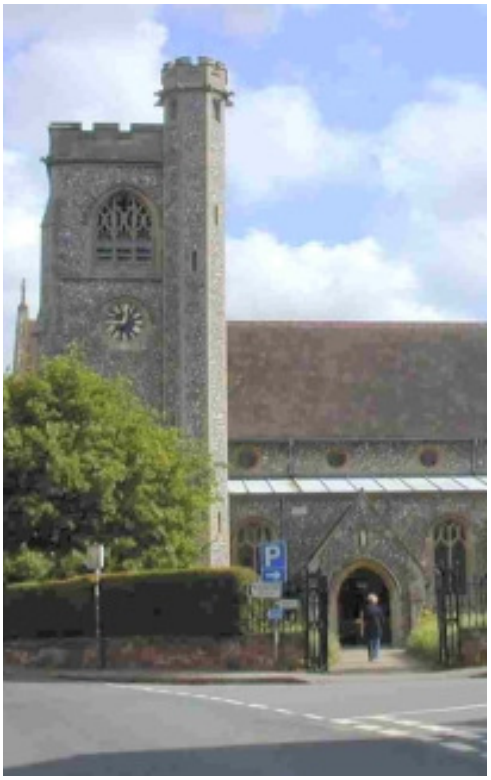
Living Faith for the Earth

Churches using heat pumps can reduce their carbon footprint, save money through reduced bills, and through the Renewable Heat Incentive, could earn money



Your Church and Heat Pumps

Types of Heat Pumps | Things to consider

This information sheet is produced by the Diocese of Oxford to introduce how heat pumps could be used to heat your church. It will help you assess the suitability of your church and provides a list of things to consider as you develop a project to install heat pump technology and benefit from the government Renewable Heat Incentive.

www.earthingfaith.org
www.oxford.anglican.org/environment

DIOCESE OF OXFORD

Introduction

This leaflet describes how heat pumps could be used to generate heat in your church. It will help you assess the building's suitability and gives you a list of things to consider as you develop a possible project to install heat pump technology in your church. By employing this technology, churches can reduce their carbon footprint, save money through reduced bills, and could, by using the government Renewable Heat Incentive (RHI), earn money.

What are Heat Pumps?

Heat pumps offer a method of heating buildings in a highly efficient way using electricity. Using less electricity is beneficial to the environment and this technology will become more so as an increasing proportion of electricity is generated using solar or wind power, which are much less damaging to the environment than oil, gas and coal based technologies. For example, St Mary's Church in Welwyn have installed a Ground-Source-Heat-Pump and reduced the amount of carbon dioxide that they produce by eighteen tonnes per year[1]. The electricity needed to run a heat pump can be sourced from a 'green' electricity supplier or could be generated onsite, for example using photo-voltaic solar panels on the church roof (see the *Your Church and Solar PV information sheet* for further details).

In well-insulated buildings, the heat pump should offer significant financial savings. In homes, heating bills may be cut by half, especially if the property was previously heated using oil. In addition to this, Renewable Heat Incentive payments can be received which could offset the cost of the installation through monthly payments for twenty years. Furthermore, as oil, gas and coal become ever more scarce, the price of these fuels is expected to rise sharply, so it is prudent to reduce our reliance on fossil fuels.

Heat pumps work most efficiently when the building is kept at a roughly constant temperature. This may mean that the church building becomes more inviting and usable throughout the week, and it also reduces problems with the church fabric due to damp, condensation and mould growth. Hence, those most concerned about the preservation of historic buildings may see this as a very beneficial way to heat a church.

However, there are a number of challenges that a church building poses, most notable are the lack of insulation and the sheer volume of the building. In addition, it is often best to combine under-floor heating with the heat pump technology, and this may be difficult if the floor tiles are of historic importance or if there are immovable pews.

Most churches also have properties such as Church Halls, clergy houses or schools which may benefit from this technology, and even within the church there may be rooms that are easy to heat with a heat pump if it is not possible to use this technology for the whole building.

If a church wishes to investigate heat pumps then they will need to seek expert assistance. This document gives a brief introduction and points to where help can be found.

