

ARE YOUR MOTORS UNDER CONTROL?

**The importance of control and automation in
maximising the system efficiency of motor driven
systems**

GAMBICA

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GAMBICA

About GAMBICA

GAMBICA is the UK Trade Association for the Control, Automation and Instrumentation industry

Representing manufacturers and suppliers of motor control equipment

www.gambica.org.uk



The screenshot shows the GAMBICA website interface. At the top, there is a navigation bar with links: Home, About us, Membership, Events, Publications, Member's Area, Links, Contact. Below this, a sidebar on the left lists various sectors: Industrial Automation, Process Control, Environmental Systems, Test and Measurement, and Laboratory Technology. The main content area is titled 'Gambica Technical' and features a table of publications under the heading 'Variable Speed Drives'.

Title	Date	Version
GAMBICA Guide to CE Marking and Technical Standardisation	12th Mar 2009	3.0
Maximising Efficiency in Power Drive Systems	2nd Oct 2008	Edition 1
Guide to ENEC Recommendation (G44-1)	14th May 2008	2th Edition
Introducing Energy Saving Opportunities for Business (Carbon Trust)	1st Mar 2007	1
Motor Insulation Voltage Stresses Under PWM Inverter Operation - Technical Report No. 1	1st Dec 2006	Third Edition
Motor Shaft Voltages and Bearing Currents Under PWM Inverter Operation - Technical Report No. 2	1st Dec 2006	Second Edition
Installation Guidelines for Power Drive Systems - User Guide No. 3	1st Dec 2006	Third Edition
Application of the ATEX Directives to Power Drive Systems	12th Apr 2006	2nd Edition
Variable Speed Driven Pumps - Best Practice Guide	1st Aug 2003	1





**Automation, Instrumentation & Control
Laboratory Technology**





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Sectors

- Industrial Automation
- Process Control & Instrumentation
- Environmental Systems
- Test and Measurement
- Laboratory Technology

Gambica Technical

Variable Speed Drives

Title	Date	Version
Status of safety-related variable speed drives in regard to the EC Machinery Directive 2006/42/EC	17th Oct 2011	Edition 1
Managing Harmonics, A Guide to ENA Recommendation G5/4-1	1st Apr 2011	6th Edition
GAMBICA Guide to Variable Speed Drives	16th Nov 2010	Edition 1
GAMBICA Guide to Variable Speed Drives	19th Jul 2010	1
GAMBICA Guide to Variable Speed Drives	9th Mar 2009	3.0
GAMBICA Guide to Variable Speed Drives	2008	Edition 1







Power Shortage Risks

"there will be a significant reduction in electricity supplies ... estimated margins decline from around 14% to 4% by 2015/2016"

-Ofgem

Electricity Capacity Assessment (Oct 2012)



The Generation Game



Efficiency biggest resource

"In many ways, energy efficiency can be seen as Europe's biggest energy resource"

-European Commission
Energy Efficiency Plan 2011



Keeping the Lights On?

Instead of worrying about keeping the lights on, we should be thinking of ways to switch the lights off

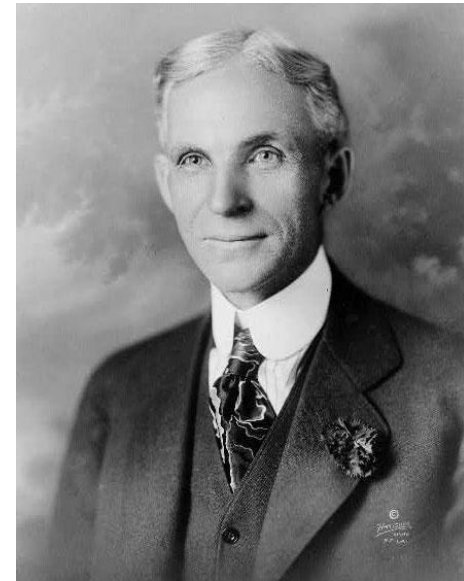
Intelligent control to
maximise energy
efficiency



Buy Now or Pay Later

"If you need a machine and don't buy it then you will ultimately find that you have paid for it but don't have it"

