2008

Small-scale solar thermal energy and traditional buildings

ENGLISH HERITAGE

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PLANNING AND HISTORIC BUILDING LEGISLATION

THE INSTALLATION OF A RENEWABLE TECHNOLOGY IMPLIES IN MOST CASES THE FIXING OF EQUIPMENT TO THE HISTORIC FABRIC OF A BUILDING. ENGLISH HERITAGE SEEKS TO ENSURE THAT ANY WORKS TO A HISTORIC BUILDING DO NOT UNNECESSARILY DISTURB OR DESTROY HISTORIC FABRIC.

In decisions on how best to incorporate a renewable technology, the principles of minimum intervention and reversibility should be adopted whenever and wherever possible.

Installation of a solar water heating system will probably need planning permission. The local planning authority can grant permission under the Town and Country Planning Act 1990, and will be looking for any issues concerning visual impact and proximity to land boundaries.

Installation of solar water panels on a listed building or a building in a conservation area will also need permission from the local planning authority, under the Planning (Listed Buildings and Conservation Areas) Act 1990. Planning Policy Guidance (PPG) 15, *Planning and the Historic Environment*, can help you with this; see **www.planningportal.gov.uk**. Work of any kind to a Scheduled Monument requires consent from English Heritage under the Ancient Monuments and Archaeological Areas Act 1979.

Your application must show clearly what you intend to do, with detailed drawings and photographs. In order to help the planning officer to visualise the system in its proposed setting and to determine its visual impact, it is useful to superimpose all elements of the system on photographs of the site or building.

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Front cover image courtesy of The Centre for Alternative Technology.

INTRODUCTION

English Heritage is the UK government's adviser on the historic environment within England. Central to our role is the advice we give to local planning authorities and government departments on development proposals affecting listed and traditional buildings, conservation sites and areas, terrestrial and underwater archaeological sites, designed landscapes and historical aspects of the landscape as a whole. For our policy statements on climate change and wind energy, refer to the Historic Environment Local Management website, of English Heritage, **www.helm.org.uk.**

The earth's climate is changing at a rate that has not been seen before in human history. The changes have been linked to rising concentrations of carbon dioxide in our atmosphere. Carbon dioxide is a by-product of the burning of fossil fuels to supply energy, and emissions have spiralled upwards as our demand for energy has increased.

The UK government, wishing to reduce the country's dependence on fossil-fuel stores and to cut carbon dioxide emissions, has made a commitment to generate 10 per cent of its energy from renewable sources by 2010, rising to 20 per cent by 2025. Renewable energy may come from self-regenerating sources such as wood, or those such as the sun, wind and waves that are effectively infinite. The technologies associated with these sources are sometimes referred to as 'low-carbon', in that they emit much lower levels of carbon dioxide and related compounds into the atmosphere than do fossil-fuel technologies.

For more information on the UK government's position on climate change, contact the UK Climate Impacts Programme (*see* Useful contacts).

This guide is one of a series examining options for the small-scale generation of renewable energy. Separate guides look at wind generation, solar energy, bio-fuels, heat pumps and combined heat and power, explaining how each system works and what you need to consider if you wish to install it in or on a historic building. The emphasis is on small-scale generation, or 'microgeneration' as it is also known.

Cutting demand for energy is as important as finding alternative means of generating it. Before deciding whether to install a renewable energy technology in a building, all available energy-saving measures, including low-energy lamps, heating controls and improved insulation, should already have been taken. An English Heritage guidance document, *Energy Conservation in Traditional Buildings*, looks at methods of improving insulation and introduces other methods for saving energy.

