

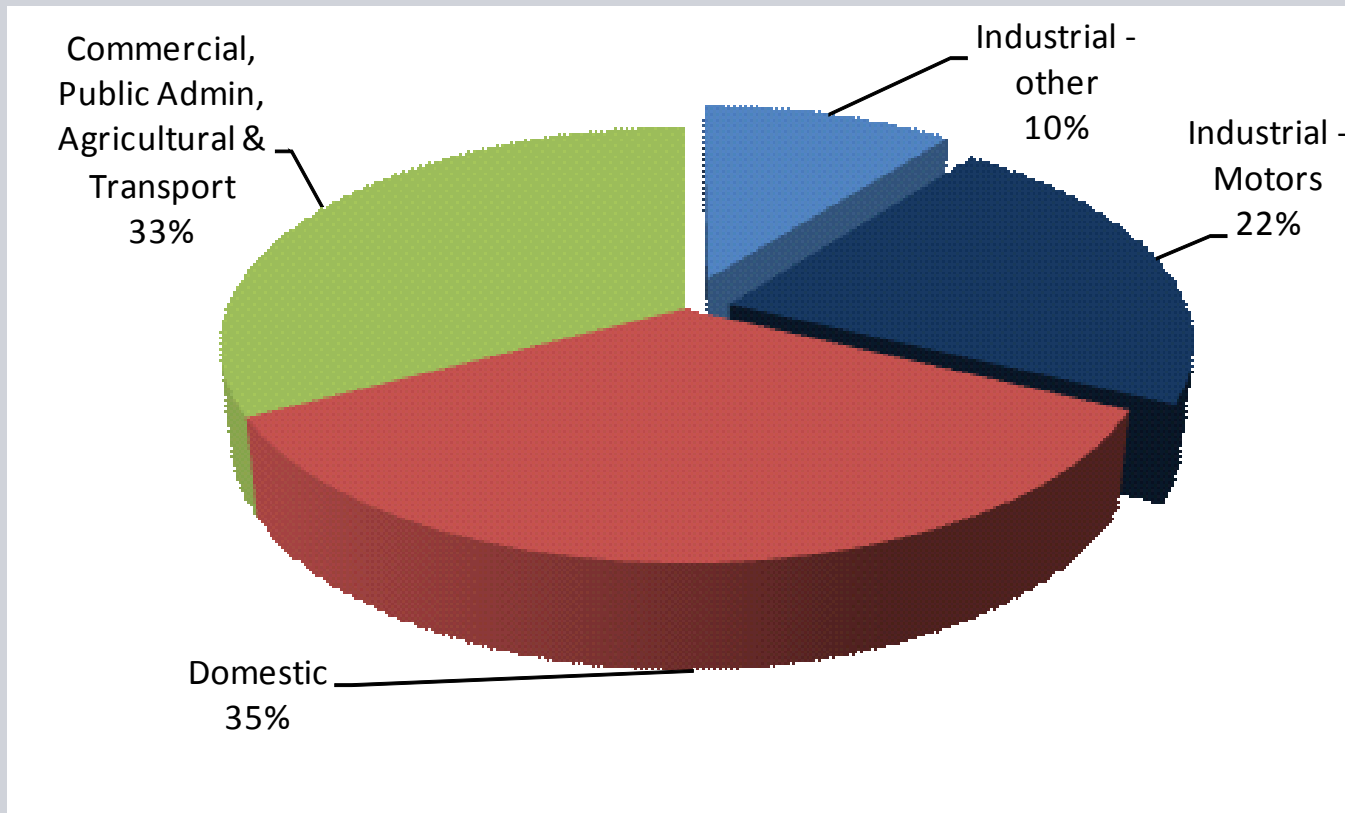
Driving Smart: energy and cost reduction using drive technologies

