100 Top Energy Saving...

...AC drive tips

ABB

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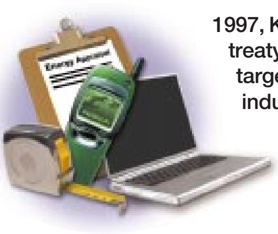
The 6-Point Energy Saving Plan

1 The **facts**

Climate change is a change in the **“average weather”** that a region experiences and includes features such as temperature, wind patterns and precipitation.

A natural system known as the **“greenhouse effect”** regulates the temperature on earth. As human societies adopt increasingly sophisticated and mechanised lifestyles, the amounts of heat-trapping gases in the atmosphere have increased. As such, mankind has enhanced the warming capability of the natural greenhouse effect. It is this that is causing environmental concern.

- **The 1980s and 1990s are the warmest decades on record**
- **1997 was the warmest year since meteorological records began**
- **The 10 warmest years in global meteorological history have all occurred in the past 15 years**
- **The 20th century has been the warmest globally in the last 600 years.**



1997, Kyoto, Japan: 159 nations negotiate a treaty setting out legally binding reduction targets averaging 5% below 1990 levels for industrialised countries for six greenhouse gases. The timetable agreed is 2008-2012

2 The **savings**

More than 65% of industrial electrical energy consumed is by the electric motor. Governments worldwide are realising the need to encourage more effective use of motors with variable speed drives.

Energy Appraisal Scheme

ABB has devised an Energy Appraisal Scheme that can rapidly determine just where and how much energy can be saved.

To discover more email: **energy@fi.abb.com** or visit **www.abb.com/motors&drives**

Replacement Drive Scheme

If you have had drives installed for more than 5 years, you could save even more energy by replacing them with the latest technology drives. ABB's Replacement Drive Scheme offers you a turnkey solution for replacing drives, giving minimum plant disruption.

3 The **finance**

There are several ways in which you can buy your AC drive and motor package, including:

- **Own cash resources**
- **Bank borrowing**
- **Hire purchase**
- **Finance lease**
- **Operating lease**

To help make the financing decision easier, ABB offers a great new way to buy a new drive, **Pay As You Save**. Pay for your new drives with the energy you save. Transfer the cost from your capital budget to your operating expenditure.

4 The **products**

ABB's high efficiency motors satisfy the market demand for reduced energy costs.

AC drives reduce energy wastage by changing the motor speed. This saves energy because the motor does not use more electrical energy than required. Technology like ABB's Direct Torque Control (DTC) brings even more savings, often up to 30%.

5 The **proof**

ABB AC drives delivered in the past 10 years for the speed control of pumps and fans alone, are estimated to have **reduced electricity consumption** by about 64,000 GWh per year worldwide. Savings have been achieved in all areas of industry in hundreds of different applications. **Ask us to find out** if your application would benefit.

6 The **Action**

Join one of ABB's cutting edge technology presentations, designed to bring you up to speed with all the latest drives and motors thinking, standards, products technology and more.

Visit: **www.abb.com/motors&drives**
Or email: **energy@fi.abb.com**

ABB AC drives save over 32 million tons of CO_2

ABB has delivered about one million AC drives during the last 10 years. Most of these units are believed to be still in use. Adding together the savings in pumps, fans, compressors, conveyors, mixers etc. results in:

- **Energy saving: 64 billion kWh/year**
- **Reduction in CO_2 emissions: 32 billion kg/year *)**
- ***Other benefits:***
  Improved process control
  Reduced maintenance cost
  Reduced reactive power

***) Calculated using an estimated average CO_2 emissions factor of 0.5 kg/kWh**

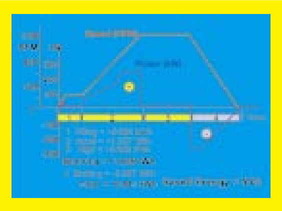
Audit by ABB representative

The energy efficiency of different motor-driven equipment in an industrial plant is not always obvious without a closer study and analysis. If the plant has no suitable personnel for doing this work, it can be carried out by a trained ABB representative, using suitable measuring equipment.

- **Benefits:**
  Outside specialist doing the work
  No drain on internal resources
  Opportunity to get financial advice

Centrifuge - regenerative AC drive instead of resistor braking

A European centrifuge manufacturer tested the energy efficiency of an AC drive with regenerative braking compared to mechanical braking. The motoring cycle, including filling, accelerating and high speed phase, consumed 1.828 kWh. During the deceleration, 0.987 kWh was fed back to the network. This saved 0.841 kWh per cycle and:



- **Energy saving: about 42,000 kWh/year**
- **Reduction in CO_2 emissions: 21,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Increased capacity

Control the engine speed instead of braking

The importance of speed control has been always clear in cars. You could imagine how difficult it would be to manage a car keeping your foot on the accelerator and control your speed with the brakes. It is much easier to change to a lower gear and reduce engine revs. With a medium size (100 kW) car:

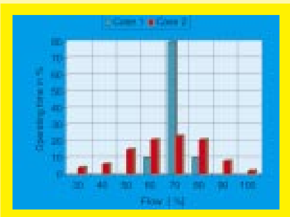
- **Energy saving: about 25,000 kWh/year**
- **Reduction in CO_2 emissions: 12,500 kg/year**
- ***Other benefits:***
  Improved safety
  Easier to control
  Reduced maintenance cost

Decanter - AC multidrive instead of mechanical control

Decanters are centrifuges used to separate solid particles from liquid or slurry. A typical decanter construction is a rotating bowl with a scroll screw inside to move the solid particles out of the bowl. By using a common DC-bus solution, about half of the scroll drive power can be saved:

- **Energy saving: about 100,000 kWh/year**
- **Reduction in CO_2 emissions: 50,000 kg/year**
- ***Other benefits:***
  Reduced maintenance cost with soft start
  Accurate decanter control
  Reduced reactive power

Considering duty cycle saves costs

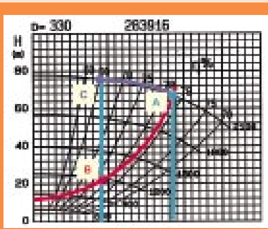


Consider the duty cycle of the controlled system. The energy saving with a variable speed drive can be compared in Case 1 and Case 2 shown in the chart.

- **Case 1 with new motor: Energy saving about 84,000 kWh/year; Reduction in CO_2 emissions 42,000 kg/year**
- **Case 2 with AC drive: Energy saving about 230,000 kWh/year; Reduction in CO_2 emissions 115,000 kg/year**
- **General rule: Install an AC drive if significant flow variations occur. Install a lower speed motor if the flow variation is small but the motor/pump is too large.**

Efficiency optimised by AC drive

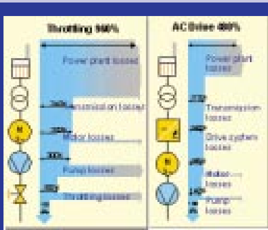
Pump or fan efficiency is usually at its highest around the rated flow and head (A = 78%). In case the flow rate is reduced by speed control, the efficiency stays close to the maximum (B = 77%). In case the flow is reduced by throttling, the efficiency is much lower (C = 60%). If we look at a 100 kW pump motor at 5,000 h/year, we get:



- **Energy saving: about 85,000 kWh/year**
- **Reduction in CO_2 emissions: 42,500 kg/year**
- **General rule: Install an AC drive instead of throttling if significant flow variations occur**

Electrical power - savings 5 times the useful energy

Use of efficient technology at the customer site can save energy, for instance 50 per cent meaning an increase of efficiency from 30 per cent to 60 per cent. Because of the low efficiency (30-40%) at the power plant, the total efficiency with throttling can be as low as 10 per cent and 50% saving improves it to 20 per cent.



- **Total primary energy savings 50%**
- **Savings 5 times the useful energy**
  Reduced losses throughout the system

Energy taxes can be avoided

Many countries in Europe are introducing some form of energy tax to encourage more efficient use of energy. In the UK, the government estimates that its Climate Change Levy will cut CO_2 emissions by 2.5 million tonnes a year by 2010. Another UK initiative to encourage the adoption of energy-saving equipment is a tax incentive - Enhanced Capital Allowances (ECA) - that will allow companies to write off 100% of the cost of certain types of equipment like AC drives.

