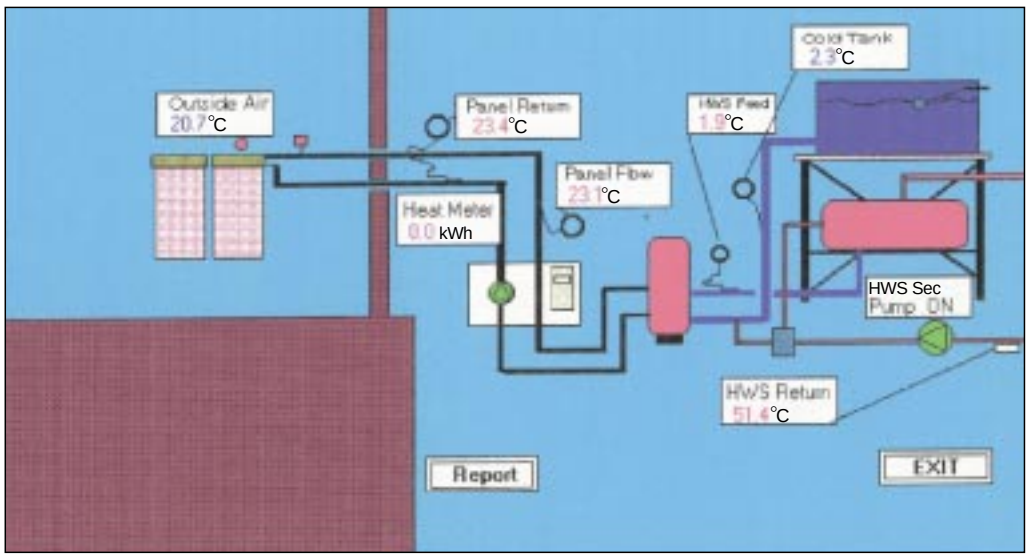
GREEN POWER

27

THE USE OF SOLAR HEATING SYSTEMS BY A LOCAL AUTHORITY

EXTENDED RENEWABLE ENERGY CASE STUDY



Schematic of the Phoenix House Building Energy Management System

INTRODUCTION

Solar water heating systems collect energy from the sun and convert it to useful heat for many domestic and commercial applications. A common misconception is that the UK is too cloudy for successful solar collection. This case study demonstrates that this is not necessarily the case.

There are a number of different systems available, ranging from cheap self-installed models to complex systems that maximise solar potential, although most use similar technology. A system comprises a solar collector, usually orientated to the south on a roof, inside which a fluid is heated by the sun. This fluid is sometimes used directly from the

Solar collector on the roof of Phoenix House

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The project described in this publication is a current example of an operating renewable energy scheme, but may not represent best practice in all respects.

BACKGROUND ON LEICESTER

Leicester is a city of 280,000 inhabitants in the East Midlands. The City Council is the local authority for the city and surrounding areas, a total of 115,000 dwellings. It has a very strong environmental record: since Leicester became the UK's first "environment city" in 1990, it has gone on to develop the Leicester Energy Strategy in 1994 and the Blueprint for Sustainable Development in 1996.

CLIMATIC DATA (1999)

Degree Days (Basis 15.5°C): 2063

Annual Mean Temperature: 10.6°C

Annual Total Sunshine Hours: 1572

collector for water heating (eg in a swimming pool), but is more commonly used to transfer the heat to a separate water supply that is then used in a conventional way.

There are now over 42,000 solar water heating systems operating in the UK, with the majority being used to produce domestic hot water, or for heating swimming pools. Currently, about 2000 new systems are added each year. Most systems are robust and reliable, giving on average 20 years' useful service.

LOCATION

Phoenix House, Leicester city centre.

