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GREEN POWER

THE USE OF SOLAR HEATING SYSTEMS TO PROVIDE HOT WATER FOR A LEISURE CENTRE

EXTENDED RENEWABLE ENERGY CASE STUDY



Roof-mounted Hitachi evacuated-tube collector at Cossington Street Sports Centre

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 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

Cossington Street Sports Centre, Leicester city centre.



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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

BACKGROUND

Leicester City Council is responsible for 11 city centre swimming pools, with six in leisure centres and five in schools. Two of the larger swimming pools have successfully installed combined heat and power (CHP) plant to provide water and internal heating, and to cover some of the electrical demand. In order to contribute to Leicester's drive for renewable energy use and to offer economic alternatives to conventional energy, it was decided as an experiment to incorporate renewable energy into some of the other pools.

A study was carried out by the Council's Energy Centre in 1995 to identify the best technology to employ, and secondly to identify a suitable pool for the trial. The study concluded that the best type of technology to use would be evacuated-tube solar collectors, installed at Cossington Street Sports Centre to preheat the make-up water for the swimming pool.

Cossington Street is a large sports centre, containing a gym, sauna, sports hall, outdoor football courts and an indoor swimming pool. This measures 30m by 14m, with a total capacity of 10,000 gallons. The swimming pool is heavily used all year round, in the day by schools and community groups, and in the mornings and evenings

by the paying public. The water therefore needs to be maintained at 29°C at all times. The water in the pool is partly changed once a week, by draining off the top few inches then trickling in the clean water. To ensure that the clean water is warm, it is first heated by a boiler and then stored in a 2500 gallon tank.

TECHNOLOGY

Having selected the site and the technology to use, the Energy Centre passed on the job of designing the specific system to the City Council's Engineering Department. It was given the task of specifying a system that would be capable of heating 2500 gallons of water in the make-up tank from the mains temperature of 10°C up to 30°C in just 7 days, given ideal summer conditions. To achieve this aim, a Hitachi NEG.SK21D evacuated-tube solar collector, measuring approximately 3m², was selected to be installed.

As this was one of the first renewable energy projects to be installed on a council building in Leicester, it was initially felt that there was no need to install any monitoring equipment. However, although good data for gas saved can be obtained by analysing past bills, the Energy Centre felt that close monitoring of all aspects of the installation

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 first "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.

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.

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. This was not an issue with this project.

would allow more detailed information to be extracted. This information could then be used to help specify new renewable energy projects. Therefore, all new renewable energy projects are now linked into the Council's Building Energy Management System (BEMS) as a matter of course, with additional meters installed to obtain further data. 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. Therefore, the system can be continuously analysed from a remote location to spot any faults before they become major or costly.

The Cossington system has not experienced any technical problems in the 3 years since installation. The only problem has been the breaking of one of the evacuated tubes - probably caused by a falling rocket, as this was noticed just after November 5! However, it did not fracture the heat-pipe so the system still operates without the need for repair work, but with an estimated reduction in efficiency of 1-3%.

COSTS AND SAVINGS

The system was installed at a total cost of £11,700 in September 1995, which was financed from the energy and environment capital top-up fund. Although this fund usually demands that any projects financed will show a payback within 4 years, it was felt that the experimental nature of this

system would generate benefits other than just financial savings, and was therefore passed for funding. The system has operated successfully since installation in 1995, and has noticeably reduced the boiler workload without affecting the temperature of the pool. In summer conditions the evacuated tubes often heat the water to 27-28°C and even in winter the temperature is increased to a minimum of 16°C. This has reduced the gas consumption of the boiler by approximately 3.2%. This works out as an average saving of 45,000kWh per annum, which equates to around £360 or 7500kg of carbon dioxide (CO₂) per annum. The simple payback for this project is therefore approximately 30 years. However, for a true comparison: to achieve the same energy and carbon savings by using gas boiler technology would have required new low-NO_x (oxides of nitrogen) gas condensing boilers to be installed at a cost of £23,500. By installing the solar system into this existing gas boiler installation the overall efficiency of the plant has been improved by 8% (including standing losses) and the carbon emissions reduced by some 7 tonnes annually. This demonstrates how solar thermal systems can be used to upgrade plant efficiency and reduce carbon emissions at half the cost of boiler plant replacement. In light of the Climate Change Levy, this type of upgrade would seem most appropriate for boiler plant which are over halfway through their projected lives. Although this project has a poor payback as it stands (which is unlikely ever to be repaid within the useful life of the equipment), there are a number of factors which contributed to this:

1. The installers recommended that a larger area of tubes would increase the efficiency of the system, but as this was the first use of this technology in Leicester, it was preferred to test it on a small scale first. Subsequent similar initiatives have used more accurately sized systems and produced a better payback.
2. The project was installed as a retrofit, which always leads to higher costs than a new purpose-designed installation. New-build swimming pool facilities can incorporate the equipment into the design and hence reduce costs dramatically.
3. Increased efficiencies and lower prices of modern panels make any new project more viable than 5 years ago. This reduction in costs is set to improve over time with sales of panels increasing almost exponentially year on year.



Cossington swimming pool

4. As the project was not linked to any other similar projects, no economies of scale were achievable through the bulk purchasing of equipment, which can significantly reduce prices. This is an area which has been addressed in other areas where the economies of scale achieved can reduce the cost of equipment by well over 50%.
5. The payback for this measure was calculated using present fuel costs. It is more than likely that this will be an underestimate over the life of the equipment and hence the payback will be correspondingly overestimated. The introduction of the Climate Change Levy will increase the cost of gas, leading to improved paybacks. It is also likely that gas prices will increase over the lifetime of the installation through market costs as well as possible additional taxes/levies. This should be borne in mind with measures which have long lifespans.



Leicester City Council feels that the money was well spent, as it has proved that a set-up like this can help to heat water for a swimming pool - even in winter. Therefore plans are in place to use a combination of large areas of evacuated tubes, combined with smaller high-efficiency boilers, for any new pools built in Leicester. Additionally, economic studies will be carried out for any pool refits, to try to specify more financially viable applications of renewable energy.

BENEFITS

- **45,000kWh of gas, £350 and 7500kg of CO₂ saved per annum.**
- **Easily maintained and reliable source of hot water.**
- **Experimental precedent established, allowing more advanced and better specified renewable energy projects to be installed.**
- **Enhanced local environmental image.**

FURTHER INFORMATION

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NEW REVIEW

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