The road ahead

From ancient historic churches and post-WWII buildings, to large Victorian churches and tiny medieval ones, the Diocese of London has a challenge meeting its carbon-reduction targets. Brian Cuthbertson outlines its plan

My earlier article* told the story of how the Church of England's Diocese of London is working to cut carbon emissions from its 480 churches by 20.12% by 2012, using *Climate Action Plans*.

Beyond that, there are medium- and long-term challenges to address as our Climate Action Programme aims for cuts of 42% by 2020 and at least 80% by 2050. We ought to be able to achieve our 2012 target by means of zero-cost savings (e.g. checking that time switch controls match occupancy periods). Low- to medium-cost measures should be enough to meet our 2020 target, with capital investments doing the heavy lifting towards 80% cuts by 2050. In practice, some churches are already making improvements – retrofitting building upgrades or installing solar panels. Others have yet to implement even the simplest of savings. So at each stage our targets must be met by a combination of low-, medium- and high-cost measures.

Generic Building Solutions, in collaboration with Arup and the Carbon Trust, is a study of how this might be done. Arup's report was launched at our Route 2050 event with the Bishop of London in St Peter's Eaton Square in May 2011. It lays out the contours of a roadmap, towards achieving the necessary savings.

Based on a sample of 20 churches, the report demonstrates how a range of low-carbon measures could allow cuts in their carbon footprint of up to 90%. The study has examined the intrinsic characteristics of church sites – not only building fabric and building services, but also their patterns of use and their overall potential for alteration as heritage structures. It has looked at the temperature profiles of the large internal spaces and the benefit of the daylighting effects from many churches having an East-West long axis. The strategy follows a hierarchy, which looks to effect:

- changes in behaviour, before…
- implementing technological solutions to reduce demand, and then…
- applying low- and zero-carbon technology.

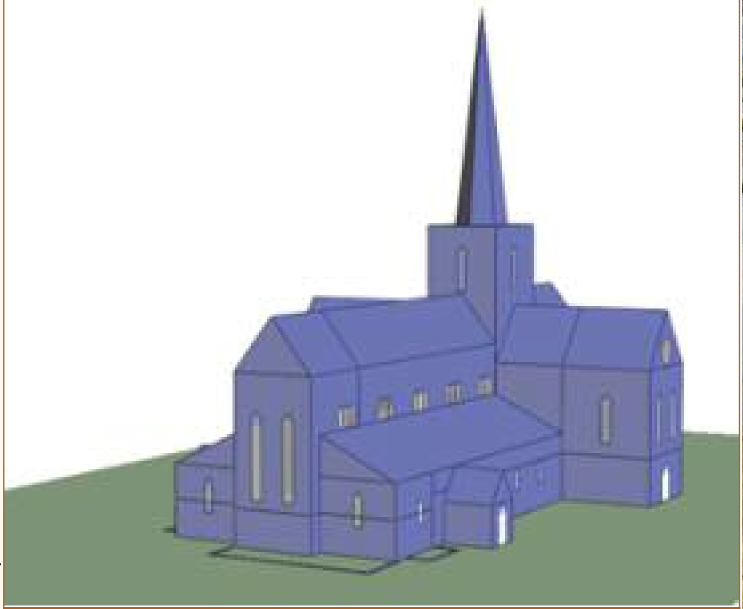
The report employs a 'model church' – St John's Notting Hill (one of the churches surveyed). This is used as a worked example to evaluate typical interventions ranging from smart meters to biomass heating. It is not a feasibility study; it does not examine exhaustively every constraint, nor all listed building considerations. These may vary from place to place, limiting what can be done in particular cases. Figure 1 tabulates these interventions in detail. The figures are annual and cumulative.

On the other hand, the measures applied to the model church do not exhaust the possibilities that can be deployed. Indications suggest that zero-cost measures could achieve savings of 20% plus (compared to 15% for the model church) on top of which, measures examined but not applied to the model church include:

- thermal insulation
- under-floor heating
- low-level radiant heating
- gas-condensing boilers
- ground and air source heat pumps (GSHP, ASHP)
- combined heat and power (CHP).