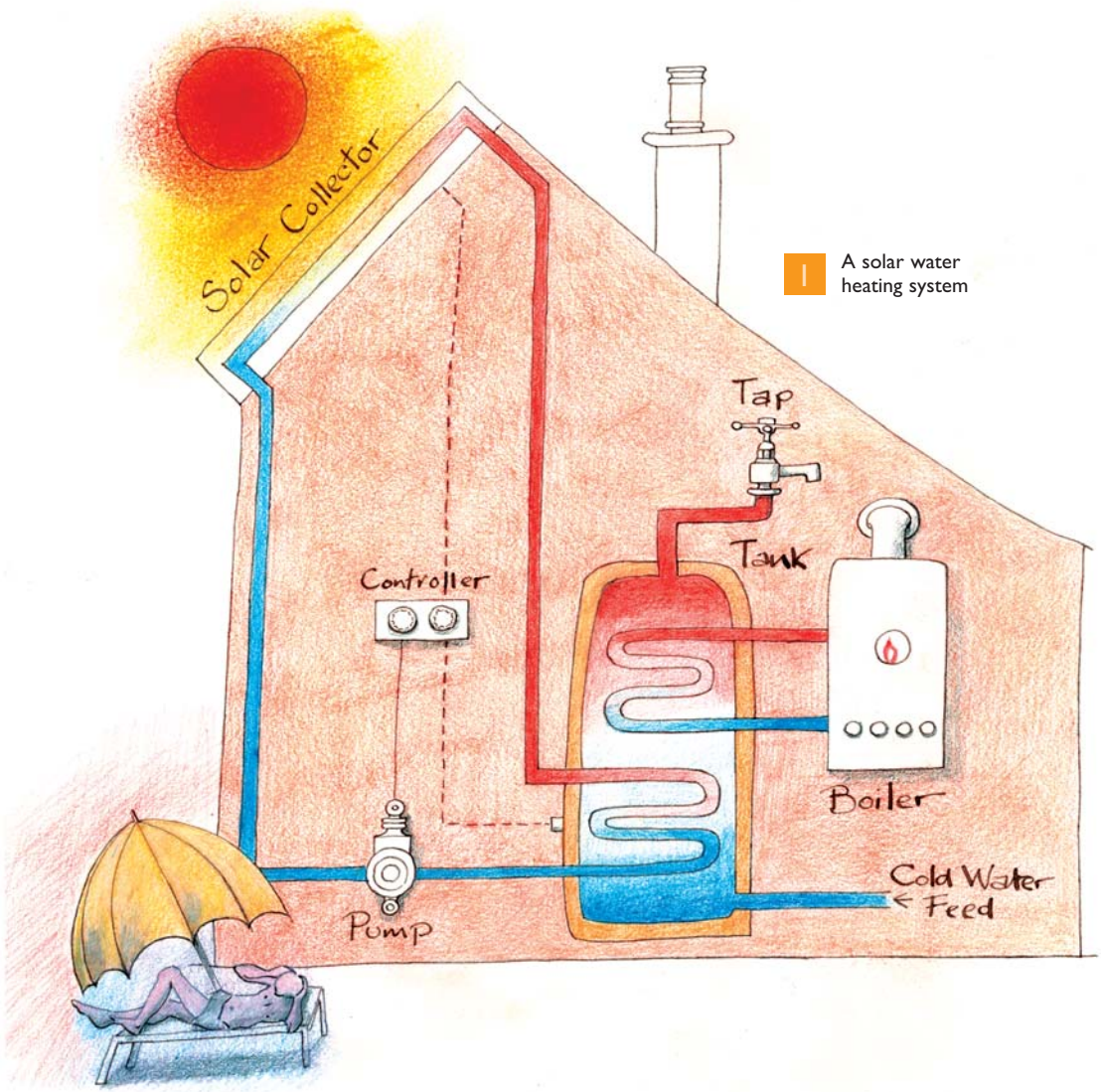
PLANNING A SOLAR WATER HEATING SYSTEM

THERE ARE A NUMBER OF FACTORS TO CONSIDER BEFORE INSTALLING A SOLAR WATER HEATING SYSTEM ON A PROPERTY.

