SevernWye
ENERGY AGENCY

Bedford Street Public Conveniences

Renewable Energy Feasibility Study

March 2009

Report

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Executive Summary

Summary of Current Situation

Bedford Street Public Conveniences are located in a busy part of Stroud town centre, Gloucestershire. Owing to their poor state of repair, a major refurbishment is planned to include: the addition of a pitched roof; an increased number of individual, street entry cubicles; integrated hand washing facilities.

Stroud District Council, who are leading the project, would like to investigate the potential for on-site sustainable energy generation in the newly refurbished facilities, plus options for innovative lighting.

SWEA gave due consideration to on-site energy demand, the proximity of adjacent buildings, the likely cost of different sustainable energy installations and likely public perception of future installations.

Recommended Actions

SWEA concludes that given the proximity of adjacent buildings, plus the general requirement for electricity rather than heating or hot water, no sustainable energy system is justifiable at this site, and that any available funds would be better spent at an alternative location. However, 'sun-pipes', which duct daylight into buildings via roof-mounted collectors, should be considered.

1 Introduction

Bedford Street Public Conveniences are housed in a small, flat roofed building in Stroud town centre (Fig. 1). They are closed to the public during evenings and at night-time. Due to their poor general condition, Stroud District Council are planning a major refurbishment of the facilities. This will include a new pitched roof and individual street-accessed unisex cubicles; presently there are separate ladies and gents toilet facilities and no street-accessed cubicles. In addition, new integrated hand-washing facilities will be installed. These units require a cold-water feed only, and use electricity to heat both water and air for hand washing/drying respectively.

Figure 1: Bedford Street Public Conveniences, Stroud

Stroud District Council would like to investigate the opportunity for sustainable energy production at the newly refurbished conveniences. They hope that this could save them money and reduce carbon emissions whilst making a visible statement of intent to the public. This report assesses the potential of various on-site renewable energy options, analyses those with the greatest promise, and makes recommendations based on costs and benefits.

2 On-Site Renewable Energy

2.1 Current energy demand

For the period April 2008 – November 2008 Bedford Street Public Conveniences used 2,249 units of electricity. This is equivalent to an annual demand of about 3,370 units which costs around £500 ex. VAT.

2.2 Renewable energy options

The primary energy requirement is for electricity for both the lighting and for the electrically powered hand washer/driers. Currently, lights are permanently left on during all times that the conveniences are open since very little daylight enters the building.

Five options exist for on-site renewable energy generation at Bedford Street Public Conveniences:

1) Ground Source Heat Pump (space heating and hot water)
2) Roof-mounted Solar-Thermal System (hot water)
3) Wind Turbine (electricity)
4) Roof-mounted Solar Photovoltaic (PV) Panels (electricity)

Given that current plans do not include a requirement for space heating at all, and only small requirements for hot water, Options 1 and 2 can be discounted at this early stage. In addition, given that Bedford Street is located in a built-up urban environment, and that the public conveniences are housed in a single storey building, a roof-mounted wind turbine is not a viable option; wind speed is likely to be low and turbulent, and strong objections are likely on the basis of noise. This discounts Option 3.

Roof-mounted solar photovoltaic (PV) panels (Option 4) would appear to be the most suitable option for providing this power from a renewable resource, but overshadowing by adjacent buildings must first be investigated since long periods of direct sunlight is a necessity.

A further measure which may reduce on-site energy demand by cutting the requirement for daytime lighting is the incorporation of solar pipes (also called sun pipes; Fig. 2). Solar pipes duct daylight from the roof-top of buildings into poorly illuminated rooms beneath, reducing the requirement for electric lighting during daylight hours, saving money and cutting carbon emissions. They consist of a roof-mounted collector (an acrylic dome), a reflective duct and a ceiling-mounted light diffuser, and can be considered an 'established technology' since they are currently installed in many building.

