Technology information leaflet ECA762

CARBON TRUST

Heating, ventilation and air conditioning zone controls

A guide to equipment eligible for Enhanced Capital Allowances

Contents

Introduction

ECAs are a straightforward way for a business to improve its cash flow through accelerated tax relief. The scheme encourages businesses to invest in energy saving plant or machinery specified in the ETL to help reduce carbon emissions, which contribute to climate change.

The Energy Technology List (ETL) is a register of products that may be eligible for 100% tax relief under the Enhanced Capital Allowance (ECA) scheme for energy saving technologies[1]. The Carbon Trust manages the list and promotes the ECA scheme on behalf of government.

This leaflet gives an overview of HVAC zone control equipment specified on the ETL and aims to help businesses present a sound business case for purchasing energy saving equipment from ETL manufacturers and suppliers.

Background

The ETL comprises two lists: the Energy Technology Criteria List (ETCL) and the Energy Technology Product List (ETPL). The ETCL defines the performance criteria that equipment must meet to qualify for ECA scheme support; the ETPL is a qualified list of products that have been assessed as being compliant with ETCL criteria.

Further information

For more information on HVAC, visit
www.carbontrust.co.uk/airconditioning
www.carbontrust.co.uk/heating
www.carbontrust.co.uk/ventilation
or download the Carbon Trust's *Heating, ventilation and air conditioning* technology overview (CTV003).

Setting the scene

HVAC zone controls can be used for a range of control applications in buildings. They allow the environmental conditions in a zone (specific controlled area) to be independently controlled to meet the desired conditions. This allows environmental parameters such as internal air temperature and ventilation to be controlled in relation to occupancy patterns.

In buildings without individual zone control, levels of heating and/or cooling can be the same throughout the building. This can result in large amounts of energy being wasted and associated high CO_2 emissions. Splitting the building into a number of separate zones can provide control that more closely matches the desired conditions. The selection of control zones will be influenced by the following:

- Internal heating/cooling requirements based on the number of occupants, amount of office/IT equipment and other sources of heat in different areas of the building.
- Occupancy patterns – whether separate parts of the building are occupied for different time periods, for example, a single area with 24-hour occupancy or evening work.
- External heat gains – increased solar gain on southerly facing areas of the building.

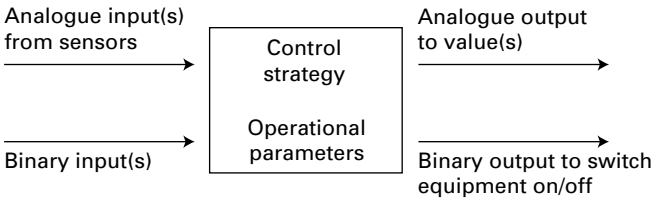
[1] Eligibility for ECAs is based on a number of factors. Visit **www.eca.gov.uk/energy** to find out more.

The level of energy savings resulting from the use of zone controls will depend on the specific application, however, properly installed and commissioned controls typically provide energy savings of around 20%[2] over systems without this level of control. In recognition of this, The Building Regulations *Approved Document L2A – Conservation of fuel and power in new buildings other than dwellings* requires that HVAC systems should be sub-divided into separate control zones to correspond to each area of the building that has a significantly different solar exposure or pattern or type of use. For existing buildings, *Approved Document L2B – Conservation of fuel and power in existing buildings other than dwellings* requires this level of zone control where work involves the provision or extension of controlled services (i.e. HVAC systems).

HVAC zone controls can also help optimise occupant comfort, health and productivity. In a building with a single control zone, areas within the building may be either over-heated or under-cooled. This will cause occupants discomfort and impact on their productivity. By splitting the building into an appropriate number of control zones, this can be improved.

The functionality of an HVAC zone controller will depend on the specific intended application, however, an example zone controller is shown below.

