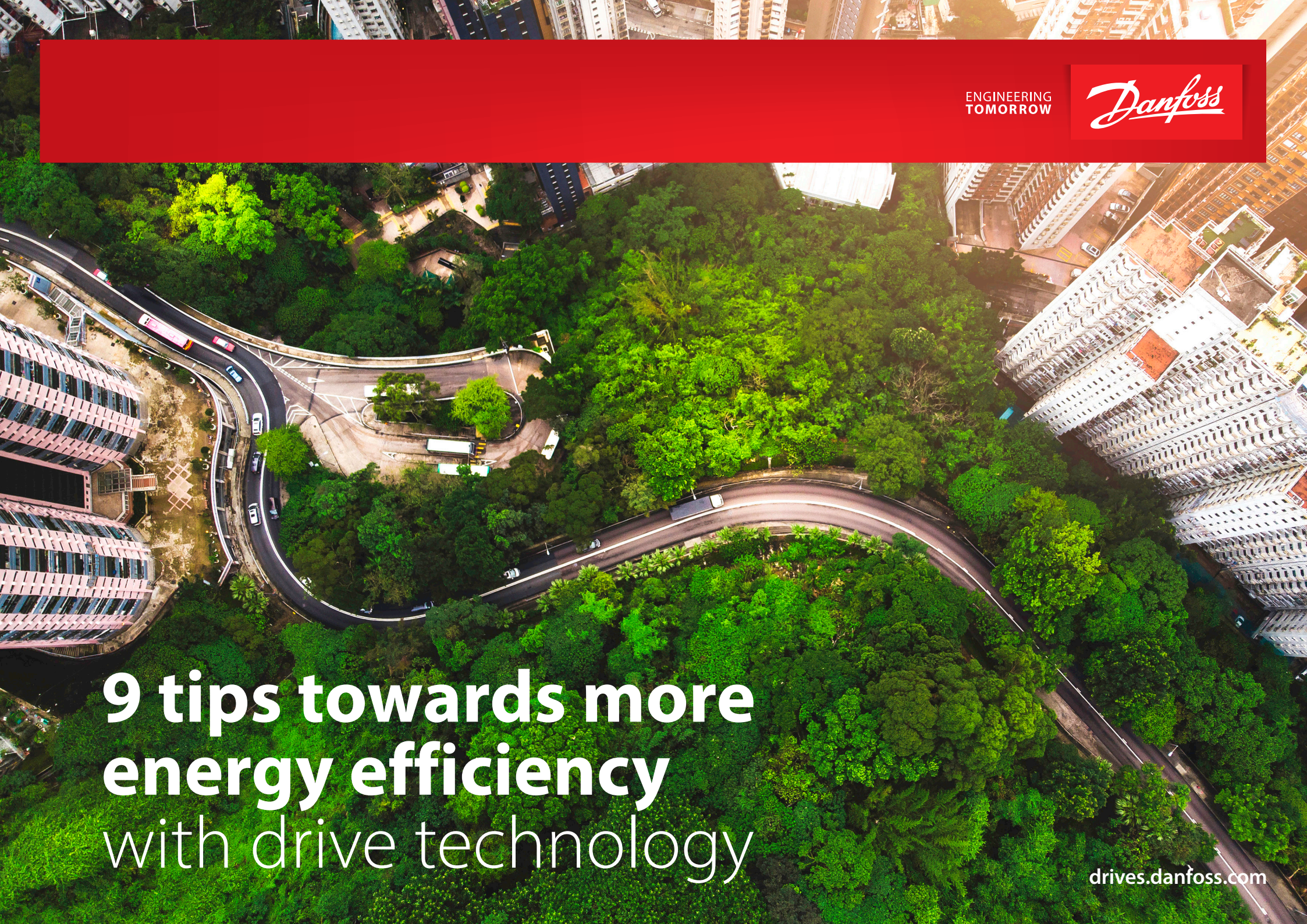
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9 tips towards more
energy efficiency
with drive technology
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Introduction: **9 tips to increase energy efficiency with drive technology**

Energy prices are soaring to unprecedented heights. It is time to review energy saving measures to keep costs in check as much as possible. With this 9-point checklist for energy-efficient drives from Danfoss Drives, you can quickly get an overview of energy guzzlers in your facilities and identify measures to leverage energy efficiency in motor driven equipment by utilizing drive technology. You will learn which areas you can improve efficiency, and in doing so, save costs. After all, electric drive technology is a key technology for increased energy efficiency. It is currently the most effective, fast, and easy solution for reducing energy consumption quickly and significantly.