-Henry Ford



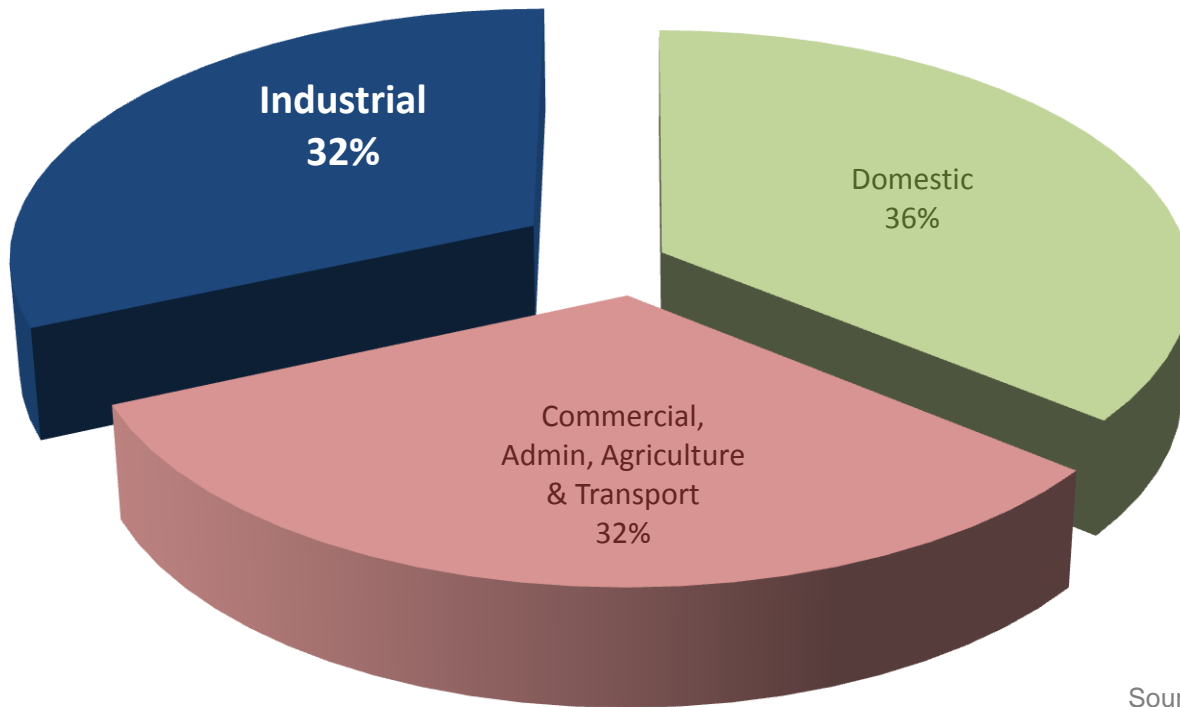
Buy Now or Pay Later

As true today as it was then

What you save by not investing in efficient systems, you lose multiple times in energy costs