Figure 1 *Schematic of a zone controller*



The HVAC zone controller will have a factory-set control strategy for each function. There will also be manual settings for variable operational parameters, which are initially set during the commissioning stage. Examples include zone occupation times, desired internal temperatures and levels of ventilation. The zone controller will have one or more control inputs such as that from an internal air temperature sensor (analogue input) and/or binary inputs, for example from an occupancy presence detector. Control outputs can include analogue outputs (for example, a control signal to adjust the position of a valve) or binary outputs to switch an item of equipment on or off.

Some zone controllers can be connected together using a communications network, to a master controller. This allows the sharing of data, for example, readings of external air temperature can be shared between individual zone controllers on a network.

[2] The Carbon Trust's guide to *Energy use in offices* (ECG019)

Benefits of purchasing ETL-listed products

HVAC zone control products listed on the ETL are those that facilitate a more efficient operation of HVAC systems to ensure that energy is consumed only when required, reducing energy waste and CO_2 emissions. An average site can potentially achieve energy savings of 20% through correct application of ETL-listed HVAC zone controls.

When replacing equipment, businesses are often tempted to opt for that with the lowest capital cost, however, such immediate cost savings can prove to be a false economy. Considering the life cycle cost before investing in equipment can help reduce costs and improve cash flow in the longer term.

The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure. This means that businesses can write off the whole cost of the equipment against taxable profits in the year of purchase. This can provide a cash flow boost and an incentive to invest in energy saving equipment which normally carries a price premium when compared to less efficient alternatives.

Using this leaflet you can calculate the benefits of investing in qualifying ETL energy saving equipment over non qualifying equipment. The calculation includes the benefits of accelerated tax relief, reduced running costs, increased efficiency, lower energy bills and reduced Climate Change Levy payments (if applicable), which in turn helps reduce payback periods.

Important

Businesses purchasing equipment must check the ETPL at the time of purchase in order to verify that the named product they intend to purchase is designated as energy saving equipment. HVAC zone control equipment that meets the ETL eligibility criteria but is not listed on the Energy Technology Product List (ETPL) at the time of purchase is not eligible for an ECA.

HVAC zone control equipment eligible under the ECA scheme[3]

There are five types of HVAC zone control equipment specified as energy saving under the ECA scheme.

- Wet (hydronic) heating systems
- Underfloor or storage heating – wet systems and electric heating
- Ventilation
- Air conditioning and comfort cooling
- Chilled water systems

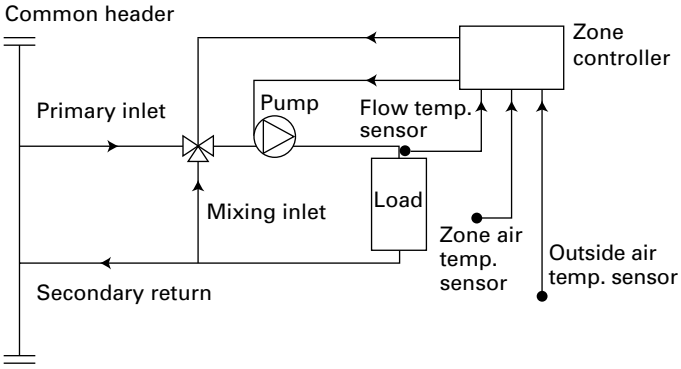
NOTE: In practice many zone controls may regulate more than one system within the zone, i.e. both the heating and ventilation, however, this will depend on the specific application.

Wet heating system

The use of zone controls for hydronic heating systems is important to ensure that overheating is avoided. A wide range of ETL-compliant heating and control options are available for incorporating constant or variable flow approaches.

The schematic diagram below illustrates the use of a zone controller applied to a constant volume/variable temperature zone heating circuit.

Figure 2 *Constant volume/variable temperature zone heating circuit*



[3] The descriptions of the HVAC zone controls given in this leaflet are examples only and do not constitute ECA eligibility. The formal criteria and details governing the ECA scheme can be found at **www.eca.gov.uk/energy**.