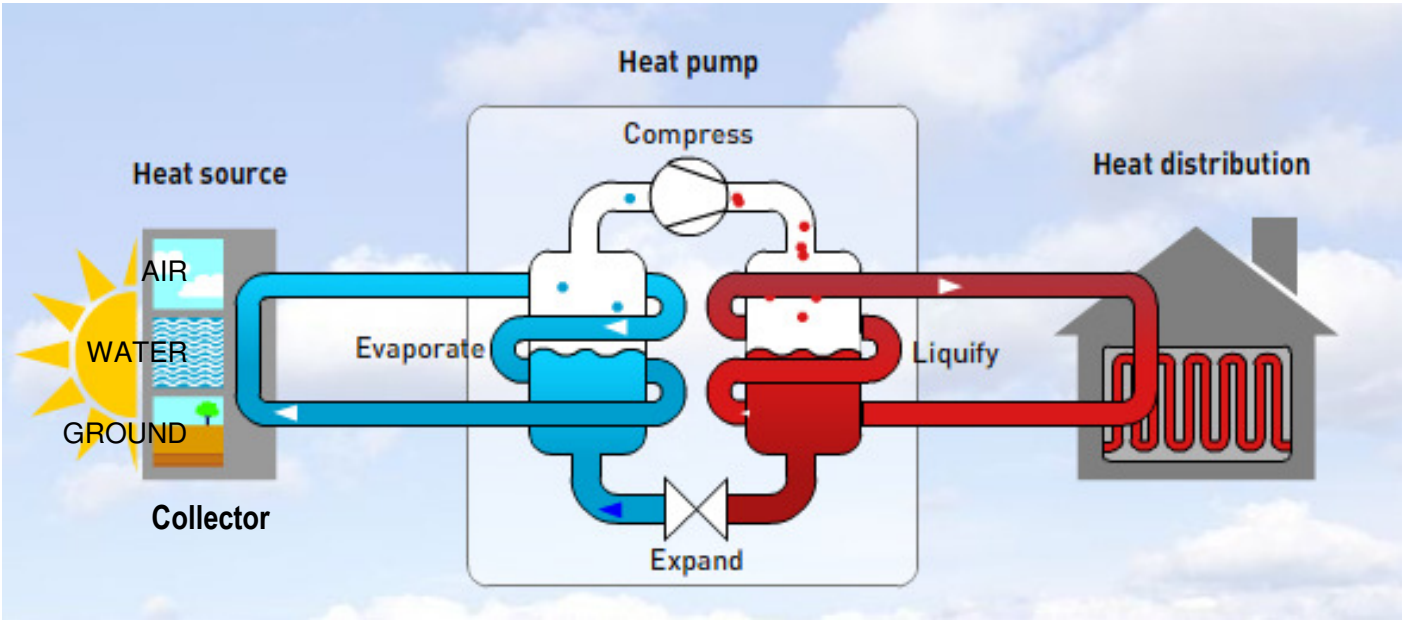
[1] http://www.gshp.welwyn.org.uk/whats_it_all_about.htm

How do Heat Pumps Work?

We all have heat pumps in our houses already – our fridges and freezers are heat pumps. They use a small amount of energy to run a compressor that makes the cold air colder within the fridge, whilst making the hot air hotter outside the fridge. The way it does this is by using a 'refrigeration cycle'. A refrigerant fluid is pumped through a continuous cycle – it is forced to expand through an expansion valve when it is within the cold area of the fridge, which turns the liquid into a gas. Energy is required for the liquid to evaporate, which is taken from inside the fridge leaving it colder (similar to the way we feel cold when we are wet, because the water evaporates from our skin, leaving our skin colder). After that, the gas goes through a compressor, turning it back into a liquid. Energy is given out when a gas condenses, plus electrical 'work' is done, raising the temperature. To get rid of this heat, the liquid is pumped through lots of small pipes at the back of the fridge, making the area behind the fridge warmer. Then the liquid goes back through the expansion valve – turning it into a gas again, and the cycle repeats, over and over, cooling the fridge and warming the kitchen. Heat pumps can therefore be used to heat or cool spaces, but there has to be some way of either getting rid of the excess unwanted heat in the case of a fridge (hence the fins at the back) or getting rid of the excess unwanted cold in the case of a heater (this is called heat exchange).

What sort of Heat Pumps are available?