Figure 2: Cross-section of sun pipe

2.3 Solar photovoltaic (PV) description

Solar PV panels generate clean electricity from sunlight which can be used for lighting, water heating, hot-air heating etc. Panels can be sized according to need and currently have a huge range of applications, from road signage to powering factories. A wide range of PV systems are available and several of the options are shown in Fig. 3[1].

Different types of PV systems available (clockwise from top left):
1/ Roof integrated Solar Tile - replacing conventional roofing materials
2/ Roof mounted modules – panels can be mounted in a frame on top of the roof surface
3/ Glass Laminates – combine glass and PV technology
4/ Roof integrated solar shingle – replacing conventional roofing materials

Figure 3: Solar Photovoltaic (PV) installations

[1] All pictures courtesy of Solar Century

A typical well-sited 4 kW (25–30 m^2) solar PV system in the south-west will generate around 3,400 kWh annually, which would currently be worth around £500–600. Such a system would cost around £20,000-£25,000 although grants are available for solar PV. Excess electricity generation, for example during periods of low on-site demand, can be fed ('exported') into the electricity distribution network. Different export tariffs currently exist; some energy companies will even pay for all *green* electricity generated, whether it is exported or not. In addition, the government will announce this summer details on fixed 'feed in tariffs', whereby green generators will be guaranteed a fixed, premium price for the electricity they produce or export.

Solar panels require very little maintenance – they do need to be kept reasonably clean, but mounting the panels on a sloping roof will ensure that rainwater will wash most of the dust off the array. The panels can be cleaned by hand if required.

The panels have a glass covering which can be smashed if hit by hard objects - panels are best sited where they are unlikely to be subject to vandalism or have things dropped on them.

2.4 Issues surrounding solar PV

In the northern hemisphere, the sun is at its maximum intensity when due south, which coincides roughly with mid day locally. Consequently, for

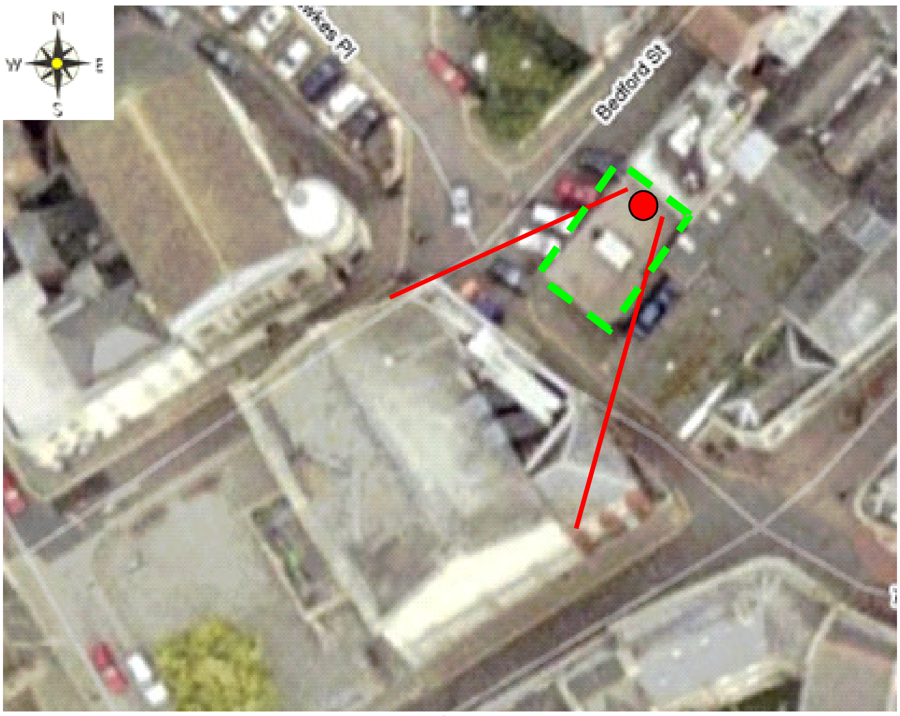

Figure 4: Building layout around Bedford Street, Stroud

optimum performance, roof mounted solar PV panels should face south, receive unobstructed sunshine from from sunrise until sunset, and be mounted at an angle of ca. 35° from horizontal. Deviations from these criteria will reduce their maximum theoretical energy output and may make a PV system non-viable at a particular location.

