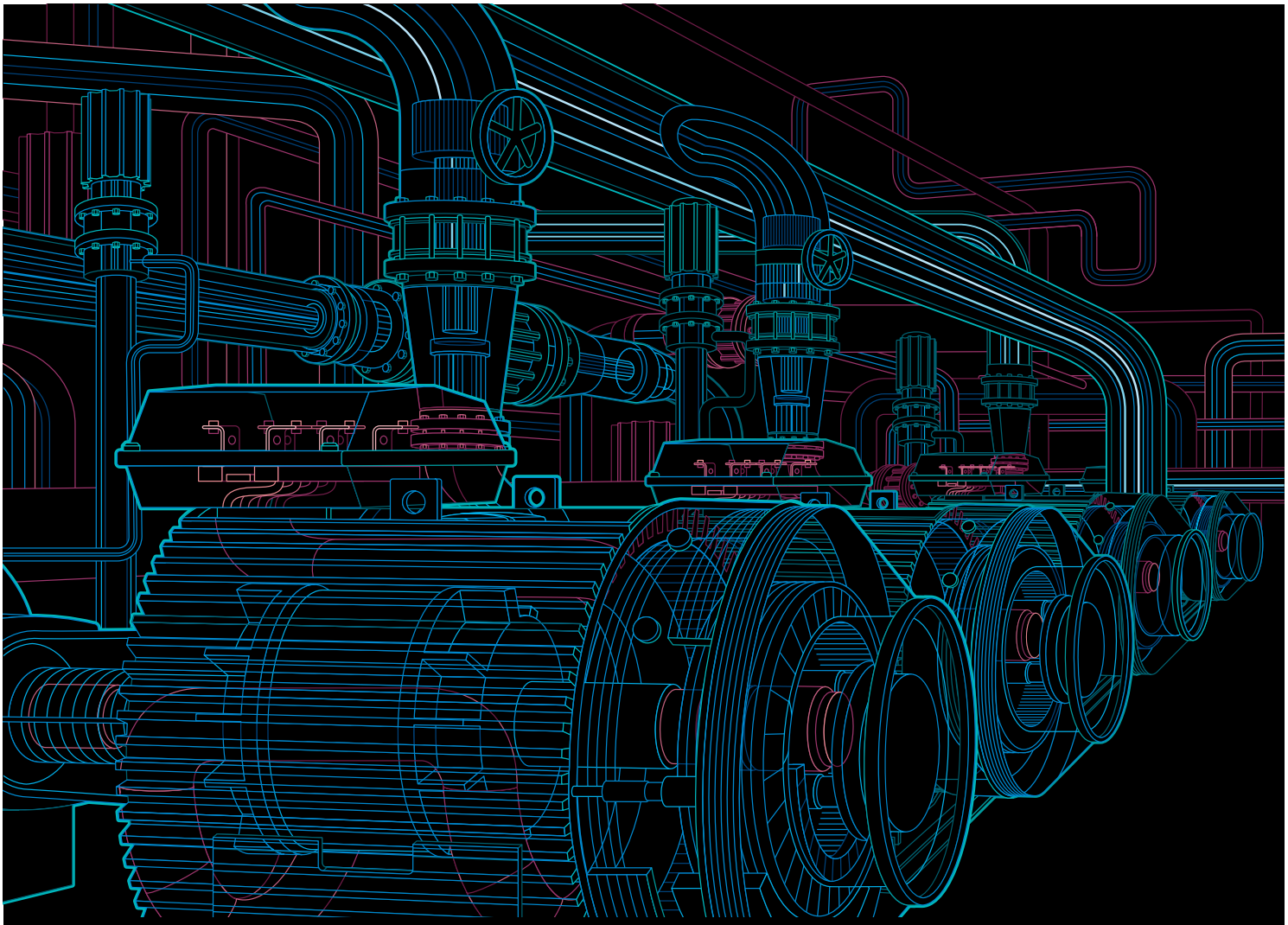


The ABB energy efficiency & productivity improvement plan
Efficient control of motor-driven applications

Power and productivity
for a better world™

The ABB energy efficiency & productivity improvement plan

1. Understanding energy efficiency and productivity improvements

All industries face two major challenges: how to reduce energy use while maintaining product quality and productivity.

Improved productivity is required to drive up profits that satisfy stakeholders. Meanwhile, energy prices are becoming much more volatile, a reflection of the uncertainties in the supply situation.

As such governments are imposing legislations to force industry to reduce energy use and greenhouse gas emissions. The UK government, for instance, has introduced the Carbon Reduction Commitment (CRC, 2008 and 2014), the Climate Change Levy (CCL, 2001) and the Energy Savings Opportunities Scheme (ESOS) which requires large users to carry out an energy audit on their plant every four years.

The impact of motor-driven applications

Improved energy efficiency and productivity cannot be introduced overnight but is the result of a determined effort over time. A good place to start is to look at your motor-driven applications. By carefully selecting specific applications and monitoring their performance within the process, a clear picture will emerge of precisely where savings and improvements can be achieved. This avoids wasting energy by controlling highly efficient components incorrectly.

Did you know?
On an industrial site with an electricity bill of **£150,000** per annum, an average of **£100,000** per annum can be spent on running motors.

Variable-speed drives (VSDs) can achieve the perfect balance between lowest energy usage and best productivity.

Energy efficiency improvements

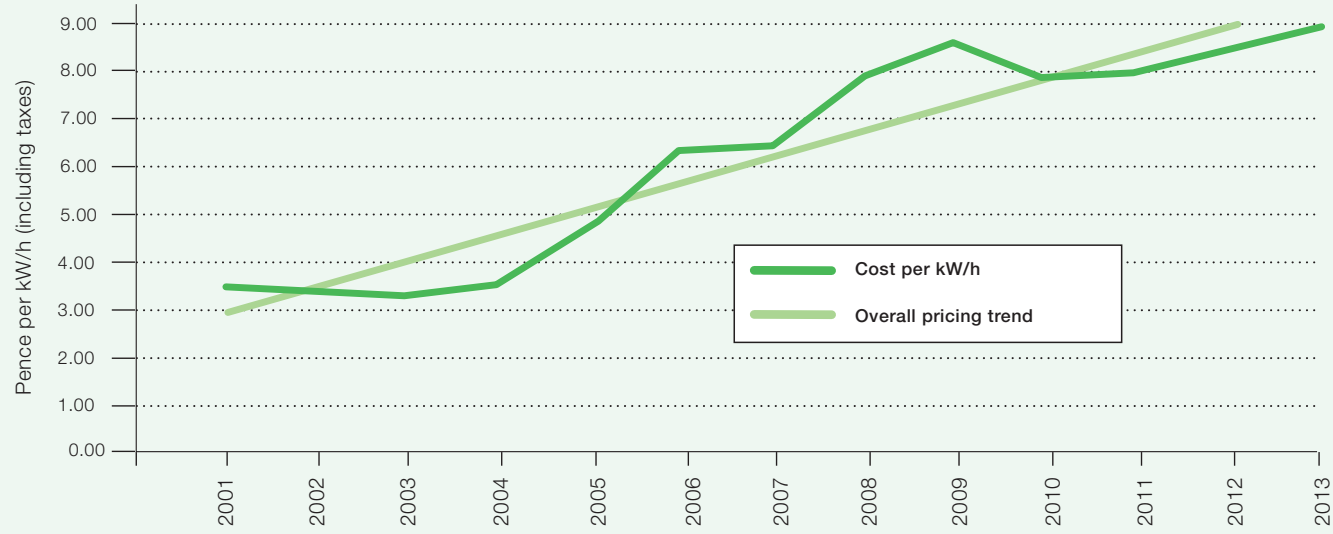
In many processes, production volumes are often altered using mechanical techniques such as opening or closing throttle valves, dampers and/or inlet guide vanes. While these mechanical devices allow system flow to be controlled, they are notoriously inefficient as energy is wasted across the restriction.