With this approach, the zone controller will activate the heating circuit based on the set time schedule for the zone. This allows different time schedules for different zones. The temperature of the water flowing through the heat emitters (e.g. radiators) is regulated by the zone controller based on the internal air temperature and an outside air temperature sensor. Weather compensation control is a requirement for ETL compliance for hydronic heating systems.

Other control options include optimum start. This activates the heating circuit at an early enough time in the morning to ensure that the zone air temperature reaches the desired setpoint by the beginning of occupancy. Optimum start control is also a requirement for ETL compliance for hydronic systems.

Non-hydronic heating options including electric storage heating, gas-fired convection heaters and gas-fired radiant heaters can also be regulated by zone controllers. ETL-compliant zone controls are available for these options.

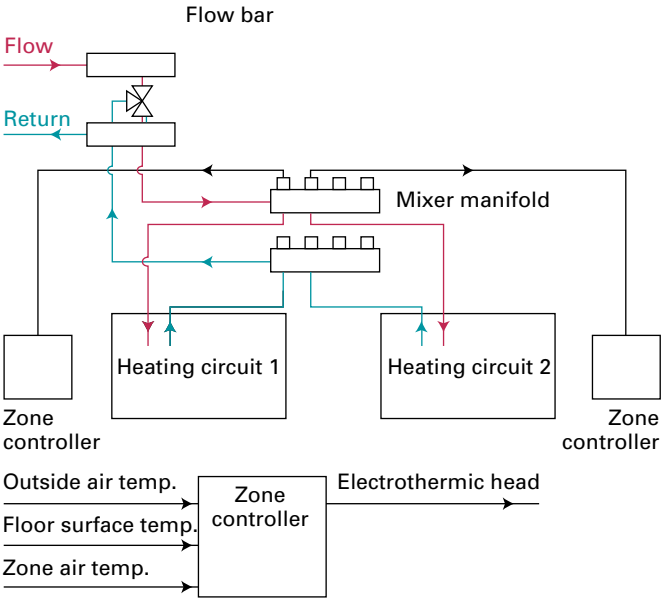
For the installation of wet heating zone controls where none previously existed within a typical 1,000m^2 naturally ventilated cellular office building, the potential annual savings are calculated as:

- £1,510
- 30,200kWh
- 6 tonnes CO_2.

Underfloor heating

Underfloor heating systems can be used in buildings where there is a danger of people injuring themselves, where there is a risk of vandalism, and in areas that require visually unobtrusive heat emitters. Figure 3 shows a simplified two-zone underfloor hydronic heating system. Each heating zone has its own controller that allows for the independent regulation of the heated water in response to the internal air temperature and a defined occupancy time schedule.

Figure 3 *Hydronic underfloor heating*



The alternative to hydronic underfloor heating is electric underfloor heating, provided by coils buried in the floor. This can either be controlled by the zone temperature or by varying the current supplied to the underfloor heating circuit. A zone high-temperature override disables the electrical control signal when the air temperature in the zone rises above a certain temperature. In order to avoid damaging the floor surface a high-temperature override disables the electrical current when the floor temperature rises above a temperature setpoint.

For the installation of underfloor heating zone controls where none previously existed within a typical 1,000m^2 naturally ventilated cellular office building, the potential annual savings are calculated as:

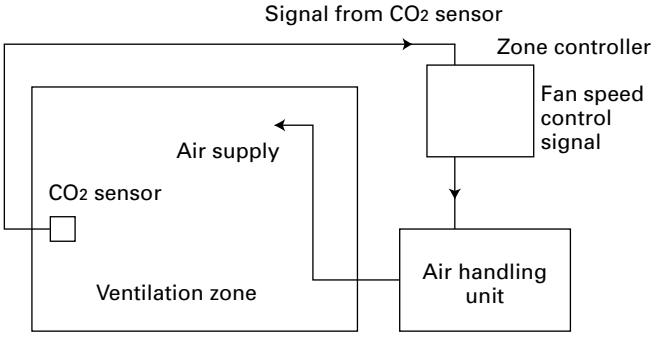
- £2,386
- 30,200kWh
- 13 tonnes CO_2.