BACKGROUND

Phoenix House is one of Leicester City Council's larger office buildings, employing around 140 people, mostly in the payroll and finance departments. In 1997, it became necessary to replace the ageing boiler plant which was becoming very costly to maintain. To support the City Council's sustainability commitment, the Energy Centre undertook a survey to specify a system that would be financially viable and would fit the Council's environmental aims. The report concluded that the best option would be to install an efficient low-NO_X (ie low oxides of nitrogen) gas-fired condensing boiler, supplemented by solar collectors. This specification met many of the Council's key commitments: increased use of renewables, reduced energy consumption, the reduction of the city's carbon dioxide (CO_2) emissions and improvements in localised air pollution problems. This was in line with Leicester's 1990 Energy Action Plan which made a commitment to use the most energy- efficient technology available.

TECHNOLOGY

The boiler plant to be replaced had serviced all of the heating and domestic hot water requirements of Phoenix House and, as the occupation pattern of the building had not altered significantly, the new plant was required to meet the same demands. Therefore, a Viessmann Vertomat low-NO_X gas-fired condensing boiler was installed, with a capacity of 225kW, to provide for this demand. However, to supplement the new boiler, a Viessmann DuoSol evacuated-tube solar collector was also installed, measuring $2m^2$. The solar collector is plumbed in between the cold-water tank and the boiler and serves to pre-heat the water (from the mains temperature of 3-10°C up to a maximum of 45°C). The boiler flow is set at 85°C, so the collector has significantly reduced the boiler workload and its gas consumption.

This is a typical set-up for most applications of solar water heaters: the systems are generally efficient at raising the water from the mains temperature of 3-10°C to up to 100°C, but are only able to achieve these high temperatures in the summer months. However, the Phoenix House system is slightly unusual in that the solar collector pre-heats the water for a *condensing* boiler. Most new solar collection systems are connected to existing boilers or new conventional boilers are installed, as this is what most plumbers and designers are more familiar with. However, it is no more complex to use a condensing boiler and, by specifying this, the system has been optimised, leading to improved energy consumption and shorter payback times for the whole installation.

To optimise performance further, the system has been included in the Council's comput-erised Building Energy Management System

HOW EVACUATED TUBES WORK

The collectors consist of a thin heat-pipe running up the centre of a glass tube on an absorber plate. The heat-pipe contains a liquid with a very low boiling point (such as alcohol) to ensure easy evaporation even at relatively low temperatures. The heat from the vapour is transferred to a copper condenser, which in turn transfers the heat to a water-pipe at the top of the panel. It is this water that is used for heating and hot water applications. Evacuated-tube solar collectors achieve higher efficiencies than standard flat-back solar collectors due to the use of the evacuated glass tube surrounding the heat-pipe. This vacuum prevents heat loss from the pipe to convection or conduction. However, the increased efficiencies are offset by the higher purchasing prices of evacuated-tube collectors.

The Roots of Leicester's Sustainable Commitment

Leicester City Council is the first unitary local authority in the UK to have achieved full Environmental Management Audit Scheme (EMAS) certification. This has been made possible due to a comprehensive and holistic approach to environmental policy. Energy awareness has been central to Leicester's environmental policy since the municipality of Leicester was granted the status of first "environment city" in 1990. This commitment to energy has been reflected since then by the continuing publication of reports and targets, together with the Council's status as one of the first Energy Efficiency Advice Centres (EEACs) to be launched in the UK (in 1993). This record is set to continue and expand as the Council bids for European Objective II funding to incorporate new and renewable energy into homes, schools and businesses in the area.

One of the key commitments Leicester gave when bidding to become firsr "environment city" was the reduction of energy use within the city to 50% of 1990 levels by 2025. This target is enhanced by the vision of meeting 20% of the city's energy needs from renewable sources by 2020. To help to meet these challenging targets, the City Council is actively promoting energy efficiency and renewable energy through the EEAC, housing associations and Article 10 regeneration projects, and, most importantly, is taking the lead itself, through the implementation of energy efficiency measures and the integration of renewable energy into council buildings.

