CARBON TRUST

Heating, ventilation and air conditioning

Saving energy without compromising comfort

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Contents

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 of heating, ventilation and air conditioning introduces the main energy saving opportunities for businesses and demonstrates how simple actions save energy, cut costs and increase profit margins.

Introduction

Heating, ventilation and air conditioning (HVAC) systems control the temperature, humidity and quality of air in buildings to a set of chosen conditions. To achieve this, the systems need to transfer heat and moisture into and out of the air as well as control the level of air pollutants, either by directly removing them or by diluting them to acceptable levels.

Heating systems increase the temperature in a space to compensate for heat losses between the internal space and outside. Ventilation systems supply air to the space and extract polluted air from it. Cooling is needed to bring the temperature down in spaces where heat gains have arisen from the sun, people or equipment and are causing discomfort.

Heating, ventilation and air conditioning systems vary widely in terms of size and the functions they perform. Some systems are large and central to the building services – these were probably designed when the building was originally commissioned and use ventilation to deliver heating and cooling. Other systems may provide heating through boilers and radiators, with some limited ventilation to provide fresh air or cooling to certain parts of the building such as meeting rooms. In some cases, individual comfort cooling units have been added to a building to overcome a specific overheating problem that had not been thought of at the time of the original design.

So if heating, ventilation and air conditioning can be separate systems, why consider them holistically? The answer lies in the interaction of these services with each other and with the building. By considering HVAC systems as individual elements rather than as an interacting system, it would be easy to overlook a major area of energy wastage – that one component might impact on another. For example, it would be wasteful to increase heating inside a building while the cooling system is fighting to reduce temperatures. It is therefore useful to look at how the elements of an HVAC system interact with each other and fine tune each part to save energy and money.

Did you know?

The true definition of an 'air conditioning system' is one which has the ability to control temperature, humidity and air quality within precise limits, yet the term is often applied to systems which simply cool the space. These cool air systems are more correctly referred to as 'comfort cooling'.

Energy consumption

Heating, ventilation and air conditioning can account for the majority of money spent by an organisation on energy. Even small adjustments to these systems can significantly improve the working environment and at the same time, save money.

How much energy do HVAC systems use?

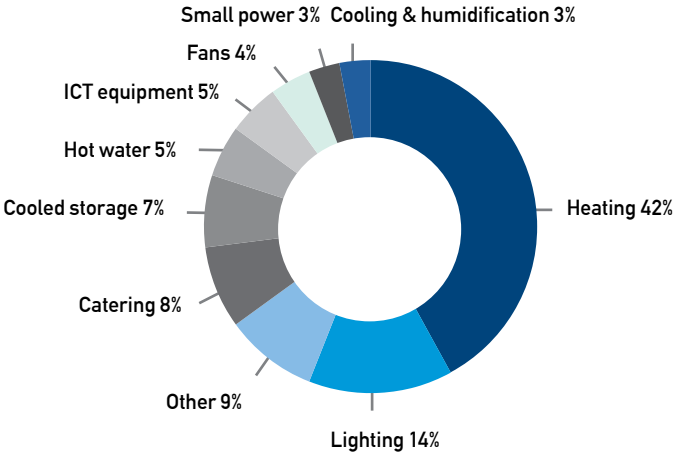
There are five important factors that determine the energy use of an HVAC system:

- The design, layout and operation of the building – these affect how the external environment impacts on internal temperatures and humidity;
- The required indoor temperature and air quality – more extreme temperatures, greater precision and more refined air quality consume more energy;
- The heat generated internally by lighting, equipment and people – all of these have an impact on how warm your building is;
- The design and efficiency of the HVAC plant – provides heat, cooling and moisture control exactly where it is needed in the building;
- The operating times of the HVAC equipment and ability of the controls – these limit operation to exactly when it is needed.

Making savings

- Reduce the need – The design and specification of buildings and HVAC systems have a big impact on energy use and hence, energy spend. Sometimes natural ventilation provides the best solution to HVAC needs – see page 13 to find out more.
- Changing staff behaviour – The way occupants use a building and its HVAC systems plays a big role in how a building performs. See page 15 for tips on how staff can learn to control their environment efficiently.
- Understand and use controls – Most HVAC systems are fitted with controls. Learning how to set and regulate these can provide substantial savings and enhance comfort conditions for building occupants. See page 17 for more information.
- Maintaining existing systems – Regular maintenance is vital for maximising energy savings and avoiding costly breakdowns, as explained on page 20.
- Hardware opportunities – If you are considering upgrading or refurbishing your HVAC systems, there are some good opportunities for energy saving. Page 21 shows how new, efficient equipment can often pay back its costs very quickly.

Breakdown of Energy Consumption by end uses in public and commercial buildings in 2014-2015



Technology overview

Identify your HVAC system

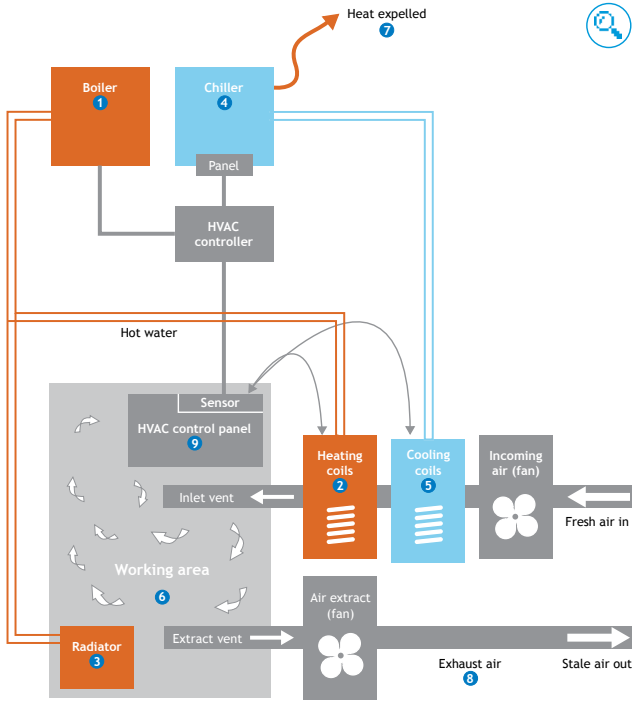
HVAC system components

HVAC systems vary widely in terms of the individual components that make them up and how they are set up within a building. An example of a typical system layout is shown below:

