A Guide to Energy Saving with Compressed Air

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A Guide to
Energy Saving with Compressed Air

1. Why should I save energy when compressed air is “cheap”?

Compressed air is one of the oldest forms of energy used by man. Over 2,000 years ago a Greek by the name of Ktesibios developed an air gun, which was wound up by hand. The winding action compressed air in specially manufactured cylinders. When this air was released (i.e. when the gun was fired) it gave the gun's projectile a much greater range of fire.

Today, compressed air is used for more peaceful purposes in every conceivable sector of industry. The fact that it is so commonly used has, for decades, led British industry to conclude that it is "cheap" to produce. The truth, however, is that it never has been. The leakage from ring main systems and the inefficient running of compressors off-load have all cost industry dear. What has made companies wake up to this fact is the Climate Change Levy (see Appendix 1), which is expected to add about 12% to all non-domestic electricity bills.

This is a blow because compressed air is generated using electricity. Moreover, the fact that its generation is equivalent to about 10% of industry's total electricity usage, rising to 30% in some sectors, highlights why companies have compelling reasons to investigate the potential for energy saving in this area. Recently, industry specialists have given added momentum to this new discipline by calculating that the operating costs of running multiple compressed air installations without some form of management control can be more than 30% higher than they should be. And this is just one aspect of a system, although usually the main one. To get the full picture the compressed air system as a whole needs to be examined, from the air compressor itself, to the dryer and filters which condition the air to the pipe work system that delivers it.

2. What are the problems associated with traditional cascade control of multiple compressor installations?

Traditionally, the control of multiple compressed air installations has been achieved using a Cascade controller. The controller ensures only the number of air compressors required to satisfy demand are running, employing a traditional principle of cascaded pressure banding. As compressed air demand rises and line pressure begins to fall, compressors with lower pressure bands come into operation increasing system output. When compressed air demand falls and line pressure rises, only the required number of compressors with higher-pressure bands will operate. This sounds fine in theory, but in practice conventional cascade controllers, or controllers based on cascade principles, have a number of inherent drawbacks. These can be summarised as problems with Pressure Optimisation, Control Optimisation, Compressor Selection and Monitoring.

Pressure Optimisation

Firstly, by using a number of pressure switches each with a typical 0.5 bar differential the controller forces the system to produce compressed air at a pressure above that required (see Figure 1). Only the compressor with the lowest pressure band setting will be operating near optimum required system pressure. This has a dramatic effect on overall system efficiency when you consider that a 0.5 bar decrease in system operating pressure will reward an additional 5.25% reduction to the overall cost of electricity consumed by the system.

The combined additional cost to overall system efficiency of the above can be as much as 11%.

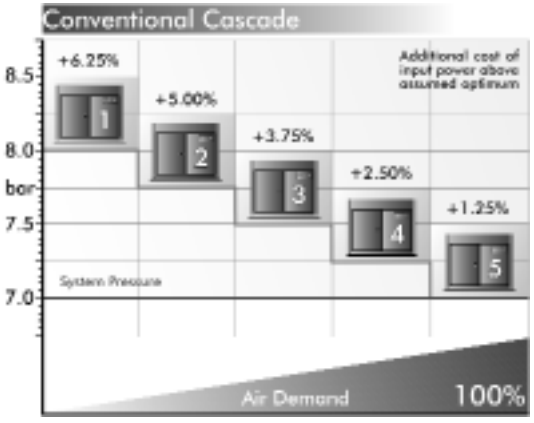
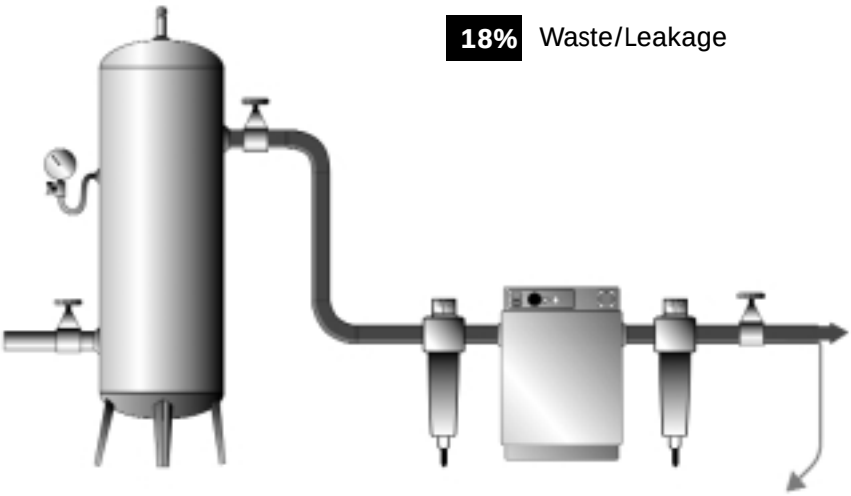


