Opportunities for Improving Energy Efficiency and Using Renewable Energy at British Wild Flower Plants©

Mike Milner
Synergie Environ Ltd, 151 West George Street, Glasgow, G2 2JJ
Email: mike.milner@synergie-environ.co.uk

INTRODUCTION

In June 2011, as part of the planning and decision-making process for proposed new office accommodation, an energy audit was undertaken for the British Wild Flower Plants nursery business, which reviewed the quantity and costs associated with energy consumption at the site and assessed the initial feasibility for and costs associated with investment in small scale renewable energy technologies.

A range of no, low, and medium cost recommendations were made. These included analysis of energy meter readings against climate and occupation, adjusting time controls on irrigation and abstraction pumps, and use of night storage heaters to ensure that overnight (cheap) rate electricity was used whenever possible. Low cost recommendations included repair of the rain sensor feedback control on the irrigation system. The greatest energy savings would be realised by fitting insulation to the office area, or ensuring that the proposed new office meets, or exceeds current building standards for insulation.

Opportunities to invest in renewable energy included an air-to-air source heat pump and solar hot water heating to the proposed new office. Installation of photovoltaic panels at the nursery would generate up to 15% of the site's electrical consumption and, under the payment regime then applicable, realise over £1,500 in financial benefits, rising each year in line with the annual rate of inflation.

While the financial value of the projected savings was relatively small (approximately £1,220 per year) it would reduce the nursery's energy consumption by 64% and carbon dioxide emissions by 7.5 tonnes per year. The overall payback period for implementing the recommendations was about 2.3 years.

BUSINESS CASE

Business energy charges have increased substantially in real terms over the past 10 years. For example, according to the U.K. Office for National Statistics Quarterly Digest of Energy Prices, in the last year alone electricity costs have increased by 3.3% in real terms, gas by 16.4%, and oil by up to 25%. In addition energy prices have become increasingly volatile as a result of increased global competition for energy. In the U.K. electricity and gas generated from non-renewable sources also attracts taxation through the Climate Change Levy which increases the potential cost savings that could be realised by improved energy management within businesses. The U.K. Carbon Trust has estimated that 21% of the total UK businesses energy spend is wasted through inefficiency.

Consequently there is a clear economic case for businesses to reduce energy consumption and maximise the efficiency with which it is used on site. Reducing the consumption of energy generated from non-renewable sources (e.g., oil and natural gas) will reduce carbon dioxide emissions and contribute to an overall reduction in greenhouse gas emissions.

To reduce the U.K.'s overall dependence on imported energy and to increase the proportion of electricity and heat generated from renewable sources, the U.K. Government introduced the Feed in Tariffs (FiT) in 2010 and the Renewable Heat Incentive (RHI) in 2011. These two incentives provide a guaranteed level of return per unit of electricity (FiT payments) or heat (RHI payments) over an extended period of time (up to 25 years) the levels of which are significantly greater than that for earlier initiatives where they existed. Both have been index linked to the retail prices index and therefore provide long-term confidence in the level of reimbursement.

Therefore investment in small-scale renewable energy systems can help businesses to reduce the quantity and cost of imported energy, provide a regular source of income, and reduce exposure to price volatility to at least a proportion of on-site energy consumption.

ENERGY STUDY AT BRITISH WILD FLOWER PLANTS

British Wild Flower Plants is the U.K.'s leading propagator and supplier of U.K. native plants of known provenance to the wholesale trade. The site, which was formerly part of Norfolk County Horticultural College, includes offices, a lodge let as holiday accommodation, workshops and stores, an unheated greenhouse, unheated polytunnels, and open propagation areas. Water is abstracted from a borehole into a storage tank. This is subsequently pumped under pressure to provide irrigation throughout the nursery. Irrigation is time controlled to deliver a specific volume of water to each of 23 different zones.

The aims of the energy assessment were to:

- Identify existing energy management practices.
- Estimate the quantity and cost of energy consumption associated with key operating areas of the business.
- Identify potential opportunities to improve energy management and appraise these opportunities against economic and environmental criteria.
- To assess the potential for different small-scale renewable electricity and heat-generation technologies to provide a proportion of the site's energy needs.
- To appraise the potential for different small-scale renewable energy technologies against economic and environmental criteria.

METHODS

Established energy auditing techniques were adapted to the specific site. In brief the audit comprised:

- Analysis of existing energy billing information to determine the annual quantity and cost of energy consumption at the site, seasonal and daily trends in energy consumption, and cost.
- An assessment of energy consumption by key operating areas of the business including irrigation, space heating, lighting, and other horticultural equipment. This was estimated from the kW rating of equipment and data supplied by the business regarding operating hours.
- The quantity and cost of energy consumption associated with space heating the existing and proposed office was estimated using estab-

lished methods, site based measurements of the building fabric, and thermal conductivity coefficients of the specific building materials.
- The electricity meter readings were compared to publicly accessible data on space heating requirements (degree-day data) available from the Carbon Trust.
- Discussion of the existing operation of the site relating to energy management and how this may change in the future due to potential changes in operation and facilities.
- The potential for different renewable energy technologies to be applied to the site was assessed by:
  - A site visit to determine the layout, spatial constraints at and surrounding the site
  - Identification of the location and capacity of the electrical connection to the site
  - Identification of key factors on neighbouring property that could affect the feasibility of different renewable energy technologies at the site.