- Boilers (1) produce hot water (or sometimes steam) for distribution to the working space. This is done either by heating coils (2) which heat air as part of the ventilation system, or through hot water pipes to radiators (3)
- Cooling equipment (4) chills water for pumping to cooling coils (5). Treated air is then blown over the chilled water coils into the space to be cooled (6) through the ventilation system. As part of the refrigeration cycle in the chiller, heat must also be rejected from the system via a cooling tower or condenser (7)
- Pumps are used throughout the system to circulate the chilled and hot water to the required areas throughout the building
- Stale air is extracted, usually using a fan, via separate ducts and expelled outside (8)
- Controls are used to make components work together efficiently. They turn equipment on or off and adjust chillers and boilers, air and water flow rates, temperatures and pressures. A controller incorporating one or more temperature sensors (9) inside the workspace sends a signal to the heating or cooling coils to activate
- If there is a demand for heating or cooling then the controls may also send a signal to the chiller and/or boiler to operate as required. There are often a number of other inputs that allow users to have greater control.

HVAC system types

Many different combinations of HVAC systems are used but common standardised approaches exist. HVAC systems are generally described according to how they use air, water or both to distribute heating and cooling energy to the space.



The more you understand your system, the better prepared you will be to make savings

HVAC technologies

There are many technology options for individual heating, cooling and ventilation components and they can all vary in application, cost and efficiency. The common technologies are shown below.

Heating

Common heating technologies include:

Boilers are used to generate steam or hot water. Within a boiler vessel, water is heated via the combustion process using fuel sources such as coal, oil or gas. Boilers come in many variations including; fire tube boilers, water tube boilers, cast iron boilers, forced/ natural/induced boilers and condensing boilers. Modern condensing boiler systems offer a substantial efficiency improvement from traditional system types as they recover heat previously lost in the exhaust. Depending on the existing system and factors such as fuel type, age and condition of the incumbent system, upgrading to condensing boiler plant can offer attractive payback periods.

Warm air heaters typically provide space heating for warehouses, retail sheds, sports centres, factories and other buildings containing similarly large spaces. They contain a gas or oil fired burner that is used to heat the air in the space directly or indirectly via a heat exchanger. A fan is used to distribute the warm air throughout the space(s) being heated. They are available in a range of different types and efficiencies. The most efficient units incorporate condensing capabilities and optimising controls similar to standard boiler plant.

Electric storage heaters are often installed where there is no mains gas supply, or where it is not cost effective to install a wet system. Storage heaters take advantage of the lower overnight electricity costs and release the heat during the day. A gas boiler or heat pump system will usually cost significantly less to run so alternative options should be investigated. Where it is not possible to upgrade, make sure to use controls effectively by storing only the required amount of heat and optimising the release settings. Modern storage heaters incorporate fan-assisted models, better levels of insulation and improved automation of settings to reduce energy use.

Radiant heaters are widely used in large, open, high-ceilinged facilities and use infrared to indirectly heat people and objects. Units can contain a gas or oil-fired burner that is used to heat a tube, cone or plaque that emits infrared radiation when hot. Electric versions are also available. The infrared radiation is focused and directed by reflectors within the units. Radiant heaters can consume significantly less fuel to provide space heating for a defined space as standard convection-style heating systems. Radiant heaters are also available in a range of different types and efficiencies with optimising controls.

Heat pumps can often provide both heating and cooling and are commonly found in commercial and residential settings. They can be both gas and electrically driven, but most commonly use electricity. Heat pumps transfer energy from a low temperature source such as ambient air, water, ground or waste heat and raise it to a higher useful temperature (the reverse cycle if cooling is required). The amount of energy required to transfer the heat is relatively small compared to the total energy transferred. Heat pumps can therefore provide an energy efficient, low carbon form of heating. For this reason, the Renewable Heat Incentive can be claimed for some installations.

Biomass systems are specifically designed to burn solid biomass fuels in order to heat air or water, or create steam. They release heat which can be transferred by means of radiation and convection to the required space or process. Biomass systems may also heat water for space heating or domestic use by means of a heat exchanger. There are a number of key considerations when installing and operating a biomass system. These include: adequate space for deliveries and storage of fuel; space for large plant and ancillary systems; high upfront capital costs; relatively higher operational and maintenance commitments; and presence of a year round thermal base load. Key benefits include a significantly reduced carbon footprint and income from the Renewable Heat Incentive.

Combined Heat and Power (CHP) or cogeneration is the simultaneous generation of usable heat and power in a single process. Electricity is generated on site, with capture and use of the resulting waste heat. In order to run effectively, CHP systems typically require a relatively high and steady year round base heat demand and usually require over 4,500 run hours per year to be cost effective. Significant savings can be made by using the electricity generated to offset site requirements, and reduce purchasing electricity from the grid. System sizing is critical to reduce up front capital costs and avoid circumstances where waste heat or electricity is required to be "dumped". The majority of systems consume natural gas to run a reciprocating engine much the same as found in a car. A water jacket around the engine typically captures the waste heat.