Further wastage occurs when these devices are controlled manually or simply left in the same position as when commissioned and not adjusted to take into account changes in system requirement.

With VSDs, changing the production volume can be achieved by changing the motor speed. While matching production requirements, this saves a lot of energy, particularly in pump and fan applications.

Benefits

– Less energy waste
– Reduced electricity costs
– Lower CO_2 emissions
– Matched motors and drives



Energy prices are becoming more volatile - the graph shows industrial electricity prices 2001 - 2013.*
*Source: Department of Energy and Climate Change (DECC).

Productivity improvements

Sometimes energy efficiency projects are not implemented because of concerns about interrupting or altering the process. However, as well as saving energy, the process also benefits greatly from the installation of VSDs. When changes are made to the plant it is important to do it with the future in mind.

Changing constant-speed equipment to provide higher production volumes requires money and time investing in gearboxes or new belt systems, as well as interrupting production to install these devices.

With a VSD, speed increases of 5 to 20 percent can be easily attained without changing the mechanics. The accurate speed control obtained with VSDs results in process optimisation.

Benefits

– Enhanced end-product quality
– Increased production throughput
– Lower switchgear and cabling costs
– Maximised process up-time
– Minimised maintenance
– Reduced wastage
– Accurate processing of materials

The energy use and productivity levels of every factory and plant can benefit from variable-speed drives and electric motors.

2. The physics of saving energy and controlling productivity

The importance of drives and motors

There are some 10 million electric motors driving production in UK industry. Collectively, they are by far the biggest users of electricity in industry, so controlling them effectively for optimal production volumes is a key target.

The vast majority of these motors are oversized due to the original design being based on worst case conditions. Often when selecting components from catalogues, the correct size is not available so larger units have to be purchased. This oversizing is another source of waste and inefficiency.

Industrial load types

Typically, all motor-driven loads can be categorised into two types: variable-torque and constant-torque.

Applying VSDs to variable-torque and constant-torque loads can result in energy savings and productivity improvements. However, energy savings are most noticeable when drives are applied to variable-torque loads.

Variable-torque load

Variable-torque loads include centrifugal pumps and fans, employed in a variety of applications such as:

- Air handling units
- Industrial process cooling pumps
- Chilled water pumps
- Hot water circulation pumps
- Cooling tower fans
- Return air fans
- Circulation and supply pumps
- Combustion blower fans

How it works

The requirement for torque, and hence current, increases with the square of the speed. The voltage varies in proportion to the speed, so power actually varies in proportion to the cube of the speed.

Hence, by reducing the speed, the power reduces by the cube of the speed change. This relationship is known as the Affinity Law, or the Cube Law.

Did you know?

Running a motor with a variable-speed drive at **80 percent** speed could only require **51 percent** of the energy.

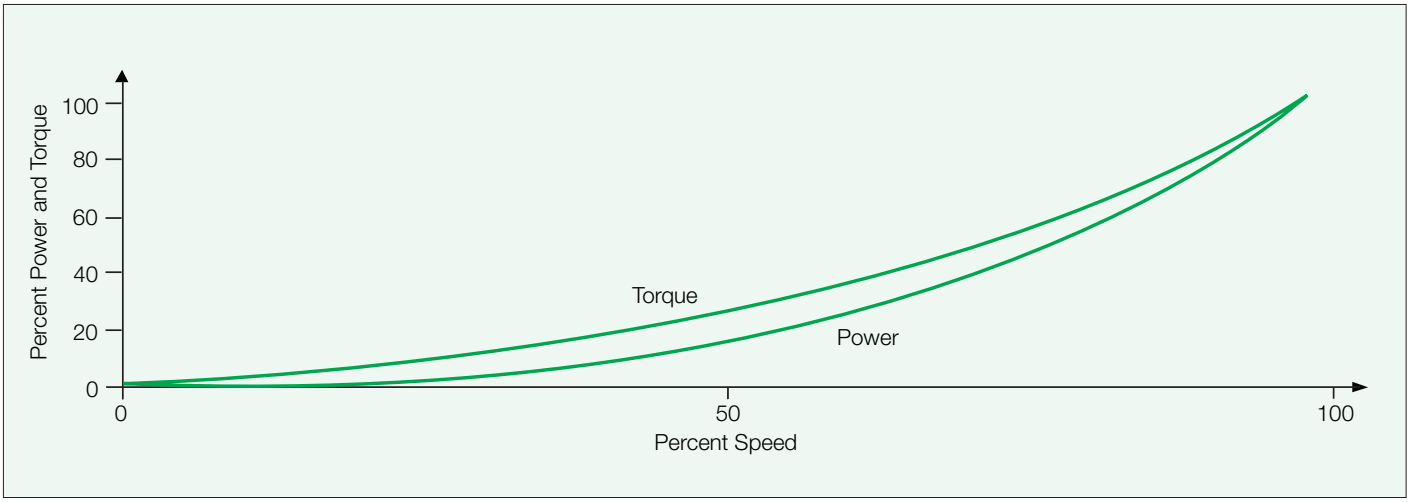
The savings derived from the Affinity Laws should be treated as theoretical. In real applications the particular characteristics of the system will determine the actual savings achieved. It is, therefore, important to have experienced appraisal engineers inspecting and analysing the system so that a realistic saving figure is produced. Short payback times are often achievable but they must be realistic.

Benefits using variable-speed drives (VSDs)

Reducing the speed of a pump or fan with a VSD will often save 30-50 percent of the energy, while savings of up to 80 percent can be achieved in some cases.

In reality, very small speed changes can yield large energy savings. These speed changes will often be totally unnoticeable in the overall process (10 percent speed reduction [5Hz] = 27 percent energy saving).

The VSD can also match the exact needs for cooling or lubrication or airflow or pressure, thus allowing the process to perform optimally, increasing product quality, and reducing wear and tear.



Constant-torque load

Typical constant-torque load applications include:

– Air compressors
– Hydraulic power packs
– Conveyors
– Mixers
– Positive displacement pumps
– Rotary kilns
– Agitators
– Crushers
– Surface winders

How it works

With such applications the torque requirement throughout the speed range is the same. The power change is proportional to the speed of change.

Power (P) = Torque (TQ) x Speed (S)

Benefits using variable-speed drives

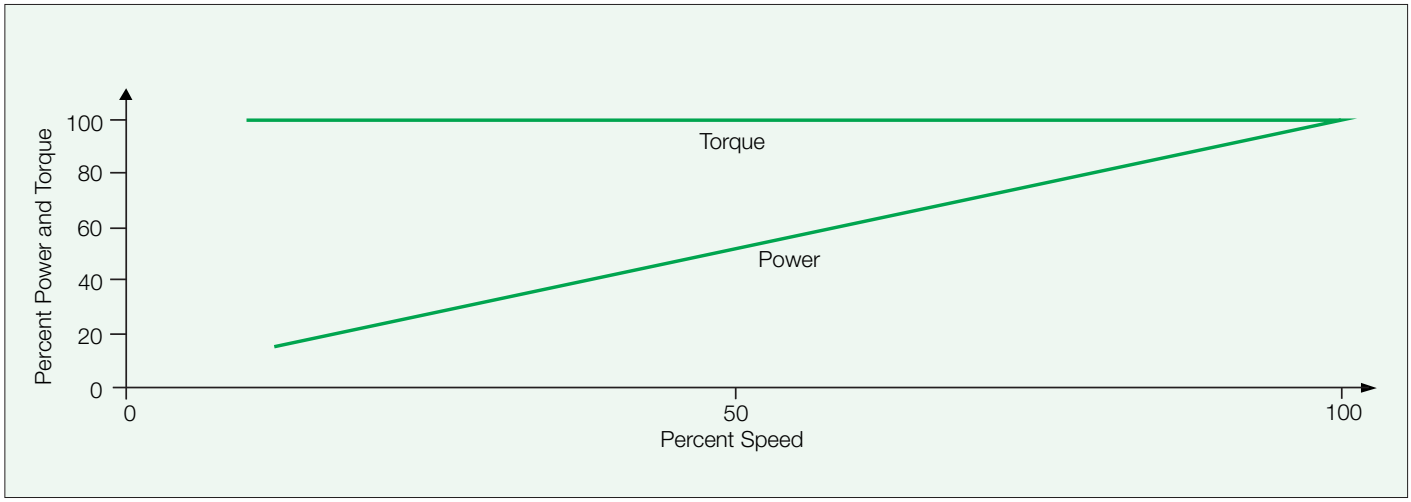
While there are still savings to be made, they are not as dramatic as those seen in variable-torque applications. However certain applications such as air compressors and hydraulic power packs can achieve significant savings depending upon the on-load and off-load cycle times.