Jeremy Wilkinson
Business manager

Agenda

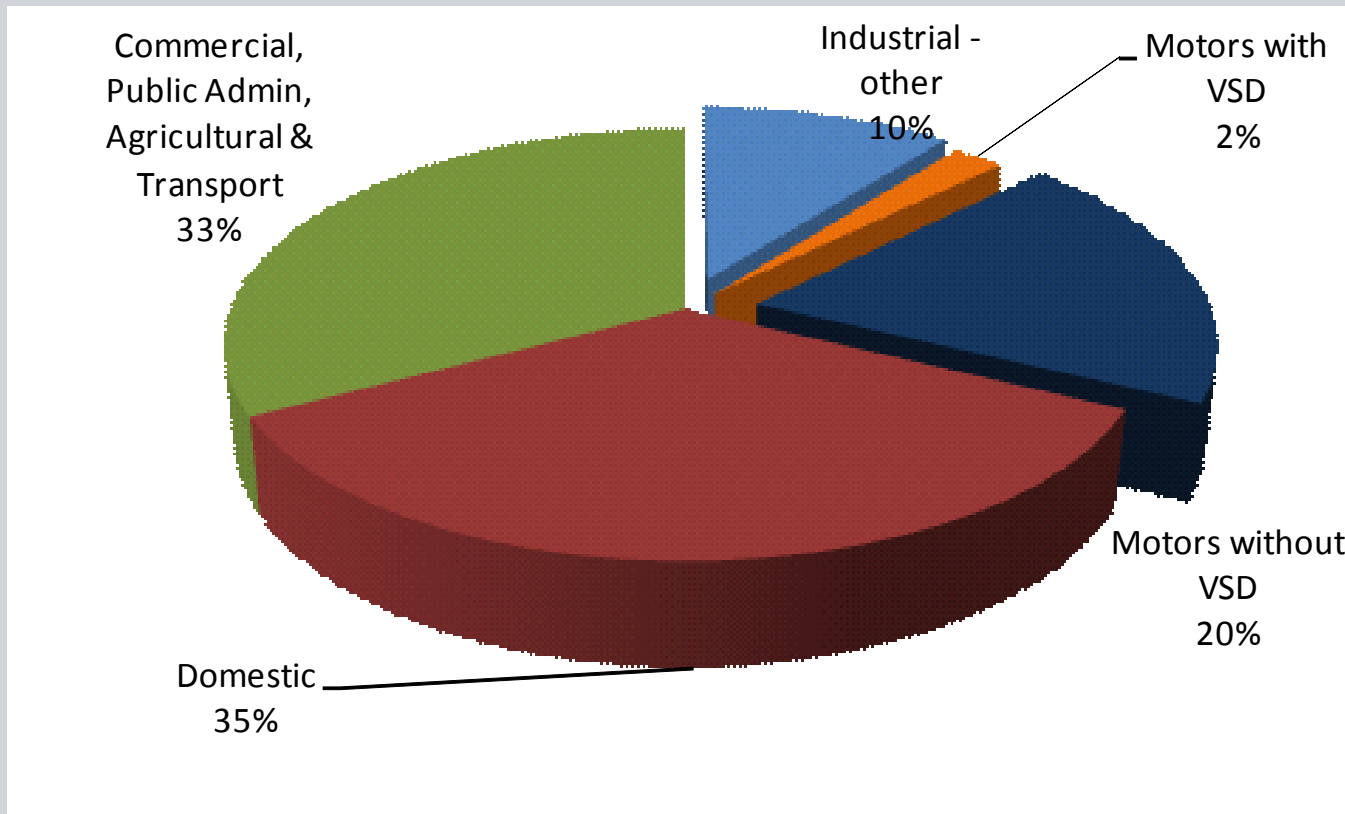
- Background
- The drive train and efficiency levels
- Motor Efficiency
- Gearbox types
- Benefits of variable speed drive control
- Financial opportunities
- Summary