Ventilation

With improvements in building fabric insulation and levels of air-tightness (reduced air infiltration), the relative contribution that ventilation makes to a building's energy consumption is increasing. The ventilation to a zone can be controlled by the following means:

- Time schedules – this is the most basic level of automatic control and allows for automatic switch on/off in relation to set occupancy patterns. This form of control is suitable where the level of occupancy is fairly consistent and/or predictable. Where this is not the case, ventilation control can be improved by using zone controls that allow the occupants to alter the fan speed and hence vary the ventilation rate.
- Occupancy detection – this allows for the automatic switch on/off of the ventilation system if occupancy is detected in the zone. This helps to reduce energy consumption by ensuring that the ventilation system only operates when the zone is occupied. There is a range of occupancy detection products, the most common being passive infrared (PIR). Occupancy detection can be suitable for zones that are intermittently occupied. Examples include conference facilities and storage areas.
- Demand-controlled ventilation – this approach allows for the optimisation of energy consumption and indoor air quality. Typically, levels of metabolic CO_2 are measured and used as a control input (the greater the occupancy density, the higher the level of CO_2). The speed of the ventilation fan is controlled to give a desired level of CO_2. Demand-controlled ventilation is suitable when levels of occupancy within the zone are highly variable and where good indoor air quality is important (for example in a conference room). Figure 4 illustrates the control of a demand-controlled ventilation system.

Figure 4 *Demand-controlled ventilation*



Where natural ventilation is used as an alternative to mechanical ventilation, zone controllers can be used to automatically control the operation of vents, windows, dampers and louvres.

For installation of ventilation zone controls where none previously existed within a typical 5,000m² air-conditioned office building, the potential annual savings are calculated as:

- £17,511
- 287,000kWh
- 81 tonnes CO_2.

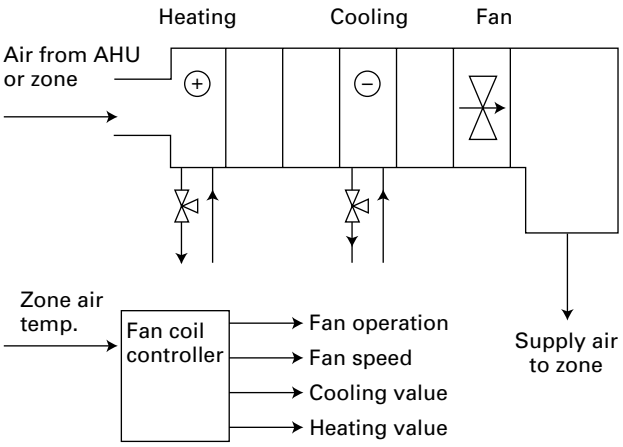
Air conditioning and comfort cooling

There are a wide range of air conditioning and comfort cooling systems, including constant air volume systems, variable air volume systems (VAV), fan coils and heat pumps.

As with hydronic heating systems, zone controls can play an important role in ensuring that air conditioning and comfort cooling systems maintain desired internal conditions without wasting energy.

The schematic diagram below illustrates the control of a fan coil unit (waterside control).

Figure 5 *Fan coil unit (waterside control)*



A fan coil unit provides heating and cooling to the surrounding zone, whilst aiding zone air distribution. Outside air can be supplied to the unit or the zone either directly from outside, or from an air handling unit. The unit incorporates a fan, a heating coil and a chilled water-cooling coil, and also induces air from the surrounding zone. The coils are controlled to achieve the required supply air temperature to the zone; if supplied with water they utilise three-port mixing valves in a diverting application to obtain the required heating/cooling effect. The operation of the coils is sequenced so that heating and cooling are never provided at the same time. The fan can be either constant speed, two-speed or variable speed. Variable speed control can be achieved with the use of DC electric motors to drive the fan.