Solar Thermal systems are designed to capture solar energy and convert it to useful heat for water heating applications. Systems are built around a solar collector that has a dark coloured absorbing surface which "traps" solar radiation and converts it to heat. Heat is then transferred to a storage vessel by means of a circulating fluid, or in some instances the solar collector is directly connected to the heating circuit. Systems generally require a significant amount of space, often mounted on rooftops local to the storage vessels. Key benefits include a significantly reduced carbon footprint and income from the Renewable Heat Incentive.

Ventilation

Common ventilation technologies and techniques include:

Natural ventilation is the most passive form of ventilation, particularly at times of the year when the outside temperate is moderate and doesn't over-cool or over-heat the internal space. It involves allowing natural air flow through a building, commonly via opening windows on opposite sides or different floors of a building. For further information on natural ventilation see page 13.

Air Handling Units (AHUs) are integrated mechanical ventilation systems that package supply and extract air units and may also contain coils to heat or cool the air flow before returning it to the building. Heating or cooling can be supplied by central boilers/ chillers via water systems to the AHU or locally via electrical means or refrigerated (direct expansion or DX) cooling systems.

Supply or extract fans are critical components of mechanical ventilation systems. They are typically used to either: provide fresh air to a space, extract fumes from a kitchen or a process area, or circulate air within a building. Air is primarily distributed through ductwork and plenums. There is a large variety of fan types but centrifugal and axial fans cover most found in HVAC applications. Variable speed drives (VSDs) can be used to set back fan speeds against measurable parameters to significantly reduce energy use.

Cooling and Air Conditioning

Cooling and air conditioning technologies can broadly be organised into two categories:

Decentralised Systems typically serve a single or small space from a location within or directly adjacent to a space. The majority of cooling systems are DX type and include:packaged thru-wall and window air conditioners; interconnected room-by-room systems; residential and light commercial split systems; self-contained (floor by floor) systems; and commercial outdoor packaged systems. In DX refrigeration, the air is cooled directly by exchanging heat from the refrigerant. The principle advantages of decentralized systems are: lower upfront capital costs; simplified installation; no ductwork or pipes; independent zone control; and less floor space requirements for mechanical, ducting and piping systems.

Centralised Air Systems are primarily connected to an air handling unit where all heating and cooling is carried out in centralised plant areas. Cooling is usually generated in a chiller at one base location and distributed to air handling units (AHUs) or fan coil units located throughout the building space. The air is cooled with secondary media (chilled water) and is transferred through air distribution duct work. DX units are sometimes used in AHUs to provide cooling directly into the air stream. In these instances, "packaged" units may provide cooling to a dedicated zone or area. The main advantages of centralised air conditioning systems are better control of comfort conditions, higher energy efficiency and greater load-management potential. The main disadvantages are they are more expensive to install and are usually more complex to operate and maintain.

Evaporative Cooling

Standard air conditioning uses refrigerant based systems with electric fans to provide temperature and humidity control. Evaporative cooling is a low-energy alternative to air-conditioning. Instead of using an energy intensive refrigerant based system to cool air, Evaporative systems use the latent heat already in the surrounding air to evaporate water held in special filter pads to take heat out of the air and provide the required temperature and humidity control. Energy savings achievable are often in the order of 75-85% compared to conventional systems. These systems are becoming the technology of choice for use in data centres but can be more widely applicable to general building cooling requirements in non-humid climates. Evaporative systems can also be combined with refrigerant based systems where they are not able to meet the full cooling load.

Hot Water

Hot water is often forgotten in HVAC conversations but in certain businesses, such as hotels or leisure centres, hot water can add a significant year-round thermal base load to the heating demand. Hot water can be heated centrally, with a boiler connected to a hot water cylinder, or by using a combi boiler. There are also separate dedicated systems, such as direct-fired hot water storage heaters and electric point of use water heaters. Typically, the dedicated hot water systems provide the most efficient arrangement.

To find out more about different types of systems and their savings opportunities, ask your site engineer, maintenance technician or call the Carbon Trust. There should also be a building log book providing details about the HVAC system which can be supplied by the building's facilities manager.

Identify your business needs

Why do air conditions need to be controlled?

Temperature, humidity and air quality are controlled for a number of reasons:

- To provide comfort for building occupants
- To enable a process to be undertaken
- To avoid deterioration of stored products and materials.

Temperature, humidity and air quality may vary greatly and fluctuate at different rates. It is therefore important to always identify core business requirements in order to make any improvements to an HVAC system.

Most businesses will have a variety of reasons for controlling their air conditions and these should be prioritised. For instance, in a refrigerated cold store, it is probably more important to preserve the food than to maintain the comfort of workers. This is not to say that workers should be ignored – they should be provided with suitable clothing to keep them comfortable while working.

If staff members occasionally work late and alter controls, don't forget to reset them or install a timer to automatically restore normal settings

What conditions should be maintained?

Start by determining what temperature and air quality standards the HVAC system should provide.

HVAC for processes

For processes and stored materials, it is important to concentrate on what is really required:

- Does the process or material deteriorate outside a particular temperature range?
- Is it moisture or air quality condition that makes the difference or is it a combination of both these factors?

For instance, it may be that deterioration of a stored product is caused by mould growth or corrosion which is actually caused by excess moisture on its surface. This requires control of the product temperature and of moisture in the air so that condensation does not form.

HVAC for staff comfort

When providing comfort for building occupants, it is important to understand how comfort is achieved and the many ways that people perceive it. The combination of air temperature, surrounding surface temperatures, humidity, clothing, body fat, nerve sensitivity and metabolic rate is different for every person – so comfort is difficult to achieve with one fixed set of conditions. Rather than set the conditions at specific levels, it is more beneficial to set bands which allow greater flexibility.