Figure 1

Control Optimisation

A conventional cascade arrangement generally does not allow for 'fine tuning' of either compressor utilisation and / or air system pressure and demand changes; such as shift pattern changes, weekend shutdowns or low demand periods. This, again, can have a dramatic effect on overall system efficiency. For example, by shutting a compressor system down when it is not required (weekends, holidays & non-production periods) typical air leakage rates of as high as 18% of annual system output can be overcome, enabling reductions in the overall cost of electricity associated with the compressed air system (see Figure 2).



Operational hours per annum would be	5600 hrs
Non-operational hours would be	3160 hrs
Thus wasted energy = 18% of (3160 hrs x 300kW)	170640kW

Therefore annual savings through timer control optimisation will save this site up to

£7678 per annum*

Figure 2

Compressor selection:

With the cascaded pressure switch method of selection, compressors are managed in a very basic and routine way to even out utilisation. Typically on a weekly or monthly rotation of selecting compressor 1, 2, 3, 4, moving to 2, 3, 4, 1 and so on. Additional factors may influence and limit the user ability to cascade compressors evenly such as varying compressor sizes and site air demand pattern changes. This restricts the users ability to select the optimum compressors to match air demand at a given point in time resulting in increased system energy costs.

Monitoring capability:

Traditional cascade controllers are generally not able to monitor the compressed air system and provide diagnostic data for the user. Any system efficiency deterioration can go undetected and result in increased operating costs.

3. How do I find out if my compressor installation is inefficient?

Data logging is the most efficient method of determining the relative efficiency/inefficiency of a compressed air installation and the commensurate opportunities for energy saving. Any data logging system that is used must be able to deliver quantifiable data and measures that can be acted upon. Systems offered by compressed air specialists can provides these facilities. A typical system from EnergAir can gather-up data at one log per second. At set time periods the logged data is downloaded to purpose designed software, EMAS Manager, which analyses usage trends. Importantly, this system focuses on the input current to each compressor, using actual electrical power consumed - not catalogue data from the compressor manufacturer.

4. What measures have to be taken to make my installation efficient?

Avoiding leakage

One of the most fundamental ways in which the efficiency of any compressed air installation can be improved is by reducing leakage. While every effort should be made to keep a compressed air system leak-tight, all systems will have some leakage. There are however, some ways of reducing opportunities for leaks:

- Don't generate at a higher pressure than necessary - the higher the pressure, the more air that will escape through a given-size hole.
- Don't keep your whole system pressurised during non-productive hours just because a few items of machinery require a constant supply of compressed air.
- Do isolate parts of the system that require air at different times. Isolation valves can be operated manually or automatically using simple control devices like time switches or interlocks, or they can be controlled using your building energy management system, if you have one.
- Do take advantage of the fact that under the Pressure Systems and Transportable Gas Containers Regulations, you must inspect your compressed air system regularly. These inspections are an ideal opportunity to find and repair leaks.

Where to look for leaks

- Condensate traps, fittings and pipework, flanges, manifolds, filters, cylinders, flexible hoses, instrumentation, tools and drainage points.

Variable Speed Drive Systems to Eliminate Off-Load Running

- Compressor installations that require energy efficient improvement show a major opportunity for inverter drive systems to eliminate off-load running, an expensive cost and energy aspect of compressor installations. The drives in conjunction with a centralised management system will almost completely eliminate off load or non-productive running (i.e. the motor is running but airis not being compressed usually represents up to 50% of full load power) and the associated energy cost.