The main difference between heat pumps is the way in which they do the heat exchange and the ways in which the heat is delivered in the building. Let's start with the heat exchange, there are three ways of removing the unwanted coldness, using air, the ground or water:



Source: David Matthews, GSHP Association

- **Using Air:**
  Air source heat pumps blow air across the refrigerant (after it has been through the expansion nozzle) and the refrigerant is at a temperature of approximately -10ºC. The heat from the outside air warms up the refrigerant, reducing the electrical work that the compressor needs to do. These heat pumps are less efficient than ground or water source heat pumps, but they have the benefit of being easy to install. The Department of Energy and Climate Change (DECC) will not be including these in the first round of the governments' renewable heat incentive (RHI) scheme, so they may not be as financially attractive. They state:

  > "We would like further work undertaken to better understand the costs associated with the technology. For air to air heat pumps, we have not developed a solution to measuring direct air heating rather than water and steam based measurements. Also, we need to consider

further how best to support a technology which will, in many cases be used for air conditioning as well as heating. We will continue to look at how we can include this technology from 2012."

The efficiency of air-source-heat-pumps is lower than that for other heat pumps. This is measured using a term coefficient of performance (COP), which describes the ratio of useful heat movement to work input. On a mild day of say 10 ℃, an air-source heat pump has a COP of 3 to 4, which compares to a normal electric heater having a COP of 1. However, on freezing cold days, the COP of the air source heat pump approaches 1, which is unfortunate as we use the heat pump most in the cold weather (however, with imporving technologies these figures are likely to improve). Ground and water source heat pumps do not have this issue. For instance the temperature of the earth is usually 10 ℃ at a depth of 1.5m for the UK all year round. Hence, their COP is therefore normally in the range of 4.0 to 5.0 all year round.

- **Using the Ground:**
  A ground source heat pump circulates a mixture of water and antifreeze around a loop of pipe, which is buried nearby. Heat from the ground is absorbed into this fluid and is pumped through a heat exchanger, where pipes containing this relatively warm water are coiled around pipes containing the very cold refrigerant. Hence, the refrigerant is warmed up before it enters the compressor. At a depth of 4-6 feet, the ground stays at a fairly constant temperature that approximates to the average temperature of the air over the year. It is solar energy that is heating the ground, and therefore the heat pump is employing this energy from the sun.

- **Deep Geothermal:**
  This is a variation of the ground source heat pump, but uses pipes that run vertically in the ground. A hole is bored into the ground, typically 23–150 m deep and the water and antifreeze are pumped through pipes that are laid in the bore. This has the advantage of needing to disturb less of the ground (particularly pertinent where graveyards surround the church), but there is the expense of drilling the bore.

- **Using water:**
  The above methods are called 'closed loop' systems where the water and antifreeze are reused in a a continuous cycle. Systems employing areas of water such as lakes can be 'closed loop', or 'open loop'. For example, water can be pumped from a lake to warm up the refrigerant in the heat exchanger, and then the cooler water can be dumped back into the lake. This is an open loop system. Alternatively, coils of pipes can be put in the lake in the same way as they are put in the ground, giving a 'closed loop' water system. In addition, aquifers (underground lakes) can also be used in an open or closed loop system. Permission from the Environment Agency is required in these cases.

Having created the heat, using the heat-pump, a heat-exchanger is used to deliver the heat into the building and provide the hot water. The three common heating methods employed are **under-floor heating**, **radiators** or a **valiant system** (hot air being blown into the room). Existing radiators can be used, but they will run at a lower temperature than conventional central heating systems, so some may need to be replaced by larger radiators. Under-floor heating is ideal for churches because the space is so large that it is important to deliver the heat into the building close to where it is required.

Case Study – St Mary's Church, Welwyn

St Mary's Church had a large building project to add a number of rooms to the church to make the building more accessible and useful to the community. As part of this project, it was important to them that the large extension and the church were as environmentally friendly as possible. There was already a wet radiator system within the church and the congregation wished to utilise this. It quickly became evident that due to delivery issues a Biomass boiler would be impossible, so they turned their attention to Ground Source Heat Pumps.

For two years, the radiators were run at a maximum temperature of 50°C, which is the temperature that the water would be if they employed a GSHP. They discovered that this was fine except for the very coldest days, perhaps seven days per year. So they decided to retain the gas boiler for those days and use a GSHP system for the rest of the time. This also provides a back-up which has been useful on two occasions when the Heat Pump system had a temporary glitch. 80% of the heat is provided by the three heat pumps which cost £50,000. If they had wanted to provide 100% using heat pumps then they would need to have spent £100,000. In addition to this, they did not need to disturb the floor of the church. In the extension the heat is delivered using under-floor heating at a temperature of 33°C. Whilst the extension was built to be as well insulated as possible, the church is very much a traditional parish church, with high ceilings and large stained glass windows. No modifications to the church have been carried out to insulate it.