- **Estimated energy saving: 5 billion kWh/year**
- **Reduction in CO_2 emissions: 2.5 billion kg/year**

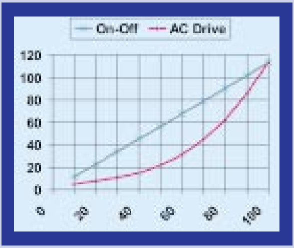
Fan speed control instead of dampers

In the past, control of air flow in ventilation systems was mainly a way to alter performance, not to save energy. Although there is a number of methods, not all are energy efficient. The most basic and inefficient way of controlling the flow rate is the adjustment of a damper in the ventilation duct. Using an AC drive with a 30 kW motor running 5,000 hours/year gives the following savings:

- **Total energy saving: 76,500 kWh/year**
- **Reduction in CO_2 emissions: 38,250 kg/year**
- ***Other benefits:***
  Soft starting, less maintenance
  Short payback period
  Better flow control

Fan speed control instead of on-off

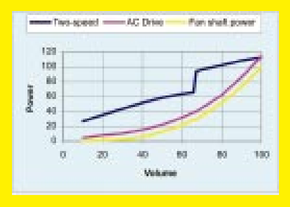
In the past, control of air flow in ventilation systems was mainly a way to alter performance, not to save energy. Although there are a number of methods, not all are energy efficient. A very basic way of controlling the flow rate is to modulate the fans on or off. Fitting an AC drive to a 30 kW motor running 5,000 hours/year gives the following savings:



- **Total energy saving: 51,000 kWh/year**
- **Reduction in CO_2 emissions: 25,500 kg/year**
- ***Other benefits:***
  Soft starting, less maintenance; much better flow control
  A more comfortable indoor climate

Fan speed control instead of two-speed motor

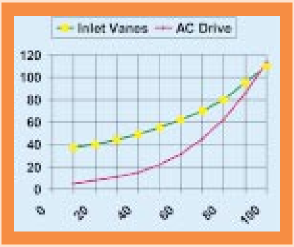
In the past, control of air flow in ventilation systems was mainly a way to alter performance, not to save energy. Although there are number of methods to control flow rates, not all are energy efficient.



A quite simple way of controlling the flow rate is the use of a two-speed motor, but it has two flow rates only. Using an AC drive instead gives the following savings for 30 kW motor running 5,000 h per year:

- **Total energy saving: 52,500 kWh/year**
- **Reduction in CO_2 emissions: 26,250 kg/year**
- ***Other benefits:***
  Soft starting, less maintenance
  Short payback period
  Better flow control

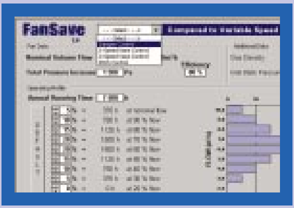
Fan speed control instead of inlet vanes



In the past, control of air flow in ventilation systems was mainly a way to alter performance, not to save energy. Although there are a number of methods, not all are energy efficient. Inlet guide vanes is a more sophisticated method for flow control, but using an AC drive instead gives the following savings for a 30 kW motor running 5,000 h per year:

- **Total energy saving: 37,500 kWh/year**
- **Reduction in CO_2 emissions: 18,750 kg/year**
- ***Other benefits:***
  Soft starting, less maintenance
  Simpler fan construction; better flow control

FanSave for fan energy calculations

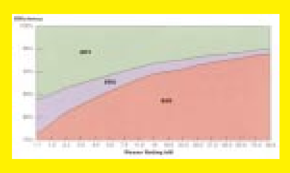


FanSave is a calculation tool for MS Excel to estimate the energy savings available when using an adjustable frequency drive. Calculations are based on typical fan operating characteristics. Results should be used only for estimating purposes. The outputs of the calculations are:

- **Total energy saving in kWh/year**
- **CO_2 reduction**
- **Total energy cost savings per year**
- **Direct payback period**
- **Net present value of investment**
- ***Other benefits:***
  Quick way to make alternative calculations
  Simple drive selection is included; available on the web

High efficiency AC motors instead of conventional AC motors

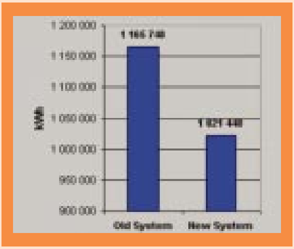
New efficiency labelling is coming into force for electric motors, ranging from 1.1 to 90 kW, used in Europe. Thus, anyone buying a motor can easily make a choice for energy efficiency. For example, 11 kW motors eff1 > 91.0% and eff3 < 88.4%. Using an eff1 motor instead of an eff3 motor in an application running 8,000 h/year gives the following savings:



- **Energy saving: 2,288 kWh/year**
- **Reduction in CO_2 emissions: 1,144 kg/year**

New AC drive and motor instead of old ones

Efficiency Tool is a calculation tool for MS Excel to estimate the energy savings when replacing an old AC drive, motor or both drive and motor with new equipment. This example is for a kiln fan case with a 315 kW motor, assuming that both the existing motor and the existing drive are replaced with new ones.



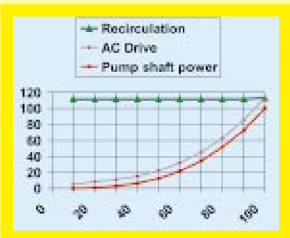
- **Energy saving: about 144,300 kWh/year**
- **Reduction in CO_2 emissions: 72,150 kg/year**
- ***Other benefits:***
  Less equipment space
  Less cooling capacity needed
  Possibility to limit the peak power

Sludge dewatering centrifuge - hydraulic control replaced with AC drive

A Finnish wastewater treatment plant modernised one of its decanter centrifuges. The hydraulic system used to control the speed difference between the bowl and the scroll inside was removed and an AC drive installed instead, cutting energy consumption by 20%.

- **Energy saving: about 226,000 kWh/year**
- **Reduction in CO_2 emissions: 113,000 kg/year**
- ***Other benefits:***
  Reduced need for maintenance
  Less space required
  More accurate control

Pump speed control instead of recirculation

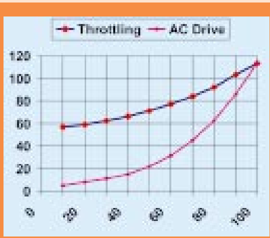


Centrifugal pumps can be controlled by methods similar to those for controlling fans. In practice, the most common method is throttling by means of a control valve. Recirculation is also used, but it is most inefficient from an energy point of view. Fitting an AC drive to the system with a 30 kW motor running 5,000 hours/year saves:

- **Total energy saving: 100,500 kWh/year**
- **Reduction in CO_2 emissions: 50,250 kg/year**
- ***Other benefits:***
  Soft starting, less maintenance
  Short payback period
  Better flow control
  Less noise

Pump speed control instead of throttling

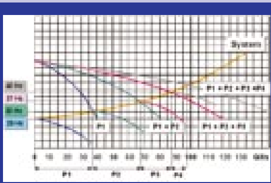
Centrifugal pumps can be controlled by methods similar to those for controlling fans. In practice, the most common method is throttling by means of a control valve. Throttling causes losses both in the pump and in the valve itself. Regulating flow with an AC drive will, in the case of a 30 kW motor running 5,000 hours/year save:



- **Total energy saving: 58,500 kWh/year**
- **Reduction in CO_2 emissions: 29,250 kg/year**
- ***Other benefits:***
  Soft starting, less maintenance; short payback period
  Better flow control; less noise

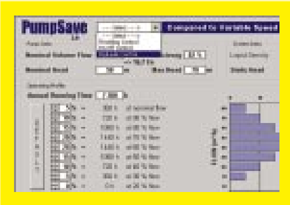
Pump flow control - PFC instead of fixed speed

When a European water utility compared the energy consumption of a fresh water pump with an existing on-off control against proposed variable speed AC drive with PFC (one 55 kW pump with variable and three 55 kW pumps with fixed speed), the results, based on 7,000 h/year, were:



- **Energy saving: about 195,000 kWh/year**
- **Reduction in CO_2 emissions: 97,500 kg/year**
- ***Other benefits:***
  Payback period only 3 months
  Better water pressure control
  Less reactive power

PumpSave for pump energy calculations



PumpSave is a calculation tool for MS Excel to estimate the energy savings available when using an adjustable frequency drive compared to other pump control systems. Calculations are based on typical pump operating characteristics. The outputs of the calculations are:

- **Total energy saving in kWh/year**
- **CO_2 reduction**
- **Total energy cost savings per year**
- **Direct payback period**
- **Net present value of investment**
- ***Other benefits:***
  Quick way to make alternative calculations
  Simple drive selection is included; Available on the web

Winders and unwinders - AC drive with common DC bus

Winders and unwinders of various sizes are used in industries like paper, metal and plastics. AC drives with a common DC bus is the most efficient solution in these applications because the braking energy from unwinders can be recycled in the winder part. This example is for a 100 kW application running 8,000 hours per year.