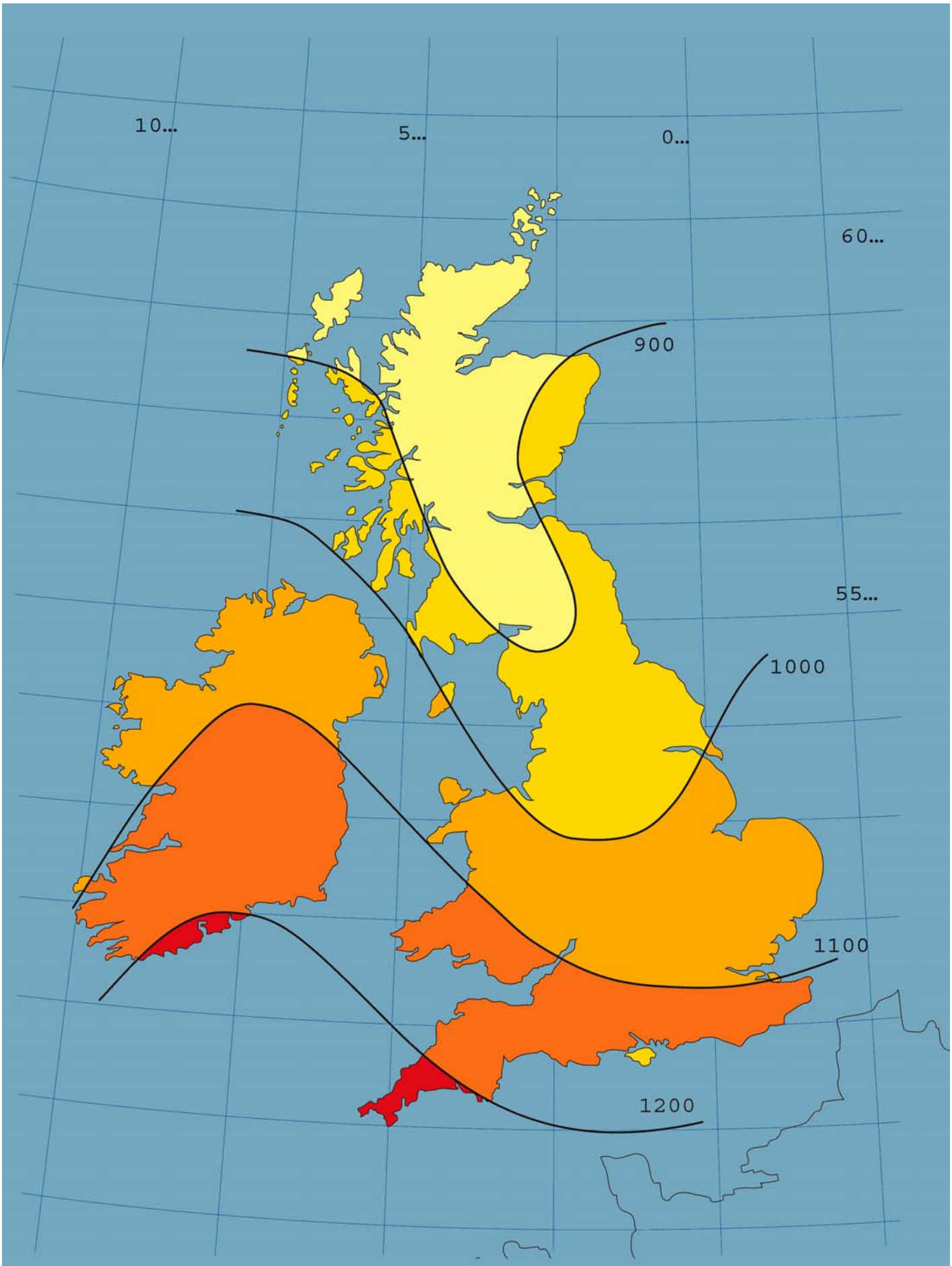
Have other energy saving measures been taken? Is planning permission or listed building consent needed and would it be forthcoming? Is solar water heating the most suitable renewable technology for the occupant's? Can this technology be installed easily on this property? The non-profit, government-funded and private funded Energy Saving Trust (see Useful contacts) has fact sheets on a variety of small-scale renewable technologies.

