Technology information leaflet ECA770

CARBON TRUST

Solar thermal technology

A guide to equipment eligible for Enhanced Capital Allowances

Contents

Front cover image courtesy of Wessex Water.

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 solar thermal 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

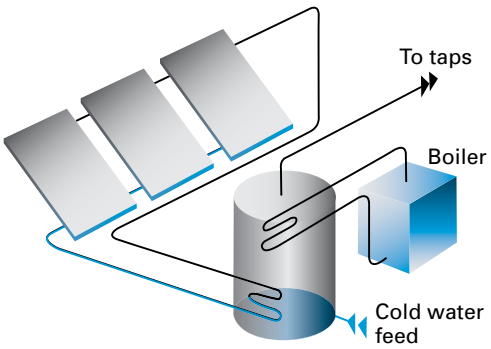
The ETL comprises two lists: the Energy Technology Criteria List (ETCL) and the Energy Technology Product List (ETPL). The ETCL defines the performance criteria that equipment must meet to qualify for ECA scheme support; whereas the ETPL is a qualified list of products that have been assessed as being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

Setting the scene

Solar thermal systems use energy from the sun to heat water. This replaces other energy sources such as natural gas and electricity as a means of providing hot water to buildings.

The most important part of a solar thermal system is the 'collector'. The collector's role is to absorb the sun's energy and efficiently convert it to heat for transfer to the hot water system. The collector is normally mounted on the roof of a building. There are a number of different types of solar thermal system; a typical system is shown in Figure 1.

Figure 1 *Typical twin coil solar thermal system*



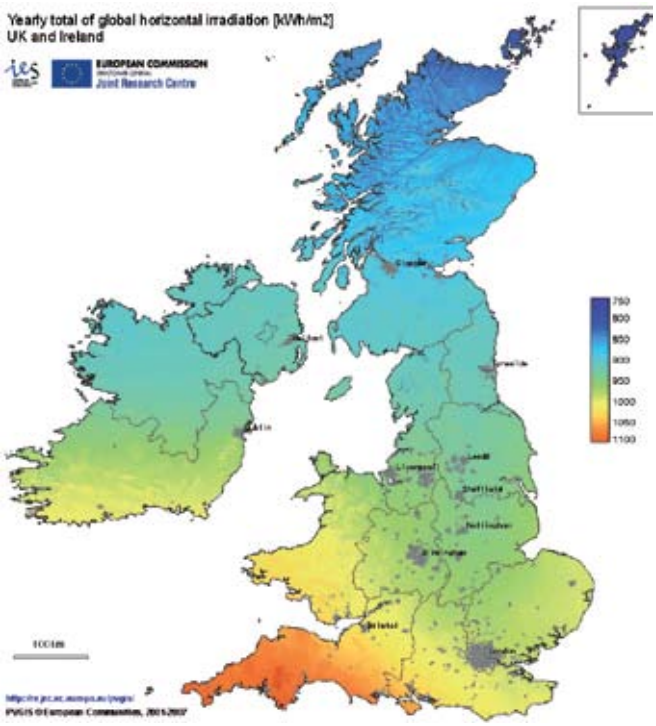
Hot water is supplied to the building by transferring the heat (energy) absorbed by the collector and pumping it down to the cylinder tank.

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

A well designed system, incorporating a collector from the ETL, can be expected to collect useful energy greater than 450 kilowatt hours per year per square metre (kWh/y/m²)[2]. However, performance is dependant on the location and orientation of the collector.

The available solar energy across the UK is shown in the solar irradiation chart below. This shows that the South West receives the highest level of solar radiation falling on the horizontal plan per square metre, making it an ideal location for the use of a solar thermal system. However, a wide range of other locations in the UK will also be suitable.

Figure 2 *Solar irradiation chart*[3]



There is a common misconception that solar thermal systems do not operate when it is cloudy. In the UK there is a relatively high percentage of cloudy days compared to clear days. When the sun's radiation passes through clouds, it is dispersed and is known as diffused radiation. On clear days, with no dispersion effect, it is known as direct radiation. Solar thermal systems are able to operate in both conditions. Figure 3 shows the average daily values for both diffused and direct irradiation for the London area.