The Council's commitment to sustainable energy use starts at the very top level, with the Chief Executive making a Corporate Commitment in 1992 to embed consideration of energy consumption into all decision-making. This means that all equipment now purchased must conform to a certain standard of energy efficiency; all new-build projects must actively seek to incorporate new and renewable energy and energy-efficient technologies. All the monitoring and purchasing of energy is now handled centrally at the Energy Centre, so that best value can be obtained and any anomalies can be spotted and rectified easily. It is this commitment at all levels that has allowed Leicester to set such ambitious energy targets.

(BEMS). A BEMS operates by continuously monitoring the energy consumption and water temperatures of any installation over a short time period (typically between 15 minutes and an hour) from a remote location. As well as being able to produce precise figures in the form of easily manipulated graphs and tables, the system can automatically flag up any anomalies. Therefore, the system can be continuously analysed for potential problems from a remote location to spot any faults before they become major or costly. A schematic from the Phoenix House BEMS is shown on the front cover.

PLANNING ISSUES

As with many construction projects planning consent may be needed to alter the external appearance of the building. Generally, water heating systems fall within the permitted development category, but formal planning applications are needed in some cases, especially if the system is to be installed on an historic or listed building. However, the plant room in Phoenix House is on the top floor of the building (floor 5) so the solar collector has been placed on the roof. The only buildings that directly overlook this roof are the New Walk Centre council buildings so formal planning application is avoided.

After installation, some teething problems were experienced. Summer return water temperatures from the collector began to exceed 100°C. While this was very encouraging at first, the very high temperatures actually caused some seals to fail on the pipework system. The BEMS alerted the team to the problem before further damage or significant losses of operational time could occur. The system now pumps over to the calorifier from the collector at a maximum temperature of 45°C.

COSTS AND SAVINGS

In order to meet the corporate commitment to purchase energy-efficient equipment, Leicester City Council has an Energy Capital Fund. This is used to pay for the difference in the cost of energy-efficient equipment over its conventional equivalent, ie the marginal cost. One of the criteria for this fund is that the payback for the marginal cost should be within four years. This means that for projects such as this with long working lifetimes, after four years the use of energy-efficient and renewable technologies will effectively earn money for the Council, making future more expensive and sophisticated projects more financially acceptable.

The following demonstrates how an holistic approach has been taken to the total installation to prove that the total marginal cost pays back within the required timescale.

As the existing installation consisted of two 30-year-old gas-fired boilers, the efficiency was only 56% under full load conditions and dropped even lower under part load. Therefore, because of their age and inefficiencies, these boilers were due to be replaced with two new conventional boilers at a cost of approximately £10,000.

However, it was decided that the Energy Capital Fund should be used to pay for a low-NO_X gas condensing boiler and evacuated-tube solar water heater, at a total cost of £13,900 (a total marginal cost of just under £4000).

The annual gas bill for Phoenix House has been reduced by £1500 as a result of this combined renewable energy and high-efficiency installation, amounting to a saving of nearly 18 tonnes of CO_2 per annum. Therefore, the extra £4000 cost of the *whole* system was paid for within 2.7 years, through the increased efficiency of the *total* system.

Two factors have allowed this project to pay back at a good enough rate for the "payback fund" (the payback fund is explained in Extended Case Study 25): firstly, the use of a high-efficiency gas condensing boiler has helped to boost the savings achieved by the solar panel; secondly, the boilers were already overdue for replacement. This means that the project effectively had a starting budget equal to the cost of replacing the existing boiler system with like boilers. However, by careful consideration of the options available, it has been possible to specify a system more suited to the building's requirements for approximately the same price but, due to the use of renewable energy and the high efficiency, with far lower running costs. This project demonstrates the opportunity that exists for using an holistic approach when refurbishing an energy plant and specifically a rooftop plant room where the existing infrastructure provides the ideal location for solar thermal use.

BENEFITS

- **Additional cost of whole system was paid back in 2.7 years.**
- **Reduced CO_2 emissions in line with Council objectives.**
- **Improved "green image" of Leicester City Council.**

FURTHER INFORMATION

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NEW REVIEW

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