Did you know?

- **Heating costs can increase by 30% or more if the boiler is poorly operated or maintained**
- **Heating typically accounts for about a third of the energy used in offices**
- **Heating costs rise by about 8% for each 1ºC of overheating.**

Low-cost measures for immediate savings

- Understand how your HVAC system works; how to control it to provide the conditions actually needed
- Find out about the building log book which should explain the services in simple terms
- Ask the landlord or managing agent where the controls are and how to use them
- Learn how to set thermostats
- If any controls are labelled 'do not touch', explore why. There may be a valid reason but it may just be for the convenience of the maintenance person
- Control HVAC systems so that they only operate as and when necessary
- Learn about 'optimum start' and 'optimum off' which can adjust the start and finish times for different weather conditions.

Reduce the need

The types of HVAC systems and how they are used have a big impact on the amount of energy consumed and the levels of comfort provided for staff and/or customers. Even in a building that has full air conditioning and cooling, it may not be necessary for them to be switched on all of the time. Using natural 'free energy' to heat, cool and ventilate a building can help save substantial sums of money and give building occupants greater control over their environment.

Opportunities for energy saving

Passive heating, ventilation and cooling

This is the control of heat from the sun along with ventilation in order to benefit a building and avoid discomfort. To maximise energy savings, it pays to organise a system so that nature provides the majority of fresh air and temperature requirements. Expensive 'artificial' and mechanical systems can then operate to fine tune the desired temperature and environmental conditions.

As simple as it sounds, natural ventilation relies on air flow through openings of a room or building, preferably from opposite sides. It also applies to rising hot air being replaced with cooler air sucked in through windows or vents from a lower level.

Making the most of natural ventilation is a simple and cost-effective way of achieving big savings.

When cooling is required inside a building, and if it is cooler outside than in, simply open doors, vents and windows. This will increase airflow, reduce heat and perhaps provide all the ventilation that is needed. Be aware, however, that opening windows in air conditioned buildings may increase the energy used by the system.

Some businesses use what is known as a 'mixed mode' system, which uses a combination of both natural and mechanical systems. The building uses natural ventilation, heating and cooling where possible, with mechanical systems being used only when needed. There are various advantages to such a system:

- The building becomes more adaptable to a wide range of requirements
- The occupants have more control over their environment
- Businesses can cut down on energy spend and carbon emissions.

Myth

Turning air conditioning thermostats down as low as they can go cools the building more quickly.

Reality
The temperature drops at the same rate but then overshoots, making it uncomfortable for the staff and using more energy than necessary. If controls are not coordinated, the temperature could even go low enough for the heating system to be switched on. Both systems then operate at the same time.

Remedy
Set thermostats correctly and educate staff to dispel this myth. As a last resort, protect thermostats to prevent tampering where possible.

Reduce overheating

Before installing cooling equipment, always identify where the excess heat is coming from – sunlight, equipment and refrigeration are often main sources.

Consider shading windows on the outside or replacing window panes with special heat reflective glass to prevent heat build-up. Alternatively, internal blinds can be angled to redirect useful light onto the ceiling while cutting out much of the sun's heat.

Energy using equipment, incandescent lighting and refrigeration are also major heat emitters in a building. As a general rule of thumb, the more energy efficient equipment is, the less heat it produces. So installing low-energy lighting and keeping equipment operating at peak efficiency reduces cooling costs.

Consider zoning to match building occupancy and reduce costs

Many buildings have problematic areas with different time and temperature requirements where only one overall heating or cooling control system exists. A solution is to 'zone' the building, installing separate time and temperature controls for individual areas. Zoned areas can provide better conditions as occupants in each area will have greater control over their immediate environment. It will also be more cost efficient, as HVAC can then be turned down or off in unused zones. For more information please refer to the Carbon Trust's How to Implement Heating Zone Controls CTL148 guide.