Step	Generic Solutions	Description	Energy and emissions (remaining after each level of improvement)
0	**Base model**	Model church	Electricity – 42,236kWh Gas – 155,951kWh Emissions – 51,587kg CO_2
1	**Motivation, accountability and energy management**	Energy monitoring, smart metering, corrective action: • 15% reduction in energy use • 15% reduction in emissions	Electricity – 35,900kWh Gas – 132,558kWh Emissions – 43,848kg CO_2
2	**Space heating creation of micro-environment**	Pew heating with lower bulk air temperature: • 17% reduction gas consumption • 3% increase in electrical energy • 8.1% reduction in emissions from Step 1	Electricity – 36,977kWh Gas – 110,048kWh Emissions – 40,290kg CO_2
3	**Low-energy lighting and controls**	Low-energy lamp technology with controls, maximising daylight, zoning, lower levels of general lighting, LEDs for task and accent lighting: • 53% reduction in electrical energy • 26% reduction in emissions from Step 2	Electricity – 17,558kWh Gas – 110,048kWh Emissions – 29,782kg CO_2
4	**Airtightness improvements**	Secondary skin to glazing, draught stripping to reduce air infiltration from 0.95ac/h to 0.5ac/h: • 13% reduction gas consumption • 9% reduction in emissions from Step 3	Electricity – 17,558kWh Gas – 95,641kWh Emissions – 27,131kg CO_2
5	**Biomass boilers**	Wood pellet boilers for remaining space heat load. Gas load transferred to wood pellets with a carbon tariff of 0.025kg/kWh: • 56% reduction in emissions from Step 4	Electricity – 17,558kWh Gas – 0kWh Wood pellets – 95,641kWh Emissions – 11,907kg CO_2
6	**Photovoltaics**	PV applied to the south-orientated roofs: 16kW from polycrystalline panels generating 17,863kWh of electricity, 25% fed back to the grid: • 76% reduction in electricity • 41% reduction in emissions from Step 5	Electricity – 4,160kWh Gas – 0kWh Wood pellets – 95,641kWh Emissions – 4,645kg CO_2
		Total	**90% reduction in emissions**

Figure 1 – Comparison of Generic Building Solutions to model church datum



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St John's Notting Hill was used as the 'model church' for analysing carbon reduction measures

All will not deliver equal savings or equal value for money. CHP, biomass and photovoltaics will yield the greatest benefits but biomass and CHP are the most difficult to roll out widely. Teething troubles with biomass systems are likely to be overcome, whereas the viability of CHP depends on using the spare heat generated, e.g. by sharing with neighbours: thus making tight urban sites potential candidates for CHP.

The Feed-in Tariff and Renewable Heat Incentive are taken into account and there are other factors in play, too. The potential for heat pumps in churches is least promising – mainly because cooling is rarely required. Savings in electricity are more beneficial than in heat, per kWh. Fossil fuel heat typically accounts for 55% of a church's emissions, but the carbon factor of electricity is nearly three times that of gas. A heat pump actually increases electricity use, therefore this must be offset in heat gained.

A range of options

Some options may be applied in combination, others are mutually exclusive – but can be swapped in exchange for those in the model church. In real-life projects, an even wider range of solutions will be considered and compared to what the church already has and the funds available. Guidance from the Diocese alongside Arup's report tabulates a very broad spread of technologies, both conventional and exotic, weighing up the pros and cons in energy and carbon terms – with their historic building implications for the 70% of our churches that are listed.

Not all of Arup's conclusions confirmed expectations. The London Diocese has a diverse a range of places and buildings: ancient historic churches, post-World War II buildings, very large Victorian buildings and tiny medieval ones, tight city centre sites and sprawling churchyards in the suburbs. The sample churches were selected to capture this diversity, and to reflect their current energy performance. Yet no correlation was found between age and use of electricity or gas.

What then have we learned? If the age and architecture of a church do not influence its energy consumption, they certainly have a bearing on what can be done to reduce consumption and emissions, and what will or will not prove feasible in practice. The main parameters are outlined for each of the sample churches – indicating in their differing circumstances which of six generic interventions may be suitable, has potential or is deemed unsuitable:

- roof insulation
- biomass
- GSHP
- mini-CHP
- photovoltaics
- pew heating.

Any church council, by comparing its site and buildings with these examples and the Diocese's guidance, should be able to appraise the broad options – before incurring consultants' fees.

Life cycle issues

It should also be borne in mind whether a scheme (e.g. a boiler replacement) is a life-cycle project – to leave until the existing plant is either failed or uneconomic to maintain. Can it be undertaken any time? Or is the decision linked to something else? Photovoltaics, for example, are most economic when roof replacement is due and they can be done together.

Generic Building Solutions may spare many a church the inefficiency of embarking on building projects for reasons other than environmental ones, while failing to take advantage of environmental improvements that could be incorporated.

Thus, we have gained a strategic tool to prioritise our efforts across the whole estate for the next four decades, while empowering each church council to evaluate its own options, get the best for its own needs and contribute to the common effort.

Information and guidance from *Generic Building Solutions* will become part of everyone's thinking on the best way to upgrade any church to save energy – yet minimising any harm to its special character. Indeed, we should be seeking to make exciting enhancements to the uses and character of our churches, while saving energy and carbon emissions.

Further information

The *Generic Building Solutions* report and the *Options, Challenges, Solutions, Limitations* guidance may be downloaded from *www.london.anglican.org/Shrinking-the-Footprint-Generic-Building-Solutions*

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* *Turning down the volume*, page 2, *Building Conservation Journal*, Mar-Apr 2011, *www.rics.org/journals*

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