Preface

Reducing energy use makes perfect business sense; it saves money, enhances corporate reputation and helps everyone in the fight against climate change.

The Carbon Trust provides simple, effective advice to help businesses take action to reduce carbon emissions, and the simplest way to do this is to use energy more efficiently.

This overview for businesses in the high temperature sector introduces the main energy saving opportunities and demonstrates how simple actions can save energy, cut costs and increase profit margins.
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Energy consumption

The high temperature industry is very energy intensive. Recent increases in energy prices have had a major impact on companies in this sector, so reducing energy consumption makes good business sense.

As the name suggests, businesses in the high temperature sector have intensive process operations, which usually use furnaces or kilns and operate at 500°C or above. Examples of the high temperature industries include iron and steel production, foundries and glass manufacturers.

Why save energy?
Some people working in the high temperature industries believe that energy bills are a static overhead cost. This is a myth. By taking a positive and proactive approach to energy efficiency, businesses can control and reduce their energy spend. All industrial companies are under pressure to cut costs and increase profits, and saving energy is one good way to meet this goal. There are many sites which have changed in the last decade, and they continue to improve. Their success demonstrates that it is possible to reduce carbon emissions and save on energy costs.

Furthermore, by participating in Climate Change Agreements (CCAs), most of the manufacturing industry is committed to achieving targets for energy saving.

Saving energy also improves environmental performance. It can help achieve ISO14001 and, by cutting carbon emissions and helping to combat climate change, demonstrates a degree of corporate social responsibility to stakeholders. For more information about CCAs and other government instruments, see page 24.

Managers in the high temperature industries are often concerned that changes in process or utilities will lead to compromising the quality or consistency of their product. But by taking action, this energy intensive industry can reduce its consumption – and its costs – with no impact on the product.

Who should read this overview?
This overview has energy cost saving ideas relevant to all industrial companies in the high temperature sector. More information about other industrial sub-sectors and further energy saving advice is available from the Carbon Trust.

This overview is for production and engineering managers and business leaders in manufacturing. It lists straightforward, low-cost measures as well as investment opportunities, which might require specialist advice and assistance.

To meet obligations from Climate Change Agreements, companies need to demonstrate continuous improvement in energy efficiency.
Energy saving opportunities

Processes and process control

A poorly controlled plant is almost always a major cause of extravagant energy consumption.

Business managers in this sector tend to be primarily concerned with product quality and consistency. As such, some people in this field worry about risks of changing their processes. However, analysis and improvement to the production process does not necessarily mean compromising the output. Energy savings mean cost savings and with the right approach, these can be significant.

Analyse the process

The first step to achieving good processes is to look at the product and see how the processes work together to create it. There may be ways to improve or tighten processes without compromising the output.

One of the key ways to improve a process is to improve its control. This is often automated and can be very complex, but there are some good reasons to ensure that the control system is well designed and maintained:

- **Energy savings** – A well-controlled plant is energy efficient, which means better profit margins.

- **Safety improvement** – Basic controls maintain safe conditions.

- **Better environmental performance** – High temperature industrial operations can damage the environment through loss of containment, for example if tanks overflow or if valves are left open. Improved process control makes such an incident less likely.

- **Consistent product quality** – This reduces waste material and increases customer satisfaction.

- **Reduced manufacturing costs** – Good control systems can minimise the cost of manufacture.
The following actions have significant potential to reduce energy use for minimal or no outlay.

**Are products being over-processed?**
If plant are manually controlled, it is common practice to operate them well within the staff members’ comfort margin. This means that while the product specification is met, the need for frequent manual intervention is minimised. A consequence is over-purification or overspecification of the product that usually results in excessive energy consumption and is very expensive. Automating simple tasks can yield remarkable results. Process operators are less effective at routine control tasks than a control system – even the best operator cannot monitor the plant every second and decide if something needs to be adjusted, whereas a control system can.

**Check for excessive or variable energy consumption**
The energy consumption of a plant will vary with throughput, but the ‘specific energy’ (energy/unit of product) should be approximately constant at any given throughput. If specific energy varies significantly, then there are likely to be control issues that should be addressed. A control engineer will be able to tune and improve existing control systems if there is a problem.

**Check controls have not been switched from automatic to manual**
This is very common in high temperature industries. Operators usually have a good reason for switching to manual control. It could be that the controller is not working properly because of poor measurement, it may be wrongly specified, or it may not be tuned correctly. A control engineer should be able to rectify the problem and restore automatic control, which is usually the most energy efficient option.

**Check for unreliable or inadequate measurements**
The control system will not work properly if the measurements it is responding to are inaccurate. The resulting poor control will waste energy, and may deliver poor product, both of which cost companies money. Measurement errors can occur for a variety of reasons, such as the measuring device may have been badly chosen or wrongly calibrated, or there may be a poor signal from the measuring device to the controller. These faults can be investigated by a control engineer and often can be easily rectified.

**Identify control system disturbances**
Disturbances leading to intermittent or cyclic signal variations stop the control system working at peak efficiency, and can lead to excessive energy usage and other problems. Disturbances can be internally generated by badly tuned controllers or externally generated due to changes in process variables. Simple controller tuning or control modifications can reduce disturbances markedly, as can upstream changes to process conditions to minimise changes in process variables. In most cases, simple changes can save money.