- **Energy saving: about 720,000 kWh/year**
- **Reduction in CO_2 emission: 360,000 kg/year**
- ***Other benefits:***
  Low power from the supply
  Low maintenance cost
  Reactive power minimised

Car painting booth fans - AC drive instead of inlet vanes

Air pressure, inside and outside a car painting booth, has to be balanced. Too high or too low pressure inside the booth causes problems. The booth's inlet air fan ran at constant speed and the air flow was controlled with a guide vane. Air pressure was unstable and the fan consumed excessive amounts of energy until an AC drive 45 kW was installed.

- **Energy saving: about 56,200 kWh/year**
- **Reduction in CO_2 emissions: 28,100 kg/year**
- ***Other benefits:***
  Stable pressure control; improved painting quality
  Improved working environment

Engine test rig - regenerative AC drive instead of mechanical

Load testing of car engines requires some kind of load to simulate the driving conditions. There are different methods but AC drive has the capability to regenerate and feed the engine power (average 100 kW/2,000 h/year) to the electric network.

- **Total energy saving: 200,000 kWh/year**
- **Reduction in CO_2 emissions: 100,000 kg/year**
- ***Other benefits:***
  Four quadrant operation
  Flexible means for programming
  Extensive speed range

Bank's computer centre cooling pumps - AC drives instead of throttling

A British bank invested in variable speed control. Four frequency converters were installed in the cooling system of the bank's computer centre to control the speed of four pumps (total power 240 kW). The pumps were previously running at constant speed.

- **Energy saving: about 1,000,000 kWh/year**
- **Reduction in CO_2 emissions: 500,000 kg/year**
- ***Other benefits:***
  Improved cooling control
  Payback in less than a year
  Reduced reactive power

Broadcasting studio fans - AC drive instead of on-off control

A television studio's air conditioning fan motors ran at constant speed and were manually started and stopped. This was unsatisfactory and an AC drive was installed for two 7.5 kW motors.

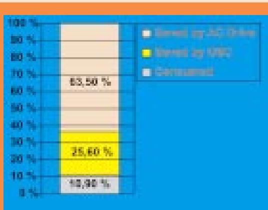
- **Energy saving: about 30,000 kWh/year**
- **Reduction in CO_2 emissions: 15,000 kg/year**
- ***Other benefits:***
  Stable pressure control
  Lower air conditioning noise level
  Improved working environment

Chiller compressor - AC drive instead of mechanical control

A European compressor manufacturer developed a new screw compressor to drive refrigeration and freezing plant. Stepless control with an AC drive allows the compressor to maintain high total efficiency even at reduced loads. Energy consumption can be reduced by 15 per cent compared with conventional capacity control (100 kW unit/6,000 hours/year).

- **Energy saving: about 50,000 kWh/year**
- **Reduction in CO_2 emissions: 25,000 kg/year**
- ***Other benefits:***
  Versatile solution
  Reduced maintenance; low life cycle cost

Gateroom air conditioning - AC drive instead of full speed



A European airport replaced its gaterooms fixed volume air handling units (AHU) with variable speed AC drives. The two fans (15 kW + 7 kW) of the AHU earlier ran continuously with full speed and energy consumption was 192,000 kWh a year. The AC drives reduced the energy consumption by 63.5 per cent.

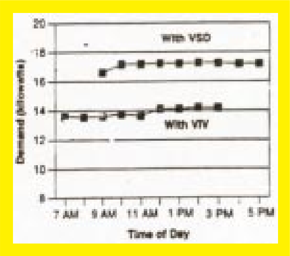
- **Energy saving: about 122,000 kWh/year**
- **Reduction in CO_2 emissions: 61,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Improved quality of air conditioning
  Less supply problems and mechanical wear

Hospital HVAC control - AC drives instead of throttling

A Finnish hospital wanted to reduce the energy wasted through the ventilation exhaust air. The hospital's HVAC system was renewed with the advanced building control system with heat recovery and 60 AC drives (2.2 - 37 kW). Specific heat energy consumption is now lower than at any other hospital in the county.

- **Energy saving: about 4,840,000 kWh/year**
- **Reduction in CO_2 emissions: 2,420,000 kg/year**
- ***Other benefits:***
  Specific heat consumption reduced by 30%
  Improved quality of air conditioning
  Estimated payback period 4 years

HVAC Air Handling Unit - AC drive instead of vanes

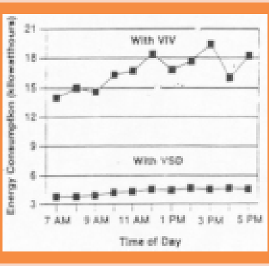


A company in New York City replaced the Variable Inlet Vane control (VIV) in its Air Handling Unit (AHU) with AC drive control (VSD). With 3,800 hours/year the projected savings were 49 per cent:

- **Energy saving: about 18,440 kWh/year**
- **Reduction in CO_2 emissions: 9,220 kg/year**
- ***Other benefits:***
  Reduced reactive power.
  Improved quality of air conditioning
  Estimated payback period 3.9 years

HVAC Air Handling Unit - AC drive instead of vanes

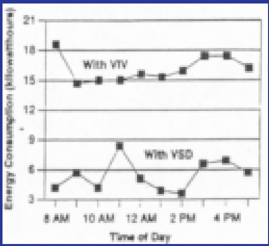
A company in New York City replaced the Variable Inlet Vane control (VIV) of its Air Handling Unit (AHU) with AC drive control (VSD). With 3,700 hours/year the projected savings were 53 per cent:



- **Energy saving: about 31,000 kWh/year**
- **Reduction in CO_2 emissions: 15,500 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Improved quality of air conditioning
  Estimated payback period 2.3 years

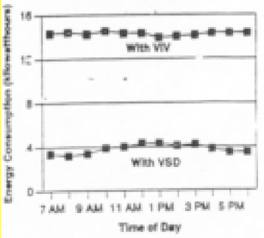
HVAC Air Handling Unit - AC drive instead of vanes

A company in Oregon replaced the Variable Inlet Vane control (VIV) in the Air Handling Unit (AHU) with AC drive control (VSD). With 2,800 hours/year the projected savings were 75 per cent:



- **Energy saving: about 26,800 kWh/year**
- **Reduction in CO_2 emissions: 13,400 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Improved quality of air conditioning
  Estimated payback period 2.6 years

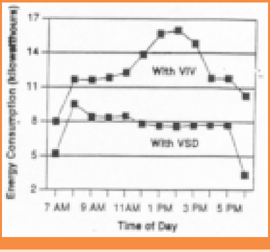
HVAC Air Handling Unit - AC drive instead of vanes



A company in New Jersey replaced the Variable Inlet Vane control (VIV) in its Air Handling Unit (AHU) with AC drive control (VSD). With 2,860 hours/year the projected savings were 68 per cent:

- **Energy saving: about 35,000 kWh/year**
- **Reduction in CO_2 emissions: 17,500 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Improved quality of air conditioning
  Estimated payback period 1.5 years

HVAC Air Handling Unit - AC drive instead of vanes



A company in New Jersey replaced the Variable Inlet Vane control (VIV) in its Air Handling Unit (AHU) with AC drive control (VSD). With 2,860 hours/year the projected savings were 61 per cent:

- **Energy saving: about 18,430 kWh/year**
- **Reduction in CO_2 emissions: 9,215 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Improved quality of air conditioning
  Estimated payback period 3 years

HVAC Chiller water pump - AC drive instead of throttling

In the chiller water distribution system of a big hotel, a conventional throttling control was replaced by 34 AC drives of 100 kW each. The system runs 4,000 hours a year.