For the installation of a cooling system where none previously existed within a typical 5,000m² air-conditioned office building, the potential annual savings are calculated as:

- £8,611
- 109,000kWh
- 47 tonnes CO_2.

Chilled water systems

Chilled water systems comprise chillers that generate chilled water and their associated equipment such as heat rejection units and pumps. By their nature, chilled water systems are centralised and usually located in a plant room. The generated chilled water is distributed to items of equipment such as fan coil units and chilled ceilings/beams located throughout a building. Chillers are normally supplied with controls already installed and configured by the manufacturer. It is the supply of chilled water produced by a chiller that is controlled at the zone level by zone controllers.

Information for purchasers

For further information about the ECA scheme, the Energy Technology List (ETL) and other Technology Information Leaflets in the series please visit **www.carbontrust.co.uk/eca**, contact the Carbon Trust on **0800 085 2005** or email **customercentre@carbontrust.co.uk**

Calculating the payback of your investment

Based on the operating conditions above, indicative savings can be calculated for replacing your existing equipment with either ETL-listed equipment or non-ETL-listed equipment.

The accelerated tax relief and cash flow benefit provided by the ECA, together with the life cycle cost savings from ETL-listed equipment, aid in bridging the price premium and shortening the investment payback period[4].

To calculate the payback period for ETL-listed equipment and non-ETL-listed equipment for comparison you will need:

- The unit price (kWh) of the fuel your business consumes.
- Estimated fuel usage (kWh) for the ETL proposed equipment solution(s), which the manufacturer or supplier should be able to help you with.
- Estimated fuel usage (kWh) for the non-ETL proposed equipment solution(s), which the manufacturer or supplier should be able to help you with.
- Estimated annual maintenance costs incurred by your business for the ETL-listed equipment (your manufacturer or supplier should be able to help you with estimates).
- Estimated annual maintenance costs incurred by your business for the non-ETL-listed equipment (your manufacturer or supplier should be able to help you with estimates).
- The value of the proposed capital expenditure.
- Your business's corporation tax rate.

In addition, the following information is also required:

- A copy of the Carbon Trust fact sheet *Energy and carbon* conversion (CTL004).
- Incorporation of the fact that capital allowance (CA) tax relief for non ETL equipment is 20% (10% if allocated to the 'special rate' pool) and that enhanced capital allowance (ECA) tax relief for ECA equipment is 100%.

Step 1: To prepare your business case for investment you first need to estimate annual energy consumption of the ETL-listed equipment and non-ETL-listed equipment.

Annual energy consumption (kWh/y) = Equipment consumption (kW) x Number of operating hours/year

Additionally, you can calculate the carbon emissions associated with the energy consumption using either the Carbon Trust fact sheet *Energy and carbon conversion* (CTL004) or by using the tool at **www.carbontrust.co.uk/conversionfactors** by simply multiplying the energy consumption by the carbon emission factor for that fuel type.

Carbon emissions = Annual energy consumption (kW) x Emission factor (kg CO_2/kWh)

Step 2: Calculate the annual running cost (ARC) of ETL-listed equipment and non-ETL-listed equipment.

ARC = Annual energy consumption (kW) x Pence/kWh + Annual maintenance cost

Step 1 and 2 can also be done for your existing equipment to calculate an ARC, in order to allow comparisons of the annual saving (step 3) between the existing equipment, the ETL-listed equipment, and the non-ETL-listed equipment.

Step 3: Calculate the annual saving between the ETL-listed annual running costs and non-ETL-listed annual running costs.

