PHOTOVOLTAICS IN BUILDINGS

LARGE SCALE FIELD TRIAL

Case Study 3: St Mary's Church Hall

St Mary's Church Hall in Osterley, West London, is a new community centre run by the Church Council. The Church Council wished to incorporate new 'green' technologies including photovoltaics (PV) into the new building, which now serves as an excellent demonstration of large-scale PV in the suburban environment.

The community centre is directly below the flight path into London Heathrow Airport, and it was intended the roof-mounted PV would double as an extra level of sound-proofing. The new building has a timber frame, and is clad externally with facing brickwork. It replaces the previous church hall, which was about 40 years old.

The building has a south-facing roof of 290m^2, making it ideal for installing PV. A total of 174 BP Solar 5170 monocrystalline modules were fitted on the roof, with a nominal peak output of 29.58 kW. The modules are connected to eight separate inverters, with the system's output displayed in the main hall of the community centre.

The Parish Church of St Mary's Osterley operates as a charitable trust. It regularly serves about 600 people per week, plus an additional 2000 people over the course of the year. The new church hall is used as a community facility for the church and local youth groups, along with groups for the elderly.

Environmental commitment

The Church Council has a commitment to green policies, and wished to incorporate energy conservation and renewable energy wherever possible. As such, the fabric of the building was specified and designed to maximise energy conservation during both construction and occupation. The church hall is a single storey building, and the timber frame construction permits high levels of insulation.

Good insulation significantly reduces heat loss from the building, and the PV provides a renewable source of electricity for services, including hall heating. (The majority of the building's heating is provided by gas. This is a sensible approach as most of the output from a PV system is outside the heating season.)

Installing the solar system

The building was designed with PV laminates (unframed modules) which are mounted on Unistrut steel support rails. These are suspended above the roof covering using support posts fixed to the main timber beam roofing structure. The PV contractor, BP Solar, recommended this design based on experience from their tried and tested previous installations.

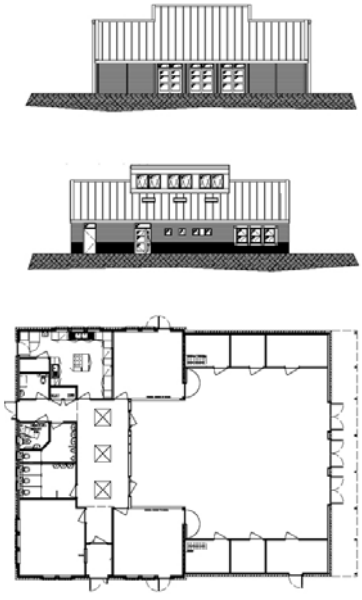
The building work was carried out by contractors, Botes Building Ltd. A structural supporting deck, made from steel and following the roof profile, was installed over the main roof beams. The deck was then covered with rigid insulation board. A single ply Sanafil roof membrane was bonded to the insulation board, forming a water-tight roof.

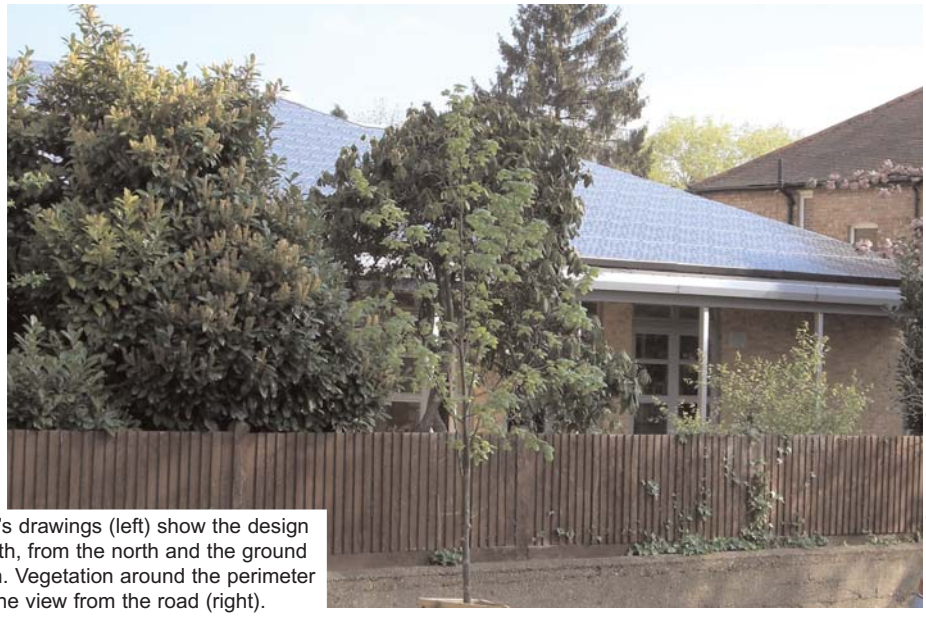
Support posts for the PV were then fixed directly to the main roof beams. This required the roof covering to be cut locally to install the support posts, which was then made good and waterproofed.