The main benefits of VSDs in these applications are precise process speed control and starting/stopping with controlled acceleration/deceleration using modern motor algorithms. Providing only the required air or hydraulic pressure reduces waste and running costs as opposed to on/off with fixed speed motors.

As well as reducing the effects of over-sizing, usually inherent in the design of the system, improved control reduces mechanical stresses and, therefore, maintenance requirements, giving higher production availability and lower lifetime costs.

Conveyors of all shapes and sizes can benefit from the use of variable-speed drives.

On an extruder, for example, improved accuracy of motor control and speed regulation could result in higher quality output, while reducing mechanical stresses and improving machinery lifespan.



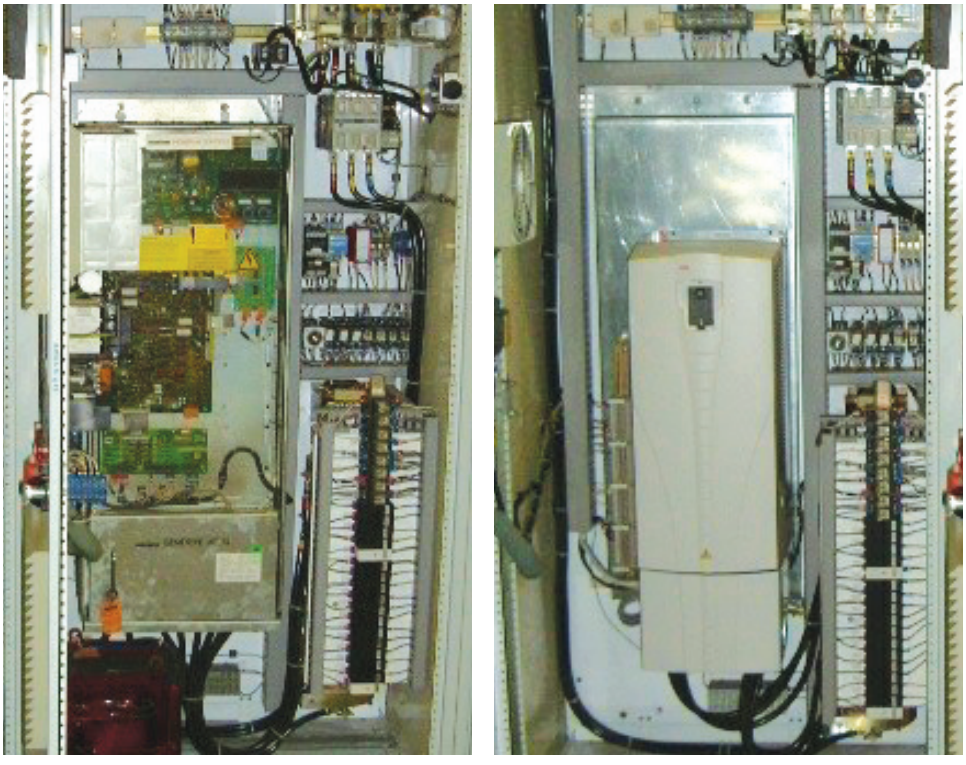
3. Enabling new motor technology

VSDs take advantage of new, higher efficiency motor designs. The synchronous reluctance motor (SynRM) has no rotor losses, so the motor operates with 40 percent lower losses compared to a conventional induction motor. The lower losses allow the motor to be constructed in two variants: an IE4 super premium efficiency motor which matches conventional motor frame sizes, and a High Output (HO) design which is two frame sizes smaller for the same power. Both motor designs are significantly lighter and quieter than conventional squirrel cage designs.

Replacing existing drives and motors

If an average 1980s AC motor and VSD are replaced with an ABB high efficiency motor and state-of-the-art VSD, the payback time due to lower energy consumption could be less than 12 months and up to 36 months, depending on annual operating hours, energy price and the utilisation of today's drives technology, such as flux optimisation. Replacing old drives and/or motors brings many other benefits:

- More energy efficient - today's motors are approximately three percent more efficient than their predecessors.
- Better motor control – today's drives enable higher quality output waveforms, reducing motor losses by 10-15 percent.
- Lower running costs - it is highly likely that older motors and drives from any manufacturer will start to suffer breakdowns. While ABB and its partners offer a full spares and repairs service, it could be beneficial to cut your maintenance bill and replace the motors and drives. This has the advantage of extending the warranty.
- Greater reliability - lower component count means new drives last longer and help reduce downtime. Likewise, high efficiency motors tend to run cooler, thereby extending the life time and intervals between maintenance.
- Smaller size - a new drive delivers much more power, size for size. A modern ABB drive can, in some cases, be just one third of the size of a drive only a few years older. This saves valuable space when replacing the drive.
- Latest technology - users with new drives and motors can benefit from recently introduced features, for instance flux (energy) optimisation, which can reduce the energy consumption in pump and fan applications by 10 percent, as well as offering several communications protocols such as Modbus and Profibus.



Before | After

The new drive on the right saved installation space compared to the old drive on the left. Severn Trent Water is saving thousands of pounds in energy and maintenance costs since replacing two old drives from the 1980s with the latest ABB standard drives at its Ladywood sewage pumping station in Ironbridge, Shropshire. Fitting state-of-the-art variable-speed drives in place of ageing ones gives energy savings as well as improved reliabilty.

4. Typical applications that benefit from variable-speed drives

The following highlights a selection of constant-torque and variable-torque applications and shows where the main improvements in energy and productivity can be made.