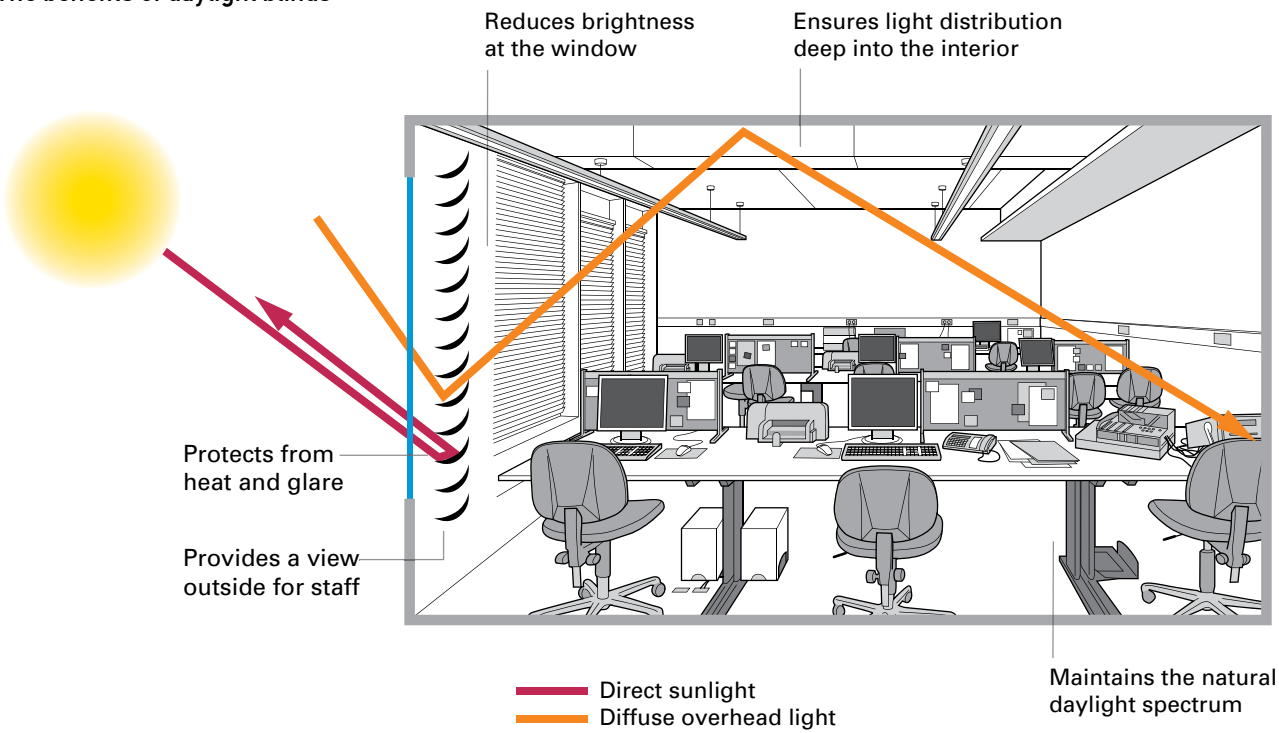
Daylight blinds

Daylight blinds enable natural light to enter the space by re-directing it onto the ceiling, thereby alleviating any discomfort felt by the occupants from direct daylight. Many daylight blinds also have perforated blades to retain the employee's view out of the window. For more information please refer to the Carbon Trust's How to Implement Solar Shading CTL065 guide.

Night cooling

Night cooling is an established technique where cool night air is passed through the building to remove heat that has accumulated during the day. When the building fabric is cooled, it will absorb more heat the following day, meaning lower internal temperatures. The movement of cool night air may be natural or fan-assisted. This free cooling of the building reduces energy consumption otherwise used by mechanical cooling and ventilation, leading to cost savings.

The benefits of daylight blinds



Good housekeeping and people issues

Understanding the needs of building occupants and informing them how to operate systems effectively can pay dividends.

Opportunities for energy saving

A common sense approach to comfort and temperatures

There are many factors which effect how warm people feel, including:

- Air temperature
- Solar radiation
- Air speed
- Humidity
- Activities performed
- Clothing

All these factors should be taken into consideration when attempting to create a comfortable environment for people to work in. Ensure workspaces are shielded from draughts and direct sunlight. These are no-cost solutions that save money and help maintain comfort.

Keep windows and doors closed

At times it makes sense to use the outside temperature to adjust the conditions inside your building. However, when the heating, ventilation or air conditioning systems are on, it is possible to save up to one third on heating or cooling costs by reducing the amount of outside air that enters a building. It is always better to adjust the system rather than open a door or window and let heated or cooled air out. For example, when the heating is on too high, staff might open windows to make the space more comfortable. Try adjusting the thermostats instead.

Turn off and power down

Try limiting the time that equipment is switched on and use 'power-down' facilities on copiers, printers, multi-function devices and computers during the day where possible, as these heat the workspace. Dim or switch off lighting if there is sufficient daylight and use as little as possible at night.

Did you know?

Comfort cooling by traditional air conditioning systems is very expensive. In the right circumstances low energy alternatives such as evaporative cooling systems can cut energy consumption by up to three quarters.

Train staff on how to operate air conditioning units and heating controls

Staff should receive guidance on recommended operating temperatures and how to set heating or cooling units correctly. Louvres (movable slats to guide the cool or heated air) are a feature on most air conditioning units and staff should be able to operate these to maintain a comfortable temperature. Display instructions on individual units and ensure that remote controls have accessible and obvious storage spaces.

Ensure controls are in place and HVAC systems operate at times and levels to reflect demand

HVAC loads will vary at different times and in different parts of a building throughout the day. Well-set time controls should ensure that systems only operate when and where required, in order to match core business hours. It is also worth regularly checking settings. Many systems are set incorrectly because someone has made a short-term adjustment and then forgotten about it. For more information, please see the Carbon Trust Technology Guide on Heating Control (CTG065).

Involve staff – run an awareness campaign

Engaging employees is crucial in eliminating energy waste. Motivate staff – encourage them to review their own working practices and suggest ways to make their tasks more energy efficient. Before staff can begin to save energy, they must be made aware of areas of potential waste in their own workplaces and the important part they play in controlling the temperatures they work in.

The Carbon Trust has promotional materials which help encourage people to be energy efficient

Further information

For further information on raising awareness in your business see the Carbon Trust's pack, Creating an Awareness Campaign CTG056.

Understanding and using controls

An efficient HVAC system provides just the right temperature and environmental conditions while using the minimum amount of energy. Once the ideal comfort conditions for a building have been identified, good controls can help maintain these conditions.

Opportunities for energy saving

There are four main types of control:

- Time controls ensure systems only operate when and where the building is occupied
- Temperature controls ensure systems provide the correct required temperatures.
- Motion sensors allow for even greater control of equipment in less frequently used areas.
- Variable air systems and demand controlled ventilation modulate airflow on real time air quality.

Set time controls to match occupancy

Check controls are appropriately set and displaying the correct time and date. Adjust if necessary to ensure heating, cooling and ventilation only operate when and where required. Optimum start and stop controls can be used to minimise the out of hours operation of heating and cooling plant. They vary the times your heating systems operate depending on external weather conditions. Using optimum start instead of fixed time controls could save you 10% in energy costs - and make your building more comfortable.

Maintain appropriate local temperatures based on outside conditions

If it is cold outside, building occupants will typically be wearing warmer clothing, so ensure temperatures are set accordingly. The reverse applies in summer if cooling is in operation. People will dress for warmer weather so do not freeze them with expensive overcooling.