The primary steel angle support for the PV was placed in position, drilled on site and bolted to the top of the support posts. The process of fixing the steel angles also secured the weathering cap to the Sanafil membrane. The secondary Unistrut module support was subsequently drilled and bolted to the primary framework, and aligned to the dimensions of the laminates.

Monocrystalline laminates were installed on the support framing at their corners and mid-span. They were secured in place with diamond fastenings and standard retaining clips. The PV acts as an additional rain screen above the water-proof roof.

Cabling was laid from the laminates to the inverters, which are located in a control room just below the roof. System tests were then carried out and the arrays checked to ensure





Architect's drawings (left) show the design from south, from the north and the ground floor plan. Vegetation around the perimeter softens the view from the road (right).

Photos: Chambers Goodwin & Partners

Left: The north side of the building has high level windows to allow daylight without overheating in summer. Below: A high ceiling and lots of light make the new church hall airy and attractive.

that the connections were correctly installed. The PV system was comissioned on 30 June 2003, witnessed by a representative of the Distribution Network Operator (DNO).

Scaffolding had been erected to provide a working platform to assemble the timber frame and complete the brick cladding. This was adapted to provide a storage platform for the PV laminates, which were delivered in crates, so simplifying the process of installing the panels.

Costs

The Church Council raised over £600,000 to rebuild their church hall and provide a modern community resource.

Technical specification

Module type:	**BP Solar 5170, monocrystalline**
Module size:	**170Wp**
Module efficiency:	**13.5%**
Active module area:	**1.26m² (1580mm x 783mm)**
Sub array arrangement:	**Various**
Sub array sizes (kWp):	**2 x 4.08, 3 x 3.74, 3 x 3.4**
Array inclination:	**15°**
Array orientation:	**15° west of south**
Inverter type:	**SMA SB3000 and SB2500**
Total number of modules:	**174**
Total area:	**219m²**
Total System Size:	**29.58kWp**

The total cost of the PV system was £132,950, with an additional £11,375 for monitoring. Because St Mary's Church Hall had been selected as part of the Large Scale PV Field Trial scheme, the DTI provided funding of £100,000. This contributed 69% towards the total costs of the PV project. The cost per kW of the system was £4,492, excluding the costs of the monitoring.

The actual installation costs were higher than estimated at the outset of the project. However, total costs were kept to a minimum by introducing a level of competition in the main building contract, and in the supply of services for monitoring.

Lessons Learnt

Architect Terry Haigh pointed out that with hindsight he would have designed the building with an aluminium standing seam roof to allow the primary and secondary framework to be clipped to a standing seam. Instead, the roof had to be penetrated in order to fit supporting posts to the main roof struts. This increased the cost and difficulty of construction.

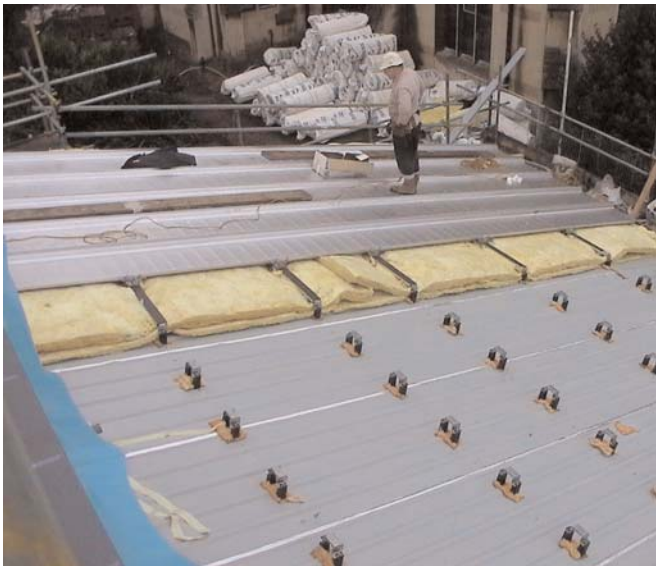
The architect also observed that more competition in the PV supply industry could result in lower installed costs. In particular he considered that manufacturers and installers should provide PV solutions on a competitive basis, from specifications put together by separate design consultants.

There were delays and poor understanding between the PV equipment supplier and the main contractor. This led to problems on site that had to be solved on an *ad hoc* basis. If these problems had been uncovered earlier, they could have been resolved more effectively during design.

Feedback from the main contractor suggests that an opportunity to view similar completed projects would have improved understanding and so enabled better planning of the project.

