

PV Roof on a Low-energy Office in the UK

by the CADDET UK National Team

Introduction

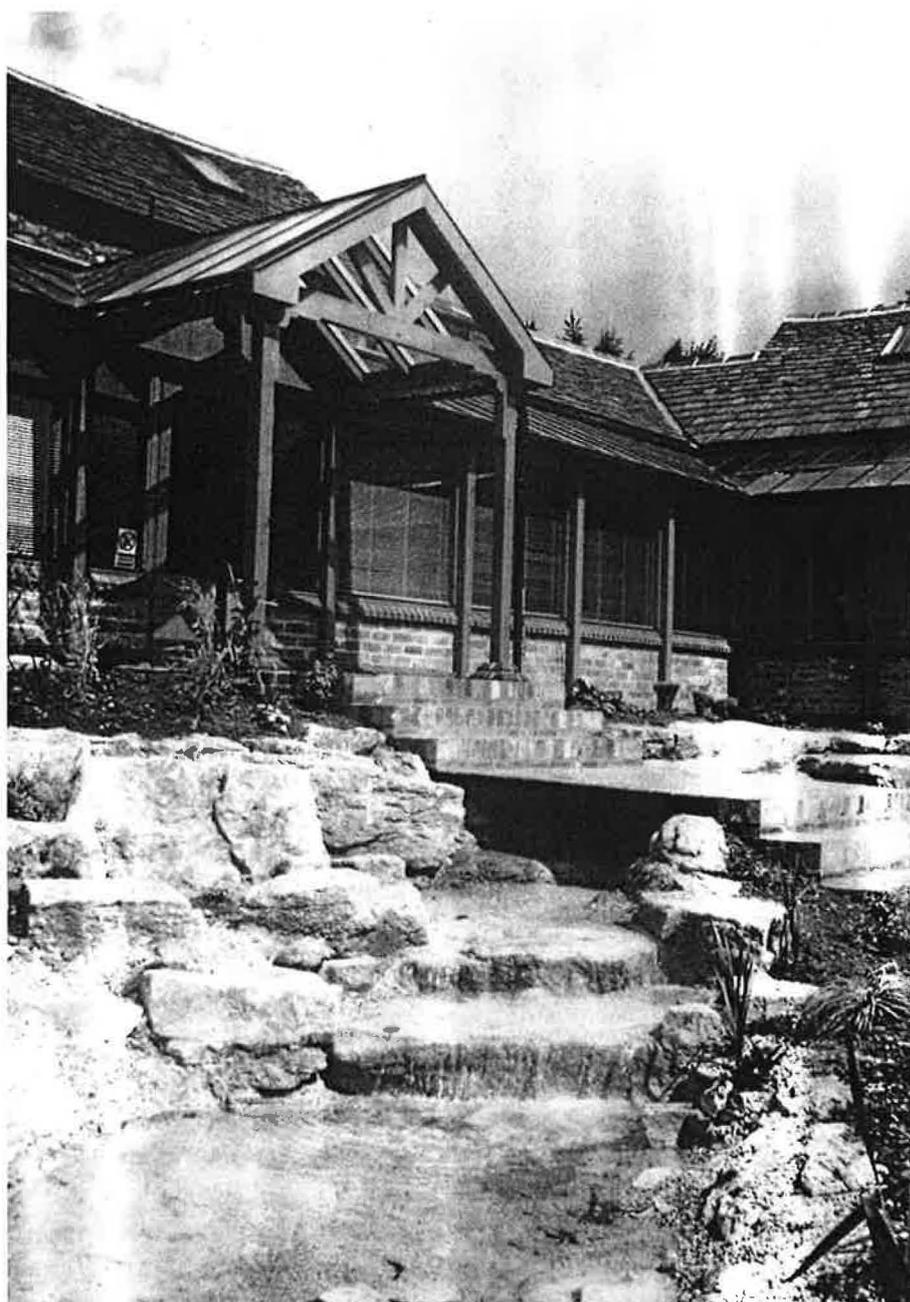
The restoration and conversion of old derelict farm buildings at Whittle Hill Farm near Loughborough, Leicestershire, has provided Beacon Energy Limited with low-energy offices complete with a photovoltaic (PV) integrated roof. The offices have now been in use for two years, and have proved themselves to be a successful and comfortable working environment. Solar-powered air-conditioning is the latest addition to the system.