Industrial Energy Use

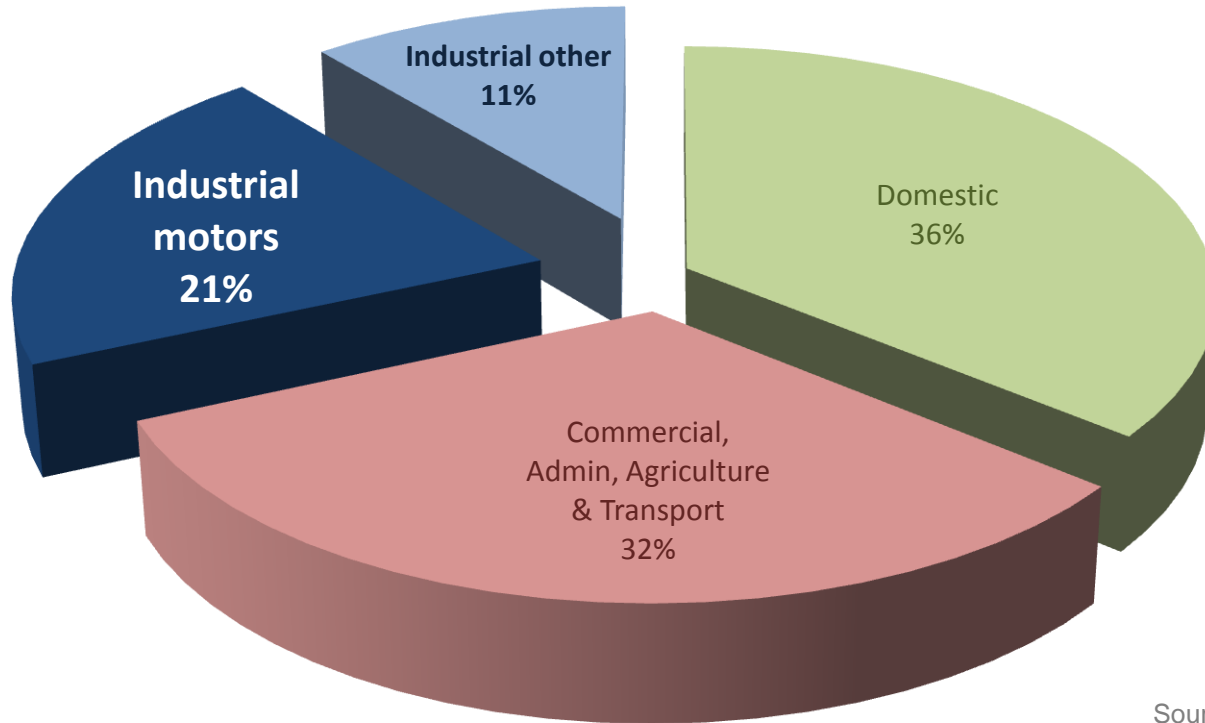


Source: DECC

Industrial Electricity accounts for about one third of the UK consumption



Industrial Energy Use



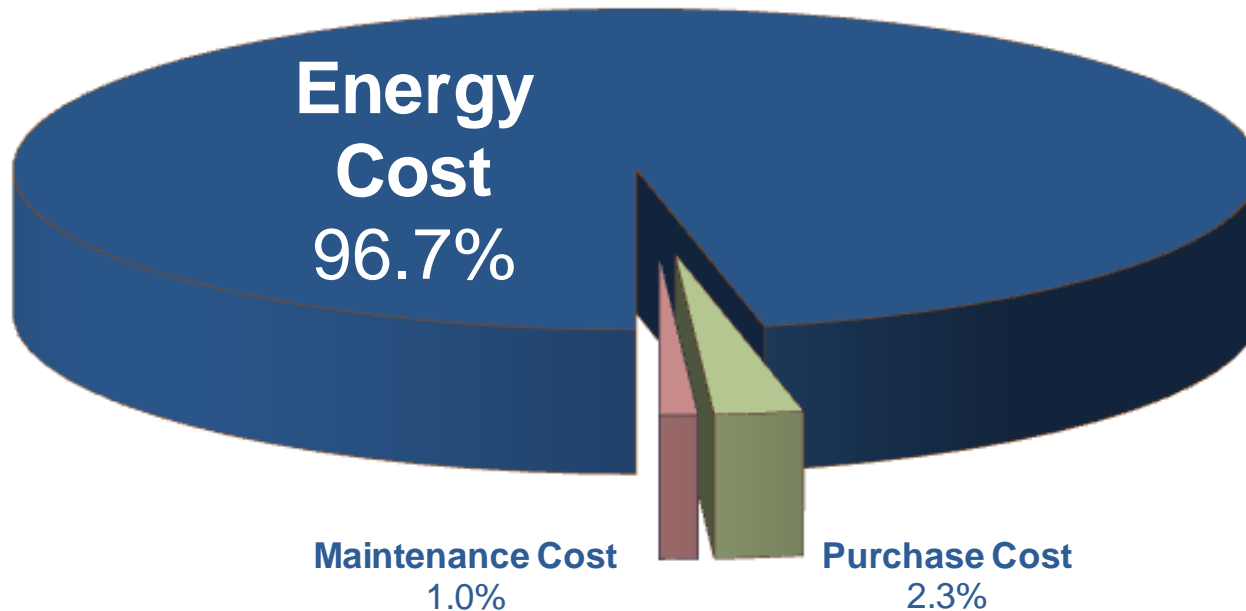
Source: DECC

21% of UK electricity consumption
is by industrial electric motors



Lifetime cost is mostly energy

Source: Almeida, EuP Lot11



- 11kW IE3 Motor
- 4000 hours per year
- 15 year lifecycle

Lifetime cost of a car

- BMW 320i SE Saloon
- £26,195 purchase cost
- 44.8 mpg
- 15,000 miles per year
- £1.36 per litre



- **Purchase cost - £26,195**
- **Annual running cost - £2,067 – 7.9% of purchase**
- **10 year running cost - £20,670 – 79% of purchase**
- **10% less efficient costs £230 per year extra – 0.9% of purchase cost**

Lifetime cost of a motor

- 11kW IE3 motor
- £675 purchase cost
- 4,000 hours per year



- **Purchase cost - £675**
- **Annual running cost - £1,865 – 276% of purchase**
- **10 year running cost - £18,650 – 2763% of purchase (over 27 times the cost to buy)**
- **10% less efficient costs £207 per year extra – 31% of purchase cost**

Imagine your car is a motor

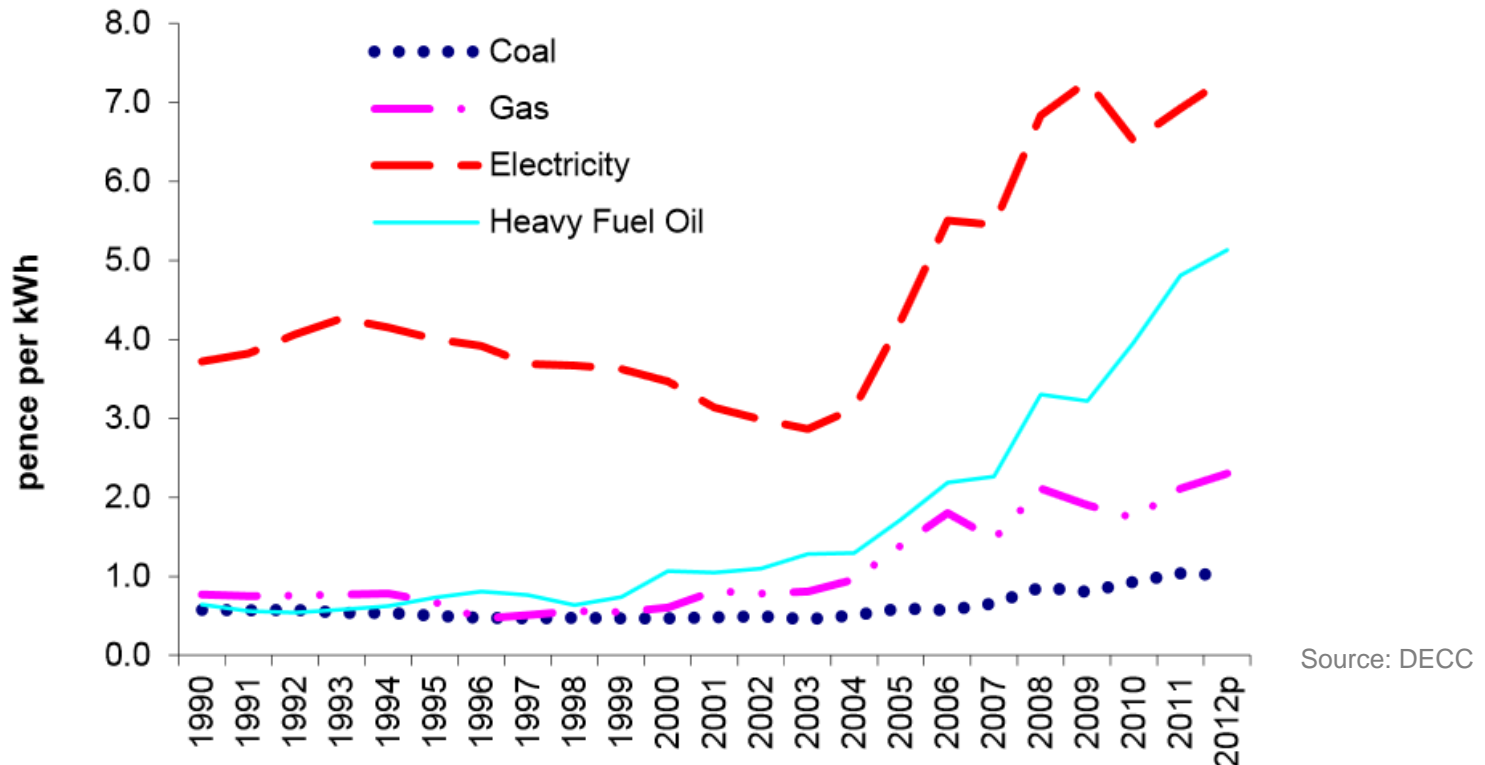
- BMW 320i SE Saloon
- £26,195 purchase cost
- ~~44.8 mpg~~ **1.3 mpg**
- 15,000 miles per year
- £ 1.36 per litre



