size and efficiency of the new boiler, details of the boiler controls and thermostatic controls, warranty and potential servicing costs, and details of how the contractor has tried to reduce the energy consumption required.

Temperature control

Heating the church to the correct temperature can protect against damp as well as reducing energy wastage. Where a church is in frequent use, it may be more efficient to keep the church heated to a low temperature of perhaps 8–10°C, and increase to 16–18°C when it is due to be occupied.

Installing zone control valves to reduce the heat used in unoccupied areas can produce savings of 5–10 per cent. This is of particular use to large centrally heated sites with different areas used at different times, such as churches with halls or offices attached.

INSULATION

Hot water pipes, including valves and joints Insulating pipes can reduce heat energy loss from the pipe by 70 per cent. This can save around five per cent of the heating bill, depending on the pipe length involved. Insulation will cost between £10 and £40 per metre including labour.

Roofs, walls or floors Insulating the envelope of a building can reduce heat energy loss by 70 per cent. However, insulating historic churches may not be practical or appropriate. Churches built after 1930 will probably be easier to insulate, particularly where they have low ceilings and cavity walls. Professional advice should always be sought before undertaking insulation work in any building, as warm moist air which passes through the material or around it will condense on cold surfaces beyond. In roofs this can cause localised damp and severe decay.

Glazing Single glazed windows transfer heat from surface to surface well, leading to heat loss and condensation. Rattling panes and gaps in frames cause draughts and damp air adds to the chill, particularly in the winter. Obviously, the tall leaded lights and stained glass windows of a typical parish church do not lend themselves to any form of insulation, but they should be properly maintained. Furthermore, ecclesiastical buildings come in all shapes and sizes: many church halls have windows that are suitable for insulated blinds and shutters which may be closed at night, or secondary glazing. Draught proofing will reduce much of the heat loss. Some windows may also be suitable for double glazing. The following table illustrates the effectiveness of different measures.

Window insulation measure	Heat transfer (U value)*
None (single glazing only)	~4.8 W/m²/°C
Single glazing with closed curtains	~3.6 W/m²/°C
Single glazing with closed shutters	~3.0 W/m²/°C
Secondary glazing	~2.9–3.4 W/m²/°C
Double glazing with low emissivity glass	~2.0 W/m²/°C

** The lower the figure, the higher its insulation value*

The new boiler house and friends at St Paul's, Gulworthy, Devon

The use of double glazing or secondary glazing will be inappropriate for most historic buildings. As well as their aesthetic impact and, in the case of double glazing, the need to fundamentally change historic fabric, they also have a high cost relative to the low energy savings produced. English Heritage provides guidance on this and other ways of saving energy in historic buildings at www.climatechangeandyourhome.org.uk.

RENEWABLE ENERGY

The sources of renewable energy most likely to be of use for heating churches are bio-fuels, ground source heat pumps, of solar power captured using photovoltaic cells (PV).

Wood-burning boilers

Wood chip and wood pellet boilers generally take up more space than conventional boilers because the fuel is fed into the furnace automatically from an overhead hopper, and because a dry store is required for the fuel, preferably next to the boiler. A new room is usually required. The running cost of burning locally-sourced timber pellets is generally similar to the cost of burning oil.

At St Paul's, Gulworthy, a 19th century Grade II listed building in Exeter Diocese, the parochial church council (PCC) recently installed a new wood-fired boiler in a purpose-built shed outside the church at a cost of £27,000.

Heat pumps

A ground-source heat pump relies on the same principles as a fridge but with the cooling pipes placed underground where they extract heat from their surroundings. Laying the pipes in trenches is less expensive than running them vertically through deep bore holes, but where a burial ground surrounds the church, this is often the only option.

A ground source heat pump was used at St Mary's, Welwyn, a Grade II listed church in St Albans Diocese, where a well-insulated extension has recently been added. For most of the year, both church and extension are heated by ground source heat pumps topped up with gas heating if required. Three electrically driven heat pumps (operating on a green energy tariff) are connected to a system of pipes drilled into the churchyard to collect ground heat. This is compressed to a higher temperature and used to heat the church buildings. For every unit of electricity used by the heat pumps, the church gets around three units of heat. It is estimated that this one church will avoid releasing around 30 tonnes of carbon dioxide per year.

The installation cost around £50,000 and initial results are in line with the performance predictions. Real-time information is available on the church's website at www.gshp.welwyn.org.uk.

Photovoltaic solar panels

Solar panels need to be oriented towards the sun. As churches are conventionally oriented east-west, their south-facing roof slopes are perfect for collecting solar energy. St Denys' Church, Sleaford in Lincoln Diocese is a 12th-century Grade I listed building which now has 56 solar photovoltaic panels installed. The project began after the PCC was inspired by panels on St James's Church, Piccadilly, London. Advice was sought from the Diocesan Advisory Committee for the Care of Churches and from English Heritage; both specified that any panels must not detract from the visual appearance of the church, nor must any damage be done to the fabric during installation.

Since the south aisle roof at St Denys' is hidden from ground level by a 900mm parapet, the location seemed ideal. Unfortunately, initial advice suggested that to achieve maximum efficiency the panels would need to be tilted at an angle of between 30 and 40 degrees, which would have rendered the panels visible over the top of the parapet. However, by laying the panels flat on the south aisle roof only four per cent efficiency was lost.

The problem of how to fix the panels to the traditional lead roll roof remained. Similar installations where solar panels could not be attached directly to the building had involved securing the panels to large plastic boxes filled with ballast. The disadvantage of this system lies in the height and weight of the boxes.

A structural engineer was engaged and a detailed brief was prepared and agreed. The PCC then invited installation companies to quote for the project and a local contractor, Julian Patrick of Freewatt Ltd, came up with a solution involving the newly developed 'Solstice' clamps. These allowed the panels to be fitted on a lightweight frame no more than 300mm high, which also meant that more panels could be fitted as no ballast weight was involved and the panels could be placed closer together.

The final plan was presented to the DAC and English Heritage, and both North Kesteven District Council and Sleaford Town Council were consulted on the visibility issue. The project, which cost around £56,000, was mainly grant funded.

Every place of worship is unique, and there is no single solution to energy reduction. It is best to start small by reducing energy wastage. Where improvements are proposed, seek the best advice available.

RACHEL HARDEN (rachel.harden@c-of-e.org.uk) is a senior communications officer of the Church of England's Archbishops' Council. Shrinking the Footprint is a CofE campaign run by the Cathedral and Church Buildings and Mission and Public Affairs Divisions of the Archbishops' Council, working closely with dioceses.