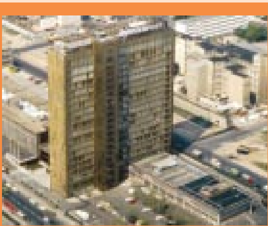
- **Energy saving: about 4,000,000 kWh/year**
- **Reduction in CO_2 emissions: 2,000,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Better flow control
  Less supply problems and mechanical wear

HVAC cooling tower fans - AC drive instead of on-off

Cooling towers typically use banks of fans, each feeding cooling cells. In the cells, the fan moves outside air through a spray of water, allowing heat to dissipate from the water. With variable speed control, the energy saving can be 60%. In the case of 100 kW total motor power and 4,000 h/year, this means:

- **Energy saving: about 200,000 kWh/year**
- **Reduction in CO_2 emissions: 100,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Better HVAC control
  Less supply problems and mechanical wear

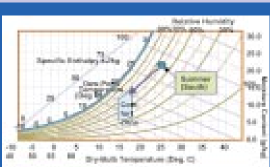
HVAC supply fan - AC drive instead of eddy-current clutch



In the ventilation system of a publishing company in Germany, a conventional damper control was replaced by an eddy-current clutch. Energy saving was 30%. There was a further energy-saving potential of around 35% with AC drives. The fan motor is 16 kW and the system is running 4000 hours a year.

- **Energy saving: about 18,000 kWh/year**
- **Reduction in CO_2 emissions: 9,000 kg/year**
- ***Other benefits:***
  Reduced reactive power; Payback period 2 years
  Less supply problems and mechanical wear

HVAC system comfort cooling with AC drive

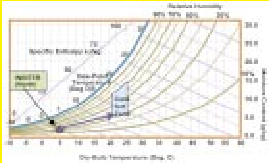


During the summer time (2,000 h/year), an office area of about 1,000 square metres requires 5m^3/s of cooling air. With an accurate AC drive (about 55 kW) control, the energy use can be optimised and 100 kW less cooling power is needed.

- **Energy saving: about 200,000 kWh/year**
- **Reduction in CO_2 emissions: 100,000 kg/year**
- ***Other benefits:***
  More comfortable indoor climate
  Reduced reactive power
  Less supply problems and mechanical wear

HVAC system comfort heating with AC drive

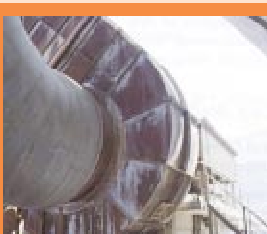
During the winter time (2,000 h/year) a painting plant of about 6,000 square metres requires $33m^3/s$ of heating air. With an accurate comfort zone control with AC drives (total 300 kW), the energy use can be optimised and 585 kW less heating power is needed.



- **Energy saving: about 1,170,000 kWh/year**
- **Reduction in CO_2 emissions: 585,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Better working environment
  Less supply problems and mechanical wear

Cement factory ID fan - AC drive instead of damper

A cement plant in Greece controls its induced draft fans with AC cascade converters of 630 kW. This way, large energy savings are achieved, compared to the conventional method of regulating the flow rate through dampers. Power consumption is reduced by 163 kW, with the following benefits:



- **Energy saving: about 1,250,000 kWh/year**
- **Reduction in CO_2 emissions: 625,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Payback period 1.8 years
  Reduced need for maintenance

Clay workshop ID fan - AC drive instead of damper

An Irish china clay workshop replaced the damper control with an AC drive in its 150 kW induced draft fan. The existing fan and motor were used without any alterations. Savings were achieved in both reduced power required by the fan and more economical use of heating fuel. The fan is operated continuously for 51 weeks per year.

- **Energy (electrical) saving: about 640,000 kWh/year**
- **Reduction in CO_2 emissions: 320,000 kg/year**
- ***Other benefits:***
  Reduced gas consumption
  Reduced pollution
  Payback period eight months

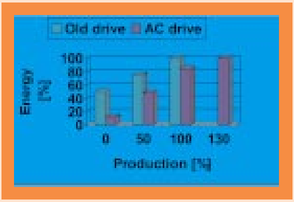
Mine cooling fan - AC drive instead of damper

A Mexican iron mining company installed an AC drive, replacing the existing constant speed 1,250 kW cooling fan motor. Energy savings of 23% was achieved.

- **Energy saving: about 2,300,000 kWh/year**
- **Reduction in CO_2 emissions: 1,150,000 kg/year**
- ***Other benefits:***
  Better process controllability
  Lower motor noise and vibration
  Reduced maintenance cost

Mine ore conveyor - AC cage motor + drive instead of slip-ring motor

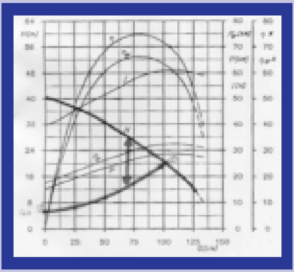
A South American copper mine had problems with its 5 km long ore conveyor belt. The conveyor capacity was limited and had a high maintenance cost. The old drive with slip-ring motors was replaced with cage motors (2 x 630 kW) and an AC drive. This caused the capacity increase of 30 per cent and:



- **Energy saving: about 1,200,000 kWh/year**
- **Reduction in CO_2 emissions: 600,000 kg/year**
- ***Other benefits:***
  Improved production capacity
  Reduced reactive power
  Reduced maintenance cost

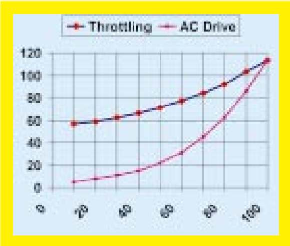
Mine submersible pump - AC drive instead of throttling

A Finnish chrome mine compared control methods for a 37 kW submersible pump. Power saving with an AC drive was 16 kW on average. The pump is running about 8,000 h/year.



- **Energy saving: about 128,000 kWh/year**
- **Reduction in CO_2 emissions: 64,000 kg/year**
- ***Other benefits:***
  Better flow control
  Reduced reactive power
  Reduced maintenance cost

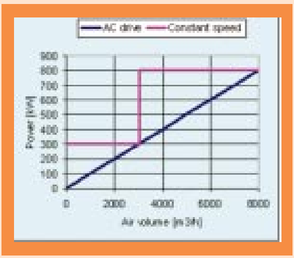
Chemical industry acid pump - AC drive instead of throttling



A Finnish chemical industry replaced its existing constant speed acid pump control with an AC drive (37 kW). The process is running about 8000 hours a year and the average flow is less than 50% of the pump rated flow. The results were:

- **Energy saving: about 120,000 kWh/year**
- **Reduction in CO_2 emissions: 60,000 kg/year**
- ***Other benefits:***
  Reliable control for a demanding material
  Reduced maintenance cost
  Payback period about 1.3 years

Chemical industry screw compressor - AC drive instead of on-off



European biochemical company processes needed oxygen with constant pressure, but the oxygen volume was very variable. The system was controlled by switching on and off two compressors of different sizes. Because of problems with high power consumption, noise level and maintenance cost, the larger compressor was equipped with an AC drive. The results were:

- **Energy saving: about 1,700,000 kWh/year**
- **Reduction in CO_2 emissions: 850,000 kg/year**
- ***Other benefits:***
  Production running stable; reduced maintenance cost
  One year payback period

Chemical industry filter - AC drive instead of damper

Filter control is an important application within the chemical sector. A drive is often sized to pull air through a dirty filter, but most of the time the air flow is too great and so a damper is used. This causes losses and the fan speed control is a better solution. The case is calculated for a 100 kW fan motor.

- **Energy saving: about 262,000 kWh/year**
- **Reduction in CO_2 emissions: 131,000 kg/year**
- ***Other benefits:***
  Production running stable
  Reduced maintenance cost
  Reduced reactive power

Chemical industry fin fan - AC drive instead of damper

A fin fan cooler is a special type of fan which normally lies in the vertical plane, drawing air from outside and blowing it downwards into a manufacturing process. Variable speed control gives enormous energy savings. The case is calculated for a 100 kW fan motor.

- **Energy saving: about 438,000 kWh/year**
- **Reduction in CO_2 emissions: 219,000 kg/year**
- ***Other benefits:***
  Production running stable
  Reduced maintenance cost
  Reduced reactive power

Bakery depanners - AC drives instead of constant speed

In a British bakery, two depanners use a vacuum system to remove bread from the baking trays and tins. The vacuum is generated in vacuum chambers by fans driven by standard 15 kW AC motors. AC drives were installed to control the fan motors, and hence the vacuum generated.