**Fact:**
Better process control can typically save a company between 5 and 15% of its process energy.
Furnaces

Furnaces usually consume a very large proportion of the energy used in the high temperature sector. Their efficient use depends on good control and regular maintenance, and their performance can be enhanced in some cases by ‘add-on’ equipment.

The following actions require little or no expense, but can save energy and money. However, making changes to a furnace, its controls or components will require the help of an expert.

Check furnace control
Close control of furnace conditions is essential for good product quality, energy efficiency and minimum emissions. The key variables that need to be controlled will be different for every furnace. A maintenance technician should be aware of the best methods of control for the furnace.

Benchmark furnaces
Quantifying furnace performance in terms of specific energy consumption (energy used per unit of product) and furnace yield (quantity of useable product per unit of material charged into the furnace) allows the monitoring of furnace performance on a day-to-day basis. Performance can then be compared with that of other similar furnaces at the site, or using data available from the furnace manufacturer. Benchmarking establishes whether furnaces are performing well, and identifies if problems are occurring. A sub-meter for electricity or flow meters for other fuels may provide the information required on energy use in the furnace, which can be compared with the feedstock throughput data.

Improve furnace yield
Furnace yield is usually defined as the quantity of useable product per unit of material charged to the furnace. There is often a trade-off between throughput and product quality that means furnace yield can be reduced at high throughputs. Improved yield can be achieved by optimising furnace conditions and throughput. Check current operating conditions against design conditions and historical data to determine the optimum furnace conditions for the best yield.

Reducing scrap material and improving yield can reduce energy use considerably and may be the biggest single factor in a campaign to reduce the energy use of the furnace. Increased yield may actually require more processing energy to achieve, but this can be more than offset by the advantage gained in production by having to waste or recycle less of the product.

Look at charging and unloading
The way a furnace is charged and unloaded can have a significant effect on its safe operation, yield and energy consumption. The two main variables are the speed with which the furnace is charged and unloaded, and the physical configuration of the charge and the way in which it is supported. A review of the current practice may show up ways of safely increasing the speed of loading and unloading, leading to energy savings. It may be necessary to engage consultants to carry out this review.

Benchmarking data can also be used to see if furnace improvements are having an effect on the energy expended.
**Improve furnace scheduling**
In systems with more than one furnace, appropriate scheduling can maximise product throughput and minimise energy use. Determining the optimum schedule can be a complex exercise and needs to be undertaken in a systematic manner. It involves looking at the schedule, throughput, temperature profile and time of operation for each furnace, and then looking at ways of carrying out the whole program in a more efficient manner. Computer-based systems are available to perform the task automatically. Again it is advisable to contact consultants to help with this exercise.

**Check air/fuel ratios**
The air/fuel ratio of the burner is important. The wrong ratio can result in excessive fuel consumption and poor combustion. Poor control, poor set-up or mechanical problems with the burner can all result in an incorrect air/fuel ratio. Measurement of the composition of the furnace flue gases will tell you whether the air/fuel ratio is correct or not. Refer to the furnace handbook for the correct composition of flue gases, and carry out measurement regularly as part of ongoing maintenance and inspection.

For the right applications, capital outlay can result in significant energy savings. Consider the following:

**Efficient burners**
There are many types of possible burners which could be used in a furnace. So when fitting a new furnace do not simply replace like for like, instead consider whether a more efficient burner is available that will give better results. An expert’s opinion would help in the selection of a new burner.

**Waste heat recovery**
A large proportion of the energy used by furnaces is lost either in the flue gases or through the hot product. If this heat can be recovered and re-used in the process, then less energy will be required. Waste heat recovery is a widely applicable technique, but is not always cost-effective: techniques are most cost-effective to large, continuous furnaces and least applicable to smaller, intermittent ones. Some of the more common forms of waste heat recovery are:

- **Flue gas recuperators** – These recover waste heat from the flue gases to pre-heat the combustion air for the furnace.
- **Self-recuperative burners** – These provide energy savings by pre-heating combustion air with the exhaust gases using a heat exchanger incorporated in the burner body.
- **Flue gas re-generators** – These use a short-term cyclic heat storage device as the means of achieving waste heat recovery.
Boilers and steam distribution

Efficiency in both steam and hot water boilers can be improved through good control and by regular maintenance.

Boilers

Efficiency can be improved by a number of methods including improving insulation on the boiler and surrounding equipment, looking at ‘blowdown’ operation and improving heat recovery.

Fouling of heat transfer surfaces should be kept in check as this leads to inefficiency and energy losses.

The Carbon Trust has several publications with ideas for energy saving in boilers, including an overview on Low temperature hot water boilers (CTV051).

Consider fitting economisers

An economiser is a heat exchanger that is attached to the flue gas outlet and transfers heat from the hot flue gas to the water being fed into the boiler. It therefore reduces the amount of energy needed to heat the water in the boiler, and is an excellent way to reduce heat loss and to save energy.