5. How can drives and systems management help?

Control Techniques, the UK's leading manufacturer of variable speed drives and systems, and EnergAir Solutions, a specialist in delivering intelligent compressed air control, have formed a drives partnership to provide UK companies with large compressor sets* (see note 1 below) with the means to save energy and offset the effects of the Climate Change Levy.

The partnership allies Control Techniques drive technology in the form of the unique multi-function Unidrive, with EnergAir's Enercon Air Management System: a modular collection of products and services which includes System Controllers, Interface Modules, Enersoft PC Monitoring and Control Optimisation Software, Data Logger and Analysis software and Active Network Interfaces. Combined, these products ensure that each and every element of the compressor installation - filter, dryer and compressor - is connected and monitored either on site or remotely - 24 hours a day - ensuring all components are used at maximum efficiency.

The Control Techniques Unidrive, which is used in conjunction with the Enercon Energy Management System, is used widely to reduce energy usage in the operation of fans and pumps.

Similar operating conditions also mean that the Unidrive is the ideal VSD for use as the optimising element in compressed air applications, matching demand to supply in cascaded compressor operations.

Note 1

Savings can be gained from almost any multiple compressor installation rated at 4kW and above. However, results have shown that 30kW is the usual baseline from which savings are of sufficient magnitude to deliver the payback periods required by UK industry.

6. What is the role of variable speed drives in energy management?

Significant efficiency gains are achieved by adding a variable speed drive (VSD) to a designated compressor in a bank of cascaded units. These gains are realised by using the drive in conjunction with a suitable controller, such as EnergAir's Enercon "S" series unit. The latter employs an enhanced efficiency single pressure band system and is also fully VSD compressor aware, meaning that it is capable of data-linking with the VSD Compressor to form a coherent air compressor management system which acts in unison with all system resources to provide optimum efficiency at all times under all operating conditions (see Figure 3).

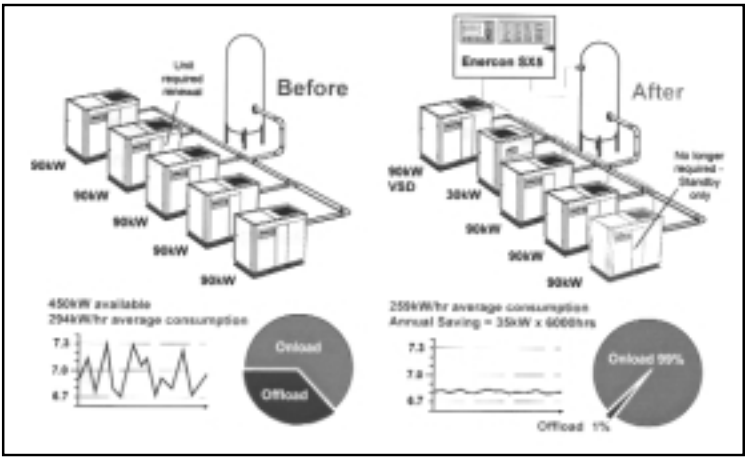


Figure 3

VSD Compressor - Operation

A VSD equipped compressor operates by varying air compression flow in response to changes in detected air system pressure in order to maintain an exact and constant pressure level (Target Pressure). As air system demand falls, and more air is delivered into the air system than is being used, the system pressure will begin to rise and the VSD compressor will reduce speed, and hence output, to maintain the Target Pressure Level.

An increase in system demand above that which is being produced will cause system pressure to begin to fall. This will cause the VSD compressor to vary output in direct response to changes in system pressure and hence changes in system demand. By operating in this manner the VSD compressor can continually maintain a close relationship between the amount of energy being consumed and the output being produced.

7. What Enhanced Capital Allowances (ECA's) mean for your company

The strong argument for investigating the energy saving possibilities of drives in compressor applications has been made more compelling by the provision, within the Government's Climate Change Levy Package, for enhanced capital allowances (ECAs) on eight categories of equipment, variable speed drives being one of the categories. (For more information log onto www.eca.gov.uk)

Under the ECA scheme companies who purchase VSDs for energy saving applications, from the approved list of suppliers, will be able to offset some, or all, of the full cost, along with any capital costs incurred on the installation of the VSD, against corporation tax in the year of purchase. This gives a cash flow benefit and is estimated at about 5% discount off the capital cost.