There are two main parts to a solar water heating system: the collector and the thermal store (Fig 1). A solar collector uses the sun's radiant energy to heat water. The collector is normally fixed on the roof of a building, but there are installations where it has been located away from the building. Heated water is pumped via an insulated pipe to the thermal store (hot water tank). The pipe is arranged in a coil at the bottom of an enlarged thermal store, more commonly. The heat is transferred through the pipe wall and heats the water in the thermal store. Another separate coil of pipe is at the top of the thermal store from the conventional gas or oil boiler. Both the coils are arranged so that the water in the thermal store is firstly heated by the solar water heating and if not sufficiently hot enough the conventional boiler is used to heat the water.

The Solar Trade Association (see Useful contacts) has produced a map for the United Kingdom (Fig 2) of the average amount of solar energy falling on a south-facing 30° incline from the horizontal. A 30° incline is considered the optimum for maximising total solar radiation in the UK, but this angle is not too critical and a shallower angle may be more appropriate where the demand is greater in summer, for example, heating for an outdoor swimming pool. The figures show that the available solar energy is sufficient for all the hot water requirements of a typical home during the summer months (when more solar energy is available), or for about 50 per cent of the annual requirement.



1 A solar water heating system



2 Annual total solar irradiation (kWh/m2) across the UK.
(Map courtesy of the Solar Trade Association)

ORIENTATION

The Energy Saving Trust advises that an area of 2-4m2 of south-east- to south-west-facing roof, receiving direct sunlight during the main part of the day, would generate a significant annual yield of energy.

It is generally not considered sympathetic to a building's appearance to have a solar collector or other equipment fixed to any of its main elevations, ie the face or faces seen from the principle view point, towards which it is mainly viewed. Thus buildings with main elevations aligned in the direction of optimal solar radiation may present special installation problems with regards visual impact.

Collectors can still be effective on the east and west faces but the annual yield would be lower. Where a collector cannot be mounted on a building in an optimal direction for solar irradiation, it may be possible to mount it away from the building. In such cases it is advisable to speak to your local authority conservation or planning officer.

SHADING

It is important that no trees or other structures – or parts of the same building such as chimneys or dormer windows – would cast shadows on a collector, as this would reduce its energy output.

WILDLIFE

Bat and birds use buildings for roosting and nesting. Bats can roost under very small spaces in roof coverings or inside roof spaces. When planning an installation you would need to assess whether they are nesting or roosting in or on the roof as all bats and some birds are legally protected. If the building is being used by them you will need to install equipment when they are not present. Subsequent maintenance will also need to avoid times when it is being used as bats tend to re-occupy the same roost every year.

Natural England should always be consulted at an early stage when planning an installation with known wildlife interest or in areas where protected wildlife is known to use. The Royal Society for the Protection of Birds (RSPB) and The Bat Conservation Trust have guidance on their website, **www.rspb.org.uk** and **www.bats.org.uk**.

INSTALLATION OPTIONS

ONCE ENVIRONMENTAL AND AESTHETIC CONCERNS HAVE BEEN ADDRESSED, THE NEXT STAGE IS TO PLAN THE INSTALLATION.

It is important to consider both the physical impact and the reversibility of any solar thermal installation. As collectors and their associated equipment have useful lives of around 20 years a building might be subject to many installations over the years. With careful planning of the installation and of its eventual removal, damage to the building's fabric can be minimised.

COLLECTOR

There are two types of solar collector: evacuated-tube and flat-plate (Fig 3). The Energy Saving Trust advises that evacuated-tube collectors have an energy efficiency of approximately 40 per cent, whilst flat-plate collectors have efficiencies of around 30 per cent. The efficiency is measured by how much energy is transferred to the heated water compared to how much energy is collected from the sun.

3

Top: Evacuated-tube solar collector. Bottom: Flat-plate solar collector. *(Photographs courtesy of Solar Thermal Ltd)*

A solar collector may be installed on a building's roof or in a separate location. A collector on a roof may be fixed on top of the roof covering, for example tiles or slates, or replace the roof covering so that it sits flush. It is not advisable to fix a collector to a thatched roof of organic material, the thickness of the thatch decreases over time.