St Mary's opted to use a "Direct System". In this case the refrigerant is pumped into the earth rather than water and a heat exchanger system. This is more efficient as the losses in the heat exchanger are eliminated. Eighteen 30m bore holes are employed in three clusters of six, one for each of the three 16kW heat pumps drilled between the graves in the graveyard.

The church and extension needs 145MWh of heat to be generated per year. Of this approximately 100MWh is generated by the heat pumps which are driven by green electricity, and 45MWh is generated by the gas boiler. The electricity used to drive the Heat Pumps is 40MWh per year.

Consequently, the heat pumps have saved 26tonnes of Carbon Dioxide per year, reducing the total annual level of $C0_2$ to 8 tonnes per year for a large church and very busy set of rooms that are used by the community all through the week.

Further information: www.gshp-stmaryswelwyn.org.uk

Case Study – St George's Church, Newbury

St George's is the first church in the Diocese of Oxford to consider Heat Pumps. It is a huge church building and the congregation have an ambitious project to reduce the carbon footprint of their church and make the building warmer and more inviting to the parishioners. Phase I involved some secondary glazing, an entirely new insulated nave and chancel ceiling and the installation of Solar PV Panels on the roof, which was completed in March 2010 and earns £8,000 per year. The church uses 45% of the energy and the rest goes to the grid. Phase II is currently in progress and involves some additional secondary glazing, roof insulation in the transepts and the creation of a new entrance which will act as a thermal lobby and disabled access. Phase III will be the installation of a Ground-Source-Heat-Pump which will require seven bore holes to be drilled. The estimated savings over the current boiler will be £4,810 pa and the estimated $C0_2$ savings will be 10 tonnes pa. Moreover, the church will be warm all week rather than just on Sundays.

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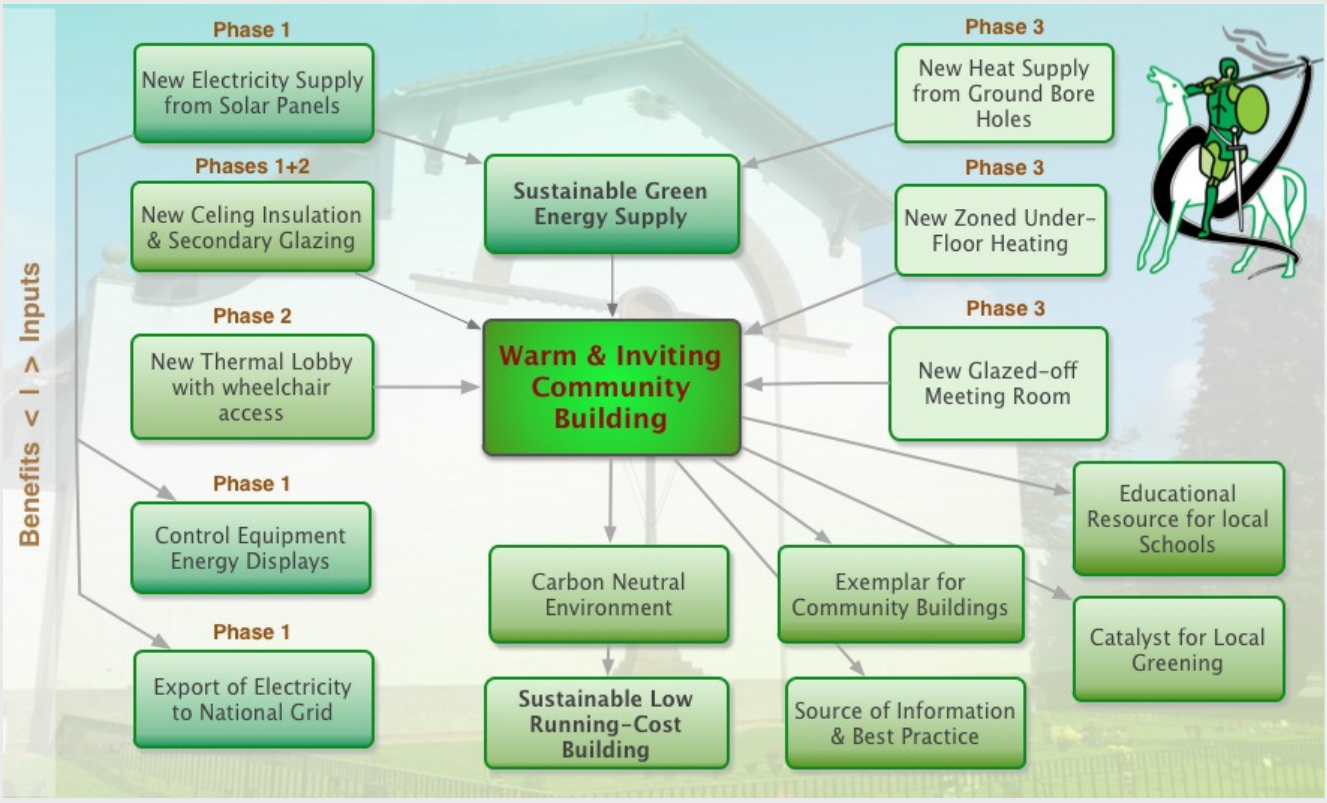
Case Study – St George's Church continued /