Don't overcool server rooms

Server rooms are often heavily cooled, however, many classes of IT equipment and servers can typically operate with no adverse impact up to 27°C

Closely control ventilation systems

Ventilation systems can also be closely controlled. Avoid excessive air flow; 8 l/s/person is sufficient for most office spaces. Check timer controls to ensure the fan operates only when required. There are also options for demand control ventilation that involves: motion sensors for occupancy control, CO_2 sensors to modulate airflow on air quality, and automated control and modulation of process exhaust systems.

Don't overheat buildings

The optimum operating temperature range for a building will depend on the type of activities being performed. Recommended heating temperatures for particular buildings, activities, and processes are provided in the table on the following page.

Don't forget about pumps

Many heating and cooling systems rely heavily on pumps to circulate water. Pumps should also be controlled closely to ensure they only run when required. As with ventilation fans, pump flow rates can be modulated based on variable demand of temperature or flow rate. Variable speed inverter drives providing close control can dramatically cut the running costs of HVAC pumping systems.

Sector	Building/room type	Temperature (°C)
Offices/service companies	Computer rooms	19-21
	Banks, building societies; post offices	19-21
	Offices	21-23
Hospitality	Restaurants/dining rooms	22-24
	Bars	20-22
	Hotels	19-21
Schools/further and higher education	Educational buildings	19-21
Industrial/factories	Heavy work	11-14
	Light work	16-19
	Sedentary work	19-21
Hospitals and healthcare	Bedheads/wards	22-24
	Circulation spaces/wards	19-24
	Consulting/treatment rooms	22-24
	Nurses' stations	19-22
	Operating theatres	17-19
Public buildings	General building areas	19-21
	Law courts	19-21
	Libraries	19-21
	Exhibition halls	19-21
	Laundries	16-19
	Churches	19-21
	Museums and art galleries	19-21
	Prisons	19-21
Retail	Retail buildings	19-24
Sports and leisure	Changing rooms	20-25
	Sports halls	15
	Pool halls	28-30*

Source: Customary winter temperatures, adapted from Environmental Design CIBSE Guide A, 2006 *Depending on pool water temperature

Did you know?

The current Building Regulations call for optimum start controls to be fitted to all boiler plant rated at over 50 kW. Your boiler rating is usually displayed on the front of the boiler or inside the front cover.

Don't let heating and cooling operate at the same time

Set controls to give a wide gap between the temperatures at which heating and cooling systems turn on. Set a gap of around 4 – 5 °C between the heating and cooling thermostat set points to create a comfortable 'dead band'. This will help to keep occupants happy and increase cost savings. Unless this is implemented, both systems may operate simultaneously and waste energy and money.

For more information please refer to the Carbon Trust Technology Guide on Heating Control (CTG065).

Do not rely solely on your maintenance technician; fine tune your controls to suit your business.

The Carbon Trust's Technology Guide on heating controls details further solutions for HVAC systems. These include:

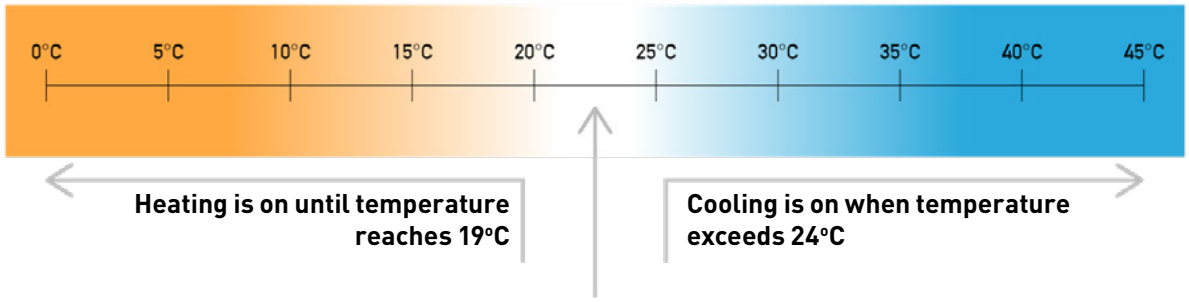
- Set temperature controls to the correct temperature and then leave alone
- Fit thermostats in the right place (away from draughts and heat sources – including direct sunlight) and set correctly
- Make sure Thermostatic Radiator Valves (TRVs) are fitted to radiators to provide more localised control and consider installing Smart TRVs
- Consider upgrading or refurbishing to integrated and smart controls if current controls are not providing comfortable conditions
- Make sure systems are controlled according to daily and weekly cycles
- Consider interlocked control of the HVAC system to prevent fans, heating and cooling operating when not required
- Match ventilation flow rates to demand and control operating times using temperature, humidity and CO_2 sensors
- Consider weather compensation and optimum start controls to adjust heating and cooling in line with the changeable UK climate

Further information

Investing in heating controls can save thousands of pounds and many will pay back their investment in just a couple of years.

Find an accredited supplier or installer in the Carbon Trust Green Business Directory.

Diagram of 'dead band' control indicating recommended temperatures



Maintaining existing systems

Maintenance matters. The right approach, implemented properly, will keep your HVAC systems running efficiently, minimise the risk of breakdown and make the most of your energy savings.

Maintenance and energy management go hand in hand – both have the common objectives of:

- Ensuring a building and its services continue to function reliably, efficiently and effectively.
- Ensuring the health, safety and comfort of occupants.
- Protecting and enhancing the value of investment in a building and its equipment.

Checking that HVAC systems are working as intended will help to prevent them from using energy ineffectively and also lower the risk of breakdown and spiralling costs. In this way, regular maintenance of equipment and controls makes good business sense.