- **Purchase cost - £26,195**
- **Annual running cost - ~~£2,067~~ £72,500**
- **10 year running cost - ~~£20,670~~ £725,000**
- **10% less efficient costs - ~~£230~~ £8,000 per year extra**

Rising Energy Prices

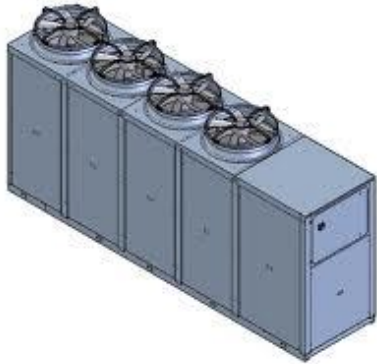
Chart 3.1.2: Fuel prices for manufacturing industry



Electricity costs have more than doubled since 2004

Purchase Price Trap

Standard System



£ 20,000

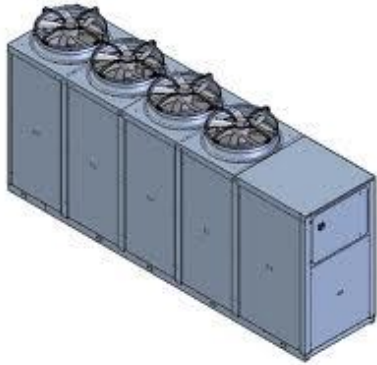
High Efficiency System



£ 40,000

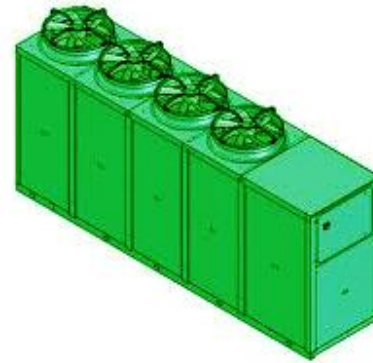
Lifetime Cost Analysis

Standard System



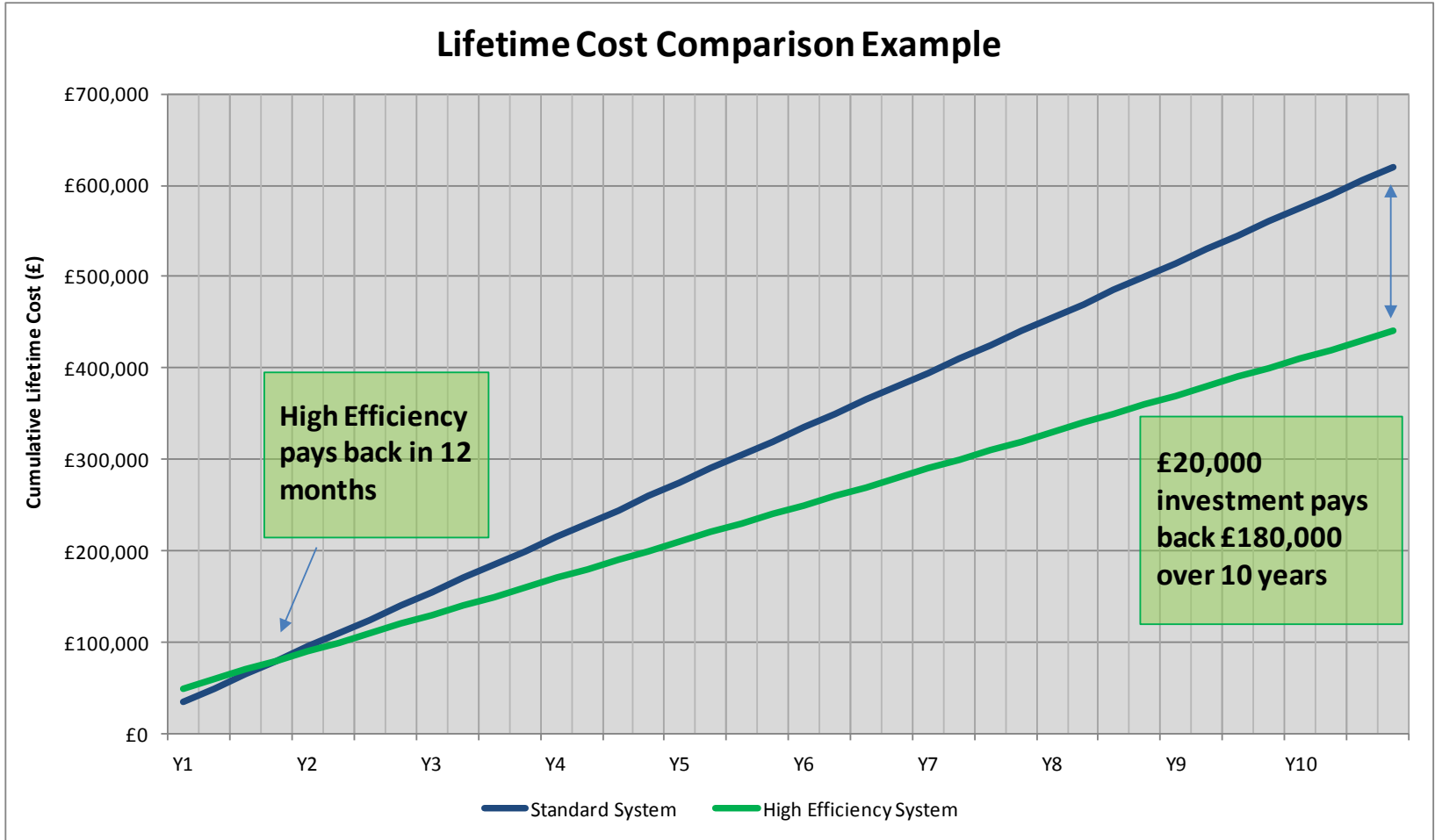
Purchase	-	£20k
Energy 1 yr	-	£60k
First yr	-	£80k
10 years	-	£620k