- **Energy saving: about 135,000 kWh/year**
- **Reduction in CO_2 emissions: 67,500 kg/year**
- ***Other benefits:***
  Damage of bread rolls minimised
  Payback period 1.3 years
  Reduced maintenance cost

Dairy air compressor - AC drive instead of relief valve

A US producer of dairy products improved its total heating and cooling processes by using so-called pinch technology. There were several changes to the system including the addition of a new AC drive to a 11 kW air compressor.

- **Energy saving: about 85,600 kWh/year**
- **Reduction in CO_2 emissions: 42,800 kg/year**
- ***Other benefits:***
  Reduced maintenance cost
  Payback period 2.7 years
  Reduced reactive power

Dairy boiler feed water pump - AC drive instead of throttling

A US producer of dairy products improved its total heating and cooling processes by using so-called pinch technology. There were several changes to the system, including the addition of a new AC drive to a 7.5 kW boiler feed pump.

- **Energy saving: about 55,400 kWh/year**
- **Reduction in CO_2 emissions: 27,700 kg/year**
- ***Other benefits:***
  Reduced maintenance cost
  Payback period 3.6 years
  Reduced reactive power

Dairy refrigeration compressor - AC drive instead of relief valve

A US producer of dairy products improved its total heating and cooling processes by using so-called pinch technology. There were several changes to the system including the additional two new AC drives to refrigerating compressors, 200 kW and 250 kW respectively.

- **Energy saving: about 202,000 kWh/year**
- **Reduction in CO_2 emissions: 101,000 kg/year**
- ***Other benefits:***
  Reduced maintenance cost
  Payback period 2.5 years
  Reduced reactive power

Distillery cooling pump - AC drive with flux optimisation

A Scottish distillery uses an AC drive with flux optimisation for two 30 kW centrifugal cooling pumps. The flux optimisation feature offers energy savings higher than other AC drives. Drive losses can be reduced by 30% when the pump is less than 30% loaded. A comparison with throttling gives:

- **Energy saving: about 131,400 kWh/year**
- **Reduction in CO_2 emissions: 65,700 kg/year**
- ***Other benefits:***
  Reduced maintenance cost
  Accurate flow control
  Reduced reactive power

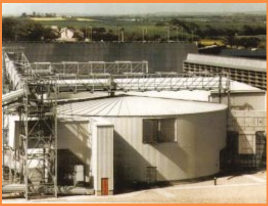
Flour mill extract fan - AC drive instead of dampers

Dust is extracted from the flour milling process by 75 kW fans driven by electric motors. Fans were originally controlled by a star/delta starter, the motors running at full speed with airflow controlled by dampers. An AC drive was installed to control the fan speed.

- **Energy saving: about 114,000 kWh/year**
- **Reduction in CO_2 emissions: 57,000 kg/year**
- ***Other benefits:***
  Payback period about 2.5 years
  Less maintenance
  Reduced reactive power

Malt kiln fan - AC drive instead of inlet vanes

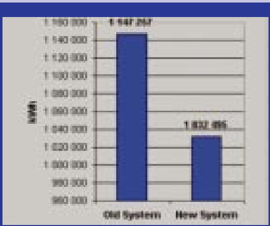
A UK malt producer installed two 400 kW variable speed AC drives for its 250 tonne capacity malt kiln installation. In other malting installations, the fans are controlled using mechanical inlet guide vanes. With AC drives, overall energy consumption has fallen from around 200 kWh per tonne to less than 100 kWh per tonne.



- **Energy saving: about 9,000,000 kWh/year**
- **Reduction in CO_2 emissions: 4,500,000 kg/year**
- ***Other benefits:***
  Better process control, high reliability
  Higher power factor

Malt kiln fan - new AC drive instead of old drive

A Finnish malt producer had used variable speed AC drives for its malt kiln fans since the early 1980's. The old drives were replaced with new ones. The average electrical energy needed for kilning one batch of malt went down by 10 per cent.



- **Energy saving: about 114,762 kWh/year**
- **Reduction in CO_2 emissions: 57,381 kg/year**
- ***Other benefits:***
  Less equipment space
  Less cooling capacity needed
  Improved loadability of the motor
  Less electromagnetic interference

Sugar centrifuge - AC multidrive instead of two-speed motor

A sugar mill replaced the two-speed motor control of its six centrifuges of 200 kW each with an AC multidrive with PLC control. The multidrive enables the common DC-bus to transfer electrical energy from the decelerating centrifuges to accelerating ones giving remarkable energy savings.

- **Energy saving: about 2,880,000 kWh/year**
- **Reduction in CO_2 emissions: 1,440,000 kg/year**
- ***Other benefits:***
  Optimum speed for the process
  Smooth starting - less wear
  Less reactive power required

Sugar mill boiler ID fan - AC drive instead of vanes

A Finnish sugar mill replaced its existing ID fan guide vane control with a variable speed AC drive (132 kW). The operation period for a six-month campaign was 4,320 hours and the measured power reduction 75 kW. Compared to guide vanes, this gives:

- **Energy saving: about 324,000 kWh/year**
- **Reduction in CO_2 emissions: 162,000 kg/year**
- ***Other benefits:***
  Payback period 2.6 years
  Accurate control of boiler process
  Less reactive power required

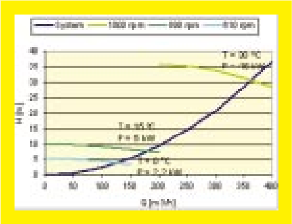
Ship podded propulsion - AC drive instead of pitch control

A recent innovation for enhanced manoeuvrability and reduced fuel consumption is Azipod. This is a podded propulsion unit azimuthing through 360 degrees, incorporating an electric motor, controlled by a frequency converter. On a recently launched cruise liner, reduction in fuel consumption was 8 per cent, equivalent to 40 tons of heavy fuel oil per week.

- **Energy saving: about 10,000,000 kWh/year**
- **Reduction in CO_2 emissions: 5,000,000 kg/year**
- ***Other benefits:***
  Improved manoeuvrability
  Reduced stress to the supply, reduced reactive power

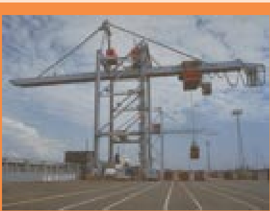
Ship sea water pump - AC drive instead of throttling

The sea water intake of a freight ship was dimensioned according to the engine cooling demand in tropical waters of 30 degrees C. Most of the time it was sailing in much cooler waters, averaging only 15 degrees C. With variable speed AC drives the consumption of the 45 kW pump motor power was reduced to 5 kW. With 5,000 hours running time:



- **Energy saving: about 200,000 kWh/year**
- **Reduction in CO_2 emissions: 100,000 kg/year**
- ***Other benefits:***
  Less corrosion
  Less mechanical stress
  Less reactive power

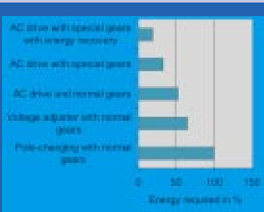
Container crane - regenerating AC drive instead of resistors



Rapid, precise and efficient control of crane movements reduces stresses on both the system and the operator. In modern container cranes. AC drives are used for all three movement directions. The hoisting movement is the most demanding and regeneration gives energy savings when braking.

- **Energy saving: about 190,000 kWh/year**
- **Reduction in CO_2 emissions: 95,000 kg/year**
- ***Other benefits:***
  Improved safety
  Faster operation
  Reduced maintenance cost

Lift speed control - AC drive instead of pole-changing motor



A lift with a load capacity of 1,000 kg, 17 m travelling height and 5 stops is conventionally driven with a pole-changing 8.8 kW motor. Compared with this conventional solution, a 6.3 kW motor fed via an AC drive with special gear and energy recovery saves up to 81 per cent. With a utilisation of 6 hours per day:

- **Energy saving: about 15,000 kWh/year**
- **Reduction in CO_2 emissions: 7500 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Payback period about 1.5 years
  Less supply problems and mechanical wear

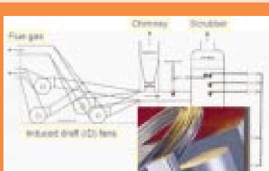
Appliances plant water pump - AC drive instead of throttling

A UK domestic appliances manufacturer invested in AC drives at its factory. Borehole water is pumped directly into the mains using a 30 kW motor. The drive installed on this motor resulted in a 30% saving and the drive installed on the raw water pump produced savings of 88%.