Speed control of electric motors can operate almost all applications like conveyors, elevators, refrigerator compressors, air conditioning systems in buildings, pumps and more, all in an energy-optimized manner. In its "World Energy Outlook 2016", the IEA estimates that global electricity consumption can be reduced by 8 percent by 2040 if AC drives are used in all suitable applications - and if they are used efficiently.

This energy efficiency checklist provides useful tips for increasing efficiency and shows where the greatest potential energy savings exist. The resulting benefits pay off twice: Every kilowatt hour of electricity saved not only reduces your energy costs, but also minimizes your company's CO_2 footprint.

1. Speed control matters: Leverage energy-saving potential in all your motor applications quickly
2. Pick the low hanging fruits: Check for fans and pumps in your applications and facilities
3. Drive technology: how to improve energy efficiency in your production by getting your AC drives' settings right
4. Suceed from the start and monitor your progress
5. Do not compromise on system reliability
6. Is regenerative energy an option?
7. Check drive efficiency: which AC drive is right for you/your application?
8. Take a closer look at motor technologies
9. Last but not least: the 10-30-60 rule

1 Speed control matters: **Leverage energy-saving potential in all your motor applications quickly**

Electric motors are responsible for around 40 percent of the world's electrical energy consumption. In industry, their share is as high as 65-75 percent depending on the region and sector.

As energy becomes increasingly expensive, variable speed control of electrical motors has proven to be one of the most effective cost-reducing measures available. For approx. 60-70 percent of motors, it makes sense to apply speed contro, making it a good starting point for your energy efficiency journey.

Large electrical machines are prime targets, but a much bigger potential might exist in your small motors, which are used in your applications, processes, and facilities. Let's leverage this potential.

Good to know

AC drives do not only help operators save energy and energy costs, but also help reduce operation, maintenance, and repairs as life cycle costs are reduced. Often, AC drives with speed control provides the best choice for saving energy and costs.

To learn more about the energy-efficient use of AC drives, go directly to **checkpoint 3.**

Consider softstarters

In applications where speed control is not an option, it is worth considering using a softstarter which is equipped with a bypass. Without a bypass, the device will create unnecessary losses in motor operation.

In general, softstarters are typically used in applications running directly on the mains. They are designed to protect your electric motor from possible damage and at the same time extend its lifetime and the lifetime of the whole system by decreasing the heat caused by frequent start/stops, reducing the mechanical stress on the motor and its shaft, amongst others.

Advice

Identify all your motors > 0.75 kW that are not speed controlled yet but have the potential to be. Do you use valves, dampers, or other technologies to control the flow or speed in applications? These are perfect candidates to start with!

At Marselisborg wastewater treatment plant the use of AC drives on rotating equipment creates net production of both electricity and heat and reduces its carbon footprint by 35%.

Read more about it **here.**

2 Pick the low hanging fruits: **Check for fans and pumps in your applications and facilities**

A good starting point is assessing your fan and pump applications. Fans and pumps are often quadratic torque applications, and they offer enormous saving potential in speed-controlled operation.

For example, by reducing the average speed of the fan motor by only 20 percent (from 100 percent to 80 percent), 50 percent energy is saved. Likewise, reducing the average speed by 50 percent increases the savings to 80 percent.

Regarding pump applications, one needs to know that many pump drives are oversized and they run at full power, while the volume flows are often controlled via throttle valves. With AC drives, the flow is controlled via speed with some good results: If the speed of a pump is reduced by only 20 percent on average, the power requirement is reduced by 50 percent.

Good to know

When considering the total life cycle costs, the capital costs usually account for only about 10 percent. The other 90 percent of the costs incurred are operating costs, for example, costs for energy, maintenance and service. Especially for applications with a quadratic load curve, speed control almost always saves considerable energy and costs, so that the investment pays for itself quickly. The former payback periods of 1 to 2 years are currently reduced to a few months due to rising energy costs. At the same time, you reduce mechanical wear and increase uptime.