High Efficiency System



Purchase	-	£40k
Energy 1 yr	-	£40k
First yr	-	£80k
10 years	-	£440k

Beyond the short term



A Sound Investment

Comparison with other investments

Investment	Annual return rate	10 year return	Source
Energy Efficient Motor System	24.6%	£180,000	<i>GAMBICA</i>
FTSE 250 shares	9.6%	£50,019	<i>FTSE Group</i>
UK Housing Market	8.4%	£44,805	<i>Halifax House Price Index</i>
Cash ISA	3.0%	£26,878	<i>Guardian Money</i>



A Sound Investment



What's stopping people?

3 reasons why people don't invest in energy efficient systems

- 1. Not aware of the potential savings**
- 2. Focus on purchase price**
- 3. Lack of systematic approach**



1. Lack of awareness



A thought experiment...

Imagine that your car;

- Has no accelerator pedal
- Has a 300 bhp engine set at constant 5500 rpm
- Can only be slowed down by gears and brakes



- Very inefficient
- Burning fuel all the time
- Wasting energy
- Costing money

Yet many electric motors are used this way. Oversized, always on, no speed control, with a damped load to control output



Control is key

Switch it off, turn it down

Control Type	Description	Energy Benefit
Fixed Speed Control (Contactor, DOL, Soft Start)	Automated logic control, motor runs at constant speed but is automatically turned off when not required	Energy is not consumed when the motor is off
Variable Speed Control (VSD)	Motor speed can be variable to match the output requirements	Energy is reduced when the speed is reduced (see load types)

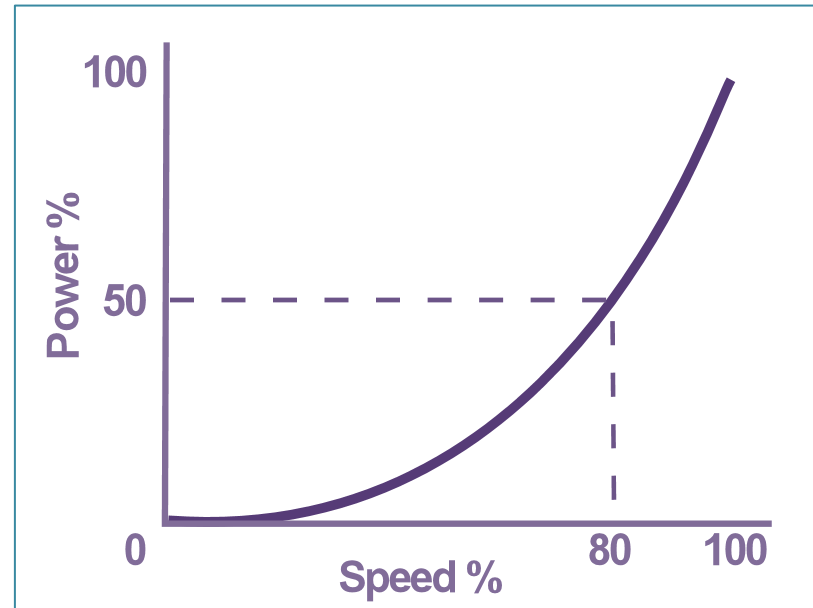


Load Types

Variable Torque

Typical applications

- Pumps
- Fans
- Centrifugal Compressors



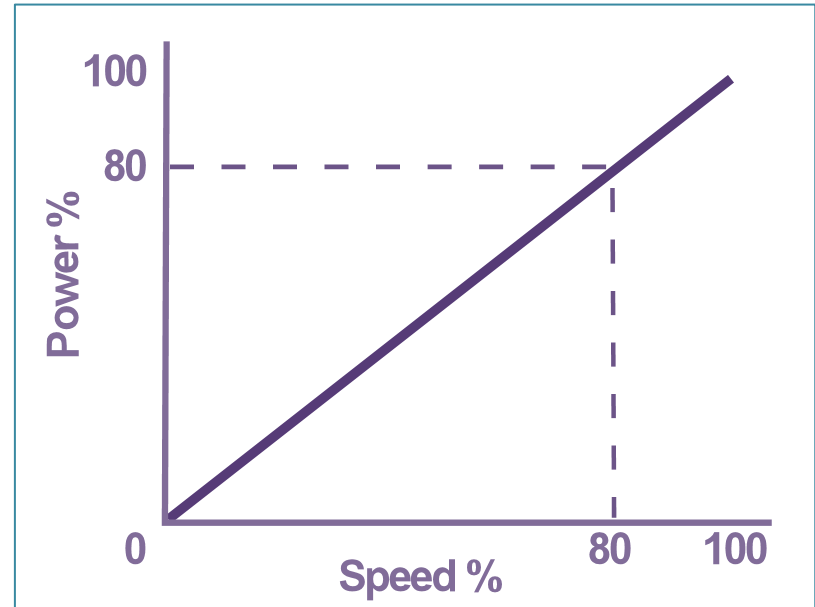
20% speed reduction = 50% energy reduction