UK Electricity Consumption



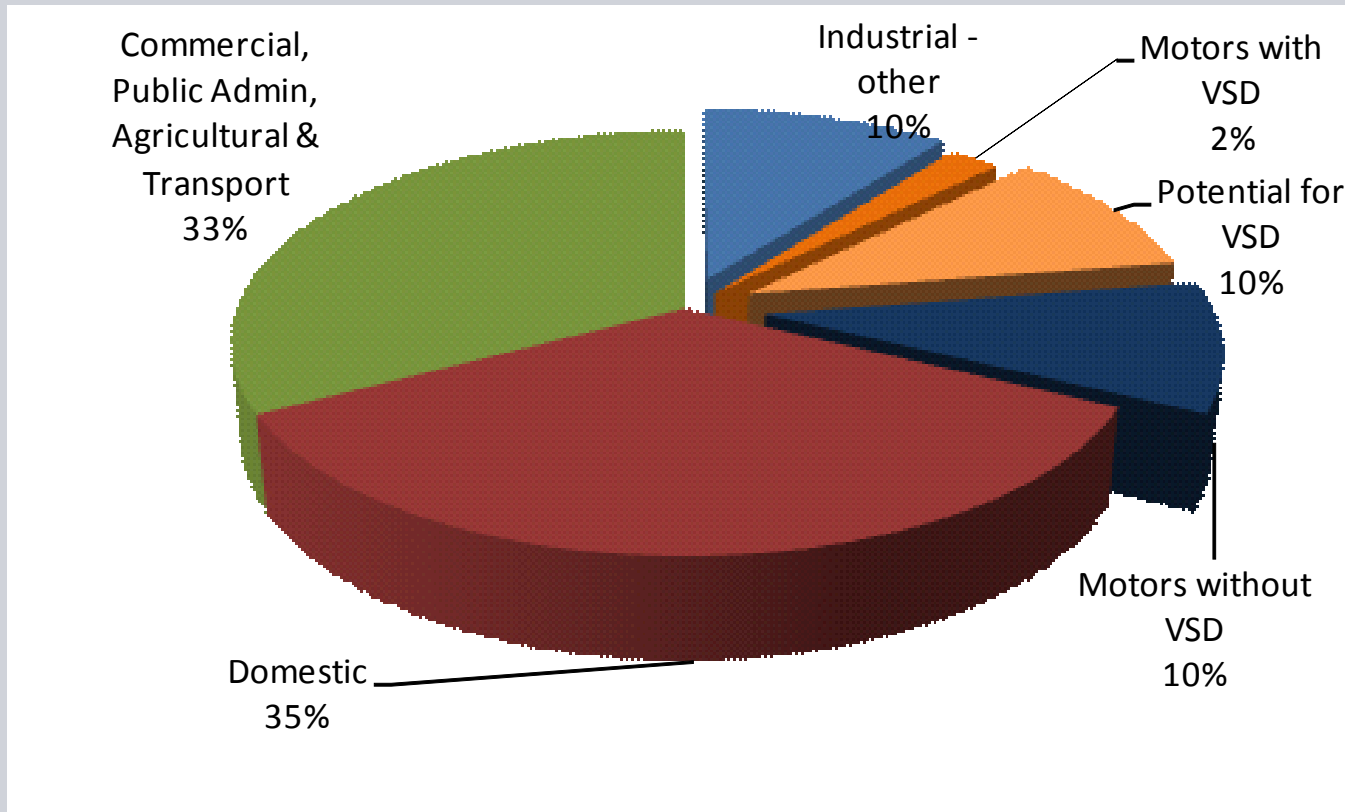
Motors consume about two-thirds of industrial energy use and therefore over 20% of total UK consumption.

UK Electricity Consumption



GAMBICA estimates that only 10% of motors are fitted with VSD

UK Electricity Consumption



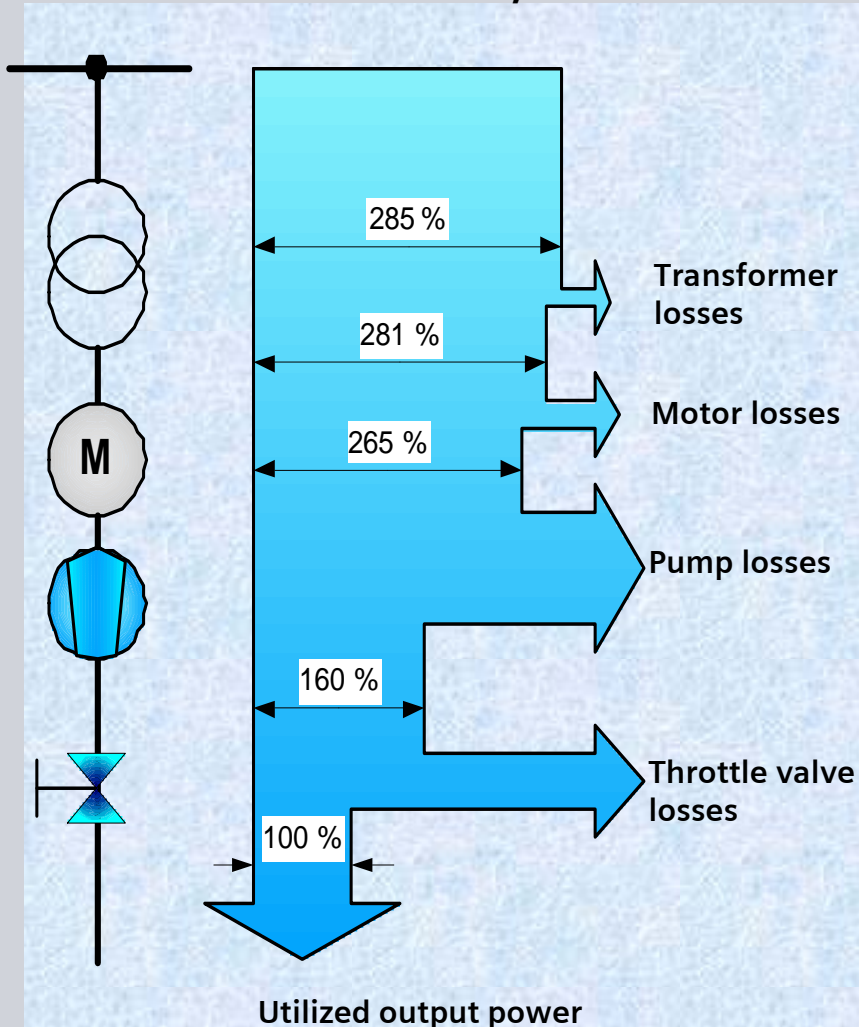
GAMBICA estimates that about half of the remaining motors would yield an energy saving benefit by being controlled by a VSD