Opportunities for energy saving

Regular maintenance for optimum performance

HVAC components must be kept free of dirt and other obstructions in order for them to operate efficiently. The overall system should be serviced annually either by a maintenance technician or a professional contractor. Routine maintenance should be regularly undertaken to identify potential problems at an early stage.

Maintain boilers

Have boilers serviced regularly by a reputable firm. Gas-fired boilers should be serviced once a year; oil boilers twice a year. A regularly serviced boiler can save as much as 10% on annual heating costs.

Did you know?

Energy consumption can increase by up to 30% if regular maintenance is not undertaken.

Don't be afraid to ask if you think your system isn't operating correctly. If staff complain about problem areas in your building, act on it immediately. Always contact your maintenance technician with any concerns.

Check condensers

Condensers are usually located on the outside of buildings and reject heat that has been removed from inside the building by the cooling system. Ensure condensing and evaporating devices are clean and well maintained. Check condensers are not obstructed, for example by equipment or vegetation.

Check air conditioning and comfort cooling plant

Ensure cooling plant is regularly maintained to avoid operating at reduced levels of efficiency. Replace insulation on refrigerant pipework as poor condition can affect the temperature of the refrigerant flowing through the system and thus consume more energy in maintaining the required temperature. Pay specific attention to pipework located outside a building. Check for refrigerant charge and leakage. If your refrigeration plant contains more than 1.27 kg[1] of R404A refrigerant then the F-Gas regulations state that you must have a schedule of regular inspection for gas leaks.

1 The maximum mass allowed and frequency of inspection varies for different refrigerants

Clean fans, filters and air ducts to improve efficiency by up to 60%

There is no point in having an efficiently running system if the conditioned air gets stopped by a solid wall before reaching the work space. Blockages in HVAC systems are common and increase running costs, so make sure that the filters are regularly checked. Consider fitting pressure gauges to indicate when replacement of filters is required.

Insulate to accumulate

Boilers, hot water tanks, pipes and valves should be insulated to prevent heat escaping. Payback can usually be expected within a few months of installation with continued savings in subsequent years. For more information please refer to the Carbon Trust's How to Implement HVAC Insulation (CTL145) guide.

Stay safe

Heat exchangers and cooling tower water treatment processes should be spotless. This saves energy and prevents health problems such as Legionella.

Looking at hardware opportunities

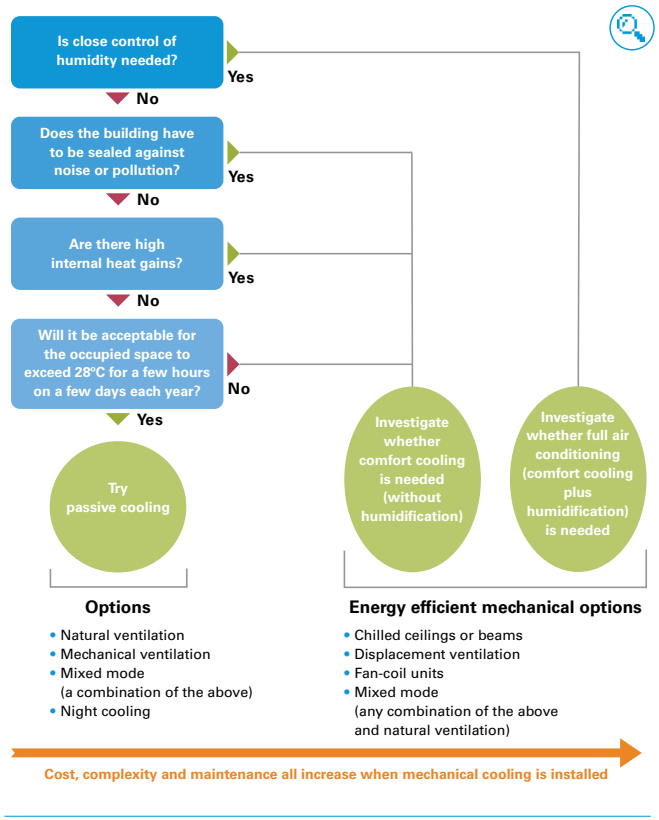
When refurbishing or putting in a new HVAC system, it pays to specify the most efficient system possible. Remember that day-to-day running costs may soon outweigh the capital costs of installation and so the more efficient the system, the less expensive it will be to run.

Always:

- Select the most appropriate HVAC system for your requirements.
- Prioritise energy efficiency in the design and installation stages.
- Implement and maintain good system controls.
- Set up and maintain the HVAC system effectively (this may be through a maintenance contractor).

Remember:

The solutions outlined here don't just apply to refurbishment and new build – they should be discussed when renting a building or moving premises. Some managers insist on a rent review to discuss these issues with the landlord. After all, you bear the costs of your landlord's inefficient equipment so it's up to you to choose carefully. Always seek expert guidance before investing in a new or upgraded system.



Energy Efficiency Financing

The Carbon Trust can help your organisation put cost-saving energy efficiency strategies into practice, with finance and implementation support to make energy efficiency easy.

https://www.carbontrust.com/finance

Upgrading or installing component parts of an HVAC system

Once inefficient components have been identified and need to be replaced, avoid simply exchanging like with like. Ensure that the replacement is of the highest possible efficiency and is still fit for purpose.