Consider combined heat and power (CHP)

Combined heat and power (CHP) can have significant cost and environmental benefits under the right circumstances. Consultancy support would be needed to determine the viability and long-term payback of CHP for your company. The Carbon Trust can provide advice and publications about CHP.

Consider air pre-heat

Pre-heating the combustion air is another way of saving energy in boilers. Gases from the flue or exhaust are a useful source of heat and flue-gas recovery devices can extract this heat and use it to pre-heat the combustion air. This method is generally cheaper than using the extracted heat to pre-heat water, but has less scope for savings. The combustion air will have to be heated by 20°C to achieve a 1% improvement in boiler efficiency and it cannot be raised above a maximum temperature of around 50°C.

Case study

What other companies are doing

A car manufacturer in the Midlands has installed ten 800kW gas-engine CHP units at its Solihull manufacturing plant, producing significant financial savings and environmental benefits, while reliably supplying electricity and heat with high plant availability.

- Investment cost £6.5 million (financed by the equipment supplier).
- Cost savings of £300,000 with no capital outlay.
- Payback period of 5.5 years, if self financed.
By ensuring efficient steam generation and distribution, you can save between 10% and 30% of the energy used in high temperature boilers and steam systems.

Use VSD-controlled fans as an alternative to dampers
Fans are used to promote the flow of combustion air. The control of air flow is traditionally achieved by applying dampers, while the fans are still working at full load. Energy savings can be made by installing variable speed drives (VSDs) to the fans to control air flow, rather than using the dampers.

Replacement boilers
If the boiler has been in use for a number of years, it may be worth switching to a new more efficient boiler, possibly of an alternative design.

Steam
Check for leaks
Any steam distribution network is likely to have leaks. Implement a regular programme of checking for leaks and repairing them, tackling the largest leaks first.

Look for wisps of steam leaking from faulty steam traps, pipework flanges and joints. Leaks are easily detected and even a small hole can waste a lot of steam so it is important to find and repair them promptly.

Check condition of lagging
All pipework should be insulated to prevent heat losses from steam pipework. Prioritise areas where lagging is missing, damaged or waterlogged.

Steam is an expensive utility. It is also difficult to contain.

Case study
What other companies are doing BP Grangemouth
Replacement and standardisation of steam traps across the refinery site resulted in:
- Annual cost savings of £69,000.
- Annual energy savings of 23,200MWh, equivalent to carbon savings of 4,700 tonnes/year.
- Easier and quicker maintenance.
- Payback period of ten months.
**Tax incentives**

Enhanced Capital Allowances (ECAs) are a straightforward way for a business to improve its cash flow through accelerated tax relief. The ECA scheme for energy-saving technologies encourages businesses to invest in energy-saving plant or machinery specified on the Energy Technology List (ETL) which is managed by the Carbon Trust on behalf of Government.

The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure. The ETL specifies the energy-saving technologies that are included in the ECA scheme. The scheme allows businesses to write off the whole cost of the equipment against taxable profits in the year of purchase. For further information please visit www.carbontrust.co.uk/eca or call the Carbon Trust on 0800 085 2005.

**Fact:**

Around 10% of the heat produced in steam boilers can be lost through insufficient or ineffective insulation of the distribution system.

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**Look for redundant pipework**

On many older sites, some of the steam distribution system may have become redundant. If this is the case it is important that the redundant part is sealed off as near to the boiler as possible. Otherwise the resulting ‘dead leg’ can become a source of unnecessary heat losses.

**Survey steam traps**

It is inevitable that some steam will condense in the distribution network. Steam traps, if they work correctly, remove this condensate from the system without significant losses of steam. However, a major source of steam loss is through sticking steam traps. Check steam traps as part of a regular distribution network survey and take corrective action if any are found to be defective.

**Return condensate**

Steam condensate from the plant is a valuable source of heat and where possible, pipework should be made available to return this to the boiler, reducing the energy required to bring the boiler up to the required temperature.
Process utilities

Use process utilities wisely and make significant energy savings.

This section considers commonly found process utilities in the high temperature industry: compressed air, cooling water and industrial gases.

Compressed air

Compressed air is a very expensive utility, produced using electricity. It is also a major source of energy wastage.

Switch off

If a compressor is not being used then make sure it is switched off. Pay particular attention to compressors at the end of shifts or over weekends.

Eliminate unnecessary usage

Identify where compressed air is used on a site and then check to make sure that it is required for the task. People working at industrial sites can misuse compressed air, for example, to clean machinery, but this can be a needlessly costly option. Consider whether applications could use air blown from a fan instead, which is a much cheaper alternative.

Produce a compressed air usage policy for employees specifying where and when compressed air should not be used, for example, compressed air should not be used for cleaning floors or machines. Ensure that the policy is displayed at appropriate places across the site.

Check frequently for leaks

Industrial sites often have leakage rates of up to 50%, wasting considerable amounts of energy and money.

The biggest losses in industrial compressed air systems are usually through leakage. Establish a systematic and regular leak-detection programme (for example, every three months) to check for leaks, then make sure that they are repaired as quickly as possible, tackling the larger leaks first.

Did you know?

- Compressed air leaking through a single 3mm hole could cost you around £4,000 per year, depending on use and pressure.
- An idling compressor can still use 40% of its full load.