Application	Energy efficiency benefits	Productivity improvement benefits
Pumps (variable-torque load)		
VSDs transport liquids safely by ensuring the motor driving a pump is running at the correct speed to maintain a safe pressure in a pipe. VSDs benefit all types of pumps including circulating water in HVAC systems, boiler feed-water pumps, industrial process cooling pumps, chilled water pumps, wastewater treatment and clean water applications.	In the UK, pumps use a total of 20 TWh/ annum, responsible for the emission of 2.7 million tons of carbon per annum. Pumps represent the largest single use of motive power in industry and commerce. Since pumps are variable-torque, they benefit from the largest savings when speed control is employed.	VSDs improve system reliability, simplify pipe systems by eliminating the need for control valves and by-pass lines, provide soft-start and stop thereby reducing wear and tear on the motors, and reduce leaks caused by pressure surges. All this leads to lower maintenance and life cycle costs and increases plant availability.
Fans (variable-torque load)		
There are many types of fans used to move air and gasses in industrial applications, such as centrifugal and axial. Whether belt driven, or direct coupled, many can benefit from VSD control to save energy, improve processes and reduce maintenance costs.	Often air flow is controlled via a mechanical damper in the duct work, either before or after the fan. The type of damper is important as different designs effect the fan performance and load. In most cases large savings can be achieved through VSD control. Where no control is present or required, savings can still be made by reducing oversizing in the design and applying the VSDs energy optimisation feature, reducing motor losses and saving further energy.	Whether belt driven or direct coupled, VSDs can reduce maintenance costs through soft-start control of the fan. Belt or gearbox wear and tear are significantly reduced, improving system reliability and availability. Where large fans 'windmill' while out of service, VSDs can catch these, slow and stop them in a controlled manner, rather than trying to start direct-on-line (DOL), which can cause huge stresses on mechanical and electrical components, often leading to premature failure.
Air handling units (AHUs) (variable-torque load)		
Fans in air handling units (AHUs) are often driven by the motor via a pulley system. The motors are oversized for blocked filter conditions and maximum room occupancy on hot days. The motors run at full speed and, in some systems, the air flow is controlled by mechanical dampers.	Installing a VSD on the supply fan and one on the extract fan allows the AHU to be run according to demand, bringing significant energy savings. The fan obeys the affinity laws (see pages 6 & 7) so large savings on power are achievable with even small changes in speed. Installing a differential pressure switch across the filter will allow fan speed to be modulated to continually provide a constant airflow as filters become blocked. This will allow the motor to run at its most efficient speed.	When an AHU no longer runs at full speed but is varied using a VSD, the lifetime of the fans' drive belt is increased; there is less wear and tear on bearings through soft-start/ stop; automatic belt monitoring which increases intervals between maintenance and gives early warning of breakages; lower noise levels and longer intervals between air filter changing (lower speed = less dirt). Outputs from the VSD can be configured to provide condition monitoring of filters to give indication of when a filter requires replacement or cleaning.
Compressors (constant-torque load)		
VSDs allow air compressors to manage pressure precisely and deliver exactly what the application needs, while compensating for line losses and coping with variability of demand. If several compressors feed into a single header, it is common to see several units run at fixed speed delivering base or minimum load while a variable-speed unit caters to process variation. Consider seeking advice from an independent compressor expert to ascertain the suitability of the compressor make, model and type for VSD conversion.	Typically one-fifth of a factory's energy bill can be attributed to the production of compressed air. Using a VSD to control the speed of a compressor saves energy compared to a fixed speed equivalent. It can be economically viable to fit VSDs to air compressors where the average loading is 75 percent of capacity or less.	A VSD reduces power surges caused during the starting of the AC motors. Air system leaks are difficult and costly to repair and maintain. A VSD driven compressor delivers a more constant pressure, often allowing the overall system pressure setpoint to be reduced. This can save further energy and reduce wasteful leaks in the pipework, caused through constant pressure fluctuations.
Hydraulic power pack (constant-torque load)		
Hydraulic power packs provide motive power for production machinery to carry out tasks. However, when the hydraulic pressure is not required, the oil is recirculated back to its reservoir tank, while the motor is still running at full speed. Systems with longer idle times provide the greatest savings.	Savings can be made by matching the output of the hydraulic power pack to the system requirements and reducing motor speed when in recirculation	Hydraulic power packs require high levels of maintenance due to the vibration and stresses involved in handling high pressure oil. VSDs help reduce maintenance by smoothing out pressure changes and improving system control. This leads to greater reliability and system availability.

Application	Energy efficiency benefits	Productivity improvement benefits
Chillers (constant-torque load)		
To reduce operating expenses, one of the most commonly replaced items of equipment in an existing HVAC plant is the packaged chiller (or chillers), either reciprocating or centrifugal. Old chillers tend to be inefficient and can suffer frequent breakdowns, with spare parts being difficult to obtain. In many industry sectors, such as food & beverage, refrigeration is often one of the largest energy costs on site. Screw compressors often run at fixed speed with mechanical slide valve control to regulate capacity.	Installing a VSD allows operation of the compressor at reduced speed. Opening the slide valve to 100 percent can provide significant energy savings.	VSDs improve chiller compressor efficiency, reducing maintenance requirements and increasing plant lifespan through reduced mechanical load.
Chiller condenser fans (variable-torque load)		
Most cooling towers associated with chiller plants are designed and manufactured to meet anticipated peak heat loads at worst case wet-bulb conditions. As such, the majority of a tower's actual life is spent operating at much lower than design duty. Operating at reduced heat loads and wet-bulb temperatures allows the operator to save fan energy by reducing fan speed and stop/start cycling.	Concentrating on reducing fan speed alone does not always maximise total cooling system energy savings. Using a 'floating head controller' to regulate fan speed to optimise condenser performance maximises the system energy savings by the corresponding reduction in compressor load. Where multiple fans are used, further savings can often be realised by operating all fans at reduced speed and utilising a greater condenser area than by switching individual fans on and off.	VSDs benefit the life of the mechanical components, such as drive belts, with fewer and smoother starts and built-in motor diagnostics. They also reduce noise pollution from the condenser fans which can be particularly beneficial during night time operation. VSDs benefit condensers operating in cold climates, where airflow can be modulated to minimise icing and reversed at low speed for de-icing cycles.
Cooling tower fans (variable-torque load)		
Many cooling towers installed across industrial plants are used to cool particular processes involved in the manufacture of product. As such they are often overlooked when plant efficiency is considered. Traditionally there may be several fans, controlled in cascade and brought on-line dependent upon water temperature. However, the cooling water may still be pumped across all the cooling elements of the tower, even when the associated fan is not running. In effect the majority of the heat load is handled by only part of the available tower capacity	Fitting VSDs can achieve significant savings by running all the fans constantly and controlling speed depending upon water temperature. Even though there are more fans, they are running considerably slower and further down their torque curve, meaning as a whole system, total energy is reduced. Utilising a VSD's built-in parameters, such as 'sleep function' can yield further savings as the drive constantly monitors the water temperature. However, the fans are only run when necessary and at the most efficient speed to maintain the target water temperature. Systems with larger circulation pumps may benefit instead by fitting VSDs to the pumps and controlling water flow, especially where existing throttle control valves are currently used.	Larger cooling tower fans are often driven via a gearbox or belt drive, both of which are costly to maintain. The inherent soft-start capability with a VSD eliminates these issues, improving reliability and increasing gearbox and belt lifespan. Running all the fans continuously, but at a slower speed, eliminates the uncertainty of whether standby units will start following long down periods. These motors are often in exposed environments and system reliability is a constant conern for site maintenance staff. Directly controlling the cooling water temperature through PID control may also yield product quality benefits as spikes in temperature can be avoided.
Conveyors (constant-torque)		
Controlling conveyors brings its own challenges and VSDs are ideally suited to meeting them. VSDs ensure that a conveyor is moving at the right speed, preventing objects falling from it, being damaged or causing a hazard.	VSDs help to save energy and can make a significant contribution by allowing processes and machines to run at exactly the right speed, saving electricity and cutting running costs. High peak starting loads can be reduced with VSDs as the drive can provide true soft-start control of the loaded conveyor.	VSDs are mainly used to improve control by matching the speed to the production needs, either manually or with the use of feedback devices. Long or heavily loaded conveyors can require very high starting torque. VSDs can overcome this problem by ramping up the speed gradually, vastly reducing shock load to the mechanical gear train. In this application reducing the costs and downtime associated with belt or gearbox damage often far outweighs the energy saving potential.
Control valves and vanes		
Installing control valves in the chilled water lines of each air-conditioning unit or using bypass dampers across the cooling coils and controlled through a space thermostat, are inefficient and wasteful ways to control cooling capacity.	Of the total power consumed by a typical office building, a central air conditioning plant alone consumes approximately 60 percent. Replacing control valves with VSDs can reduce energy from 20 to 80 percent.	Using controlled speed on pumps or blowers also allows users to eliminate control valves and vanes, allowing a reduction in moving parts that can give higher system reliability and lower failure rates.