Example calculation: pump or fan

Nom. power of motor: 22 kW
Running hours: 8760 hours/year
Energy price: $ 0.39 per kWh
Average speed reduction: 10%
Motor efficiency: 94%
Danfoss AC drive efficiency: 98%
Investment Danfoss AC drive: $ 6,809

Energy costs without AC drives p/yr: $ 78,020.80
Savings with AC drive: $ 19,504.67

Regulator payback time: 4 months
Savings after 10 years operation (at the same energy price): $ 195,963

Advice

Pick the low hanging fruits in energy savings: Consider speed control for all your fan or pump applications. Your investment will pay off quickly.

Have you ever considered a retrofit?

To ensure the highest possible savings, drive technology components should be state-of-the-art and regularly maintained. In most cases, replacing an older AC drive will pay off within months.

We have already helped companies pick the low hanging fruits. One example of this is at Volkswagen's Navarra factory, where they achieved 20% energy savings in AHU operation. Learn more about that **here**.

3 Drive technology: How to improve energy efficiency in your production by getting your AC drives' settings right

AC drives are often commissioned only partially or incorrectly. However, to operate as energy efficiently as possible, it is important that they are parameterized for their operation. Additional functions such as **Automatic Motor Adaptation (AMA)** and **Automatic Energy Optimization (AEO)** should always be activated:

Utilize optimized motor control:

AC drives can run many motors reliably with standard motor data. However, to make installation and initial commissioning easier, automatic motor configuration functions like AMA from Danfoss are becoming increasingly common. These functions measure the stator resistance and inductance, for example. The effect of the cable length between AC drives and motors is also considered.

Automatic energy optimization with AC drives

In applications where there are no rapid load changes, the operator can use AEO. The AC drive then reduces the motor magnetization to a minimum. This saves energy, and the functions have proven themselves with all slow controls, such as those common with pumps and fans.

Good to know

Some small measures can have a huge impact on energy efficiency and savings: For example, with an energy-saving or sleep mode, fans and pumps only run when it is needed. Furthermore, an AC drive with AEO can save an additional approx. 5 percent of energy by tuning the motor voltage.

Advice

Verify if the right motor data is programmed and if an AMA has been conducted and AEO considered.

4 Suceed from the start **and monitor your progress**

When starting to optimize your system, document your learnings right from the start. This will help to identify the most promising measures for your system. Furthermore, you might be surprised by some positive side effects like an extended lifetime through less mechanical wear and reduced number of starts.

Reduction of starts

Each uncontrolled start of an electric motor requires additional energy to start the motor and re-accelerate the loads. Speed control can reduce the number of starts in many applications. Example: For pumps, energy consumption for starts is typically 5-10 percent of total energy consumption, but there are examples of up to 40 percent of energy being required. In addition, current peaks, and mechanical stresses due to shocks during start-up are reduced.

Good to know

When applying speed control to an application some positive side effects will happen. For example, the amount of required starts per day decreases. This not only leads to energy savings, but also decreases mechanical wear and increases the lifetime of an application.

Advice

Monitor the energy consumption prior and after applying speed control. Further benefits include less mechanical wear and an extended lifetime of your application due to a reduction of starts.

5 Do not compromise **on system reliability**

Variable speed drives, due to their operating principle, produce a series of unwanted secondary: motor winding isolation stress, bearing stress, acoustic switching noise in the motor, and electromagnetic interference. In most applications, these effects do not affect existing installation – but in some cases, e.g., motors that have been in operation for 20 to 30 years, these effects need to be mitigated. For the mitigation of these effects, filters are installed at the output of the drives. The most commonly known filters are dU/dt filters, sine-wave filters and common-mode filters. However, the efficiency of the motors itself is probably also worth checking!

Good to know

When a piece of equipment or system can function satisfactorily in its electromagnetic environment without introducing intolerable disturbances in that environment, it is called electromagnetic compatibility (EMC).

AC drives potentially create EMC interferences. To avoid negative effects on your installation, ensure that you select products with the best-in-class EMC filter suitable for your environment. Also, make sure that the standard rules for EMC installation are followed.

Advice

Make sure that your chosen product provides the best-in-class EMC filters for safe operation and high system reliability. Also ensure correct EMC installation e.g., by using compliant cable glands and suitable earthing.

6 Is regenerative energy **an option?**

Electrical motors can work as generators under certain conditions and the energy can be fed back into the power system. Unfortunately, the required technology for utilizing this energy typically results in higher losses during the standard motor operation.

Especially with soaring energy prices, the use of freed-up energy is tempting. You can regenerate braking energy, use it directly in additional axes, or store it for later use. However, as good as it sounds, it is important to be aware that energy regeneration more often results in more losses than savings in applications where AC drives are used.