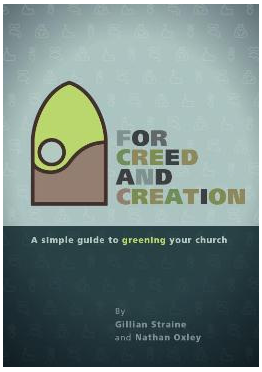


Further information: www.georgegoesgreen.org

Exploring Heat Pumps for your church

IMPORTANT NOTE
The most important advice at the outset is that any installation of renewable technologies must be an outcome of a comprehensive project to reduce the carbon footprint of the whole church, rather than as a tariff-generator or indeed as a standalone statement of environmental intent.

To help churches get started the *Diocese of Oxford* has published *For Creed and Creation: A simple guide to greening your church*. This is a great little book of practical suggestions for making your church more energy efficient. With simple ideas and advice from the way the building is run, to how rubbish is recycled and the light switches used, the guide will help to reduce bills and put your church on the right track to tackling your carbon footprint in simple and cheap ways.



To read the *For Creed and Creation* book, and to order copies, visit:
www.oxford.anglican.org/environment/resources

Things to do:

1. **Be encouraged -** Caring for the environment is a crucial part of mission and the Living Faith vision. The church has a unique role to play in environmental issues, which in turn provide opportunities to model, in practical ways, the love of God. Furthermore, Heat Pumps mean that the building is warm all week, giving greater opportunities for the community to 'cross the threshold' and use the building for community events.

2. **Carry out an environmental assessment and energy audit –** Using the book *For Creed and Creation*, the *Directory of Suggested Eco-Professionals* (see resources at end), and environmental enthusiasts from your church and local community carry out an environmental assessment and/or energy audit of your church building and activities. Would Heat Pumps fit within a comprehensive effort to reduce the carbon footprint of the whole church? You ***must*** deal with the basics before considering Heat Pumps – insulate the walls, the roof and the windows, where possible.

3. **Contact the DAC –** Heat pumps in churches will probably require the drilling of bore holes, often in the ground and the siting of these are sensitive. It is best to involve the DAC from an early stage to ensure you have the best advice. (See DAC contact details on p 9)

4. **Follow the example of others -** There are other churches who have installed Heat Pumps; visit them to see what was involved, ask for copies of relevant documents, take photographs and feed-back to your PCC. Ask the PCC for permission to do a feasibility study for your church.

5. **Community involvement -** Winning the hearts and minds of your community and stirring enthusiasm will help make your project run more smoothly and increase your funding opportunities. Meet and talk to as many people as you can – the local school, community groups (such as parents and toddlers), local environmental groups, the Parish Council, your PCC, your whole congregation. Help others see that becoming more 'green' is possible, desirable and relevant to the life and mission of your church.