4. Typical applications that benefit from variable-speed drives

Application	Energy efficiency benefits	Productivity improvement benefits
Dust extraction		
Often a plant may have more dust extraction capacity than might be needed on a particular shift. This can waste energy. Installing VSDs to take control of the extraction system can yield large savings. Many systems have bag filters to allow collection and disposal of the dust.	Installing differential pressure monitoring across the bag filter allows motor speed to be regulated as the filters become blocked, ensuring the correct airflow while saving energy	VSDs alleviate excessive wear of bearings and drive belts, reducing maintenance requirements and downtime. The VSD can also be configured to provide indication of belt failure and maintenance triggers.
Extruders (constant-torque load)		
Specific AC and DC motor and drive solutions can be applied dependent on the type of plastic product being produced as well as the type and size of the extruder. Motor types typically used include AC induction (enclosed or laminated frame designs), DC, servo or permanent magnet. Extruders can run at a fixed or uncontrolled speed, but variations in line voltage or frequency will affect screw speed and therefore product geometry.	Savings of up to 40 percent can be achieved by replacing traditional control techniques such as eddy current couplings with VSDs. Energy savings can be made through improved control and speed regulation, which often results in higher quality output.	Converting DC driven extruders to AC has many benefits including reduced maintenance, increased availability and higher efficiency. Modern AC drives and induction motors are entirely suitable for these demanding, high torque applications. DC machines often require regular intervention to clean and maintain brushgear, which is costly in maintenance and production terms. Many conversions can be justified in the reduction of these costs alone, as the brushgear is not required in the AC solution. VSDs improve extruder operation by bringing the unit online at very low revolutions per minute before ramping it up, thereby eliminating the need to shut down and clean out the unit after long idle periods. This procedure saves maintenance labour costs. Product consistency also improves because the VSD can adjust batch speed to continuously maintain desired temperatures and also provide dynamic torque limit for protection of the extrusion screw without speed or position feedback devices, resulting in lower initial investment costs and higher operational reliability.
Injection moulding machines (constant-torque load)		
VSDs reduce operational costs by cutting energy consumption, while also addressing some environmental concerns surrounding hydraulic drive systems. VSD controlled machines tend to be quieter, faster and have a high accuracy.	Up to 70 percent of the electricity consumed by injection moulding machines is never used in the moulding process which can lead to excessive heating and cooling of the machine's oil, noise and general wear and tear of the hydraulic system. VSDs save energy and help cool the hydraulic oil, thereby prolonging the lifetime of the injection moulding machine.	Lower working noise and oil temperature are significantly reduced. Smooth soft-start protects the electric motor and prolongs service life. There is reduced impact of clamping/ opening the mould, thereby extending the machinery and moulds service life. The VSD provides comprehensive protection of the electric motor's overvoltage, overcurrent and phase loss.
Prover, oven and cooler		
In an industrial bakery the prover, oven, cooler and associated steam boiler plant typically account for between 50 and 60 percent of the total carbon emissions, with the oven using the most energy, typically accounting for between 35 and 45 percent of the total site carbon emissions. VSDs can ensure that an oven is at the right temperature to achieve the correct quality of a heat treated product.	Provers and ovens require the speed and temperature to be maintained accurately and with relative compensation for ambient conditions. Significant energy saving is available with VSD controlled fan and conveyor systems.	VSDs help optimise the speed of conveyors bringing a high degree of accuracy and repeatability for produce entering the ovens. In addition they can control various aspects of the system including, baking times, loading and unloading, temperature settings and fan optimisation. Innovative opportunities include use of sensors in extraction linked to VSDs that can automatically vary the fan speed with the cooking load.


ABB
Remote
1141E01
18.8 Hz
Output frequency
Hz
16.78
Motor current
A
5.56
DC voltage
V
550.27
Options
15:19
Menu
?
Stop
Loc/Rem
Start

5. VSD features that enhance energy efficiency

Flux optimisation - energy optimisers
ABB's motor control platform, direct torque control (DTC), features energy optimisation which minimises motor losses. The result is additional energy saving compared to a standard VSD on pump, fan and other centrifugal applications. The magnetic flux within the motor is continuously matched to the torque required for a given motor load. This reduces motor thermal and electrical losses.

Energy monitoring built-in as standard
Users can identify the energy they are saving compared to the application being controlled direct-on-line. The savings are displayed on the keypad in local currency; in tonnes of CO_2 saved; and in kWh and MWh so information can be used to provide a picture of an applications performance. This data can also be exported via fieldbus.

DTC – intelligent motor control
Fourth generation direct torque control (DTC) algorithm with improved torque and flux control, giving better control performance and increased productivity, while reducing energy use.

Real-time clocks
The process can alter depending on the time of day, allowing easy automation of processes and reducing energy usage.

Internal fans
Internal cooling fans slow down, minimising energy used by the VSD whilst operating.

Improved power factor
VSDs that are near-unity true power factor (at least 0.95) offer best reduced energy. The efficiency of the electrical supply is increased and more of the electrical current drawn is used to drive the load. Many energy companies charge for poor power factor.

Harmonics
Drives with a lower harmonic signature help to reduce energy wasted in the electricity network supplying the driven loads. ABB drives include high performance harmonic suppression as standard. Low harmonic variants are available.

Regenerative or overhauling loads (renewable energy)
Options are available where the rectifier stage in the VSD is similar in design to the inverter stage, making it possible to return energy recovered from electrical braking of the load to the mains supply. This is more energy efficient than using a braking resistor to dump the recovered energy. Cost savings can be achieved and in many overhauling applications (water running downhill, strip being 'pulled' or wind turbines etc) the additional cost of the 'active rectifier' is justified. These designs also induce less harmonic interference on the electrical supply.

5. VSD features that improve productivity

Extensive parameter set for flexible programming
Drives contain many useful programmable features which allow the process to be controlled and tailored perfectly.

Motor and load protection
This helps prevent costly downtime and increases productivity. Load characteristics can be programmed into the VSD to provide under-and over-load monitoring and protection.

Catching spinning loads and reversing
With a rotating motor, the inverter is first started with a reduced voltage and then synchronised to the rotating rotor. After synchronisation the voltage and speed are increased to the corresponding levels, reducing mechanical and electrical stress.

Soft starting
When a VSD starts a motor, it applies a very low frequency and very low voltage to the motor, gradually ramping these up at a controlled rate. This improves control and torque response compared to traditional soft starters, reducing stress on the mechanical components, improving equipment availability and reducing maintenance.

Stall detection
Supervision limits can be adjusted and you can choose how the drive reacts to a motor stall condition.

Communications and remote monitoring
VSDs can be interfaced to wider process control systems such as SCADA systems and building management systems (BMS) using simple plug-in option modules.

Inputs and outputs
Different kinds of process information can be fed to the drive to control the motor. Load can be limited to prevent nuisance faults, thereby protecting the machine. I/O can be used to gather telemetry from the local application and fed back over fieldbus making installation cheaper.

Torque boost
This is necessary if a very high starting torque is required. Provides automatic increase of starting current for loads with high starting torque.

Load fault detection
An under-load can indicate a broken belt while an over-load can indicate blocking filters. Displays on the drive panel can be used by the operator to highlight their own messages.

Power loss ride-through
If the incoming supply voltage is cut off for short periods, the VSD continues to operate using the kinetic energy of the rotating motor.

Maintenance triggers
Maintenance counters and triggers monitor the motor and the process, thereby giving early warnings.

6. Financing your investment

Financing for energy efficient equipment is available through the Carbon Trust. Organisations can take advantage of leases, loans and other financing options to help make paying for an energy reduction programme simple and affordable.

The Carbon Trust will consider any energy saving project and the way the financing is structured, the investment will pay for itself through the energy savings the new equipment achieves.