There are three main ways to check for leaks:

- **Listen** – run the compressor without using any air tools or equipment. Make sure that there is as little background noise as possible and then walk slowly around the system listening for hissing or rasping sounds. Check all joints, flanges and valves carefully.

- **Look** – make up a simple solution of soapy water. Run the system without using air tools or equipment. Apply the solution to all pipework and then look to see where the soapy liquid bubbles up.

- **Detect** – hire or purchase ultrasonic leak detection equipment from your compressed air system supplier. Using ultrasonic equipment is the most accurate way to check for leaks.

Mark all leaks on a plan of the system. Before attempting any repair work, make sure that the system is de-pressurised. Small leaks can be repaired on-site, but equipment suppliers should be contacted before tackling larger leaks. If in any doubt about how to proceed, contact a supplier.
Are there parts of the system that are not needed?
Consider whether there are parts of the compressed air system that are not needed (for example, areas of unused pipework). Isolate areas that are not in use as this will increase the efficiency of the system.

If a system requires compressed air at different times in its operation, then consider using isolation valves to divide the system into zones.

Reduce delivery pressure
The higher the pressure, the more air will be lost through existing leaks. Analyse the uses of compressed air and then see whether there is scope for reducing pressure. Remember to allow for the pressure drop along the distribution system. It may be best to reduce pressure in small steps and check for any problems at each stage.

Rationalise compressor use
Further savings can often be made by reducing the number of air compressors in operation and ensuring that they are working as efficiently as possible. Many companies change their set up from having a number of compressors operating at part load, to having fewer compressors operating nearer full load. It is more likely that this will be possible after a reduction of overall compressed air usage.

Investigate bringing in compressor air from outside
Cold air is denser. Therefore if the intake air is cooler, the compressor does not need to work as hard because the air requires less compression. Bringing in cooler intake air from outside can produce substantial savings. Consider measuring the temperature difference to see how much could be saved. For every 4ºC drop in temperature of the intake air, efficiency improves by 1%.

Cooling water
Minimise the flow of cooling water
Most process operations use cooling water. Use of cooling water requires energy to pump the water around the cooling circuit. In many cases, cooling towers are used to cool the water but, in others, refrigeration chillers are used which are big users of energy. Many companies have excellent opportunities to save energy in their plant by minimising the flow of cooling water and by not cooling to a temperature lower than is actually required. Further savings can be made in pump energy by the measures discussed in the motors section on page 15.

Industrial gases
Consider industrial gas management
Industrial gas use should be carefully managed to maximise both energy and cost savings. Measure the use of industrial gases carefully and review their usage to identify potential for further reductions. Through regular monitoring, any high levels of use can be identified and action taken to manage them.

The production and storage of industrial gases such as oxygen, nitrogen and argon is highly energy intensive.
**Review purity of gas**
Many companies use industrial gases that are much purer than actually required. The higher the purity, the more energy is used to produce it. It may be possible to reduce energy requirements by relaxing the purity of the industrial gas produced, assuming that this less pure gas continues to meet the requirements of the process.

**Consider utilising waste gas**
Waste gas streams from industrial gas production may be useful elsewhere in the plant, for example, waste gas from nitrogen production is rich in oxygen and can be used as part of the combustion gas for a furnace or boiler.

**Look at alternatives**
There are options for alternative production strategies and energy saving measures. It may be economical to use an alternative method to generate industrial gas, or a smaller and potentially more economical plant could be used. Consider use of a consultant to examine the viability of alternative strategies.
Motors and drives

Motors are widely used in high temperature industries to drive pumps, fans and other equipment. This means that there are likely to be excellent opportunities for energy savings.

Motors and drives are often overlooked in industry and as a result, many sites have relatively inefficient motors. Managers in the high temperature sector should pay particular attention to the pumps and fans connected to their motor systems as these offer particularly good sources of savings.

The Carbon Trust has several publications with ideas for energy saving in motors and drives and their use with pumps, fans and other equipment.

Switch off

Motors are sometimes left on when not required. This wastes money. Where there is a chance of this happening, put in place a procedure to switch off the pump or fan at the end of operation, or even better, use a timer or automatic sensor to turn the pump or fan off.

Make sure that all employees are aware of the importance of switching off equipment when it is not required.

Reduce pumping load

Look for opportunities to reduce the load on pumps and fans. The process may not need the volume of cooling water or process liquid that is currently pumped. In the same way, fan loads can be reduced by lessening the amount of fresh air drawn into buildings or reducing gas flows used in various process operations.

Check that motors are the correct size

Motors are often larger than they need to be. Compare the details on the motor rating plate with the actual rating required by the equipment that the motor is driving. In many cases, motors are oversized by 20% or more (for example an application might require a motor rated at only 7.5kW, but has been supplied with a motor that is 11kW). Consider replacing with smaller, higher efficiency motors where possible. If the motor is very lightly loaded (<40%) and cannot be changed, it may be possible to run the motor continually in a different connection mode that could result in energy savings of between 5 and 10%.

Consult a motor supplier regarding connection modes. They will be able to assess the business’s needs and advise.