6. **Feasibility study** – Better Planet (www.betterplanet.co.uk) offer free advice on renewable technologies. One of the first considerations will be whether to heat your church using a Biomass Boiler or whether Heat Pumps are more appropriate. Biomass Boilers are a cheaper option, but the storage and sourcing of the fuel may be unassailable problems (see *Your Church and Wood Fuel (Biomass) Info Sheet* for further information. Installers will give you preliminary quotes based on the volume of space and the heat losses in the building (see *Installers and Professionals* section on page 9). It is likely that you will need to use under-floor heating with heat pumps in a church building, because it warms up the fabric of the building close to the people before you lose the heating upwards. Also start looking at ways of funding the project (see *Funding* section on page 8).

7. **Put together a proposal -** If the PCC is happy with the feasibility study findings then set up a group to prepare a proposal. This will be useful for obtaining funding and for the Faculty. Involve your Church Architect, the treasurer and the DAC. Look at proposals from other successful churches. Remember that you are more likely to be successful in gaining funding if you can show that there is community-wide involvement in your project.

8. **Do a Geological Survey.** If you will be using bore holes then you will need to know what is under the church to a depth of 100m. Before going ahead with the project a test bore hole is likely to be needed to check the efficiency of the Heat Pump with bore holes in the proposed locations and to finalise how many bore holes will be required for the project. Each bore hole has to be at least 10m from the adjacent one, so finding appropriate sites for the holes may involve using a fairly large section of your land. Note: the British Geological survey (and in some areas your local water company) have data on boreholes, so it may be possible to access data that way rather than drill a trial borehole.

9. **Work with English Heritage, SPAB and the District Council -** If your building is listed then you will need to work alongside English Heritage and SPAB (Society for the Protection of Ancient Buildings). This will involve a number of visits to prove that the heat pump will not harm the building. A Faculty from the DAC will probably take about 4-6 months to achieve. Planning permission is given by the District Council and your Church Architect should be able to help with this.

10. **Contact Ofgem** - The Gas and Electricity Market Authority (Ofgem), will be responsible for administering the Renewable Heat Incentive (RHI). They will deal with applications for support, the

accreditation process, making incentive payments to participants and ensuring compliance with the rules and conditions of the scheme.

11. **Installation -** Having received your Faculty, approvals and planning permission, gained your funding and become confident you are eligible for receipt of the Renewable-Heat-Incentive, you are in a position to install your Heat Pump. Inform your insurers about the installation. It shouldn't raise your insurance premium.

12. **Celebrate -** Throw a party, thank the community for their help, tell your local media, hold a special service of thanksgiving with some guests.

Funding

Churches will probably be able to access grants and raise the remaining funds locally. Some banks may lend you the money. Start exploring funding options at the same time as starting the process of gaining a Faculty.

- **Grants** – There are many grant making foundations that will consider this sort of project, for example you may be able to apply to the Landfill Communities Fund (www.entrust.org.uk). Look for local foundations and use the contacts of your congregation. Funding Central may also be a good source of information on funding - www.fundingcentral.org.uk. You may also contact the Environment Officer (environment@oxford.anglican.org) for the latest suggestions.

- **Local fundraising** – Many people are happy to contribute to projects of this nature, especially if it is part of a reordering project that improves the wider community use of the building. They will also like the fact that the project may provide a long-term income for the church through the RHIs.

What is the Renewable Heat Incentive?

The Renewable Heat Incentive is designed to provide financial support to encourage individuals, communities and businesses to switch from using fossil fuel for heating, to renewables such as wood fuel or heat pumps. Anyone who has installed eligible technology since 15th July 2009 will be able to apply for the RHIs.

The scheme will be introduced in two phases.

- The first phase, will be targeted in the non-domestic sectors, which should include churches, and opens for applications from the end of November 2011. *Under this phase there will also be support of around £15 million for households through the Renewable Heat Premium Payment, which churches cannot access.*
- The second phase of the RHI scheme will see it expanded to include more technologies as well as support for households. This transition will be timed to align with the Green Deal, which is intended to be introduced in October 2012.

The incentives for heat pumps apply for ground, water and deep geothermal heat pumps:

- Less than 100 kWth, 4.5p per kWh will be paid for 20 years.
- 100 kWth and above, 3.2p per kWh will be paid for 20 years.