Figure 3 *Average daily light energy for London*[4]

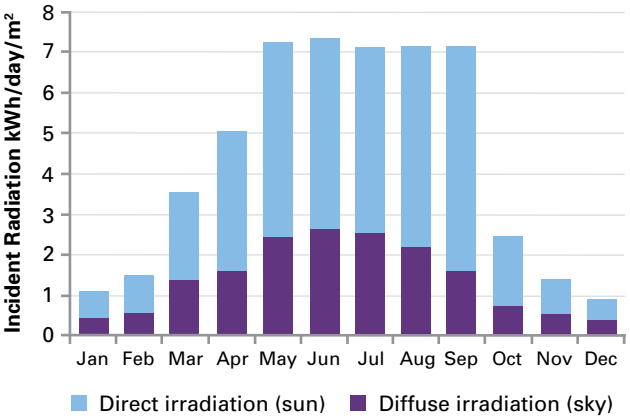


Figure 3 shows that solar thermal systems will provide more hot water during the summer than during the winter. This means that an auxiliary heat source will still be required to heat the water during the winter months. However, solar thermal systems are still able to save between 40% and 60% of the energy that would have been required annually to heat up the hot water using conventional energy sources, such as gas[5].

[2] ETL Technology Review – Solar Thermal Systems (August 2006).

[3] PVGIS, European Communities.

[4] Solar Irradiance Database.

[5] CIBSE (2007) Solar Heating Design & Installation Guide.

Benefits of purchasing ETL-listed products

Solar thermal products listed on the ETL are highly energy efficient, particularly when compared to non-ETL-listed products, and can potentially achieve energy savings of between 40% and 60%[5] for hot water heating when installed in a well designed system.

When replacing equipment, businesses are often tempted to opt for equipment 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 enhance the cash flow benefits still further.

The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure, and the ETL specifies the energy saving technologies that are supported by the ECA scheme. 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 that 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, including 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 ETL at the time of purchase in order to verify that the named product they intend to purchase is designated as energy saving equipment. Solar thermal 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.

Types of solar thermal collector eligible under the ECA scheme

There are two types of solar thermal collector that are specified as energy saving under the ECA scheme. Within these, further sub-division can be made:

- Glazed flat plate collectors
- Evacuated tube collectors electric heating
  - Direct flow
  - Heat pipe collectors.

Using the baseline scenario below, the potential financial (£), energy (kWh) and carbon savings (kg CO_2) have been calculated for comparison unless otherwise indicated:

- Gas cost 1.986p/kWh and electricity cost 6.54p/kWh
- Annual solar energy delivered to hot water system: 1340kWh/m^2 for a collector that does not meet the ECA criteria[6]
- Carbon dioxide emissions factors of 0.206kgCO_2/kWh (gas) and 0.523kgCO_2/kWh (electricity)[7]
- Carbon factors of 0.052kgC/kWh (gas) and 0.147kgC/kWh (electricity)[7].

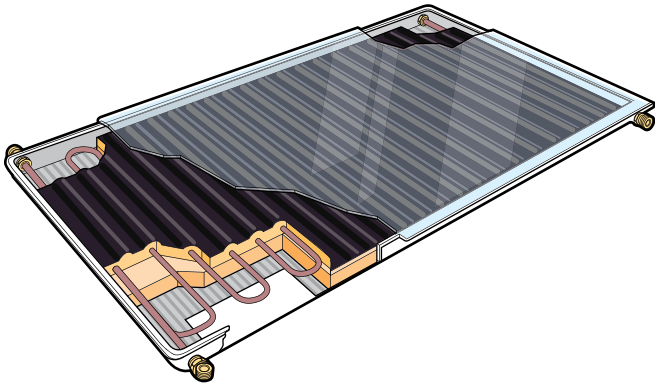
[6] ETL Technology Review – Solar Thermal Systems (August 2006).

[7] Guidelines to Defra's GHG conversion factors for company reporting.

Glazed flat plate solar collector

There are two main types of flat plate collector, but only glazed flat plates qualify for inclusion on the ETL. Glazed flat plates are constructed with insulation on their back and sides and are covered by a transparent cover. This reduces the heat loss to the surrounding area and therefore improves the performance of the collector compared to an unglazed version. These collectors can be integrated with the roof, mounted on the roof or façade mounted. Figure 4 shows a glazed flat plate collector.

Figure 4 *Schematic of a glazed flat plate collector*



Flat plate collectors are generally cheaper than evacuated tube collectors with a good cost-to-performance ratio.

Did you know?

A glazed flat plate collector will collect approximately 450kWh/m² per year[8]. This is equivalent to 4,500 100W light bulbs being turned on for one hour.

Installing an ETL-listed glazed flat plate collector with an annual solar yield of 1559kWh/m² could result in the following annual savings when compared to an equivalent non-ETL-listed product.