If a VSD is purchased from the list of qualifying VSDs enhanced capital allowances can be claimed on the cost of that VSD along with any capital costs incurred directly on its installation. In order to do this, companies will need to keep a record of their expenditure, i.e. their invoice statement in order to claim on the correct amount. Do not use the amounts in the table below.

In instances where a larger item of plant or machinery is acquired, with a qualifying VSD already installed, then the proportion of the cost that relates to that VSD will attract enhanced capital allowances. The amount able to be claimed when buying a secondary piece of equipment that is incorporated with an eligible VSD is given in the table below (Figure 4). It includes provision for supply of the VSD and typical enclosure (including measures to meet EMC directives) or the cost of integrating it into other equipment. Other costs for associated control equipment such as programmable logic controllers (PLCs), transformers etc are not included.

The provision of ECAs is not limited to new installations. Companies with "mature" installations can also benefit. In the past the retrofitting of drives to older installations was viewed as too difficult. The Control Techniques/EnergAir partnership overcomes this problem. The Enercon Management System with its comprehensive interfacing facilities enables integration of the Unidrive and the savings to be made.

Enhanced Capital Allowance Motor Claim Levels

Motor Rating	**Incorporated prices**	
kW	Up to 690 V	Over 690 V
1 phase input		
0.37	£202	
0.55	£224	
0.75	£260	
1.1	£310	
1.5	£338	
2.2	£429	
3 phase input		
Up to 0.75	£474	
1.1/1.5	£547	
2.2	£672	
3	£767	
4	£900	
5.5	£1,211	
7.5	£1,628	
11	£1,902	
15	£2,494	
18.5	£3,079	
22	£3,592	
30	£4,057	
37	£4,818	
45	£5,376	
55	£7,178	
75	£8,102	
90	£9,889	
110	£10,841	
132	£12,469	
150-160*	£14,911	

Figure 4

*Allowances available for larger drives. See www.eca.gov.uk

8. What is the first step in implementing an energy saving programme?

The first step in implementing an energy saving program is to contact EnergAir for a free, no obligation quotation and pay back estimation. Alternatively take advantage of EnergAir's NO capital cost supply, fit and installation plan which could allow your company to enjoy the energy savings benefits of installation immediately.

For further information contact:
Graham Coats, EnergAir Solutions Ltd, Unit 2, Goodsons Mews, Wellington Street, Thame, Oxfordshire, OX9 3BX.
Tel: 01844 215328.
Fax: 01844 216595.
E-mail: sales@energair.co.uk.
Internet: www.energair.co.uk

Control Techniques UK Headquarters, Stafford Park 4, Telford, Shropshire, TF3 3BA
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9. Useful web sites for further reference information

Ø www.eca.gov.uk - for qualifying equipment and ECAs
Ø www.etsu.com - for data regarding energy efficiency and sustainable energy technology
Ø www.greendrives.com - for information on the role of drives in energy saving applications
Ø www.energair.co.uk - for information on energy management of compressed air systems.

Appendix 1
The climate change levy

The Climate Change Levy, announced by the Government in 1999, the UK's response to the Kyoto Summit on Global Warming held in December 1997. At that summit Her Majesty's Government (HMG) made a legally binding commitment to reduce the UK production of a basket of 6 greenhouse gasses by 12.5%, but also made a manifesto commitment to reduce the UK production of CO2 by 20%. These targets are for a reduction on 1990 levels for the period 2008 -2012.

The Climate Change Levy is the result of these commitments. Basically a tax on energy usage by business and commerce, the CCL is designed to motivate business and commerce to adopt energy efficiency measures, leading to a reduction in CO2. Under the levy the cost of gas, coal, LPG and electricity will rise by a constant levy per kWhr equivalent. As electricity is generated by burning the other fuels, at an efficiency no better than about 35%, it will carry a levy of 0.43p/kWhr. Assuming a consumer is paying 3p/kWhr at present, that is an increase of 14.3% on current prices. This will take effect in April 2001.