Fact:

A motor running for 11 hours a day (4,000 hours a year) at a typical commercial or industrial site costs around ten times more in electricity in a year than its capital cost.
Fit higher efficiency motors (HEMs)
Failed motors should be replaced by higher efficiency ones. Higher efficiency motors (HEMs) are around 3-4% more efficient than standard motors. Although they can be a little more expensive than standard models, purchase costs of motors are small compared with running costs, so their use will quickly more than pay for the difference.

Establish a motors and drives policy
Many companies have a written policy involving surveying all motor use and fan use and having a roll-out programme of replacement with higher efficiency equipment.

Consider variable speed drives (VSDs)
A variable speed drive (VSD) is an electronic device that controls the characteristics of a motor’s electrical supply.

If the load on a motor is variable, consider fitting a VSD as it will respond to the varied requirements of the motor and operate more often in its most efficient regime.

Reducing the motor speed by 20% reduces the power requirement by about 50%, offering considerable energy savings. The installation of a VSD is easily justified when there is variable load because of the reduced running costs of the motor (see box below).

VSDs are not as expensive as you might think. Fitting one to an average motor can cost around £650 – including installation. When you consider that one average (2.2kW) motor can consume over £500 worth of electricity per year, a VSD is well worth the investment.
Industrial buildings

Energy use in buildings is likely to form a small part of the overall energy use of the site. However, it is an important area to look at because the potential for savings may be significant.

Industrial buildings in the high temperature sector typically require large areas for storage and production and often have high ceilings and considerable ventilation rates. Usually there is further ‘social’ space in areas such as offices, and canteens or kitchens. With such a range of activities and characteristics, industrial buildings usually have complex energy requirements.

Opportunities in industrial buildings include systems such as heating, ventilation and air conditioning. Lighting and building fabric are also worth investigating.

Heating

Keeping the workplace at a comfortable temperature is essential for a happy workforce and may be important for processes too.

Additional heating may not be required in areas where there is considerable incidental heating from high temperature processes, but in areas where heating is needed, save money by using simple time and temperature controls, understanding how the heating system works and raising staff awareness about heating costs.

Take control of the heating system

Heating control systems are sometimes tampered with in response to a change in weather conditions or a change in shift patterns. Staying in control of the heating system can save 10% of costs. Focus on these simple measures:

- Check the thermostat regularly and set to the recommended temperature (19-21°C for site offices, 16-19°C for workshops and 10-12°C for stores). Doing this can save 8% for each 1°C reduction in temperature.
- Check all timer switches regularly – make sure that the heating is off when the building is unoccupied.
- Raise awareness – discuss the costs of heating at team meetings and encourage people not to leave doors and windows open when the heating is on. Adjust the thermostats instead.

Consider using a de-stratification fan

As processes in this sector can generate a lot of heat, the heat will rise to the top of the building. Consider using a de-stratification fan to recirculate this heat to lower levels.

Consider radiant heating

Factories and warehouses can easily lose heat because of high ceilings, extract ventilation systems and frequently used delivery doors.

If the site has convective ‘blown air’ heaters, then consider changing to radiant heating. In this system, surfaces and workstations are heated directly as opposed to warming the air generally. Radiant heating reduces loses and can improve comfort as there is more control over when the heat is on and where it is directed – the whole space need not be heated. Correct positioning of the heater is important. It needs to be directly in line with the person/object requiring the heat.
Ensure appropriate use of heating
Heating can be in many forms. Make sure that the method of heating is the most appropriate for the area. If a boiler is being used to produce steam or hot water for the heating, then boiler checks need to be made as described in the sections: Furnaces (page 7) and Boilers and steam distribution (page 9).

Ventilation
Ventilation is essential for high temperature industry, but it can still be excessive. Appropriate ventilation can increase staff comfort and save money.

Turn off unnecessary ventilation
Check that local extraction fans are not left running unnecessarily, either outside of production hours or during long breaks. If you cannot see or hear the fans, then you can detect air movement very simply using thin strips of tissue paper or with a child’s bubble maker. Turn off ventilation when not needed either by raising staff awareness or by fitting simple controls.

Consider interlocked controls
Automatic controls can be in the form of timers, occupancy sensors or controls linked to machinery (interlocked controls). Using automatic controls to replace a previously manual action can result in significant energy savings.

Localise ventilation
Put process plant that needs local extractor ventilation in a special area and introduce fresh untreated air close to the plant and extractor. This reduces costs by preventing heated or cooled air being drawn from surrounding areas.

Fit and maintain shutters
All fans should have back-draught shutters or dampers to prevent air blowing through them when not in use. Fit shutters or dampers and ensure that they are kept clean and in good working order.

Ventilation can often be excessive and optimising it can increase staff comfort and save money.
**Air conditioning**

Air conditioning is most likely to be used in office blocks and laboratories rather than the main factory areas.

Air-conditioned buildings use about twice as much energy as naturally ventilated buildings. It is used to condition the air and to power pumps and fans to circulate it throughout the building.