Load Types

Constant Torque

Typical applications

- Conveyors
- Reciprocating Compressors
- Roots Blowers
- Crushers



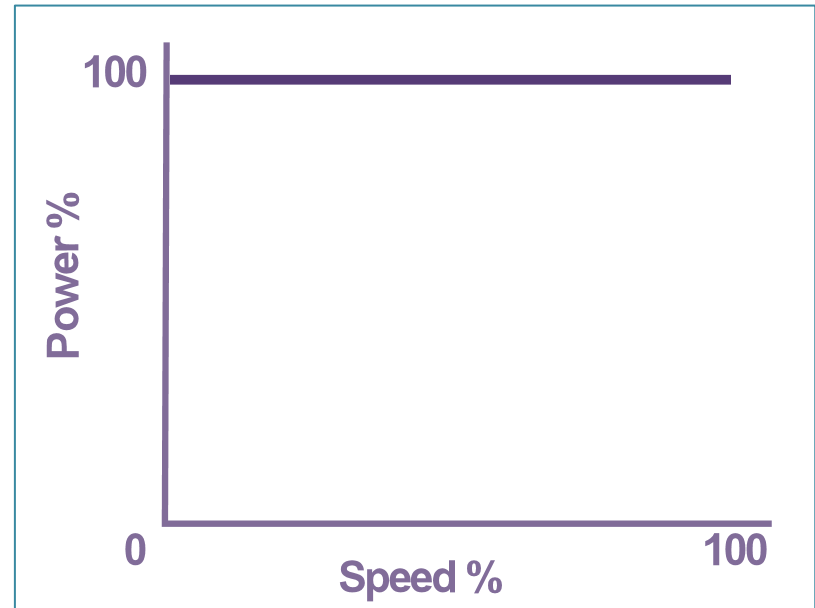
20% speed reduction = 20% energy reduction

Load Types

Constant Power

Typical applications

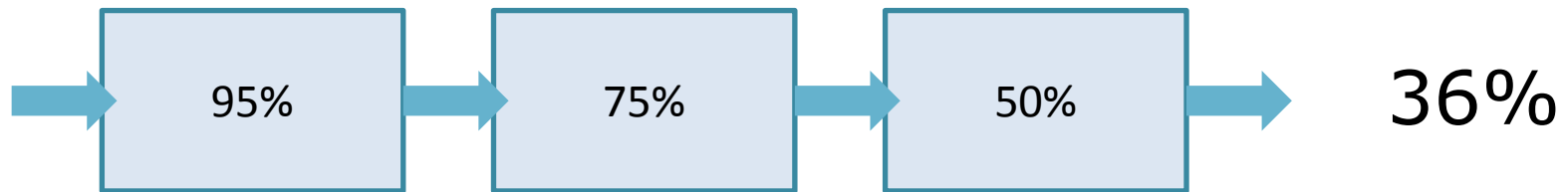
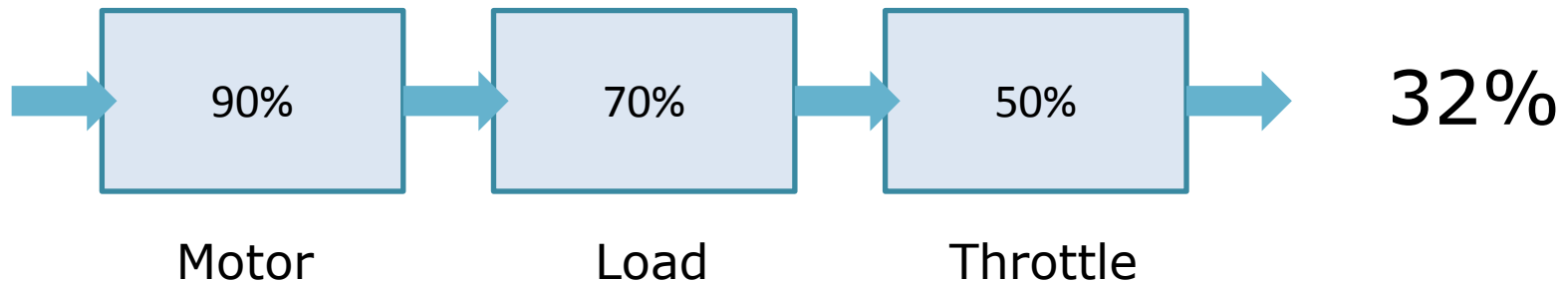
- Machine Tools
- Centre Winders