As noted earlier, the optimum angle for mounting a collector is 30° off the horizontal. The closer the mounting angle is to this optimal value, the more efficient the collector will be but slight variations do not have a very significant effect. Most pitched roofs have angles of 30-50°, the actual angle (pitch) generally determined by site exposure and local climate.

If the collectors are going to be mounted on the roof, as described with the following options, then a structural survey is first necessary. The weight of the collector/s and fixing frame work will be borne by the roof rafters which must be capable of supporting the combined weight of the collector (with water in it) and its supporting framework. The supplier or installer will have this information.

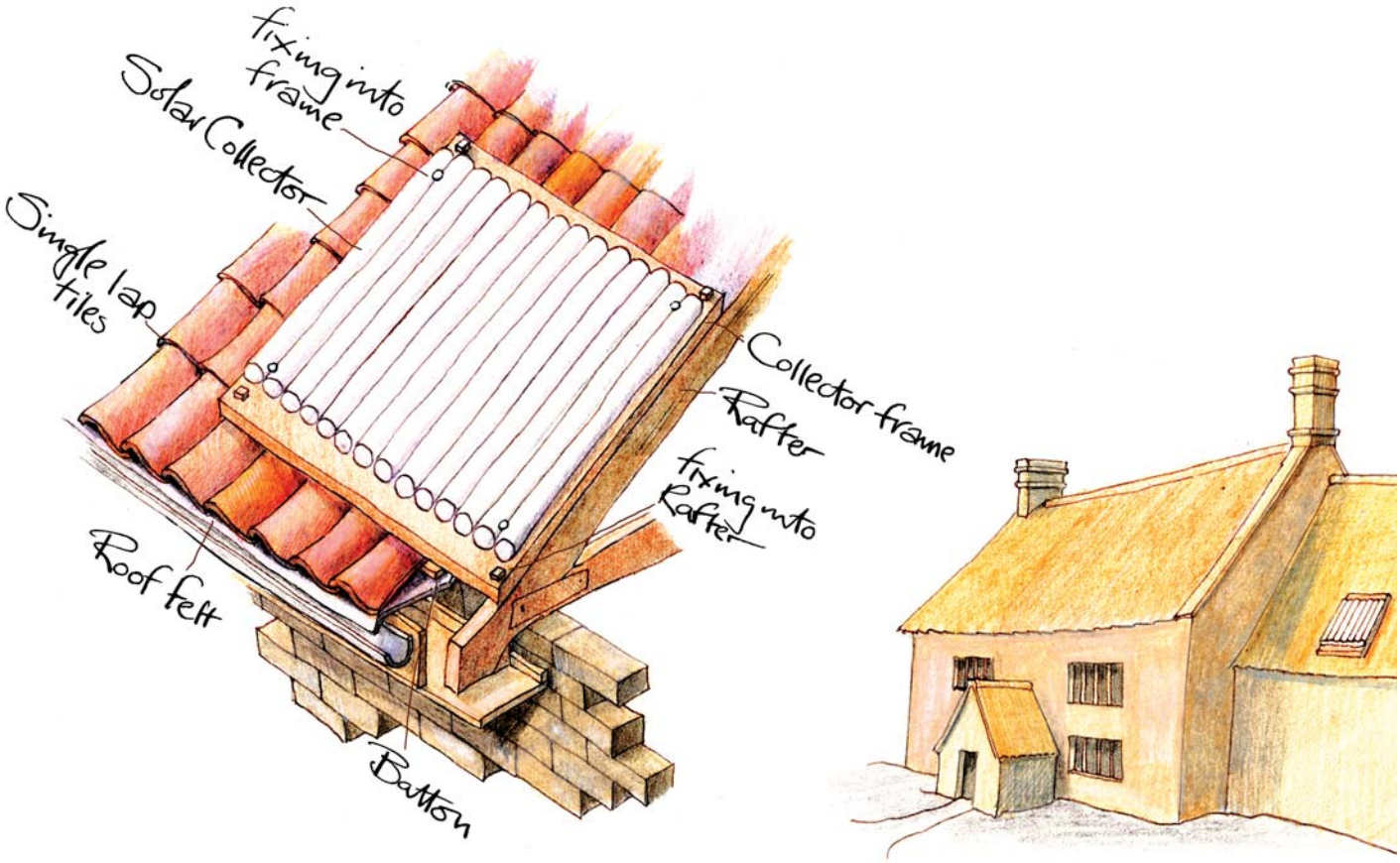
However careful the installer, it is normal for tiles or slates to get broken during installation, so it is advisable to have replacements readily available.