In order to reduce costs, this needs to be carefully selected and controlled. In heated buildings, make-up air to replace that lost through ventilation will need to be heated, so linked heating and air conditioning can reduce costs. In recent years there has been significant progress in the application of techniques that reduce the dependency on conventional air conditioning. There is now a move towards natural and passive ventilation, mixed-mode operation and low energy cooling systems.

**Consider if air conditioning is needed**

Air conditioning may well be necessary if processes require a constant temperature or precise humidity control. However, if air conditioning is used for comfort cooling, there may be other options. Investigating appropriate ventilation and minimising heat gain may make comfort cooling unnecessary.

These include reducing space heating, for example; by limiting the time that office equipment is on and using ‘power down’ facilities. Switch off lighting if there is sufficient daylight and use solar films or blinds to cut out direct sunlight that might be causing overheating. Open windows and doors to reduce this need further.

**Control it – temperatures and times**

It is easy to alter the settings on air conditioning units and not put them back to their correct settings, so check temperature and time controls regularly. Make sure that temperatures are not set at an excessively low cooling set point (say below 22ºC). Look at operating patterns of the air conditioning chillers relative to outside conditions and check for excessive running. It is important to meet comfort and process requirements, but keep operation to a minimum.

**Stop relative humidity control – if possible**

Controlling relative humidity is very energy intensive and large savings can be made by discontinuing it, whilst still achieving comfort. However, some processes do require control. If this applies to you, then keep the minimum and maximum acceptable humidity levels as far apart as possible to reduce usage.

**Take advantage of free cooling**

Investigate ways which reduce the internal temperature at no cost, such as night cooling. This is especially effective where external temperatures are colder than the required internal temperature and operate by simply ventilating the building with fresh air. For information on these opportunities, refer to the Carbon Trust’s publication, [Heating, ventilation and air conditioning (CTV046)](https://www.carbontrust.co.uk/).

**Review switch-on temperatures**

Set higher switch on temperatures, and set a gap or ‘dead band’ between heating and air conditioning control temperatures of about 4ºC. This improves staff comfort, cuts operating costs and reduces wear and tear on both systems.
Building fabric

Many businesses in this sector do not set aside money to maintain their walls, doors, windows and roofs. But investing in the building fabric of the premises is almost always cost effective: it will decrease the chances of heat loss. It can also increase the value of your property and, by providing a more comfortable working environment, boost staff morale.

Stop draughts – doors and windows

When not in use, keep factory and loading bay doors closed to prevent heat loss.

Separate heated offices or workspaces from unheated storage areas to reduce heat losses and improve comfort. A warm air curtain, PVC curtain or a swing door are all suitable partitions.

Repair broken or cracked windows as soon as possible and apply draught strips wherever draughts can be felt.

Separate warm from cool spaces

For doors that are used frequently, consider fitting one of the following:

- Air locks.
- PVC curtains.
- Warm air curtains.
- High speed motorised doors.

The doors need to be sealed to the building fabric to prevent draughts and there should also be seals between the door and the frame. Avoid using doors at opposite sides of the warehouse at the same time because this will create a through-draught.

Insulate roofs and walls

Improving loft and cavity wall insulation is the single most cost effective measure you can make to the building fabric.

- If the structure allows, make sure that there is at least 200mm (8 inches) of loft insulation. Roofs made of single skin corrugated asbestos or corrugated iron can have heat losses 15 times that of a modern, well-insulated roof. Methods for insulating these types of roof include lining, over-spraying and under-spraying.

- Consider installing polycarbonate secondary glazing under rooflights – it can reduce heat losses by up to 50% and eliminates down-draughts.

- Insulate cavity walls – it can reduce heat loss by over 70%.

Energy Efficiency Loans

Investing in energy efficient equipment makes sound business and environmental sense, especially with the easy, affordable and flexible Energy Efficiency Financing scheme brought to you by Carbon Trust Implementation and Siemens Financial Services. To find out more visit www.energyefficiencyfinancing.co.uk
Lighting

Most industrial companies spend little time considering how their sites are lit. But many of the actions cost little or nothing to implement and can get the workforce involved.

**Switch off lights**

Lights switched on in the morning are often left on all day – even if they are not needed. Here are some simple ideas to ensure that lights in unoccupied areas are switched off:

- Encourage people to turn off lights – use posters and team meetings to raise energy awareness and motivate people to turn off lights. Free posters and stickers can be ordered from the Carbon Trust.
- Make sure everyone knows where the light switches are – label light switches and make sure everyone knows which switch controls their light.
- Make sure that lights are switched off when the factory is closed – carry out a survey to find out if lights are turned off out of hours. Ask cleaning and security staff to turn off lights in unoccupied areas.

**Make good use of natural light**

Most people prefer to work in natural light. Interior lighting will be used less when adequate daylight is available. To make the best use of natural light try the following:

- Check how often and how well your windows are cleaned; get the cleaner in more often if necessary.
- Check that any roof lights are being used effectively.
- Make sure window blinds are open in daylight hours, except when needed to reduce glare or solar gain.
- Move any objects that are obstructing windows
- Review the location of people and, if possible move them closer to a natural light source.