20% speed reduction = No energy reduction

System Efficiency

More than just the sum of the parts

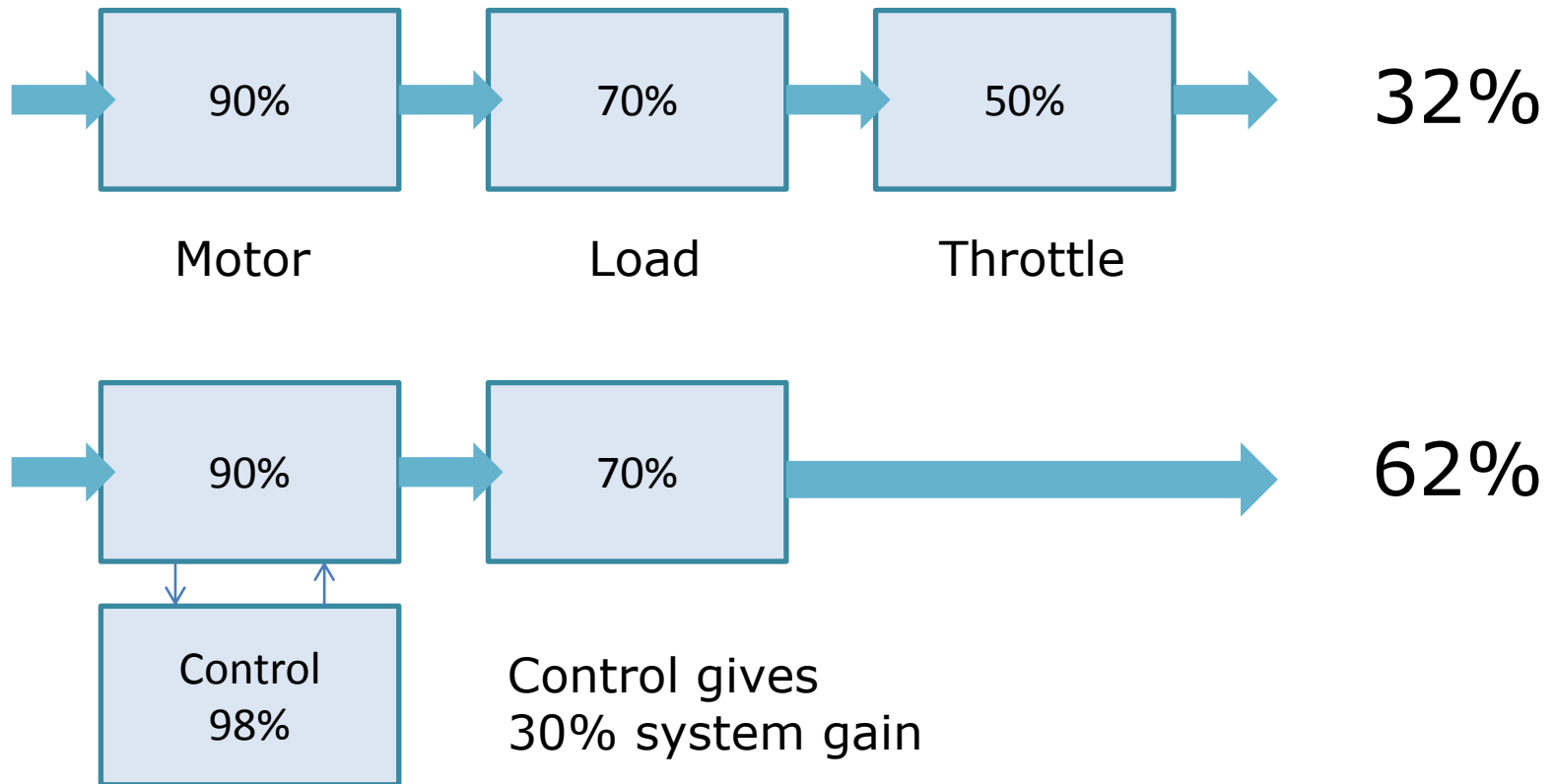


High efficiency components give 4% system gain



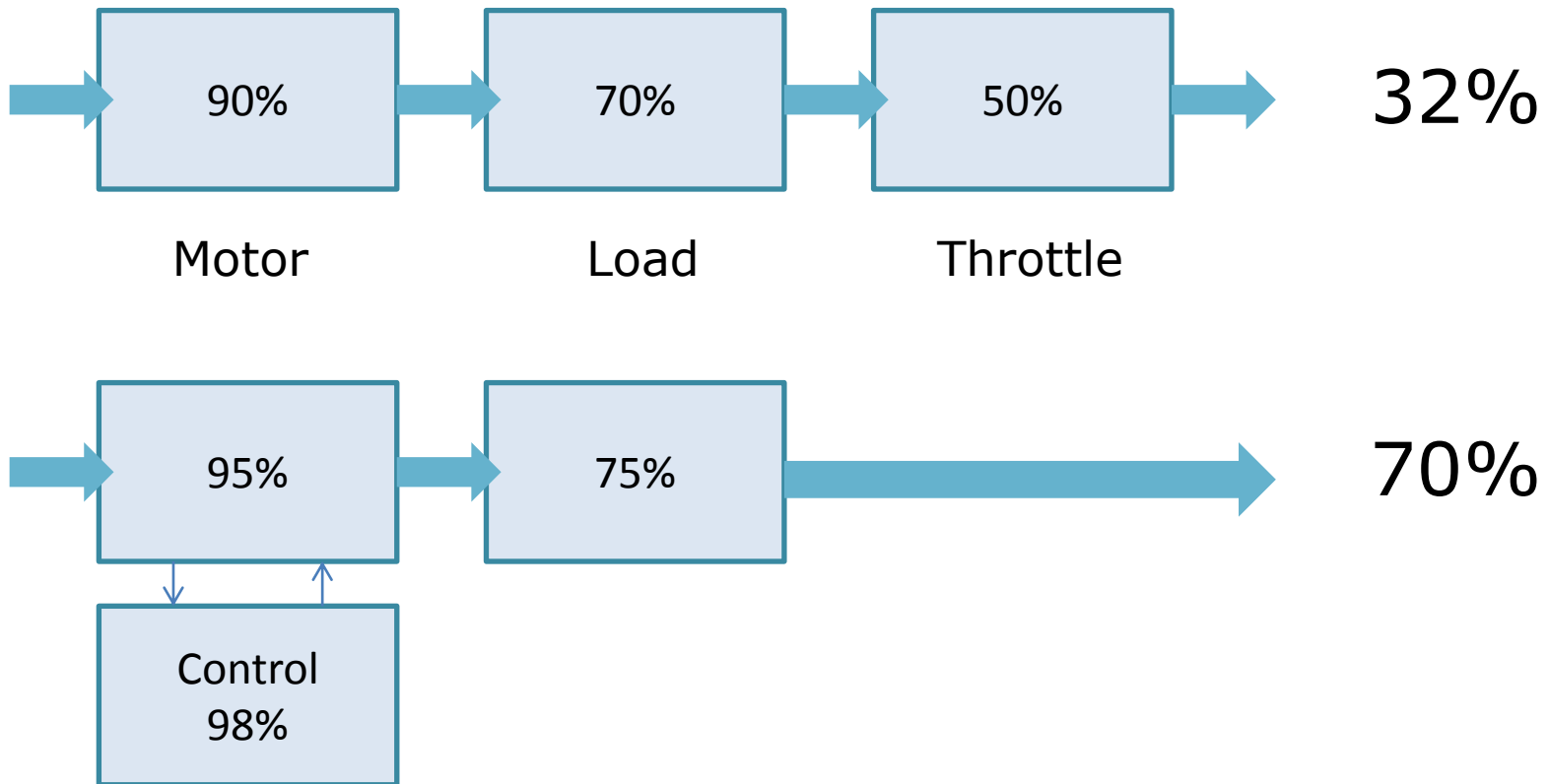
System Efficiency

Control can add significant system benefits



System Efficiency

The combination can yield even greater gains



2. Focus on selling price

Problem – Lifetime cost is not part of the purchasing decision

Buyer

- Purchaser is measured on purchase price
- User is measured on output and uptime
- Energy bill paid by financial admin

Vendor

- Competes on selling price



2. Focus on selling price

Solution – Lifetime cost built into specification, quotation, selection, validation and performance measurement

Specification	Energy consumption targets are set
Quotation	Vendor estimates annual energy cost
Selection	Lifetime cost is one of the selection criteria
Validation	Equipment signed off if meets the agreed target
Performance Measurement	Production and Maintenance are measured



3. Systematic approach

Energy management system

- Use of standards such as ISO 50001
- Appoint responsibilities to drive change
- A nominated energy manager
- A board member champion
- Energy as a company KPI
- Energy consumption as a KPI for key staff in relevant areas.



3. Systematic approach

Common pitfalls

- Seeing energy as a technical project for engineering departments without a budget
- Sweating assets in the belief it saves money, but in reality consumes more energy
- Purchasing energy efficient products, but not making big gains that system control brings
- Viewing energy cost reduction as a tariff negotiation exercise with the energy supplier



Case Study 1

Airport Air Handling System - *Variable Speed Motor Control*

	Before	After
Control method	All fans on continuous running	All fans controlled by Variable Speed Drives
Output control	Motors run at full speed.	Fan speed controlled by VSD, linked to air monitors
Saving (£pa)	-	£100,000
Payback period (months)	-	12 months



Case Study 2

Industrial Process Cooling System - *Variable Speed Motor Control*

	Before	After
Control Method	Direct on line started	Variable Speed Drives
Output Control	Variable dampers	Output controlled by VSD
Absorbed Power (kW)	320 kW	50 kW
Operating Cost (£ p.a.)	£128,656	£38,348
Capital Investment (£)	-	£47,440
Payback Period (months)	-	6 months



Case Study 3

Airport baggage conveyors

- *Automated Direct On Line start/stops*

	Before	After