In applications like elevator systems, which benefit from DC-bus systems typically starting at a certain power level (> 7.5 kW), this option makes most sense. In most other applications, it does not.

Please note: The higher the power sizes, the better. Using regenerative energy usually does not pay off for power sizes below 7.5 kW. Please contact your drives' expert if in doubt.

Good to know

Regenerative input modules of the AC drives can feed regenerative energy back into the mains through a controlled rectifier. In most applications, the motor operating state dominates. The energy gained by regenerative power is often less than the additional losses caused by the controlled rectifier in motor operation. Therefore, regenerative converters often only pay off at higher power levels, considering the load cycle and many boundary conditions such as frequent braking.

Operators should thoroughly examine investments in DC link couplings or regenerative systems. As a rule, they usually overestimate the share of energy generated. Determining the regenerative share of the operating cycle, as well as estimating the average braking energy of the system, is essential for an economic assessment. In most cases, the use of braking resistors makes more economic and ecological sense than using the energy generated in braking operation.

Advice

Carefully check when applying AC drives in systems for energy regeneration. It often does not pay off!

7 Check drive efficiency: **Which AC drive is right for you/your application?**

AC drives from different manufacturers can be compared more accurately based on the information on the power loss of a device - sometimes with serious differences in the total power loss and the corresponding additional energy consumption!

In Europe, manufacturers must provide for the losses by law. In nominal point but even more importantly at part load. As the benefit of variable speed control lies in part load operation, do not forget to check this data.

Good to know

Not all efficiency is the same. Compare AC drives not only based on their efficiency class, but also based on their power loss. This will save you money, because the operating costs can exceed the purchase costs many times over - despite the same efficiency rating.

Why? Here is an example: The higher the power loss of the AC drive, the more exhaust heat it will produce – which leads to a further increase in energy costs as you will need to operate additional cooling devices to cool cabinets.

Advice

The devil is in the details: It is worth comparing the power losses (in kilowatt hours) of AC drives from different manufacturers. As the benefit of variable speed control lies in part load operation, do not forget to check this data.

8 Take a closer look **at motor technologies**

For decades, 3~ induction motors were state of the art. In the last years, new and more efficient motor technologies have hit the market and motor efficiency classes have been identified to cluster motors regarding their energy efficiency.

Please note that these efficiency classes differ for motors at mains and when operated with variable speed drives (VSD).

Good to know

The IEC 61800-9-2 standard helps users to establish efficient motor - VSD systems by providing a unified method. Just add the losses of the individual components in a certain load point.

The **Danfoss MyDrive® ecoSmart™** is an online tool made for this. It makes it easy for you to calculate IE and IES classes according to the standard.

You can use the tool for the following:

- Looking up standard partial loss data for Danfoss AC Drives
- Acquing application specific part load points
- Calculating IE class and part load data for an AC drive
- Calculating IES class for a combination of induction motors and AC drives
- Generating reports of part load loss data and IE or IES efficiency classes
- Exporting the part load data to transfer it to your system

Advice

Especially when operating older motors, it makes sense to check the efficiency class. If no class is given, there is a good chance that more efficient motors are available.

When evaluating a new motor, make sure that you consider part load points!

If this sounds interesting to you, make sure to read our case story about Hjørring District Heating A.m.b.a **here**.

9 Last but not least: **the 10-30-60 rule**

Most savings are realized in the system. As a rule of thumb, energy-efficient components can contribute 10 percent to the potential savings in a system. Using speed control adds an additional 30 percent, but the majority (60 percent) can only be realized in the system!

When you assess your system for speed control, take the time and check if there are more savings possible by using a system perspective.

Good to know

Here are two examples:

1. Using the most efficient motor and AC drive does not pay off when using, for example, a gear box with low efficiency.

2. Having huge heat losses in a cabinet resulting in the need for extra climatization is also not considered an optimal solution.

Please note: Modern AC drives can do more for you than speed control. They help you monitor your system's condition.

With **Condition-based monitoring** you detect and eliminate, for example, leaks or pipe bursts more quickly.