**Replace inefficient lamps**

Replace lamps with more efficient equivalents. For example, replace any 38mm diameter (T12) fluorescent tubes with slimmer 26mm diameter (T8) tubes and specify all new tubes to have a ‘tri-phosphor’ coating. This will save 10% of the energy consumption and improve the quality of lighting over the whole tube life. Note: slimline tubes will not work in some older fittings, so buy one new tube to check that it works before investing in bulk purchase.

In some industrial settings (for example where bay lighting, freestanding and wall-mounted uplighters, floodlighting or street lighting is used), high pressure sodium discharge lamps (SON) should be considered. SONs combine high efficacy with long life and are particularly suitable where lamp access is difficult or expensive. SONs work well in situations where exterior areas need to be illuminated for long periods.

SONs are not made for frequent switching and, therefore, should not be operated by presence detectors for security lighting. They do not offer good colour rendering so may not be appropriate where accurate colour perception is required.

If good colour rendering or fast warm-up is important, then consider using metal halide lamps. Although these have a shorter life than SONs, they provide excellent, crisp white light and consume low amounts of energy.

For further advice on lighting please download our [Lighting overview guide (CTV049)](https://www.carbontrust.gov.uk/).
Energy management

For a business to be energy efficient, its processes should be monitored and managed effectively. To achieve this, it is essential to have an energy management policy that demonstrates both a strategic approach and commitment from every part of the business.

Good housekeeping

It is important that management and employees are aware of the benefits that energy efficiency can bring to a site. Ensure that the whole workforce is involved and committed to an energy efficiency programme. The Carbon Trust’s guide to Creating an awareness campaign (CTG056) could be helpful. See below for ordering information.

Remind everyone that effective energy management means:

- Cost savings.
- Healthier and more productive working conditions.
- An enhanced corporate image that can be promoted to customers and suppliers.

Good energy management costs almost nothing.

Take responsibility and show commitment

Commitment to energy efficiency needs to come from senior managers, who should agree and implement an energy policy. The policy should clearly identify the formal roles and responsibilities of the management team. Make one person responsible for implementing energy saving initiatives and allocate enough resources, in terms of time and money, to the role.

Conduct a walk round

Review energy use and procedures regularly by carrying out a walk round. Use a checklist, which could be based on the action checklist on page 21, to identify new sources of waste energy or new ways of saving energy. It is often useful to do this at different times of the day. Feed the findings into the action plan. See page 21 for an example of an action checklist or order Assessing the energy use at your industrial site (CTL171) from the Carbon Trust.

Monitor energy consumption

Understand energy consumption by reviewing the invoices received over the last year and build a picture of monthly energy performance. Larger sites will often have meters recording half-hourly electricity consumption and corresponding data should be available from the electricity supplier for comparison with your bills.

If a site does not have a half-hourly electricity meter then monthly meter readings should be checked and recorded in-house. It is also advisable to check and record monthly gas consumption in the same way.

Understand energy use

Monitoring energy use helps to identify periods of high-energy use, such as periods of extra production. It can also demonstrate whether energy saving measures are having an impact.

For further advice on energy management please download the following publications:

- Introduction to energy management (CTV045).
- Energy management guide (CTG054).
As well as being a basic check on how the business is performing, energy use data can be useful when compared with production levels.

The simplest way to do this is to plot a graph comparing energy use against production levels like the one shown in Figure 1, to the right.

This graph demonstrates that energy is being used, even when there is no production, and costs are still incurred. To reduce these costs, machinery should be switched off when not required, and lighting and heating only used as and when necessary.

The slope of the graph shows production-related energy use. Try to reduce the slope of this graph by using equipment more effectively. As energy saving measures in this overview are implemented, there should be a reduction in both the gradient and the intercept on the energy usage axis.

Comparing energy use and performance data month on month, year on year can also show where energy savings measures have had an impact.

For more information about energy management, contact the Carbon Trust. Relevant publications include How to monitor your energy use (GIL157) and Understanding your energy consumption (CTL001).

**Set targets**
Setting realistic targets for energy savings will help keep the momentum going and maintain employee awareness and interest. Set deadlines for the completion of each improvement detailed on the action plan and check to ensure that each has been completed.

Most businesses in the UK could reduce their energy consumption by between 10 and 40%. However, it is important to be realistic: many companies start by aiming for savings of 5% per year.

**Have an action plan and implement it**
An action plan should be developed that lists the improvements that need to be made, when they will be made and who will be responsible for making them. Improvements should be prioritised according to the potential energy savings and the time taken to recoup the cost (payback period).

**Case study**
What other companies are doing
An electronics manufacturer saved £45,700 per year through monitoring energy consumption and taking action on the findings. By looking at half-hourly electricity data, a potential base load saving of 500kW was identified. Energy savings came from turning off production and service equipment that had been left idling outside of production hours.
Government energy-related regulation

Many companies have Climate Change Agreements (CCAs) with the UK Government. By agreeing a CCA, the Government grants the sector a 65% discount from the Climate Change Levy – the discount will be increased, on electricity only, to 90% from April 2013.

Further information can be found on the DECC website: [www.decc.gov.uk](http://www.decc.gov.uk)

Companies may find themselves liable to the EU Emissions Trading Scheme. In this scheme, companies are given emissions caps, and can trade any carbon emissions saved if they stay within the required emissions limits. However, if a company exceeds its cap, then carbon has to be purchased. Hence, this scheme is a powerful incentive for companies to save energy.