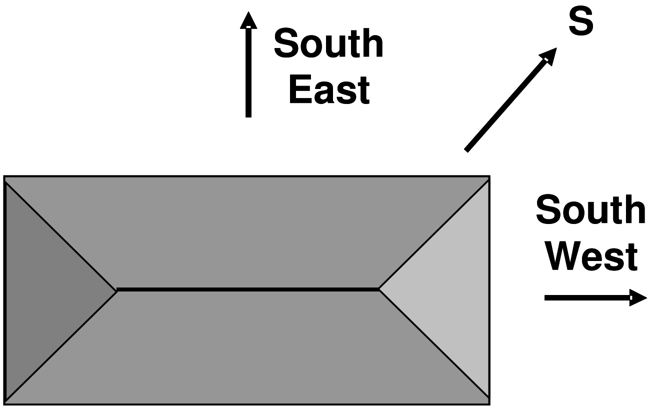

Figure 5: New roof configuration, Bedford Street

Figure 4 illustrates the layout of buildings around Bedford Street Public Conveniences[2]. The conveniences are highlighted in green, and a red spot is marked at the NE end of the building as a point of reference. The two red lines indicate the field of view to the nearest large building, the 'Subscription Rooms' which casts a shadow across the conveniences.

As outlined earlier, the refurbished facility will incorporate a new pitched roof, whose ridge axis is likely be aligned NE/SW (Fig. 5). This will create two large roof pitches, one facing SE and the other facing NW. It is also likely to create a smaller SW facing pitch if the creation of a new gable-end is to be avoided.


Figure 6: Close proximity of Subscription Rooms to public conveniences

[2]Image obtained from Google Earth

Three key problems exist with regard to mounting solar PV panels on the new roof. First, the NW facing pitch is entirely unsuitable for solar PV panels. Second, the SE and SW facing pitches offer sub-optimum conditions for panel mounting (about 70% of optimum for a 45° offset from South facing). Third, adjacent buildings, most notably the Subscription Rooms, cast shadows across the public conveniences; the proposed SW facing pitch is likely to be in near-permanent shadow (Fig. 6).

Consequently, this leaves the SE facing pitch as the only viable option for mounting solar PV panels. However, the influence of shading must be considered before a conclusion can be reached.

2.5 Analysis of solar PV performance

Figure 7 illustrates the influence of the Subscription Rooms on shadowing of the roof space of Bedford Street Conveniences. View A shows the side view, View B is the view of an observer looking directly towards the subscription rooms and View C is the plan view. The diagrams are based on measurements taken from photographs plus approximate on-site measurements.