Collector fitted over roof covering

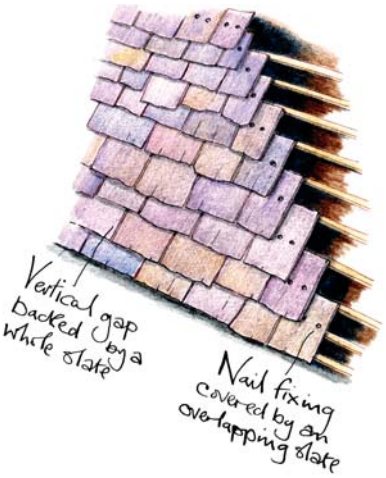
In this type of mounting the collector is fixed to the roof structure by drilling through the roof covering (tile or slate, and roof felt) directly into the rafters (Fig 4).

For roofs with stone or old handmade tiles replacements can be expensive and difficult to find and drilling through them will render them unusable. It is therefore advisable to investigate what type of roof covering you have and how to get replacements before undertaking any work.

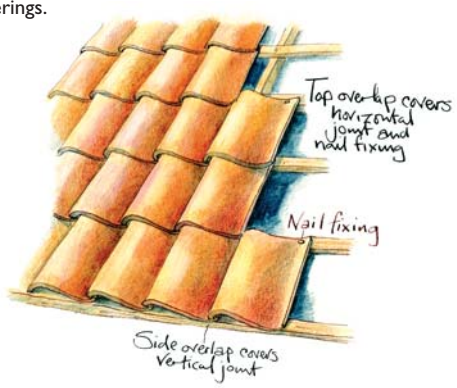
Careful planning is required, both in the locating the rafters and in drilling through the roof covering. To locate the rafters it is best to chalk a line up the roof rather than remove tiles. If the rafters don't coincide with where the frame needs to be, existing noggins can be used, or noggins can be attached to the rafters.



4 Cross-section showing solar collector fitted over roof covering.



5 Single-lapped and double-lapped roof coverings.



Slates or tiles are laid in a variety of ways. Plain tiles and slate are normally double-lapped, profiled tiles single-lapped (Fig 5). It is important to know the difference, because with double-lapped tiles you will be drilling through several tiles at once.

The holes must also be made into the loft space for the pipework to and from collector to the storage tank. These holes should be weather-sealed with roofing sealant and with lead flashing on a non-profiled tiled roof.

Roof-integrated collector

To integrate the collector into the roof finish so it sits flush with the covering, the tiles or slates are removed from area where the collector would take up. Slates have such a slim profile that the roof battens would have to be removed to allow the collector to be flush. For a tiled roof, the tiles are pushed up and the collector brackets are screwed directly into the rafters.

Flat-roof collector

On a flat roof the frame can be constructed to hold the collector at the optimum 30° angle. The frame can be held in place with ballast or more permanently fixed with screws through the roof structure. Where the roof covering must be penetrated it is important to ensure that it is sealed against the weather.

Where a tilted collector might have an undesirable visual impact it may be mounted horizontally. Fig 6 shows a horizontal installation, allowing the collector to be hidden from ground-level view behind a parapet wall.