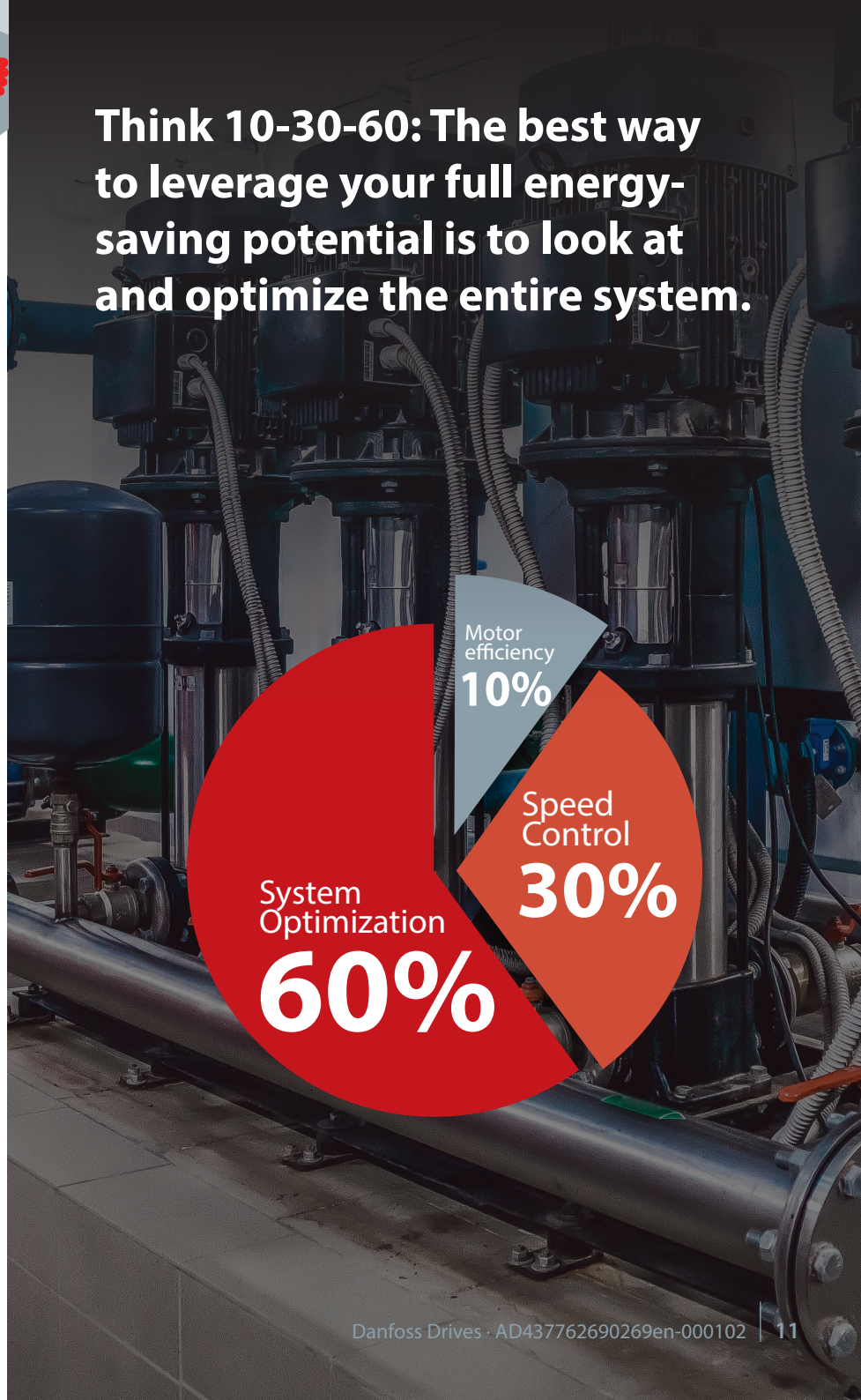
Did you know that you can use your drive to monitor the condition of an application, and get early warnings to avoid downtime? Using intelligent drives with embedded condition-based monitoring (CBM) ability, you get the right information at the right time. It allows you to monitor the load level of your pumping and ventilation applications so you can detect leakages or broken pipes earlier. It also helps you to detect dirty filters so that they can be replaced before they clog.

You can plan ahead and reduce costs significantly – saving unexpected downtime and even reducing your spare parts.

Advice

Think 10-30-60: The best way to leverage the full energy-saving potential is to look at and optimize the entire system. It simply does not help using a best-in-class energy-efficient motor and highly efficient AC drive combined with an inefficient fan or pump.

Danfoss has helped the brewing company HEINEKEN with simple condition-based-monitoring. Learn more about that **here**.



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