- **Energy saving: total 191,000 kWh/year**
- **Reduction in CO_2 emissions: 95,500 kg/year**
- ***Other benefits:***
  Payback period of 14 months
  Reduced stress to the supply
  Reduced reactive power

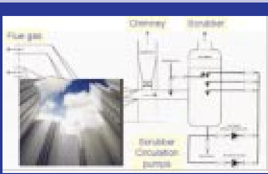
Metal industry ID fans - AC drive instead of damper

A Norwegian aluminium producer compared its boiler ID fans (8 units 400 kW each) existing damper control against variable speed control.



- **Energy saving: about 2,738,400 kWh/year**
- **Reduction in CO_2 emissions: 1,369,200 kg/year**
- ***Other benefits:***
  Payback period 1.1 years
  Improved controllability
  Reduced reactive power

Metal industry scrubber pump - AC drive instead of throttling



A Norwegian aluminium producer compared its scrubber circulation pumps (8 units of 100 kW each) with throttling control against variable speed control.

- **Energy saving: about 2,240,800 kWh/year**
- **Reduction in CO_2 emissions: 1,120,400 kg/year**
- ***Other benefits:***
  Payback period 0.5 years
  Improved controllability
  Reduced reactive power

Steel melting plant fan - AC drive instead of damper

A British steel melting plant converted two of its four 1,200 kW extraction fans from inlet vane control to variable speed AC drives. An energy saving of approximately 37% was achieved when using a combination of obscuration meter and AC drive.

- **Energy saving: about 4,680,000 kWh/year**
- **Reduction in CO_2 emissions: 2,340,000 kg/year**
- ***Other benefits:***
  Payback period 2.3 years
  Better for environment
  Less reactive power required

Steel mill roller table - AC drive instead of fixed speed

In a steel mill, roller tables transport steel profiles between workstations. A common regenerative AC drive is used for efficient braking every 18 seconds of the 82 pcs of 3 kW motors. Compared to mechanical braking, considerable savings are achieved:

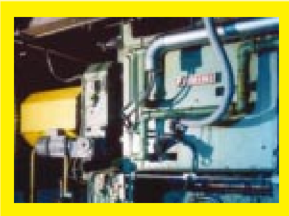
- **Energy saving: about 504,000 kWh/year**
- **Reduction in CO_2 emissions: 252,000 kg/year**
- ***Other benefits:***
  Payback period 2.3 years
  Better for environment
  Less reactive power required

Oil terminal pumps - AC drives instead of throttling

An oil terminal in the United Arab Emirates was looking for new solutions to control the oil pumping between tanks, from tank to ship and from ship to tank. This was a green field project with 20 centrifugal pumps (350 kW each) and a Multidrive with 2 supply units was selected.

- **Energy saving: about 580,000 kWh/year**
- **Reduction in CO_2 emissions: 290,000 kg/year**
- ***Other benefits:***
  Total flexibility in pump selection
  Less moving parts and less maintenance
  Simple and effective solution - user friendly

Rubber mixer - AC drive instead of hydraulic drive



A Finnish tyre manufacturer installed AC drives (1500 kW) to its new rubber mixer instead of the traditional hydraulic drive. The estimated energy saving was 20%.

- **Energy saving: about 1,200,000 kWh/year**
- **Reduction in CO_2 emissions: 600,000 kg/year**
- ***Other benefits:***
  Better quality of the end product
  Reduced noise level
  Less reactive power

Boiler coal mills - AC drive instead of bypass

In a boiler installation, 20 coal mills with a drive output of 710 kW each are used. A speed-controlled drive with a control coupling or with an AC drive is used to replace the bypass method. The possible saving with a control coupling is about 11 GWh and with an AC drive 23 GWh as shown below.

- **Energy saving: about 23,000,000 kWh/year**
- **Reduction in CO_2 emissions: 11,500,000 kg/year**
- ***Other benefits:***
  Better boiler control with fewer losses
  Crushing wheels of the mills last longer
  Payback period 2.5 years

Boiler extract fans - AC drive instead of dampers

The extract fans at a UK power plant (200 kW + 150 kW) were running at full speed with flow control by dampers, but as the boiler ran at low loads for long periods management believed that energy could be saved with variable speed control. With variable speed AC drives:

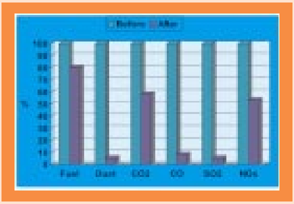
- **Energy saving: about 1,000,000 kWh/year**
- **Reduction in CO_2 emissions: 500,000 kg/year**
- ***Other benefits:***
  Faster response to load changes
  Noise level reduced from 89 dBA to 77 dBA
  Payback period of just 16 months

Boiler feed pump - AC drive instead of fluid coupling

A European power plant was comparing fluid coupling with AC drive for its feed pump (1,450 kW) control. The comparison shows that within the speed range needed, the AC drive consumed about 150 kW less than the fluid drive.

- **Energy saving: about 1,200,000 kWh/year**
- **Reduction in CO_2 emissions: 600,000 kg/year**
- ***Other benefits:***
  Reduced reactive power
  Reduced stress to the supply
  Reduced need for maintenance

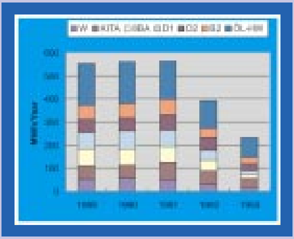
District heating emissions reduced by refurbishment



The refurbishment of a district heating system in a German town project included not only the pump control, but also flue gas cleaning and change from lignite to coal. All this reduced the combustion process emissions of dust, CO_2, CO, SO_2 and NOx.

- **Heating energy saving: 38,000,000 kWh/year**
- **Reduction in CO_2 emissions: 19,000,000 kg/year**
- ***Other benefits:***
  Reduced maintenance cost
  Reduced noise
  Reduced reactive power

District heating pump - AC drive instead of throttling



A small town in Germany had throttling and on-off control for its seven district heating pump stations. In September 1992, AC drives were installed to control the pumps. During 1993, the first full year with the AC drives, the energy consumption was reduced by about 60 per cent.

- **Energy saving: about 330,000 kWh/year**
- **Reduction in CO_2 emissions: 165,000 kg/year**
- ***Other benefits:***
  Reduced maintenance cost
  Reduced noise
  Reduced reactive power

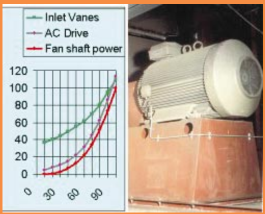
Power plant booster fan - AC drive instead of inlet guide vanes

A US university power plant installed a 1,000 hp AC drive for its scrubber booster fan. Energy efficiency improved by 25% against that of inlet vanes.

- **Energy saving: about 1,460,000 kWh/year**
- **Reduction in CO_2 emissions 730,000 kg/year**
- ***Other benefits:***
  Better process controllability
  Less maintenance by soft starting
  No more start-up problems

Power plant FD fan - AC drive instead of inlet guide vanes

A power plant compared inlet guide vanes to AC drives (110 kW each) for its FD (Forced Draft) fan. The power plant is running continuously and the fresh air flow varies from 50% to 90% of the maximum capacity. With AC drives:



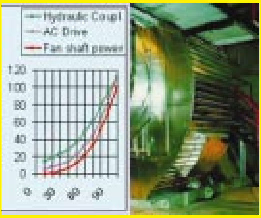
- **Energy saving: about 482,000 kWh/year**
- **Reduction in CO_2 emissions: 241,000 kg/year**
- ***Other benefits:***
  Better pressure control with varying loads
  Less maintenance by soft starting
  Efficient combustion

Power plant fans - AC drive instead of inlet guide vanes

A peat power plant replaced inlet guide vanes with AC drives (total 300 kW) for its Primary air, Secondary air and Induced Draft fans. The electric power required to produce 1 MWh heat was reduced by 33% from 30 kWh to 20 kWh.