6

Evacuated-tube solar collector on the flat roof of Beaufort Gardens, a mid-Victorian terraced house in the Royal Borough of Kensington and Chelsea. *(Top image: Photograph courtesy of Royal Borough of Kensington and Chelsea; Bottom image: Photograph courtesy of Claire Craig, English Heritage)*

Flat roof coverings tend to have a life of 10 to 15 years before the felt must be replaced. As a collector has a similar useful life (around 20 years, according to the Solar Trade Association), it is sensible to plan its installation at the same time as re-covering of the roof.

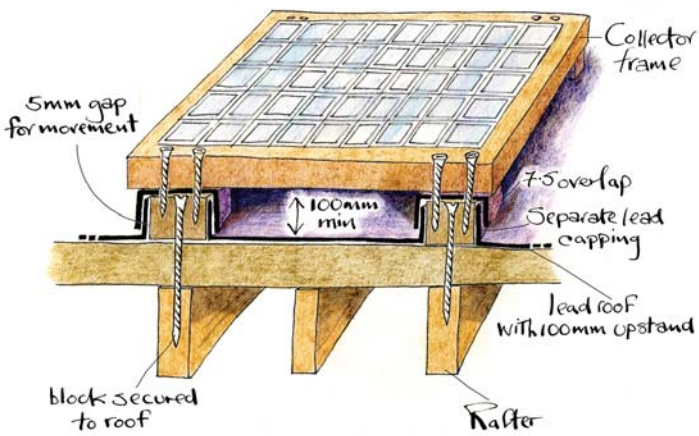
This is not an issue with lead roofs, which can last well over 100 years and require little maintenance. Lead sheet, with its high coefficient of linear expansion, undergoes

considerable expansion and contraction as the temperature changes, so joints in lead roofs are designed to allow the material to shift. As a rule of thumb, lead sheet is only fixed at the top third of the sheet to allow contraction and expansion of the two thirds below, therefore any fixings should come within this top third.

Rolled lead sheet works in partnership with most building materials. However, additional precautions may be required when using some types of materials as they will most probably have different coefficients of expansion and contraction (metal pipes as against plastic).

Before designing the installation it would be advisable to consult with an experienced lead contractor because of the positioning of fixings and pipework that go through the roof is critical to the longevity of the lead. Fig 7 shows a detail of a fixing through lead sheet into the roof rafter. Anyone contemplating putting solar panels on a lead roof should refer to the Lead Sheet Association (see Useful contacts), manual for guidance (ref: *Rolled Lead Sheet – The Complete Manual. A guide to good practice in the specification and use of rolled lead sheet to BSEN 12588:1999. Lead Sheet Association 2003*) on detailing.

7 Fixing through lead sheet



Free-standing collector

If it is not acceptable to fix collectors to the roof, or it is not physically possible to accommodate them one alternative is to position them elsewhere – on another building, for example – with the pipes buried and routed back to the storage tank. Where land is abundant the collector may be mounted on the ground. An example of such an installation is at Keeper's Cottage, a National Trust holiday cottage in West Sussex (Fig 8). The collector is mounted in the garden and surrounded by a willow fence, with hot water piped back to the cottage.

All pipework associated with a solar thermal installation must be insulated to minimise heat loss (and to prevent contact with the hot pipes that can burn), but insulation is especially important with remote collectors as pipework will be exposed to lower exterior temperatures.

8

Ground-mounted solar collector at the Keeper's Cottage, Woolbeding, West Sussex, a timber-framed cottage dating back to the early 17th century, now owned by The National Trust. *(Photographs courtesy of Robert Williams)*

Thermal store

Pipes run from the collector to the thermal store, a tank where the heated water is stored until required. Normally the property's existing hot water storage tank would be replaced with a larger tank fitted with heat-transfer coils (see Fig 9). Planning for any installation must address the question of this upgraded storage capacity.

The installer can advise on the appropriate tank size, based on the number of occupants and how the hot water is to be used. A typical domestic hot water tank has a capacity of 120 litres and is about 0.5 metres in diameter and 1 metre tall. A typical tank incorporating heat-transfer coils for the solar collector has a capacity of 200 to 300 litres and is has a similar diameter but is 1.5 metres to over 2 metres tall.