(see ofgem's *Simple Guide*: www.ofgem.gov.uk/e-serve/RHI/Documents1/Renewable%20Heat%20Incentive%20leaflet.pdf

Other sources for information and guidance on the RHI include:

- **Energy Saving Trust**: www.energysavingtrust.org.uk/Generate-your-own-energy/Sell-your-own-energy/Renewable-Heat-Incentive
- **Department for Energy & Climate Change**: www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/incentive/incentive.aspx
- **Better Planet**: www.betterplanet.co.uk

Installers and professionals

All ground and water source heat pumps of 45kWth capacity or less will need both the technology and the installer to be certified under the Microgeneration Certification Scheme (MCS) in order to qualify for the Renewable Heat Incentive.

The Diocese of Oxford has put together a *Directory of Suggested Eco-Professionals* that have had experience of working in churches and that offer a range of services, such as energy efficiency audits and renewable energy installations. This is not necessarily a recommended list, but rather a starting place for those wanting to find companies with experience of working in renewable advice and installations with churches. To see the current list of eco-professionals visit:

www.oxford.anglican.org/environment/resources/eco-professionals-list.html

DAC Guidelines: Heat Pumps in church buildings

The Diocese Advisory Committee (DAC) have yet to create formal guidelines for the installation of heat pumps, as so few have been fitted. If you are embarking on this project please contact the DAC secretary for advice early in the process – the DAC secretary is Natalie Merry (natalie.merry@oxford.anglican.org).

Below is the advice that the DAC would initially offer:

- **Air-source-heat-pumps** are rarely worthwhile; the plant is unsightly and the efficiencies not yet high enough to justify the carbon or financial cost.

- **Ground-source-heat-pumps** are worth considering in conjunction with an under-floor heating scheme. In most cases boreholes will be the preferred option in order to avoid excessive disturbance of the churchyard; even so, trial pits are likely to be required in the borehole locations where the site is archeologically sensitive (eg has remains of former churches or ancillary buildings; or perhaps an intact set of early burials). Even in an ordinary churchyard the chances of disturbing buried remains is high. Siting of the boreholes is therefore a sensitive matter and should be done with the guidance of the diocesan archaeological advisor (Julian Munby - julian.munby@oxfordarch.co.uk). It should also be noted that the suitability of this technology is to a large degree dependent on the geology of the site. You will need a discreet space to locate the heat-exchanger and manifolds.

Further Resources

Environment related news and further information on the Diocese of Oxford and the environment can be found at **www.oxford.anglican.org/environment**

Church building resources:

- **DAC - Diocese of Oxford:** www.oxford.anglican.org/pcc-and-dcc-support/buildings-and-property/
- **Shrinking the Footprint website:** www.shrinkingthefootprint.org/best_practice.php?CC
- **Church Care website:** www.churchcare.co.uk
- **Eco-Congregation website:** www.ecocongregation.org
- **St George's, Newbury:** www.georgegoesgreen.org and www.st-george-newbury.org
- **St Mary's GSHP Project:** www.gshp-stmaryswelwyn.org.uk/

Heat Pumps resources:

- **Ground Source Heat Pump Association:** www.gshp.org.uk/index.html
- **Energy Saving Trust**: www.energysavingtrust.org.uk/Generate-your-own-energy/Ground-source-heat-pumps

Renewable-Heat-Incentive resources:

- **Ofgem**: www.ofgem.gov.uk/e-serve/RHI/ - including ***A Simple Guide*** which can be downloaded at www.ofgem.gov.uk/e-serve/RHI/Documents1/Renewable%20Heat%20Incentive%20leaflet.pdf
- **Energy Saving Trust**: www.energysavingtrust.org.uk/Generate-your-own-energy/Sell-your-own-energy/Renewable-Heat-Incentive
- **Department for Energy & Climate Change**: www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/incentive/incentive.aspx
- **Better Planet**: www.betterplanet.co.uk

Diocese of Oxford Contacts

DAC Secretary: Natalie Merry | natalie.merry@oxford.anglican.org | 01865 208229

Environment Officer: Matt Freer | matt.freer@oxford.anglican.org | 01865 208745

Earthing Faith

Earthing Faith is a network established by the Diocese of Oxford to resource and encourage individuals and churches in the diocese as they connect their faith with the earth.

To join the network or to find out more, visit: **www.earthingfaith.org**

Acknowledgements:
This guide was written and edited by Lesley Crawley (Renewable Technology Advisor) and Matt Freer (Environment Officer), with input from Natalie Merry (DAC Secretary)

November, 2011

Photo credits: pages 2, 3 & 4 David Matthews, GSHP Association; page 5 St Mary's, Welwyn; page 6 St George's, Newbury

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