- **Energy saving: about 43,600 kWh/year**
- **Reduction in CO_2 emissions: 21,800 kg/year**
- ***Other benefits:***
  Better pressure control with varying loads
  Less maintenance by soft starting
  Efficient combustion of peat

Power plant ID fan - AC drive instead of fluid coupling



A Finnish pulp mill compared hydraulic coupling to AC drive (1,370 kW) for its power plant ID (Induced Draft) fan. The power plant is running continuously and the flue gas flow varies from 50% to 90% of the maximum capacity. With AC drive:

- **Energy saving: about 376,000 kWh/year**
- **Reduction in CO_2 emissions: 188,000 kg/year**
- ***Other benefits:***
  Better pressure control
  Less maintenance by soft starting
  Fan critical speeds can be avoided

Wind power generator - AC drive instead of blades only

Conventionally, the wind generator is coupled directly to the electricity grid. The speed of the generator is limited by the network frequency, thus limiting the speed range which can be exploited. By using an AC drive it is estimated the energy output can be increased by 20%. If the generator power is 1,000 kW and it is running 4,000 h/year, we get:

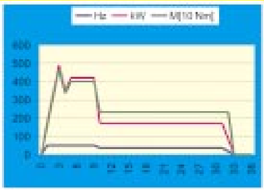
- **Energy saving: about 800,000 kWh/year**
- **Reduction in CO_2 emissions: 400,000 kg/year**
- ***Other benefits:***
  Less mechanical stress, better controllability
  Reactive power can be controlled

Paper machine - AC drive instead of DC drive

A US paper mill compared its paper machine (4,000 kW total power) drive losses between AC drive and DC drive. The losses with AC drive were about 4.5% less than with DC drive:

- **Energy saving: about 1,600,000 kWh/year**
- **Reduction in CO_2 emissions: 800,000 kg/year**
- ***Other benefits:***
  Robust motors
  Less maintenance
  Less reactive power

Paper mill pulper - AC drive instead of full speed



A German paper mill improved its pulper control because there was often a long wait before the ready pulp could be delivered further in the process. By reducing the pulper speed (from 50 HZ to 35) with an AC drive, the power consumption was reduced from 400 kW to 164 kW. With 7,500 h/year:

- **Energy saving: about 442,500 kWh/year**
- **Reduction in CO_2 emissions: 220,000 kg/year**
- ***Other benefits:***
  No sedimentation with continuous running
  Less maintenance by soft starting; shorter pulper cycle time

Pulp mill debarking drum - AC drive instead of constant speed

A pulp mill's debarking drum did not debark logs satisfactorily because the drum speed could not be adjusted for the different quality of the logs. The mill bought three AC drives (400 kW each) to control the speed of the drum motors.

- **Energy saving: about 1,200,000 kWh/year**
- **Reduction in CO_2 emissions: 600,000 kg/year**
- ***Other benefits:***
  Logs can be equally debarked
  Less maintenance by soft starting
  Reduced reactive power

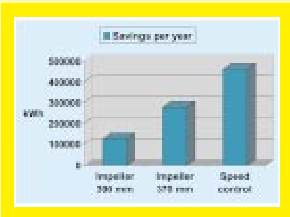
Pulp mill pumps - AC drive instead of throttling

A Swedish pulp mill discovered that at 850 kWh per pulp ton, its energy consumption was far too high. Variable speed control of pumps, changing oversized pump motors with more suitable alternatives and making changes in pipe layouts, reduced consumption to 635 kWh per pulp ton. With variable speed AC drives:

- **Energy saving: about 134,400,000 kWh/year**
- **Reduction in CO_2 emissions: 67,200,000 kg/year**
- ***Other benefits:***
  Improved pulp process control
  Less maintenance by soft starting
  Payback period of hardware investment 12 months

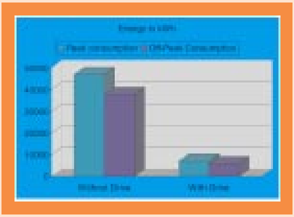
Pulp pumping - AC drive instead of smaller impeller

Quite often industrial pumping systems are oversized for the real average need. If the maximum capacity is never needed, there is an opportunity to reduce the pump impeller size. This was the case with an original pump impeller of 410 mm.



- **Energy saving: about 461,000 kWh/year**
- **Reduction in CO_2 emissions: 230,500 kg/year**
- ***Other benefits:***
  Improved pulp process control
  Less maintenance by soft starting
  Reduced reactive power

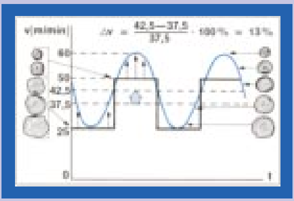
Fabric dyeing pump - AC drive instead of throttling



An Australian dyeing company retrofitted its dye circulation pump with an AC drive (30 kW). The energy consumption was monitored before and after the drive installation. The average power was reduced from 14.1 kW to 2.1 kW. With 6,000 operating hours per year the results are:

- **Total energy saving: 72,000 kWh/year**
- **Reduction in CO_2 emissions: 36,000 kg/year**
- ***Other benefits:***
  Payback period was 32 months
  Mass throughput increased 9.7%
  Fabric length throughput increased 10.3%

Sawmill conveyor - AC drive instead of two-speed motor



Most sawmills today use AC drives to control the speed of the sawmill line conveyor according to the timber diameter. In this example, the average line speed can be increased 13 per cent if compared to a two-speed motor. The energy saving can be estimated to be 13 per cent as well. The power of line motors is about 100 kW and the running hours about 5,000 hours a year.

- **Energy saving: about 65,000 kWh/year**
- **Reduction in CO_2 emissions: 32,000 kg/year**
- ***Other benefits:***
  Better quality of the end product
  Protection against too high load
  Less reactive power

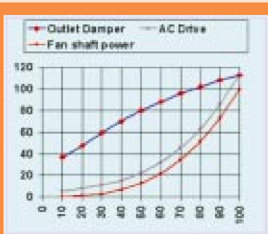
Timber drying - AC drive instead of throttling

A Swedish company in the woodworking business identified the timber drying as one of the most energy-consuming parts of the process. Timber is dried in kilns, each having eight fans maintaining continuous air circulation. Previously, the fans were operated continuously at full speed. The company invested in a total of eight AC drives. The fan motors are 7.5 kW each.

- **Energy saving: about 900,000 kWh/year**
- **Reduction in CO_2 emissions: 450,000 kg/year**
- ***Other benefits:***
  Payback of investment in 12 months
  Better drying process; better end-product

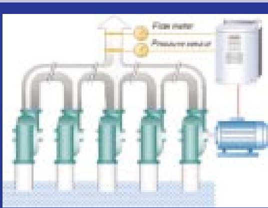
Wood-processing extract fan - AC drive instead of throttling

In a wood processing plant, a fan with a rated power requirement of 7.5 kW is used in the air extraction system. The comparison applies to mechanical throttling vs. variable speed drive control.



- **Energy saving: about 8,400 kWh/year**
- **Reduction in CO_2 emissions: 4,200 kg/year**
- ***Other benefits:***
  Payback of investment in 12 months
  Better controllability
  Reduced reactive power

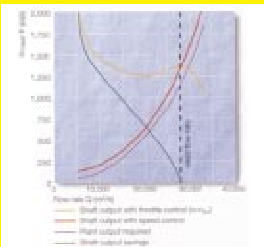
Clean water pump - AC drive instead of on-off



A German city waterworks improved its clean water pumping station control by installing an AC drive (185 kW). Estimated energy saving was about 50% with other benefits.

- **Energy saving: about 740,000 kWh/year**
- **Reduction in CO_2 emissions: 370,000 kg/year**
- ***Other benefits:***
  Constant water pressure
  Reduced pressure shocks
  Reduced maintenance cost

River water axial pump control - AC drive instead of throttling



In a river-water pumping station, an axial pump with a rated output of 1,500 kW is used. Considering the energy efficiency for partial load, the axial pump at constant speed and with throttling as flow-rate control is extremely inefficient. In contrast to this, the pump output can be matched to the output of the installation with low losses if electronic speed control is used.