	ETL	Non ETL
Fuel savings	£101	£87
Energy saving	1,559kWh/m²	1,340kWh/m²
Carbon dioxide savings	815kg CO_2	700kg CO_2
Carbon savings	230kgC	197kgC

Evacuated tube solar collectors

Evacuated tubes are highly efficient even with low solar radiation, as well as in circumstances where there is a large temperature difference between the absorber and ambient temperatures. In general, evacuated tubes are more expensive than glazed flat plate collectors and cannot be installed integral to the roof.

Evacuated tube collectors use glass tubes in which a vacuum is created. This acts as a source of insulation, reducing heat losses from the collector and making the product very efficient. There are two types of evacuated tube collectors: direct flow and heat pipe collectors.

Direct flow

Direct flow evacuated tube collectors use an evacuated tube inside a U-shaped tube. There are three different designs of direct flow evacuated tubes for the U-shaped tube. These are: concentric fluid inlet and outlet, two separate tubes for inlet and outlet and the Sydney tube. The fluid in the solar system is used as the heat transfer medium and the fluid runs through a concentric tube-in-tube or a U-shaped tube to the base of the glass bulb and then returns to the header. The Sydney tube is an example that incorporates a vacuum double glass tube sealed together at one end.

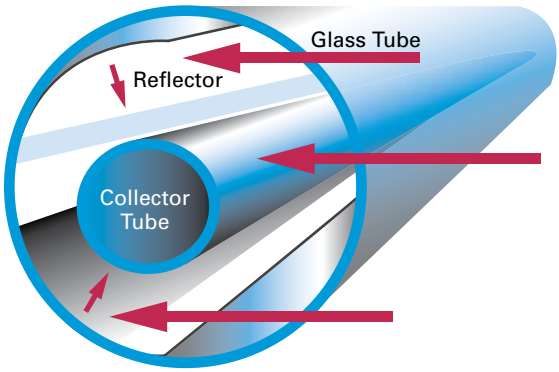
[8] German Solar Society (2005) Planning and Installing Solar Thermal Systems.

Heat pipe collectors

A heat pipe evacuated tube collector uses alcohol or water in a vacuum which is used to absorb the sun's energy. Due to the vacuum, the alcohol or water will evaporate at a low temperature of 25°C to form a vapour. This vapour then rises up the collector tube to the heat exchanger where heat transfer to the solar fluid takes place. Following heat transfer, the vapour condenses back to a liquid and flows back down the collector tube. It should be noted that heat pipe evacuated tubes must be installed with a tilt of at least 25°C degrees.

There are two types of heat pipe evacuated tube collector: a dry connection and wet connection. In a dry connection collector, the condenser completely surrounds the collector tube. This provides good heat transfer between the tube and the heat exchanger and allows for tubes to be replaced without the need to drain the solar fluid. In a wet connection collector, the tube is submersed in the heat transfer fluid. Therefore, if a tube needs to be replaced then the system must be drained.

Figure 5 *Schematic of heat pipe evacuated tube collector*



Did you know?

An evacuated tube collector will collect approximately 450-550kWh/m² per year[9]. Therefore, a system could provide an annual solar yield of 4,066kWh.

Installing an ETL-listed evacuated tube collector with an annual solar yield of 2033kWh/m² could result in the following annual savings when compared to an equivalent non-ETL-listed product.

	ETL	Non ETL
Fuel savings	£132	£87
Energy saving	2,033kWh/m²	1,340kWh/m²
Carbon dioxide savings	1,063kg CO_2	700kg CO_2
Carbon savings	298kgC	197kgC

Conclusion

It can be seen that a ETL solar thermal product will save you between 219kWh/m² and 693kWh/m² of energy. This means a financial saving of between £19 to £59 and an environmental saving of up to 505kg of carbon dioxide and 138kg of carbon. These savings are dependent on the type of collector used, a flat plate collector or an evacuated tube collector.

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**

[9] German Solar Society (2005) Planning and Installing Solar Thermal Systems.

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[10].

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

- The unit price (kW) of the energy your business consumes.
- Estimated energy usage (kW) for the ETL proposed equipment solution(s), which the manufacturer or supplier should be able to help you with.
- Estimated energy usage (kW) 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 new equipment	-	ARC of existing equipment

[10] 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.

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.

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.

$$\textbf{Payback period} = \frac{[\text{Capital expenditure} - \text{Tax allowance}]}{\text{Annual saving}}$$

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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