Control Method	Always On	DOL, Automated
Absorbed Power (kW)	2.2 kW	1.2 kW
Operating Cost (£ p.a.)	£8,126	£4,131
Saving (£ p.a.)	-	£3,995 (49%)



Where are motors used?

Hidden in basements and behind panels

Not just in heavy industry

Also in offices, retail, assembly, etc

- Ventilation, Air conditioning, Heating
- Refrigeration and Chilling
- Lifts, Hoists, Cranes
- Conveyors, Storage, Handling
- Water, Oil, Gas, Fluid handling
- Machinery, Packaging, Automation



GAMBICA VSD Calculator

For pump and fan loads

<http://www.gambica.org.uk/vsdcalculator>

BEFORE

Step

Application data

①	8	hours per day
②	7	days per week
③	50	weeks per year
④	£0.10	Price per kWh
⑤	90	Motor size kW

Running costs

→	2,800	Hours run per year
	=	
→	£25,200	Motor annual energy cost

AFTER

⑥ **20%** **Motor Speed**
Percentage turn down



→	£9,642	Total VSD/installation cost	i
	+		
	£12,902	Revised annual energy cost	
	=		
	£12,298	Yearly energy savings	=
	=		
	9	months payback period	

=

49%

Energy Savings



Capital Allowances

Enhanced Capital Allowance scheme (ECA)

- Run by The Carbon Trust
- Valid for products on the Energy Technology List (ETL) – VSD and Motors -
<https://etl.decc.gov.uk/etl/site/etl/browse-etl/motors-drives.html>
- Customer can claim 100% value in the first year on tax return

Capital Allowance changes

- From Jan 2013 for 2 years
- Investment allowance changed from £25k to £250k per year



Capital Allowances

Type	Value
Enhanced Capital Allowance (ECA)	Qualifying products: 10 x 90kW Variable Speed Drives Claim Value: £100,000 Corporation Tax rate: 24% ECA saving: £24,000
Capital Allowance	Claim Value: £200,000 Corporation Tax rate: 24% Capital Allowance Tax Saving: £48,000
Energy Saving	10 x 90kW drives, 4000 hours per year saving 33% of energy Energy saving per year: £120,000
Total Savings	First year: £192,000 Following years: £120,000 Payback: less than 2 years



Ecodesign Directive

Commission Regulation (EC) No 640/2009 sets minimum standards for electric motors, defined by IEC standard 60034-30:2008

Date	Motor Range	Minimum Efficiency Standard
June 2011	0.75 kW to 375 kW	IE2 (with fixed or variable speed control)
January 2015	7.5 kW to 375 kW	IE3 (with fixed or variable speed control) or IE2 with Variable Speed Drive
January 2017	0.75 kW to 375 kW	IE3 (with fixed or variable speed control) or IE2 with Variable Speed Drive



Further Information

GAMBICA Technical Publications

www.gambica.org.uk/technicalpublications

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Thank you