- **Total energy savings: 2,386,000 kWh/year**
- **Reduction in CO_2 emissions: 1,193,000 kg/year**
- ***Other benefits:***
  Soft starting less maintenance
  Payback period one year; energy saving 32 per cent

Sewage aeration control - AC drive instead of throttling

A Swedish sewage treatment plant succeeded in reducing the nitrogen release more than 50% with speed control of the aeration fan motor (55 kW). An efficient control is needed because incoming flow varies dramatically during the year. This application is doubly ecoefficient because in addition to reduction of nitrogen releases the energy savings are:

- **Energy saving: about 200,000 kWh/year**
- **Reduction in CO_2 emissions: 100,000 kg/year**
- ***Other benefits:***
  Payback time 16 months
  Accurate control of treatment process; less reactive power

Sewage pump - AC drive instead of throttling

For an outdoor pumping station, the following data is available: Maximum flow of waste water is 750 m^3/h and the average flow is 400 m^3/h.The pump is operated for 8,000 hours per year. Motor output is 70 kW. Average power input with three control methods were compared: Throttling: 44.4 kW; on-off control: 32.4 kW; and AC drive: 23.0 kW. AC drive compared to throttling gives:

- **Energy saving: about 172,000 kWh/year**
- **Reduction in CO_2 emissions: 86,000 kg/year**
- ***Other benefits:***
  Payback period only 6 months
  Accurate control of treatment process
  Less reactive power required

Sewage pumps - AC drive instead of on-off control

A Dutch city has a sewerage system in which both waste water and storm water from paved areas is collected. A pumping station transports the sewage to the next station, or to the treatment plant. In 15 stations, the pumps are driven by AC drives. Energy savings are achieved under dry weather conditions. AC drives compared to on-off control gives:

- **Energy saving: about 150,000 kWh/year**
- **Reduction in CO_2 emissions: 75,000 kg/year**
- ***Other benefits:***
  Less maintenance; less reactive power required
  Better control of treatment process

Wastewater pumping - AC drive instead of on-off control

The efficiency of a Scottish wastewater pumping station has more than doubled since two AC drives were installed and interfaced with an ultrasonic level gauging system. This arrangement replaces simple on/off control of the motors, with the level monitored with a mechanical float.

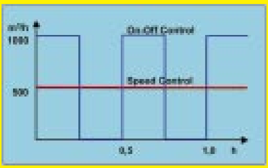
- **Energy saving: about 130,000 kWh/year**
- **Reduction in CO_2 emissions: 65,000 kg/year**
- ***Other benefits:***
  Pumping index up from 14 m^3/kWh to 30 m^3/kWh
  Maintenance cost reduced
  Risk of overflowing minimised

Water booster pump - AC drive instead of throttling

A UK water utility designed a booster pump station to maintain a minimum suction head and to output a maximum of 17 million litres per day. Two variable speed pumps (total 680 kW) were needed instead of four fixed speed pumps. Energy saving is approximately 34%.

- **Energy saving: about 990,000 kWh/year**
- **Reduction in CO_2 emissions: 495,000 kg/year**
- ***Other benefits:***
  Lower construction cost
  Better water pressure control
  Less reactive power

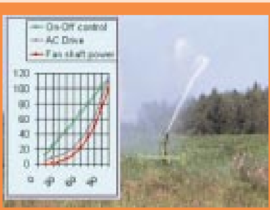
Water treatment pump - AC drive instead of on-off



A European water utility compared the energy consumption of a fresh water pump with existing on-off control against a proposed variable speed AC drive. The power demand at full volume (1,000 m^3/h) every half an hour was 85 kW but at the average volume (500 m^3/h) with AC drive speed control only 21 kW. With 8,000 h/year the results were:

- **Energy saving: about 512,000 kWh/year**
- **Reduction in CO_2 emissions: 256,000 kg/year**
- ***Other benefits:***
  Less maintenance with soft starting
  Better water pressure control
  Less reactive power

Irrigation pumps - AC drive instead of on-off control



A farmer irrigates his fields during periods of dry weather to ensure normal growth. As the irrigators are driven by water flow, a constant pressure is essential for even water distribution over the fields. To keep up the constant pressure a 75 kW AC drive was installed instead of on-off control.

- **Energy saving: about 60,000 kWh/year**
- **Reduction in CO_2 emissions: 30,000 kg/year**
- ***Other benefits:***

  Reduced maintenance cost
  Water pressure peaks eliminated
  Farm's profitability increased

Laboratory glove boxes - AC drive vacuum control

In a research laboratory, toxic materials are handled in closed glove boxes and good ventilation is required. The laboratory replaced the suction air fan's 75 kW constant speed drive with variable speed AC drive. Estimated running hours are 4,000 h/year.

- **Energy saving: about 150,000 kWh/year**
- **Reduction in CO_2 emissions: 75,000 kg/year**
- ***Other benefits:***

  Reduced reactive power
  Safe control of vacuum in the boxes
  Only one common fan is required

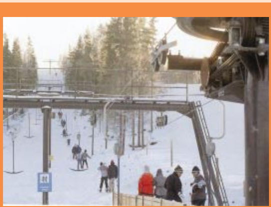
Milking machine - AC drive instead of relief valve

A US manufacturer replaced the mechanical vacuum controller in its milking machine with a variable speed AC drive (22 kW/ 5 hours/day). The mechanical controller was replaced with a vacuum transducer giving the pressure signal to the AC drive. The energy savings were remarkable:

- **Energy saving: about 26,800 kWh/year**
- **Reduction in CO_2 emissions: 13,400 kg/year**
- ***Other benefits:***
  Reduced noise and heat; increased life time of mechanical parts
  More pleasant working environment

Ski lift - AC drive instead of constant speed

A ski resort manager had problems with constant speed skilifts which were for some skiers too fast and for others too slow. After looking at several options, the resort chose an AC drive (132 kW) as a replacement drive for the ski lift. Among the other benefits, a clear energy saving was also experienced.



- **Energy saving: about 26,400 kWh/year**
- **Reduction in CO_2 emissions: 13,200 kg/year**
- ***Other benefits:***
  Safe and reliable lift and happy customers
  Soft start increases comfort
  Less reactive power required

Glossary

AC
Alternating current

Carbon dioxide, CO_2
A colorless and, at room temperature, gaseous substance found in the atmosphere. Human activities, especially the burning of fossil fuels, can increase levels of carbon dioxide in the atmosphere, which is believed to affect the climate. The primary greenhouse gas is carbon dioxide.

CEMEP
European Committee of Manufacturers of Electrical Machines and Power Electronics.

DC
Direct current.

ELU, Environmental Load Unit.
The measurement unit used in the EPS method. One ELU corresponds approximately to one USD.

EPCA (or EPAct).
The American Energy Policy and Conservation Act.

EPD, Environmental Product Declaration.
A description of the environmental performance of a product, system or service over its entire life cycle, from raw material acquisition, manufacturing and use to waste disposal and decommissioning. ABB's EPDs are based on full life cycle assessments as specified in ISO 14025.

EPS, Environmental Priority Strategies in product design.
A method for the weighing of the environmental impact of products over their entire life cycle on biodiversity, human health, production capacity of ecosystems and depletion of non-renewable resources. Based on the willingness of OECD countries to support environmental protection.

EU
European Union.

Greenhouse effect
The effect that certain variable constituents of the Earth's lower atmosphere have on surface temperatures. Greenhouse gases keep ground temperatures at a global average of approximately 15°C. In their absence, the global average would be below the freezing point of water. Environmental scientists are concerned that changes in the atmosphere's CO_2 content, caused by human activities, could have a dangerous warming effect on the Earth's atmosphere.

Greenhouse gases
Gases that contribute to the greenhouse effect and global warming. Key examples are carbon dioxide (CO_2), water vapour(H_2O), methane (CH_4), nitrous oxide (NO_x), chlorofluoro-carbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbon (PFCs), and sulphur hexafluoride(SF).

HV
High voltage.

ICC, International Chamber of Commerce
A non-governmental organisation, that serves world business by promoting trade and investment and the free market system. Founded in 1919, the ICC helps the international business community to develop solutions for environmental problems, while ensuring that intergovernmental organisations concerned with the environment “consider business views.

IEA, The International Energy Agency
An autonomous agency for the exchange of energy information, linked with the Organisation for Economic Co-operation and Development (OECD).

ISO 14000
A series of international standards for environmental management systems, life cycle assessment, environmental auditing of processes, environmental labelling, environmental performance evaluation and terms and definitions.

Kyoto Protocol
A legally binding agreement under which industrialised countries will reduce their collective greenhouse gas emissions by 5.2%. The agreement was reached in Kyoto on December 11, 1997, at a meeting arranged by UNEP, and attended by delegates from 160 nations.

LCA
Life cycle assessment. A management tool for appraising and quantifying the total environmental impact of products or activities over their entire lifetime by analysing the entire life cycle of particular materials, processes, products, technologies, services or activities. Life cycle assessment comprises three complementary components: inventory analysis, impact analysis and improvement analysis.

LCI
Load commutated inverter.

LV
Low voltage

Negawatt
Energy saving, “negative energy consumption”.

VSI
Voltage source inverter.

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