Annual saving = ARC of ETL listed equipment - ARC of ETL non-listed equipment

Step 4: Calculate the tax allowance for ETL-listed equipment and non-ETL-listed equipment which will be business-specific based on the following:

- The value of your capital expenditure
- Capital allowance (CA) tax relief for non-ETL equipment is 20%. If allocated to the special rate pool it is reduced to 10%.
- Enhanced capital allowance (ECA) tax relief for ECA equipment is 100%
- The rate of corporation or income tax for your business.

[4] The values used in the examples given are for illustrative purposes only and do not reflect specific case studies. Anyone considering purchasing this type of equipment would be advised to also analyse the benefits that would be available based on their own circumstances. It should also be noted that the use of formally trained heating, ventilation and air conditioning equipment technicians can provide significant energy saving benefits.

CA tax allowance = Capital expenditure x 20%* x Rate of corporation tax

ECA tax allowance = Capital expenditure x 100% x Rate of corporation tax

To calculate the available CA tax allowance on capital expenditure beyond Year 1 you need to decrease the capital expenditure by 20% per year (10%if allocated to the special rate pool) on a reducing balance basis. Over the nine years the available CA tax allowance are shown in the table below.

Step 5: Calculate the pay back for ETL-listed equipment and non-ETL-listed equipment.

$$\text{Payback period} = \frac{\text{Tax allowance} + \text{Annual saving}}{\text{Capital expenditure}}$$

Table 1 *The cash flow boost to your business of an ECA over a CA for a capital investment of £10,000*

	Year								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Capital Expenditure (£)	10,000	8,000	6,400	5,120	4,096	3,277	2,621	2,097	1,678
Capital Allowance (CA) @ 20% (£)	2,000	1,600	1,280	1,024	819	655	524	419	336
CA Tax Allowance	560	448	358	287	229	184	147	117	94
Enhanced Capital Allowance @100% (£)	10,000	0	0	0	0	0	0	0	0
ECA Tax Allowance	2,800	0	0	0	0	0	0	0	0

Calculations are based on 28% corporation tax/income tax and a capital allowance rate of 20%.

* Replace with 10% if allocated to the special rate pool.

Go online to get more

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.

Carbon Footprint Calculator – Our online calculator will help you calculate your organisation's carbon emissions.

→ **www.carbontrust.co.uk/carboncalculator**

Interest Free Loans – Energy Efficiency Loans from the Carbon Trust are a cost effective way to replace or upgrade your existing equipment with a more energy efficient version. See if you qualify.

→ **www.carbontrust.co.uk/loans**

Carbon Surveys – We provide surveys to organisations with annual energy bills of more than £50,000*. Our carbon experts will visit your premises to identify energy saving opportunities and offer practical advice on how to achieve them.

→ **www.carbontrust.co.uk/surveys**

Action Plans – Create action plans to implement carbon and energy saving measures.

→ **www.carbontrust.co.uk/apt**

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.co.uk/casestudies**

Events and Workshops – The Carbon Trust offers a variety of events and workshops ranging from introductions to our services, to technical energy efficiency training, most of which are free.

→ **www.carbontrust.co.uk/events**

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

→ **www.carbontrust.co.uk/publications**

Need further help?

Call our Customer Centre on 0800 085 2005

Our Customer Centre provides free advice on what your organisation can do to save energy and save money. Our team handles questions ranging from straightforward requests for information, to in-depth technical queries about particular technologies.

* Subject to terms and conditions.

The Carbon Trust was set up by Government in 2001 as an independent company.

Our mission is to accelerate the move to a low carbon economy by working with organisations to reduce carbon emissions and develop commercial low carbon technologies.

We do this through five complementary business areas:

Insights – explains the opportunities surrounding climate change
Solutions – delivers carbon reduction solutions
Innovations – develops low carbon technologies
Enterprises – creates low carbon businesses
Investments – finances clean energy businesses.

www.carbontrust.co.uk
0800 085 2005

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