Further information can be found on the Defra website: [www.defra.gov.uk/environment/climatechange/trading/eu](http://www.defra.gov.uk/environment/climatechange/trading/eu)
## Action checklist

Use the checklist below to note which opportunities could help you save energy and how you will take them forward.

<table>
<thead>
<tr>
<th>Cost</th>
<th>Action</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Process control</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>If automatic control is switched to manual, check why and if possible revert to automatic</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Check whether product is being over-processed</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Check whether measurement of controlling variables is adequate</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Check for control system disturbances</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Furnaces</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Check furnace control</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Benchmark furnaces</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Improve furnace yield</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Look at charging and unloading</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Improve furnace scheduling</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Carry out regular maintenance</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Check air/fuel ratios</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Use the correct burner type</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Consider waste heat recovery</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Action</td>
<td>Progress</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Medium</td>
<td>Consider the use of an economiser</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Consider using air pre-heating</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Check condition of lagging</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Check for and remove redundant steam pipework</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Carry out a check on steam traps</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Check for possibility of condensate recovery</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Consider the viability of combined heat and power</td>
<td></td>
</tr>
</tbody>
</table>

**Boilers and steam distribution**

**Pumps and fans**

None | Switch off pumps and fans                           |          |
None | Reduce unnecessary load                              |          |
Low  | Size pump and fan motors correctly                   |          |
Low – Medium | Consider high efficiency motors and variable speed drives |        |

**Process utilities**

Low  | Check if industrial gas use can be reduced            |          |
Low  | Check if cooling water use can be minimised           |          |
Medium | Check for any opportunities for waste heat recovery and use |  |
None | Stop any unnecessary use of compressed air             |          |
Low  | Find and repair compressed air leaks                   |          |
Low  | If possible, reduce delivery pressure of compressed air |        |
<table>
<thead>
<tr>
<th>Cost</th>
<th>Action</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Check that heating is not being wasted when not required, or through open doors/windows</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Review heating and air conditioning temperatures</td>
<td></td>
</tr>
<tr>
<td>Low – Medium</td>
<td>Investigate different heating methods</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Insulate roofs and walls</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Switch off lights and make use of natural light</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Replace inefficient lamps</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Turn off unnecessary ventilation</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Consider using interlocked controls</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Energy management</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Develop an energy policy</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Create action plan</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Conduct a walk round</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Monitor progress on an action plan and set targets</td>
<td></td>
</tr>
</tbody>
</table>
Next Steps

Start with the following easy low and no-cost options to help save money and improve the energy performance of your site:

Step 1 Understand your energy use

Look at your site and identify the major areas of energy consumption. Check the condition and operation of equipment and monitor the power consumption over one week to obtain a base figure against which energy improvements can be measured.

Step 2 Identify opportunities

Compile an energy checklist. Walk round your site and complete the checklist at different times of day (including after hours) to identify where energy savings can be made. An example checklist can be found in the Carbon Trust’s fact sheet Assessing the energy use at your industrial site (CTL171), and some ideas of actions you can take are given on the previous page.

Step 3 Prioritise your actions

Draw up an action plan detailing a schedule of improvements that need to be made and when, along with who will be responsible for them. Improvements can be measured.

Step 4 Seek specialist help

It may be possible to implement some energy saving measures in-house but others may require specialist help. Discuss the more complex or expensive options with a qualified technician.

Step 5 Make the changes and measure the savings

Implement your energy saving actions and measure against original consumption figures. This will assist future management decisions regarding your energy priorities.

Step 6 Continue managing energy efficiency

Enforce policies, systems and procedures to ensure your centre operates efficiently and that savings are maintained in the future.
Related publications
The following publications are available from the Carbon Trust:

Guides
- Energy management (CTG054)
- Monitor and targeting (CTG077)

Technology overviews
- Heating, ventilation and air conditioning (CTV046)
- Low temperature hot water boilers (CTV051)
Further services from the Carbon Trust

The Carbon Trust advises businesses and public sector organisations on their opportunities in a sustainable, low carbon world. We offer a range of information, tools and services including:

Website – Visit us at www.carbontrust.co.uk for our full range of advice and services.

Publications – We have a library of publications detailing energy saving techniques for a range of sectors and technologies.

Case Studies – Our case studies show that it’s often easier and less expensive than you might think to bring about real change.

Carbon Trust Advisory – Delivers strategic and operational advice on sustainable business value to large organisations.

Carbon Trust Certification – Delivers certification and verification services to companies and runs the Carbon Trust Standard and Carbon Reduction Label.

Carbon Trust Implementation – Delivers services to businesses in support of implementation of energy efficient equipment and energy efficiency financing.
The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

We help to cut carbon emissions now by:
• providing specialist advice and finance to help organisations cut carbon
• setting standards for carbon reduction.

We reduce potential future carbon emissions by:
• opening markets for low carbon technologies
• leading industry collaborations to commercialise technologies
• investing in early-stage low carbon companies.

www.carbontrust.co.uk