The financing packages are designed to allow energy efficient equipment to be purchased and paid for through the savings achieved as a result of reduced energy bills. The scheme is open to all kinds of businesses and organisations, with financing available from £1,000, and there are potentially no upper limits. If a business takes out financing to fund the purchase of a variable-speed drive and high efficiency motor on an application with long running hours and large potential energy savings, they will be able to cover the cost of the equipment within a short time period (usually under 12 months).

Did you know?

Using a variable-speed drive to reduce a conveyors speed from **100 percent** to **80 percent**, saves **20 percent** in energy. But with a pump or a fan, the same speed reduction means the saving is closer to **50 percent**.

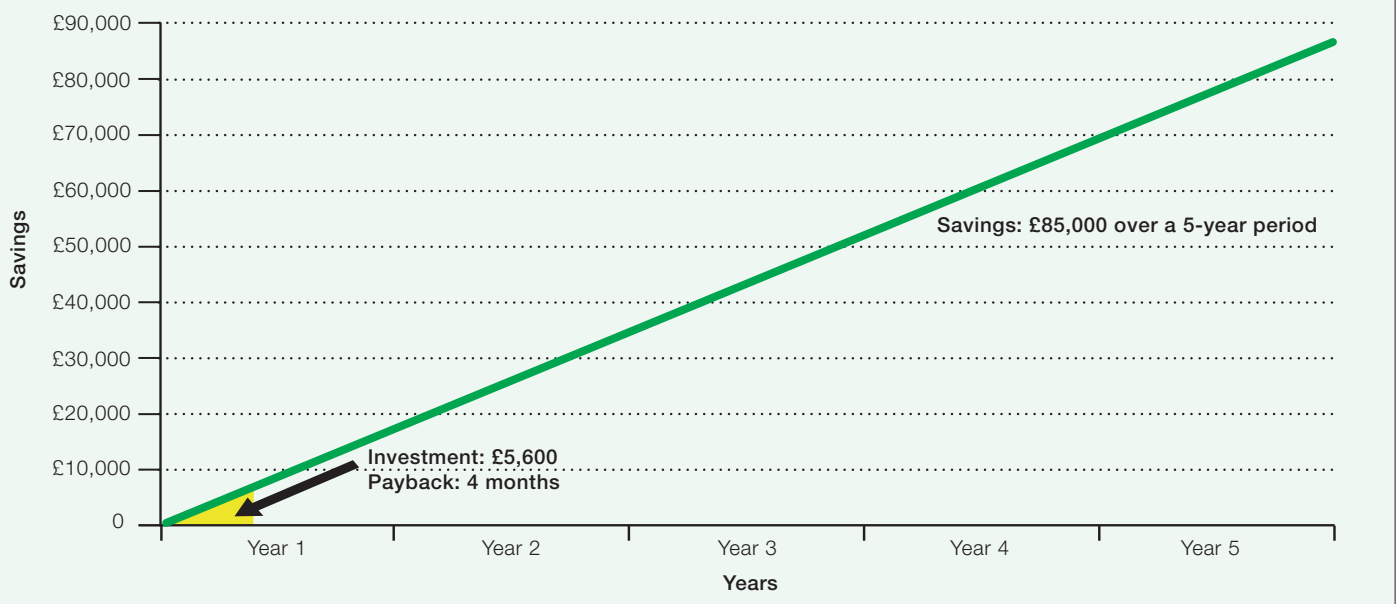
You can work out your potential savings using ABB's free energy saving calculator available at www.abb.co.uk/energy. Click onto the Online Calculator section on the right of the web page.

DriveSave

DriveSave is a risk and reward scheme for large energy consumers that identifies and guarantees energy saving from multiple motor-driven applications across a site. DriveSave is aimed at those industry sectors which are willing to make significant investment to achieve targeted savings of over 1000 MWh's per year.

Even projects with less spectacular energy saving figures, for instance: drive applications with shorter running hours; replacement of an old drive with a newer model; or investments in energy efficient motors, are well worth looking into.

In addition to the guaranteed energy savings, the scheme offers installation and commissioning of the variable-speed drives and an optional extended warranty and preventive maintenance programme.



After installing a variable-speed drive energy spend falls dramatically.

7. Energy Efficiency and Productivity Improvement Team

ABB's Energy Efficiency & Productivity Improvement Team is equipped to show industrial and commercial premises, in just half-a-day, ways in which they can improve their energy use or productivity performance.

Following the energy & productivity appraisal, ABB offers advice on replacing drive or motor components as part of a preventive maintenance plan. It can also advise on upgrading entire systems to the latest technology or to extend the functionality of existing drives and motors.

Other options include retrofitting existing drives with modern technology or recycling of all removed drives and motors to the latest legislation.

ABB's expertise in motor-driven applications means it can easily assess the condition of the installed base of motors or drives and make educated or calculated assessments of what is needed.

ABB also engages with the plant's process engineers to determine the exact design criteria for the various processes. This gives ABB a clearer understanding of how the process is meant to operate and its critical design operating points, thereby ensuring that the correct motor and/or drive is selected.

Assessing a process for its speed control potential will often highlight other areas where a VSD could play a role in modifying the operation of the process to make it run more efficiently saving time, resources or wastage. ABB engineers have the skill and experience to analyse both aspects.

ABB's Authorised Value Provider network brings together knowledge and expertise to help you find the right motor-drive solutions for your business. And with its app, you can now access the power of that network from the palm of your hand.

8. Energy and productivity appraisal process

1. Outlining the scope of supply

An ABB engineer or one of ABB's Authorised Value Providers visits the end-user to get an understanding of their facility including location of the applications, an inventory of motors, any health and safety restrictions as well as anything unusual that might affect the energy profile.

The energy part of the appraisal focuses on processes and applications where significant energy savings can be made. These will most often be variable-torque applications that obey the cube law, running continuously and where flow is controlled by a mechanical means such as valves or dampers. Air compressors and hydraulic power packs will also be included. The productivity part of the appraisal will look at both variable and constant-torque loads, their control methods and where improvements such as reduced maintenance, increased availability or product quality can be made.

2. Monitoring and data collection

ABB will spot applications that may be running inefficiently. The engineer will look not only at fixed-speed motors but also any drives currently being used, to see if the application is running at maximum efficiency.

The selected applications may be monitored in order to accurately determine which applications are consuming the most energy or operating inefficiently.

This stage may be performed over a seven-day period, to gain a complete picture of the plant's typical energy use and productivity profile over a working week.

3. Data analysis

The findings are analysed and potential savings identified using dedicated software. The findings are methodically presented, with tables and graphs being created to help identify where savings are likely to arise.

Among the data available includes present energy usage, areas of potential savings, payback time if an investment is made in drives and/or motors and carbon dioxide emission reduction.

Variable-speed drives could help unlock hidden energy savings and productivity improvements throughout a plant, process or building.

4. Recommendations

An action plan is prepared, comprising an Executive Summary and a detailed engineer's report, highlighting applications that can benefit the most from using VSDs.

The figures will be translated into monthly savings, and there will be detailed recommendations for fitting particular drives and motors, including costs and payback times.

As part of the new Energy Saving Opportunity Scheme (ESOS), those companies falling under the scheme are required to assess their energy usage and build an evidence pack of energy saving opportunities.

The ABB Energy & Productivity Appraisal report can be used to assist end users in identifying potential energy saving opportunities and satisfy the requirements of ESOS

5. Implementation

Using the recommendations from the appraisal, ABB can identify the correct drive and motor for the respective application. ABB can help with the installation and start-up or commissioning of the drive and motor. Our country-wide network of dedicated ABB Authorised Value Providers are fully trained and experienced in these services.

6. Verification and follow-up

Once new equipment is fitted, it is normal to track the actual savings against the predictions shown in the engineer's report.

This will also help justify the investment in drives and electric motors.