Appendix 2
What typical levels of saving can I expect?

The results of applying the Enercon Management System to achieve Pressure Optimisation, Control Optimisation and Leakage Optimisation on a typical five compressor installation are shown in Figure 5. In this typical installation savings of £14,757.50 per annum are realised

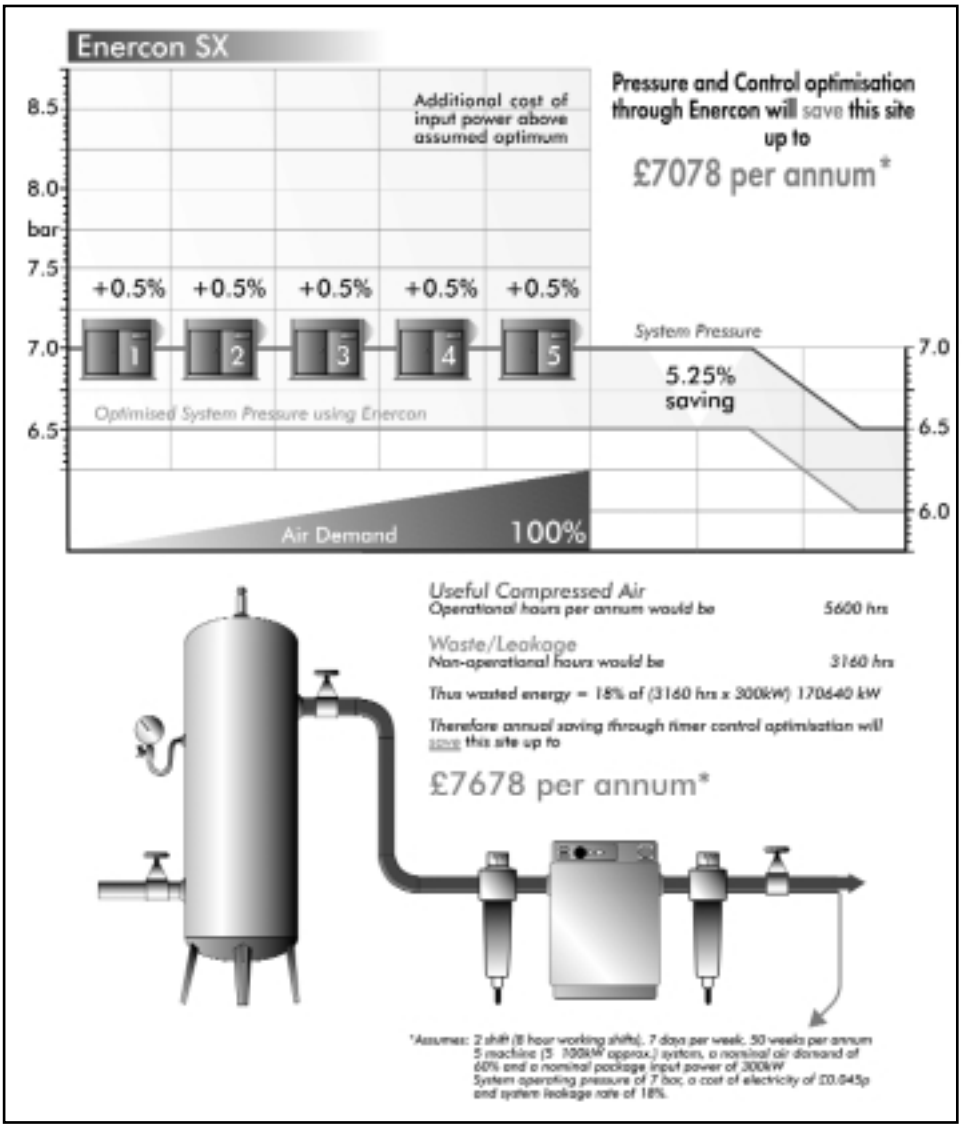
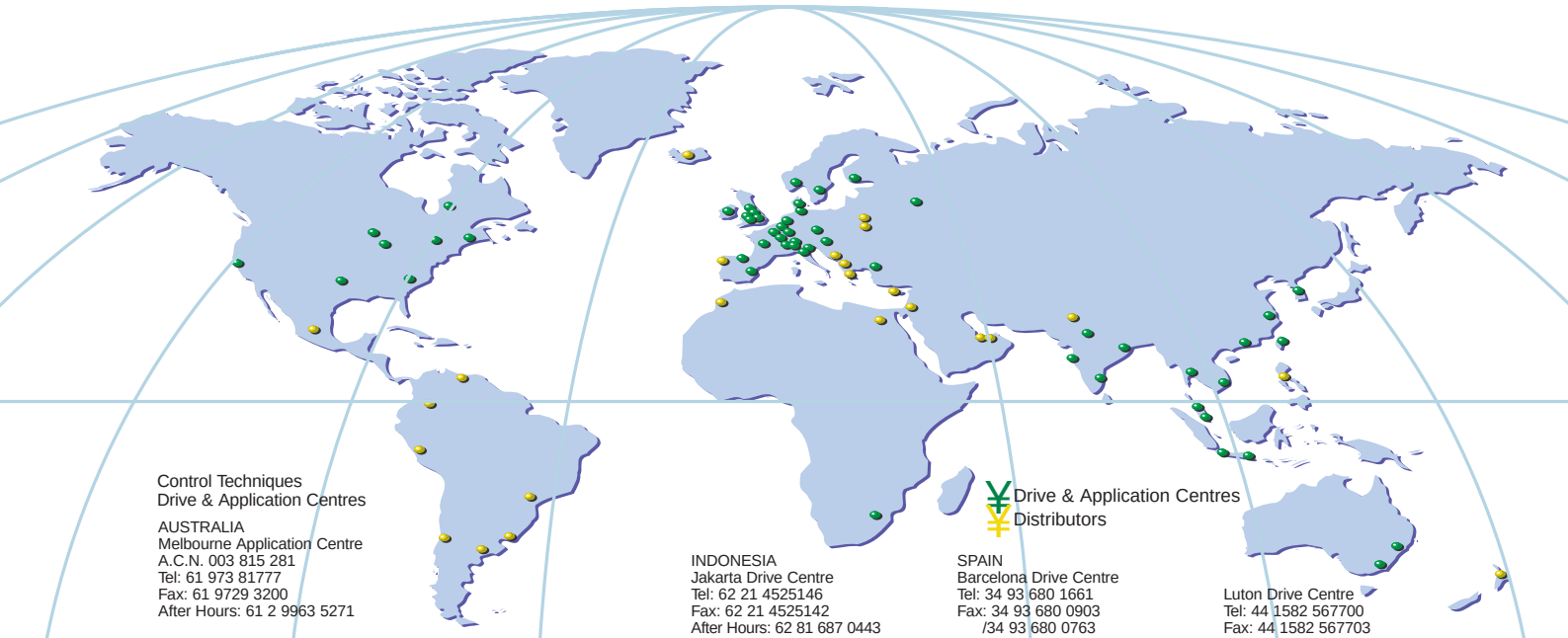

Enercon SX
Additional cost of input power above assumed optimum
Pressure and Control optimisation through Enercon will save this site up to
£7078 per annum*
8.5
8.0
bar
7.5
7.0
6.5
+0.5%
+0.5%
+0.5%
+0.5%
+0.5%
1
2
3
4
5
System Pressure
5.25% saving
Optimised System Pressure using Enercon
7.0
6.5
6.0
Air Demand
100%
Useful Compressed Air
Operational hours per annum would be
5600 hrs
Waste/Leakage
Non-operational hours would be
3160 hrs
Thus wasted energy = 18% of (3160 hrs x 300kW) 170640 kW
Therefore annual saving through timer control optimisation will save this site up to
£7678 per annum*
*Assumes: 2 shift (8 hour working shifts), 7 days per week, 50 weeks per annum
5 machine (5 100kW approx.) system, a nominal air demand of
60% and a nominal package input power of 300kW
System operating pressure of 7 bar, a cost of electricity of £0.045p
and system leakage rate of 18%.

Figure 5

driving the world...



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