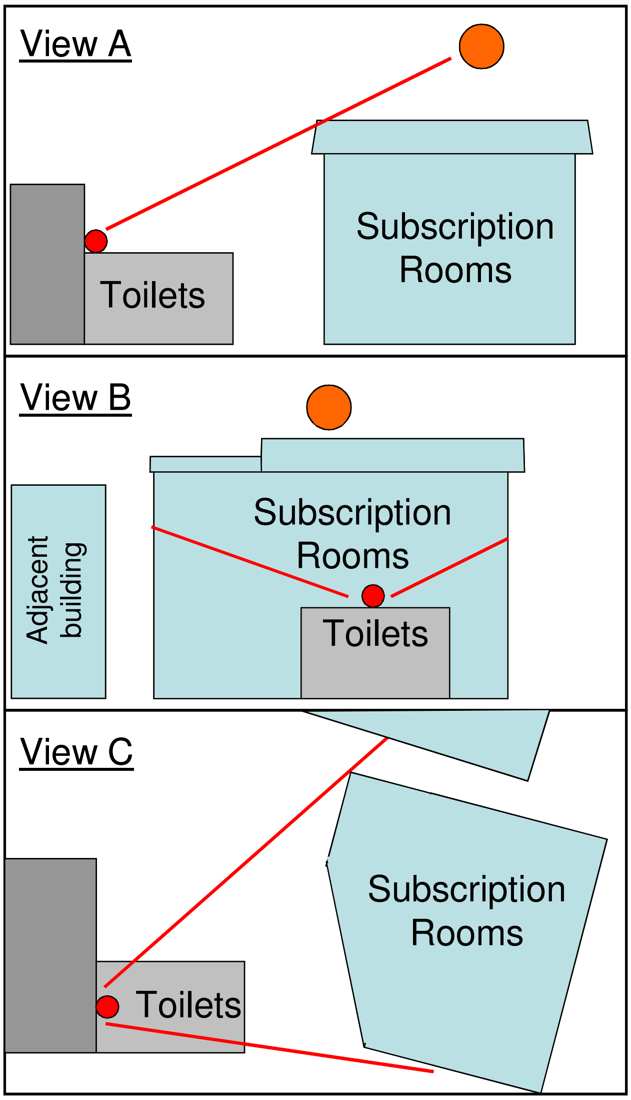

Figure 7: Relative position of Subscription Rooms

What is immediately clear is that the end of the roof marked with the red-spot (the NE end) will be subject to the least amount of shading. Consequently, further analysis is made from this 'best-case' reference point.

It is worth bearing in mind that the solar zenith, the angle created between horizon, point of observation and sun at a given time of day, varies throughout the year. This impacts on shadow length, causing short shadows in summer and longer shadows in winter. Both seasonal and diurnal variation in shading requires consideration.