ABB provides life cycle services to ensure that the drive or motor is looked after throughout its working life.

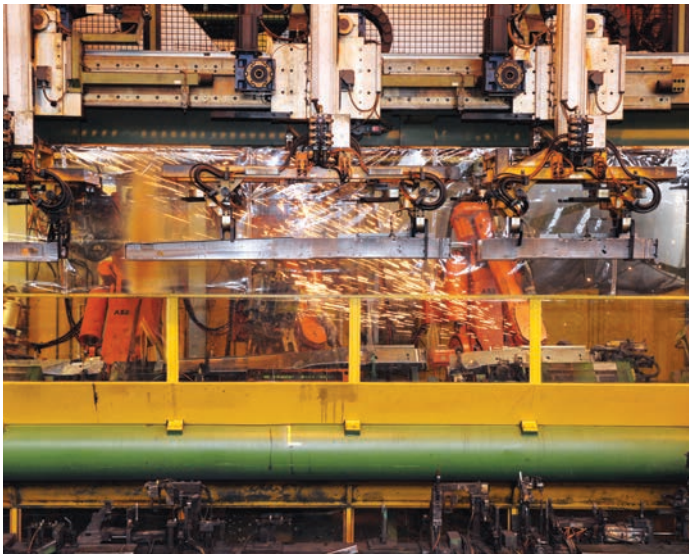
For example, during the operation and maintenance stage, ABB can continually monitor the energy consumed by the motor and compare this with the original specification.

It may be that the process is changing or that the drive or motor is at a specific stage in their maintenance schedules. Whatever, the reason, any deviation can be adjusted to ensure that the drive and the motor are always performing at their optimum.

A selection of tools are used to measure and monitor potential energy savings, before, during and after an energy appraisal.

9. Energy efficiency in practice

GKN



Application: Air handling units

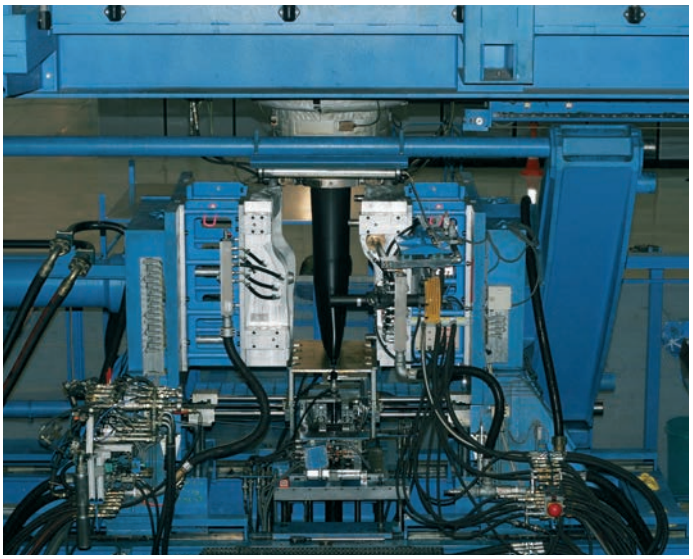
Challenge: Save energy costs on fume extraction system

Solution: GKN's production area for Toyota chassis is divided into two sections, one for the Auris and one for the Avensis. Each line has an air intake and air extraction fan, driven by motors of 55 kW and 30 kW respectively. These were oversized for the applications and were not drawing their rated power. In a two week trial, ABB installed two temporary drives of 55 kW and 30 kW and turned the speed of the motors down until they were extracting a sufficient air volume to maintain the proper air quality for the workers in the production area.

The optimum speed was found to 42.5 Hz. This produced an average saving on power use of 55 percent, with one fan motor seeing a peak saving of 64 percent.

Benefit: Once the system was fully installed, GKN saved around £20,000 on energy costs, with a payback of around six months.

TI Automotive



Application: Granulator used to chop waste plastic for reuse

Challenge: Run at best speed to save energy but prevent jams

Solution: The granulator chops up waste HDPE trimmed from finished fuel tanks for reuse in the blow moulders. In production 24 hours a day, the granulator is only actually working for 10 seconds out of each minute.

The granulator needs to run at the correct speed to prevent chopped material jamming the mechanism.

ABB authorised value provider, Central Group, installed a hire drive on one of the two granulators for a week to prove that it would work and not cause clogging of the machine. The ABB industrial drive reduced the motor's power consumption from 42 kW to only 15 kW, a saving of 27 kW, a 65 percent reduction.

Benefit: Together with other drives applications, the plant is saving around £2,000 a month on its energy bill, some 10 percent of its total energy spend.

9. Energy efficiency in practice

Ricoh

Application: Air handling units, water pumps and compressors

Challenge: Reduce energy bill of £1.25 million per annum

Solution: ABB authorised value provider, Central Group, initially trialled two ABB drives, one on a pump and one on an air handling unit. The results were very favourable, encouraging Ricoh to evaluate all possible motor-driven applications on site for their energy saving potential.

Some 90 percent of the originally identified applications have now been retrofitted with ABB drives. A total of around 70 drives run a large variety of applications around the site, with an average payback time of around six months per installation.

Benefit: Ricoh is saving £100,000 a year, as well as improving its process control

Manchester Airport

Application: Air handling units

Challenge: Improve efficiency of air handling to cut energy use and CO_2 production

Solution: ABB authorised value provider, Quantum Controls, carried out extensive trials on air handling units (AHUs) 48 and 49, which serve the Terminal 1 check-in hall. ABB high efficiency motors were installed and resized to a more suitable frame size, giving energy savings of five per cent.

The trial also installed ABB drives for HVAC on the two AHUs. The drives maintain the desired air flow by measuring it in the supply air duct via a pressure difference sensor.

By reducing the set point frequency from 50 Hz to 40 Hz, it was shown that savings of 50 percent could be made with no noticeable change in the airflows provided by the AHUs.

Benefit: Using high efficiency motors and inverter drive elements on 95 AHUs across all terminals, the airport is saving approximately 4,000 MWh and around 2,200 tons of CO_2 a year.

Tata Steel

Application: Extraction fans on steel casting plant

Challenge: Cure motor ‘run-on’ issues and save energy

Solution: The extraction plant is used to remove fumes produced by the two casting machines and two ladle arc furnaces.

The original installation used four 3.3 kV motors: two 650 kW and two 410 kW. Due to motor limitations the fans were restricted to four starts per hour, as additional starts would risk damaging the windings. The motors would be forced to run-on for 15 minutes even when extraction demand was low, wasting a lot of energy.

The project was carried out by ABB system integrator Drives and Automation at Tata Steel’s Aldwarke Bloom Caster complex in Rotherham, South Yorkshire. Drives and Automation replaced existing fixed speed direct-on-line motors in the plant with low voltage motors, controlled by four ABB low harmonic variable-speed drives, two at 400 kW and two at 570 kW.

Benefit: The company is saving in the region of £250,000 a year on energy costs. It has also reduced wear and tear on the motors and duct work and achieved a less noisy environment.

Severn Trent Water - Wanlip

Application: Dry well flow pumps

Challenge: Investigate and cure low flow rates in pumps

Solution: ABB authorised value provider, Sentridge Control, suspected the low flow rates were due to ragging. It suggested installing 75 kW ABB industrial drives on all the pumps, each equipped with ABB pump clean software.

The pump clean software module performs a number of cleaning cycles every time the pump starts. Each cycle consists of a series of rapid ramp-ups in both forward and reverse directions. Taking one to two minutes to complete, the cleaning cycle removes the debris from around the pump volute, preventing it from entering the pump and blocking it. The cleaning cycle is also started when the drive detects a drop in pump efficiency.

Benefit: As well as curing the flow problem, the new installation allows Wanlip to achieve its pumping requirement using only two or three pumps instead of all six, achieving an energy saving of approximately £100,000 per year.