The Buildings

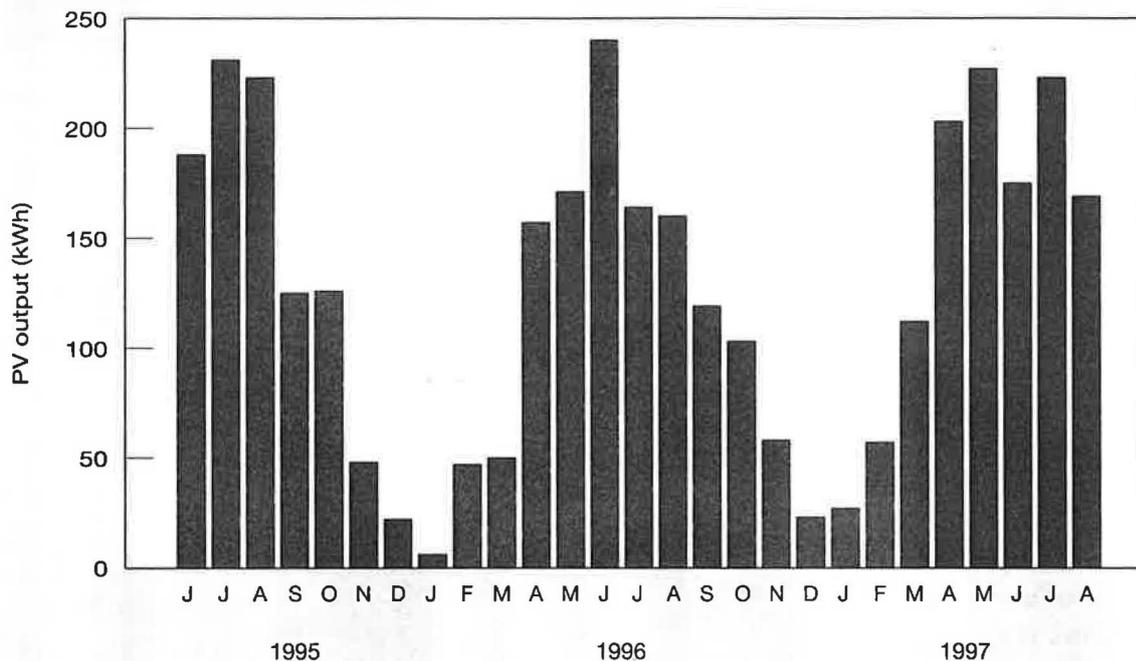
The original farm buildings covered about 105 m² and were arranged around a courtyard. A high level of insulation was applied to the building structure —on the inside walls, under the concrete floor and below the roof. The existing slate roof tiles were refurbished, repaired, re-laid and insulated; a mix of spray foam and 50 mm thermal board insulation was used.

PV Power

The offices are all connected by a walkway 2 m wide. The walkway



A PV-integrated roof covers the walkway linking the low-energy offices.



Energy generated from the PV array at Whittle Farm.

roof incorporates 50 PV Siemens Model M55 panels, each measuring 800 x 400 mm and rated 55 W_p. The modules are inclined at about 24° from the horizontal. Open circuit voltage is 17.4 V, and short circuit current is 3.15 A. The roof has a total power rating of 3 kW_p, and can export to the grid via an inverter.

The rest of the walkway roof, including the porch, is made of laminated glass sheets, colour-matched to the PV panels. The design of the PV integration uses the laminate mounting extrusions as the structural members, while providing ventilation at the rear of the laminates. Details for flashings were developed to allow attachment

at the interface between the existing uneven granite wall and the head of the PV roof, while allowing ventilation air to escape. All the external surfaces have been coated with epoxy powder.

The PV arrays (three strings of 16 modules) are interconnected in junction boxes within the ceiling of the walkway to allow access for research and testing. Two extra modules have been left unconnected for later monitoring. DC wiring from each array is fed to an inverter in the plant room, located near the end of the walkway. This feeds the distribution board for the offices. Excess power is exported to the grid.

Energy Efficient Systems

Internally, the offices have been designed to maximise energy efficiency. The heating is provided by an 11.4 kW Lennox condensing air heater optimised with a heat exchanger. The total lighting power load limit is 10 kW, requiring the use of low-energy appliances.

In summer, the offices are kept comfortable by ventilating the buildings between 12:30–07:00 with forced draught air from outside, and then coasting during the day with all doors and windows shut. During the hot summer of 1995, the buildings were typically



The rest of the walkway roof, including the porch, is made of laminated glass sheets colour-matched to the PV panels.

maintained at 22.2°C compared to 33°C, which was the outside ambient temperature for several weeks.

As a low-energy building, the office development is definitely a success. Energy consumption in typical UK air-conditioned offices can range from 400–600 kWh/m²/year. After two years of operation, the actual energy consumption at Whittle Hill Farm has been an average of 100 kWh/m²/year. From June 1995 until August 1997 the PV array has generated 3,454 kWh (see figure opposite).

Air Cooling

The latest addition to Beacon Energy's systems is a passive solar cooling system designed by the Institute of

Building Technology at Nottingham University. The design of the system is unique in that there are no active components such as compressors or pumps. The refrigerant used in this system is H₂O—plain water—making the system entirely environmentally friendly. During the summer the system will provide about 6.5 kW of cooling and, on sunny days in winter, about 13 kW of heating. It is the first commercial installation to pave the way for solar-powered air conditioning with zero energy use (no pumps, controls or motors) throughout the world.

Automatic Irrigation

It is worth noting other 'environment-friendly' aspects of the buildings.

Water that runs off the roof (1,260 litres for every 1 cm of rain) is collected in a 18,000 litre underground tank to be used for irrigation, washing and drinking. Irrigation is automatically triggered by ground-water wetness sensors. Water for drinking is fed through an activated carbon filter and a reverse-osmosis plant producing 6 litres per minute. Even the toilet is used to good effect—the Servator Lectrolav dehydrates solids to 10% of volume, which is left to compost and is finally recycled with the garden compost.

For more information please contact the UK CADDET National Team in Oxfordshire.