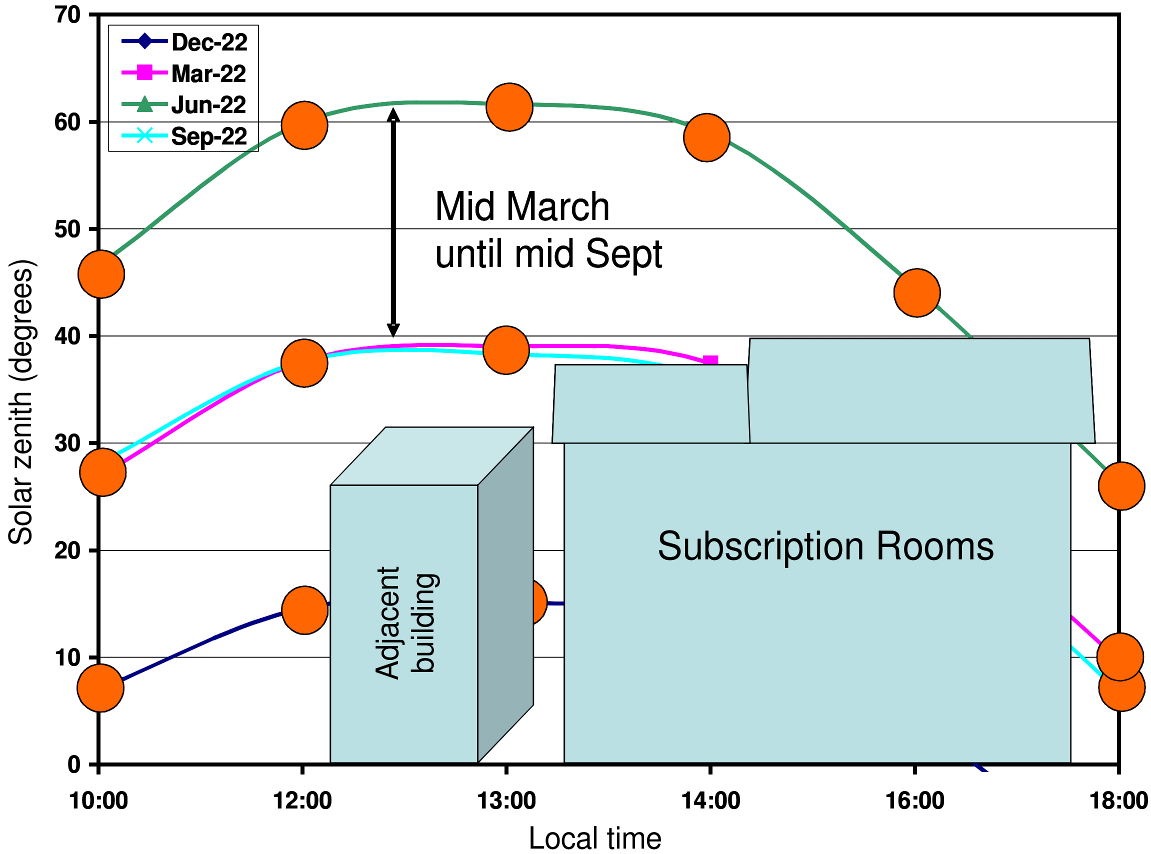

Figure 8: Seasonal view from reference point, Bedford Street

To investigate the affect that adjacent buildings would have on shading, the diurnal 'solar-position' (10:00 – 18:00) for the Bedford Street reference point was calculated. Calculations were made for the summer and winter solstices (June and December) plus the spring and autumn equinoxes (March and September). Calculations were performed using NOAA's Solar Position Calculator[3] and the US Federal Communications Commission's Coordinate Calculator[4]. The results were plotted and the exact positions of the two most dominant nearby buildings, as observed from the reference point, superimposed in order to predict shading times (Fig. 8).

As expected, the summer solstice gives the greatest amount of sunshine, with no shading during the most productive part of the day (10:00 – 16:00). However, during the winter solstice, there is almost complete shading. At the mid point of the solar year, there is about a 50% loss in available sunshine due to shading. On an annual basis, we predict that about 50% of available sunlight will be lost to shading at the Bedford Street reference point.

[3]http://www.srrb.noaa.gov/highlights/sunrise/azel.html
[4]http://www.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html

3 Summary and Conclusions

3.1 Solar PV feasibility

Our analysis indicates that on an annual basis, the Bedford Street reference point (on the roof of the public conveniences; NE end) receives about 50% of total available sunshine due to local shading. Sub-optimal SE alignment of a solar PV system effectively reduces this figure to 35%. Furthermore, this figure relates to the reference point, which is the *optimum* position; in reality, some of the panels would need to be mounted closer to the Subscription Rooms, increasing shading and thus reducing the figure of 35% further still.

Consequently, given the significant expense of a solar PV system, the relatively low energy demand, plus its predicted poor performance, SWEA does not advocate a solar PV system at Bedford Street Public Conveniences.

3.2 Other energy saving measures

Current building regulations (Part L) will ensure that a proportion (30%) of the lighting installed in the refurbished conveniences will have low energy consumption. However, SWEA recommends that all new lighting should be low energy, and should be complemented with solar pipes. As detailed in section 2.2, solar pipes duct daylight from the exterior of buildings to the interior and are ideal for situations where windows are not a practical option. This measure will reduce electricity consumption still further, while allowing natural daylight into the building. The new lighting system should be fitted with motion/light sensors and delay timers to ensure that electric lighting only switches on when light levels are low and when the conveniences are occupied.

4 Further Information

4.1 Contact Details

Please contact *Sean Hayward* at SWEA to discuss the findings of this report.

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4.2 Acknowledgements

SWEA's work in preparing this report is funded under the Intelligent Energy Europe Innovative Thinking project. The report was carried out for Stroud District Council.

Thanks to Catherine Dodd for her assistance during the initial survey of Bedford Street Public Conveniences.

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