- Replace conventional boilers with condensing boilers where possible
- Motors are used extensively throughout many HVAC systems so it pays to replace standard motors with new high efficiency ones when they fail. Investigate the potential for Variable Speed Drives (VSD) additionally to reduce motor speeds where possible and save energy. Regulations state that new motors brought from January 2017 (>0.75kW) are required to be class IE3 or class IE2 when using a VSD. Make sure that new motors have an efficiency class as high as possible. IE1 is the lowest efficiency class with IE4 (and now IE5) being the highest.
- HVAC systems include a variety of fans and pumps– consider directly driven systems which are more efficient than belt driven systems. Fans and pumps powered by AC induction motors are also less efficient than electronically commutated (EC) alternatives. EC motors offer a lower power, lower energy alternative to conventional AC motors commonly used in chillers, fan coil units and HVAC systems more generally.
- Consider the opportunity for heat recovery and recirculation to recover a portion of the heat generated in your building or process and re-use it to warm fresh air as it enters the building. See our Heat recovery guide www.carbontrust.com/heatrecovery
- Consider a Building Energy Management System (BMS or BEMS). A BEMS based on a network of controllers offers closer control and monitoring of building services performance, including heating ventilation and air conditioning. This is shown on a computer screen in real time and allows the performance of plant to be monitored and settings to be changed quickly and easily. BEMS can reduce total energy costs by 10% or more so they are well worth considering.

As part of the Enhanced Capital Allowances (ECA) scheme, an Energy Technology List is produced. The list details all energy-saving technologies and products that qualify for the ECA scheme and should be used as a guide when purchasing new HVAC system components. See the box on the right for more information.

Upgrading or installing an entire system

The choice of a passive or a mechanical cooling approach can be determined by a series of relatively straightforward questions about a building and its internal environment. The flow chart on the previous page presents a summary of these questions and indicates whether comfort cooling or full air conditioning is required.

When replacing HVAC systems, some managers choose like-for-like equipment, believing this will minimise disruption to the business. Planning upgrades carefully and keeping the system maintained at its peak will mean that emergency decisions and inefficient purchases can be avoided.

Case study

What other organisations are doing?

A leading UK provider of labelling and marking solutions received an onsite energy assessment from the Carbon Trust, funded by the Green Business Fund. The assessment identified an opportunity to replace an aged gas boiler with a more energy efficient sealed filled condensed boiler. The organisation went on to install the new boiler and expect to save £2,200 each year. Furthermore, they have been offered a rebate from the Carbon Trust's Green Business Fund of £2,200.

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).

The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure. The ETL specifies the energy-saving technologies and products 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 https://etl.beis.gov.uk/etl/site/etl.html or call the Carbon Trust on 03003300657.

Next steps

There are many easy low and no-cost options to help save money and improve the operation of your HVAC systems and your building.

Step 1. Understand your energy use

Look at your HVAC system components and check the condition and operation of all pieces of equipment. Monitor the consumption of the building over, say, one week to obtain a base figure against which energy efficiency improvements can be measured. Be aware of seasonal variations over the year however.

Step 2. Identify your opportunities

Compile an energy checklist. Walk round your building and complete the checklist at different times of day (including after hours) to identify where energy savings can be made. An example checklist is on page 25.

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.

Step 4. Seek specialist help

It may be possible to implement some energy saving measures in-house but others may require specialist assistance. Discuss the more complex or expensive options with a qualified technician and contact the Green Business Fund to see if you are eligible for funded support.

Step 5. Make the changes and measure the savings

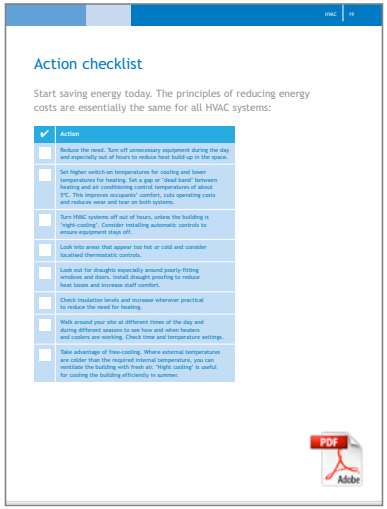
Implement your energy saving actions and measure against original consumption figures but be aware of all factors affecting energy use. This will assist future management decisions regarding your energy priorities.

Step 6. Continue to manage your business for energy efficiency

Enforce policies, systems and procedures to ensure that your business operates efficiently and that savings are maintained in the future.

Appendices

Action checklist



Start saving energy today. The principles of reducing energy costs are essentially the same for all HVAC systems.

Download

Go online for more information

The Carbon Trust provides a range of tools, services and information to help you implement energy and carbon saving measures, no matter what your level of experience.

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

www.carbontrust.com

Tools, guides and reports – We have a library of publications detailing energy saving techniques for a range of sectors and technologies.

www.carbontrust.com/resources

Events and workshops – We offer a variety of events, workshops and webinars ranging from a high level introductions to our services through, to technical energy efficiency training.

www.carbontrust.com/events

Small Business Support – We have collated all of our small business support in one place on our website.

www.carbontrust.com/small-to-medium-enterprises/

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

www.carbontrust.com/our-clients

The Carbon Trust Green Business Fund – is an energy efficiency support service for small and medium-sized companies in England, Wales and Scotland. It provides direct funded support through energy assessments, training workshops, and equipment procurement support. *

www.carbontrust.com/greenbusinessfund

SME Network - Join a community of over 2000 small and medium-sized businesses to discuss your strategy and challenges to reducing carbon emissions and improving resource efficiency. Sign up for free to share knowledge, exchange useful resources and find out about the support and funding available in your area, including the details of your local energy efficiency workshops.

www.carbontrust.com/resources/tools/sme-carbon-network

*Subject to terms and conditions.

The Carbon Trust is an independent company with a mission to accelerate the move to a sustainable, low-carbon economy. The Carbon Trust:

- **advises businesses, governments and the public sector on opportunities in a sustainable, low-carbon world;**
- **measures and certifies the environmental footprint of organisations, products and services;**
- **helps develop and deploy low-carbon technologies and solutions, from energy efficiency to renewable power**

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