The Complete drive train

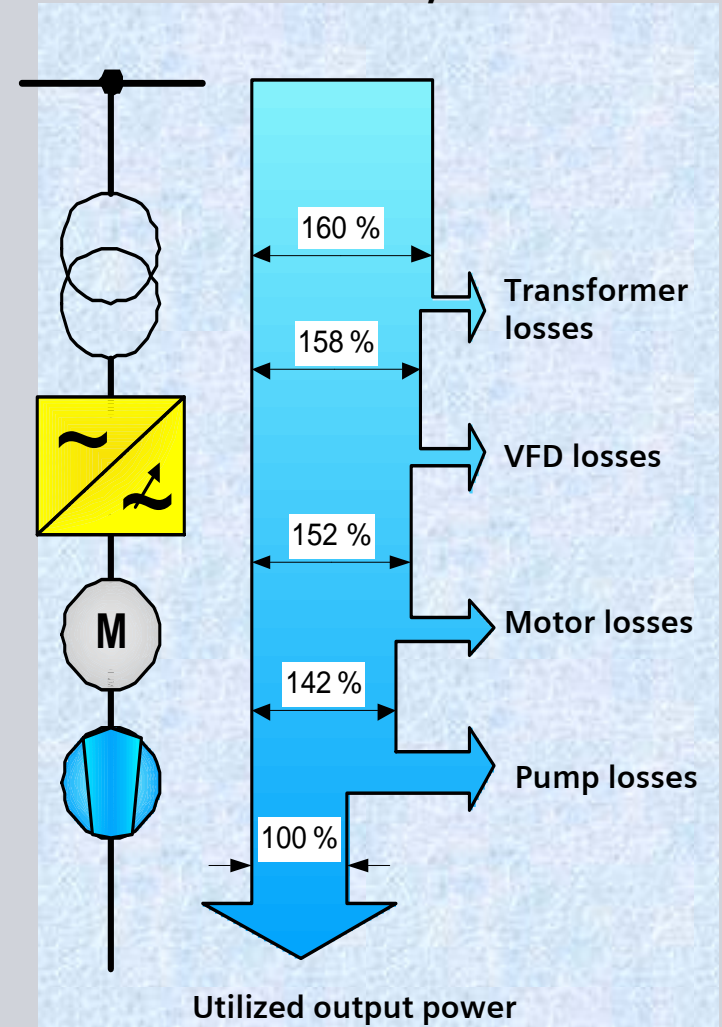


Example of pumping system losses/efficiencies

Power fed in, 285 %



Power fed in, 160 %



Motor efficiencies

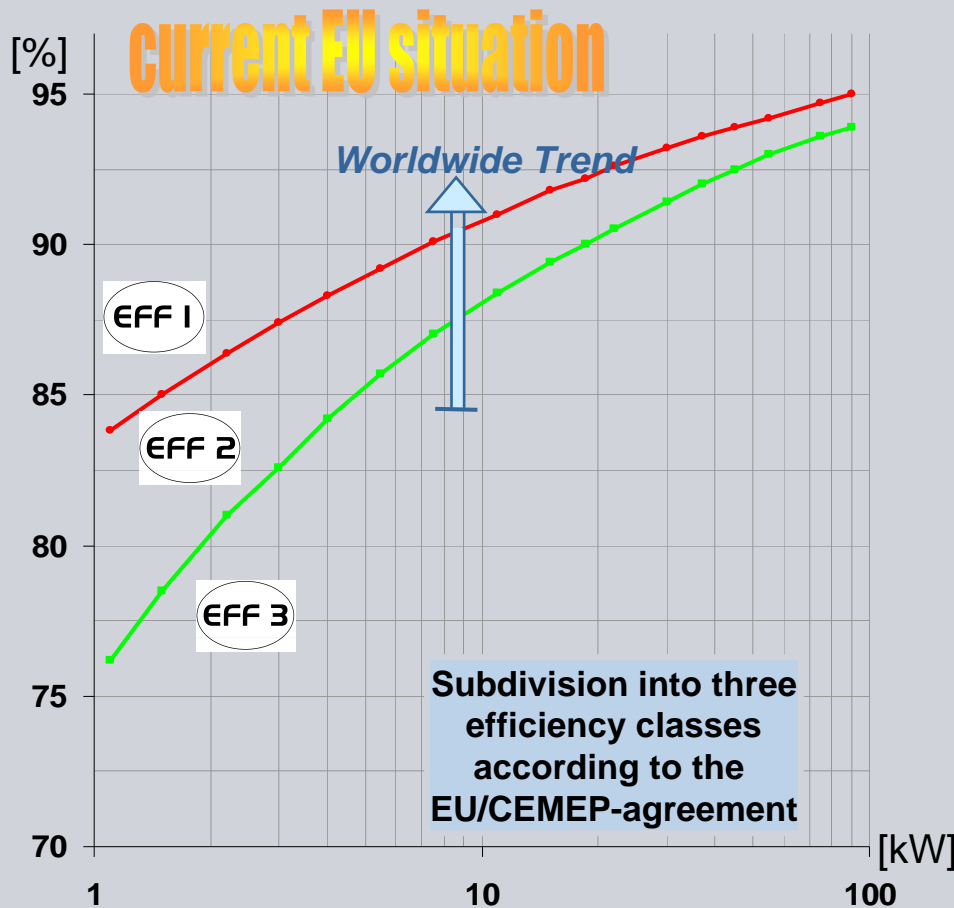
- Motors use around **2/3** of electrical energy in industry
- Motors cost industry around £5 Billion a year to run
- A single 75kW motor will cost more than **£1M** to run during it's typical useful lifetime (e.g. 20 years)
- A motor uses it's cost price in electricity charges in less than one month
- The purchase price of a motor is around **1%** of it's lifetime cost....

Motor efficiencies - Siemens Eff1 motors

Rated power, 4-pole	1.5 kW	15 kW	110 kW
Statistical useful life	12 years	15 years	20 years
Reduction in power losses with the energy-saving motor	0.120 kW	0.311 kW	1.0 kW
Energy costs of Eff3 motor	£11966	£130,861	£1,228,933
Energy costs of Eff1 motor	£11122	£128,408	£1,216,430
Energy-cost saving	£844	£2453	£12,503
Net additional price (estimated)	£19.00	£106.00	£753.00
Amortization time of the additional price	3 months	7 months	15 months

Assumes continuous duty and an electricity cost of 6p/kWh

Motor efficiencies – old standards



Current scope

2 and 4 pole single speed motors

1.1kW to 90kW

Standard type motors ie no brake motors, EX, high torque etc

Moderate success rate in UK with ECA scheme

However uptake in EU, EFF1 < 3% of total sale

Today we have a voluntary agreement

Motor efficiencies – timescales of new standard implementation

- From 16th June 2011 all motors shall meet **IE2** efficiency levels (minimum).
- From 1st January 2015 all motors rated 7.5kW to 375kw shall either meet efficiency level **IE3**, or be supplied as **IE2** + variable speed drive.
- From 1st January 2017 all motors rated 0.75kW to 375kW shall either meet efficiency level, **IE3** or meet **IE2** and be equipped with variable speed drive.
- **IE4** Super Premium Efficiency is a future proposal which is yet to be ratified.