9

Airing cupboard with existing hot water storage tank and after with new thermal store for solar water heating installation on a house in Dulverton, Exmoor. *(Top: Photograph courtesy of Ivan Gunn; Middle: Photograph courtesy of Maurice Shortman; Bottom: Photograph courtesy of Caroline Gunn)*

MAINTENANCE AND WORKING LIFE

ALL RENEWABLE-ENERGY INSTALLATIONS REQUIRE MAINTENANCE TO ENSURE THEIR RELIABILITY AND EFFICIENCY.

Maintenance, however, carries the potential for damage to the fabric of the building. When planning an installation it is important to talk to the installer about the methods and frequency of routine maintenance.

Solar water heating systems generally come with a 10-year warranty, with the thermal store guaranteed in some cases for 20 years. A yearly check by the householder and a more detailed check by a professional installer every three to five years should be sufficient.

GRANTS

THE TYPICAL COST OF A DOMESTIC SOLAR THERMAL INSTALLATION IS £3,500-4,500.

Grants for solar water heating systems are available to householders, community organisations and schools from the Low Carbon Buildings Programme of the Department for Business Enterprise and Regulatory Reform (see Useful contacts). The programme is managed by the Energy Saving Trust. Grants are for a maximum of £400 (exclusive of VAT), subject to an overall 30 per cent limit, independent of the size of the project. They are payable on completion of the installation.

Recipients of these grants must use programme-accredited installers and materials. The programme's list of accredited installers is a useful resource even if you are not applying for a grant.

USEFUL CONTACTS

RENEWABLE ENERGY AND CLIMATE CHANGE

Historic Environment, Local Management (HELM)
English Heritage
1 Waterhouse Square
138-142 Holborn
London EC1N 2ST
Tel: 020 7973 3000
www.helm.org.uk

UK Climate Impacts Programme (UKCIP)Oxford University Centre for the Environment
Dyson Perrins Building
South Parks Road
Oxford OX1 3QY
Tel: 01865 285717
www.ukcip.org.uk

ENERGY CONSERVATION

Energy Saving Trust
21 Dartmouth Street
London SW1H 9BP
Tel: 020 7222 0101
www.energysavingtrust.org.uk

SOLAR POWER

Centre for Alternative Technology
Machynlleth
Powys SY20 9AZ
Tel: 01654 705950
www.cat.org.uk

Solar Trade Association
The National Energy Centre
Davy Avenue
Knowlhill
Milton Keynes MK5 8NG
Tel: 01908 442290
www.solartradeassociation.org.uk

WILDLIFE

The Royal Society for the Protection of Birds
The Lodge
Sandy
Bedfordshire SG19 2DL
Tel: 01767 680551
www.rspb.org.uk

Bat Conservation Trust
Unit 2, 15 Cloisters House
8 Battersea Park Road
London SW8 4BG
Tel: 020 7627 2629
www.bats.org.uk

Natural England
Northminster House
Peterborough PE1 1UA
Tel: 0845 600 3078
www.naturalengland.org.uk

PLANNING GUIDANCE

Department for Communities, and Local Government
Eland House
Bressenden Place
London SW1E 5DU
Tel: 020 7944 4400
www.communities.gov.uk

RENEWABLE ENERGY GRANTS

Low Carbon Buildings Programme
Department of Trade and Industry
Tel: 0800 915 0990
www.lowcarbonbuildings.org.uk

Department for Business Enterprise and Regulatory Reform
1 Victoria Street
London SW1H 0ET
Tel: 020 7215 5000
www.berr.gov.uk

LEAD ROOFS

Lead Sheet Association
Hawkwell Business Centre
Maidstone Road
Pembury, Tunbridge Wells
Kent TN2 4AH
Tel: 01892 822773
www.leadsheetassociation.org.uk

HISTORIC PROPERTIES WITH RENEWABLE-ENERGY INSTALLATIONS

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