Costs

	£	
Equipment & installation		
Modules, inverters, mechanical installation & warrantees	149,270	
Electrical installation	6,500	
DNO connection	1,500	
Energy meter	750	
Total		132,950
Monitoring (over two years)		
Equipment	5,308	
Installation	2,678	
Commissioning & reporting	3,389	
		11,375
Total		144,325
Specific costs	£659/m^2, £4876/kWp	



Right: Support posts were attached to the main roof structure, overlaid with a steel support deck. Below right: Eight Sunny Boy inverters convert DC power from the PV into usable AC electricity. (The wiring and labelling were improved after this photo was taken.)

After the PV system was installed, the biggest problem faced by the Church was obtaining agreement from their Regional Electricity Company to buy back surplus electricity generated. At the early stages of their application, they were advised that net metering would be permitted, enabling them to buy and sell electricity at the same price. However, since connecting they have only received 1p per unit of electricity exported whereas they pay 4.6p per unit of electricity that they purchase.

The Church had also intended to recoup their investment in PV from revenue earned from Renewable Obligation Certificates (ROCs) and exemption from the Climate Change Levy via Levy Exemption Certificates (LECs). To date nothing has been earned from ROCs or LECs due to the difficulties in interpreting and completing the registration process.

This is in part because Ofgem (the Office of Gas and Electricity Markets) is more used to dealing with large players in the electricity industry and not small micro-generators such as St Mary's Church. However, prospects are improving and Ofgem is in the process of adapting its procedures to cater for small generators such as St Mary's Church.

Monitoring

The photovoltaic system is monitored via a computer and energy generation figures are displayed in the main hall of the community centre. The system operated well throughout the two-year monitoring period. In November 2003, within the first few months of monitoring, a solar panel was replaced after it was destroyed by vandalism. There have been no similar incidences since.

In the second year of monitoring software problems caused a number of days' data to be missed. This was resolved by

restarting the software using a modem link. The graph (right) summarises the energy output over the two years of monitoring, displaying both the DC output and the AC output. The difference in these two outputs is due to losses in the inverter.

The performance ratio of the system was about 80 to 85% in the summer months, falling to 60% in the winter. This is expected with PV systems in the UK, as inverters operate more efficiently at higher levels of solar irradiance.

The daily energy yield of the PV system varied from 5.2 kWh/kWp in June to a low of 0.1 kWh/kWp in December. (Average daily yields were 3.6 kWh/kWp in June and 0.3 kWh/kWp in December).

User Perception

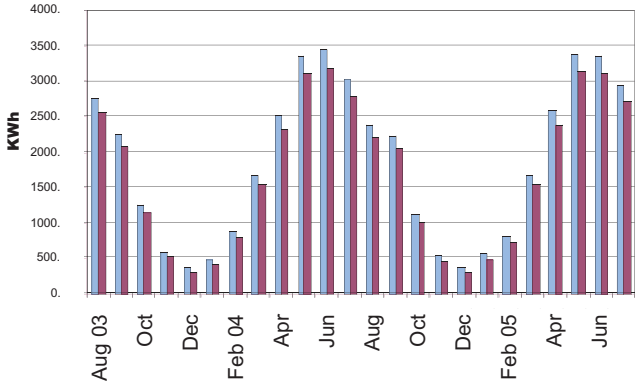
Surveys were completed by a representative number of Church Hall users. This showed that most people had a high degree of awareness of the PV installation, and had known about it from the initial concept stage. Everybody surveyed liked PV because it was considered good for the environment, had an attractive visual impact and was a good talking point with visitors.

The lead architect for the project Terry Haigh commented:

"Two years on and what has the church community achieved? A substantial contribution to the reduction of greenhouse gases, greater public awareness of the benefits of renewable energy and lower energy costs in running the community facilities. When you talk to members of the parish community, they fully support the action taken to install the PV system."

Above: Glazing is modestly proportioned to prevent big thermal losses in winter. Below: A new access path means that the hall is accessible for people with disabilities.

Electricity generated from August 2003-July 2005



This graph summarises the energy output over the two years of monitoring, displaying both the DC output (blue) and the AC output (red). The difference between these two outputs is due to losses at the inverter.

Contract details

Client:	Parochial Church Council of St Mary's, Osterley
Architect:	Chambers Goodwin & Partners
Main contractor:	Botes Building Ltd
Electrical contractors:	G H Gabb Ltd
PV contractor:	BP Solar
Electricity distribution company:	Scottish and Southern Energy

Key dates

Building completed:	June 2003
PV work carried out:	April to May 2003

Summary in numbers

Total PV array output	20,141kWh/year
Power used in building	31,440kWh/year
Power imported to building	24,650kWh/year
Power exported to DNO	13,350kWh/year
Building electricity generated by PV	64%

Further information available on:
www.dti.gov.uk/energy/renewables
or telehone:
Renewable Energy Enquiries Bureau, 0870 190 6349

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