The Directive will be brought into UK law and the exclusions include :-
ATEX motors, some liquid cooled motors, smoke extraction motors....

Gearbox types and related efficiencies

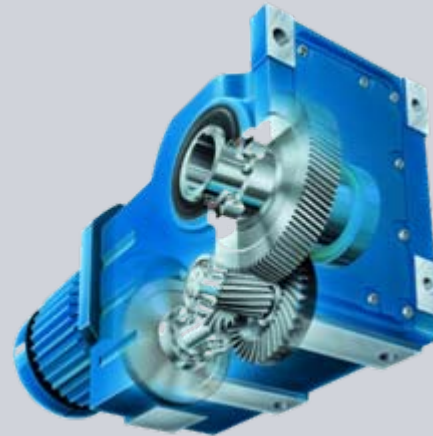
Product Development

Helical Worm average efficiency = 75%

Helical Bevel average efficiency = 96%

Improvement in efficiency = 28%

Achieving paybacks on investment of less than 1 year



Opportunities With Variable Speed Drives (VSD's)

- Installed base of VSDs is already saving 5M tonnes CO₂ pa
- Around 1000, 000kW of new low voltage VSDs sold per year
- Provides c. ½ million tonnes CO₂ additional savings each year
- Another 100, 000 tonnes CO₂ possible with HV VSDs
- Currently less than 10% of possible applications use VSD's
- Offers a relatively low cost of carbon abatement
- If 50% were converted, this would save 20M tonnes CO₂ p.a..

Assumptions:

30% of drives below 5.5 kW are centrifugal, 60% from 7.5 kW through 75 kW, and 80% above 90 kW

Benefits of variable speed drive (VSD) control

- Improved process control
- Increased production flexibility
- Near unity power factor
- Reduced maintenance
 - Soft starting and braking using up and down ramps reduces stress on the machine
- Longer system life
- Trending and reporting – complete visibility
- Inbuilt motor protection
- Energy (cost) saving capability.....

Application Areas For Variable Speed Drives

- Fans
- Pumps
- Compressors
- Conveyors
- Mixers
- Extruders
- Hoists
- Cranes
-

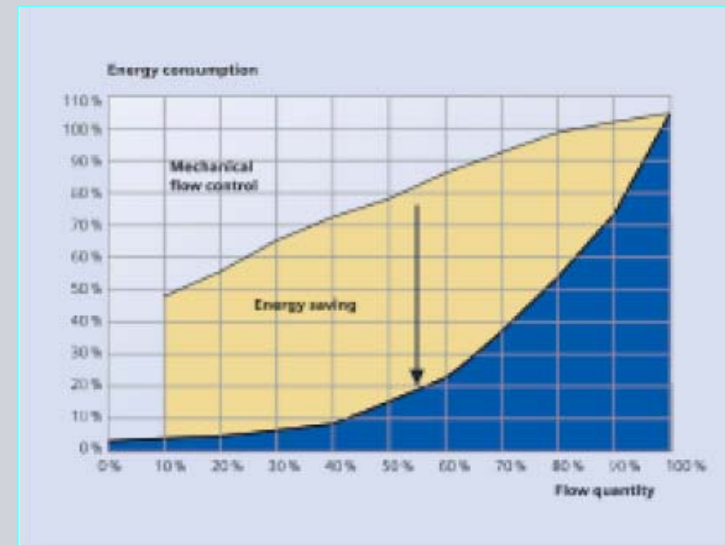


A few Watts to 100MW!

Increased Energy Saving using variable speed drives

Best benefits are from “centrifugal” type loads (fans, pumps and turbo compressors). Power demand varies with the cube of the speed.

Savings depend on application and speed range, but savings of 30% – 40% are not unusual.



Savings are also evident with “constant torque” applications (conveyors, “Roots blowers”, reciprocating pumps...) – whereby the power demand is proportional to the speed

Financial opportunities – accurate payback calculation

Basic entries
Advanced Entries
Results
Characteristic

1. Fan parameters

Total pressure difference	Δp_{tot}	330	mbar	Specific speed	n_q	15.68	1/min
Flow	Q	15,000	m ³ /h	Fan capacity	P_{fan}	160.82	kw
Rotational speed	n	2,960	1/min	Electrical efficiency	η_{el}	0.96	
Power	P_{el}	167.52	kw	Fan efficiency	$\eta_{fan,opt}$	0.86	
Density of the medium	ρ	1.2	kg/m ³	Total efficiency	η_{tot}	0.82	