9. Energy efficiency in practice

Aberthaw Power Station

Application: Oil injecting lances for lighting boilers

Challenge: Make it easier to achieve correct, safe air flow rate

Solution: The flame size is dependent on the oil-to-air ratio – too much air and the flame will blow out, while too little air and there is the danger of too much oil entering the boiler, causing potentially dangerous combustion conditions.

ABB authorised value provider, APDS recommended 7.5 kW ABB general purpose drives to control the combustion air flow. 32 ABB drives were installed on particular oil injecting lances with a plan to install 16 more, their location depending on the required oil flow rate at certain points on the boiler.

The drives can run the motors at either of two speeds. 50 Hz corresponds to the high or normal flow rate, which is used for lighting the boiler. The 35 Hz speed is used to maintain a flow rate that sustains the burn.

Benefit: As well as saving £350,000 on oil costs, the power station anticipates that savings could rise even further as oil prices escalate.

Sandcastle Leisure Centre

Application: Water circulation pumps

Challenge: Need to improve energy efficiency of pool installations

Solution: ABB drives distributor Radway Control Systems (RCS) carried out an energy appraisal, connecting variable-speed drives to the pumps and looking at the energy use both before and after they were connected. The pumps were originally used in a two duty, two standby configuration, with peak periods using a three duty, one standby configuration. RCS found that running costs were nearly £33,000 per annum. Following connection of four ABB variable-speed drives, the circulation system was run in both a three pump and four pump configuration.

Benefit: An original power consumption of 34.8 kW fell to 21kW for three pumps and 17.5.kW for four pumps, giving an estimated saving of £13,000 and £16,000 respectively.

10. Productivity improvements in practice

John Baarda Ltd

Application: Tomato handling conveyors

Challenge: Co-ordinate conveyors with wrapping machinery to maximise production

Solution: The two feeder conveyors are each driven by an ABB machinery drive in master-slave configuration, with the master receiving an encoder signal from the wrapper. This ensures that the drive knows where the wrapper is in its cycle and can control the speed of the conveyor precisely to ensure the tomatoes arrive at the wrapper at the correct time. If the speed of the wrapper changes, the drive can alter the speed of the conveyor accordingly to maintain the correct timing.

Benefit: The drive based electronic control system gives an average of 70 to 80 packs per minute, compared to 60 packs per minute for mechanical systems.

GKN

Application: Walking beam

Challenge: Prevent jamming that causes stoppages

Solution: The walking beam uses a system of reciprocating parallel bars to pass wheel rims from an oil dip to a flare press. As the beam reaches top dead centre, the larger wheel rims can cause the beam to over speed and the momentum carries them too quickly towards the press. This can result in the system jamming. Estil, a systems integration company, and ABB developed a system that employed a 1.5 kW

ABB general purpose drive. At the beginning of the walking beam's cycle, the drive is started and the internal timer runs the drive for one second at full speed. After this time, the drive is switched to two thirds speed and is then gradually decelerated. The beam, carrying the wheel rim, is slowed gradually as it approaches the press. As the wheel rim reaches the press, the beam triggers a limit switch that stops the drive to complete the cycle.

Benefit: GKN has dramatically reduced the number ofstoppages and is on target to save £25,000 a year.

10. Productivity improvements in practice

Fox's Biscuits

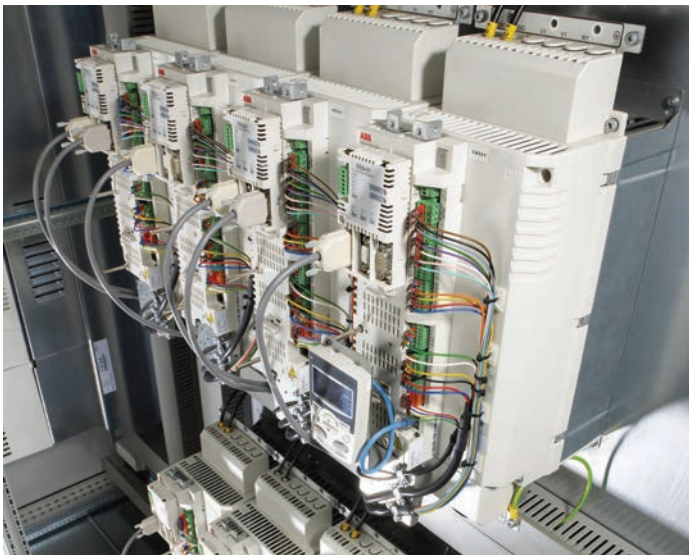
Application: Dough mixers

Challenge: Save energy on ten dough mixers

Solution: The mixers typically run 24 hours a day, seven days a week, with a duty of around 10 minutes operating time every 30 minutes. ABB authorised value provider, Halcyon Drives, retrofitted an ABB induction motor controlled by an ABB general purpose drive and compared this against one of the original slip-ring motor driven mixers.

Benefit: The ABB general purpose drive gave a cut in energy use of 30 percent. It also produced other benefits such as the ability to run at different speeds, preventing ingredients such as fruit from being crushed. Fox's can also experiment with different recipes made at different speeds, while the greater torque of the ABB motor also leads to higher reliability of the mixer.

Tathams



Application: Control system for crosslapper weaving machine

Challenge: Provide higher production speeds with improved product weight distribution

Solution: A crosslapper accepts a light weight fibre web from a carding machine and uses it to build up a heavier web in layers (known as a batt). The crosslapper overlaps the layers by means of a complex arrangement of conveyors and reversing mobile carriages.

The new control system uses ABB motion control product ACSM1 drives and ABB M1 servomotors. The system is linked to the master process control using Profibus. An ABB AC500 PLC provides positioning data to the drives which convert it into control signals to maintain the speed of the ABB M1 servomotors.

Benefit: The ABB drives allow precise positioning that is repeatable, resulting in total control of the batt profile. Using the ABB PLC and drives allows Tathams to vary the heaviness of the batt precisely, giving a much more accurate and controllable build-up of the layers. The ABB drives have also cut peak current from 60 A to 15A.

The Village Bakery (Nutrition)

Application: Depositing line for dough

Challenge: Save £10,000 running costs on new line

Solution: ABB supplied a machinery drive with high ingress protection (IP66) to replace the existing drive on the line. ABB machinery drives are specifically designed to be quick and easy to install, set up and commission. The drive was installed by The Village Bakery (Nutrition) personnel.

Benefit: Overall, The Village Bakery (Nutrition) is saving £20,000 per year, double its target. The higher accuracy of the new drive gives a 10 percent reduction in tin greasing agent, as more of the greasing agent ends up where it's supposed to. The ABB drive can also optimise the speed of the conveyor to match the size and throughput of different products more accurately, saving around 25 percent in the running costs for the line. The second depositing line has reduced downtime at the bakery, since production staff can shut down each line independently for cleaning without halting production. As the drive is protected to IP66, frequent wash downs are no problem for the ABB drive system.

Cardiff International White Water (CIWW) Centre

Application: Artificial river system

Challenge: Control flow rates to suit a range of users

Solution: Four, low harmonic ABB drives, each of 350 kW, are housed in a motor control centre, controlled by a PLC and SCADA system.

The CIWW centre takes water into a reservoir from the River Ely and uses the drive controlled pumps to raise the water from the reservoir through a height of two metres to the course. Each pump can move 4 m3 of water a second, giving a total maximum flow of 16 m3 a second.

Level sensors within the course and reservoir feedback data to the PLC, allowing it to calculate and adjust pump speed slightly to maintain the correct flow rates.

Benefit: This system of four drives gives maximum flexibility, allowing the centre to maintain standard flow rates by switching in successive pumps. This means the different levels, amateur, intermediate and expert, will match those in other similar centres.

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