2. Profile of the fan

Pump head ratio	10	20	30	40	50	60	70	80	90	100	%
Hours	0	1.2	2.4	3.6	4.8	4.8	3.6	2.4	1.2	0	24
	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Using time	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	
Days/Year	365										
Efficiency	22	42	58	71	81	87	93	97	99	100	%

3. Selection of converter

Built-in products

Micromaster 430/440

Cabinets

Sinamics G150 400V

Sinamics G150 500V

Sinamics G150 690V

Investment costs	17,488.00	GBP
Energy costs per kwh	0.10	GBP
Installed motor power	160	kw

www.siemens.com/sinasave

Increased Energy Saving using variable speed drives

Example **10 off 110kW** fan units which are upgraded to VSD control:-
 (warning: lose profit of £28k/annum energy cost if no action taken)

10 off 110kW VSDs	{Based on energy costs of £0.06/kWh}
Capital cost based on ECA	£123, 890
Saving in yearly running costs	£145,425
Return on Investment (R.o.I.)	117%
Payback time on capital	10 months

VSD gives annual savings of **£145,425 (Increase in profits!)**

- Savings are repeated every year
- VSD often gives process improvements

Regenerated energy savings – Hoisting example

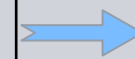
Sinamics regenerative drive



- A pulsed resistor is not required
- A braking chopper is not required
- Additional cabinet cooling can be eliminated
- Energy saving

22kW drive/motor combination

	Energy of a load duty cycle	Total energy (Energy x Σ Load cycles)	Energy price	Energy costs
Drive with standard braking	0.15775 kWh	110,712 kWh	0.08 £ / kWh	£8857
Regenerative drive	0.0753 kWh	52,845 kWh	0.08 £ / kWh	£4228



Energy costs are reduced by 52.3%!

Financial opportunities - barriers ?

Examples of the main barriers are:

- Knowledge? - Increasing information into the marketplace
- Visibility - many applications are misleadingly “invisible”
- Upfront investment - **ECA scheme helps**
- Capital vs revenue budgets - Financing schemes may solve problem:-
 - **Hire purchase** - Rental Scheme leading to ownership
 - **Finance lease** - Rental scheme excluding ownership
 - **Operating lease** - Finance company takes residual value risk
- **In each case, a monthly payment (lower than the monthly energy cost savings) provides a “risk free” profit increase.**
- The electrical/mechanical system aspects must also be considered
- Concern about technology and application.

- ▶ Energy
- ▶ Cars with low CO₂ emissions
- ▶ Water

ENHANCED CAPITAL ALLOWANCES

Enhanced Capital Allowances (ECAs) enable a business to claim 100% first-year capital allowances on their spending on qualifying plant and machinery. There are three schemes for ECAs:

- Energy-saving plant and machinery
- Low carbon dioxide emission cars and natural gas and hydrogen refuelling infrastructure
- Water conservation plant and machinery

Businesses can write off the whole of the capital cost of their investment in these technologies against their taxable profits of the period during which they make the investment.

This can deliver a helpful cash flow boost and a shortened payback period.

- Air-to-air energy recovery
- Automatic monitoring and targeting
- Boiler equipment
- Combined heat and power
- Compact heat exchangers
- Compressed air equipment
- Heat pumps for space heating
- Heating ventilation and air conditioning zone controls

- Lighting
- Motors and drives
- Pipework insulation
- Refrigeration equipment
- Solar thermal systems
- Warm air and radiant heaters



See www.eca.gov.uk

Summary

- Motors use > 60% of electrical energy in industry
- Variable Speed Drives offer numerous process and maintenance benefits
- >90% of lifecycle costs are in energy usage
- Use all installed costs for realistic payback calculations
- Correct installation and commissioning is critical
- Also consider the complete mechanical drive system
- Consider options such as financing
- Claim ECAs where possible www.eca.gov.uk
- Apply a formal **motor management policy** as part of a systematic energy programme.....

Thank You

Jeremy Wilkinson

Business Manager – Large Drives

Siemens Industry Automation & Drive Technologies

Sir William Siemens House

Princess Road

Manchester M20 2UR

Phone: 0161 446 6400

Fax: 0161 446 5302

Mobile: 07808 824563

E-mail: jeremy.wilkinson@siemens.com