RESULTS

Electricity is the only energy source supplied to the nursery. Generating the National Grid electricity consumed at the site releases about 11.8 tonnes of carbon dioxide per year. Opportunities to reduce energy consumption by up to 64% were identified during the site visit. While the level of cost savings (approximately £1,220 per year) was relatively small this was a reflection of the already relatively low energy input of the nursery's operations.

Since May 2010 the electricity meter fitted to the site has been equipped with the capability to supply automatic readings on a monthly basis to the electricity supply company. This provided an opportunity to examine trends in electricity consumption. From this information it was determined that electricity consumption overnight during the winter (October to March) accounted for the greatest proportion of electricity consumed (Fig. 1). When the trends in the daily cost of electricity supplied to the site was compared against the requirement for space heating this showed a strong correlation which indicated that most of the electricity consumed by the business was associated with space heating (Fig. 2).

Electricity consumption by refrigerated appliances and for irrigation were the next major consumers of electricity (Fig. 3).

To improve energy management at the site the following recommendations were made:

- Assign responsibility for regularly taking and systematically recording and analysing electricity meter readings against a baseline and seasonal trends.
- Regularly check and adjust time controls on space heating, abstraction, and irrigation pumps to maximise the use of off-peak electricity supplied at a lower tariff.
- Replace or repair the automatic rain sensor used to switch off external irrigation when there has been sufficient rain.
- Purchase, install, and use 7-day programmable time switches to control space heating in the offices.

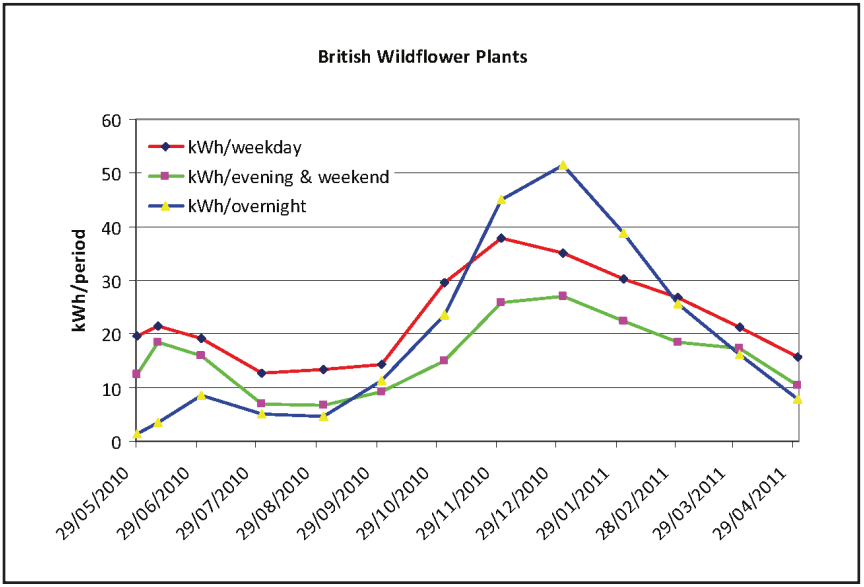

Figure 1. Trends in electricity consumption at British Wild Flower Plants from May 2010 to April 2011.

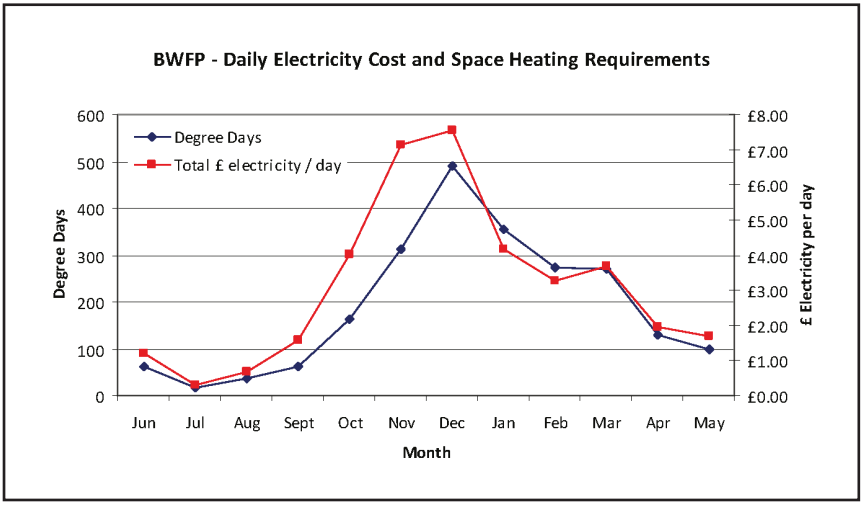

Figure 2. Comparison of daily electricity cost at British Wild Flower Plants (£ per day) against the requirement for space heating (degree days) from June 2010 to May 2011.

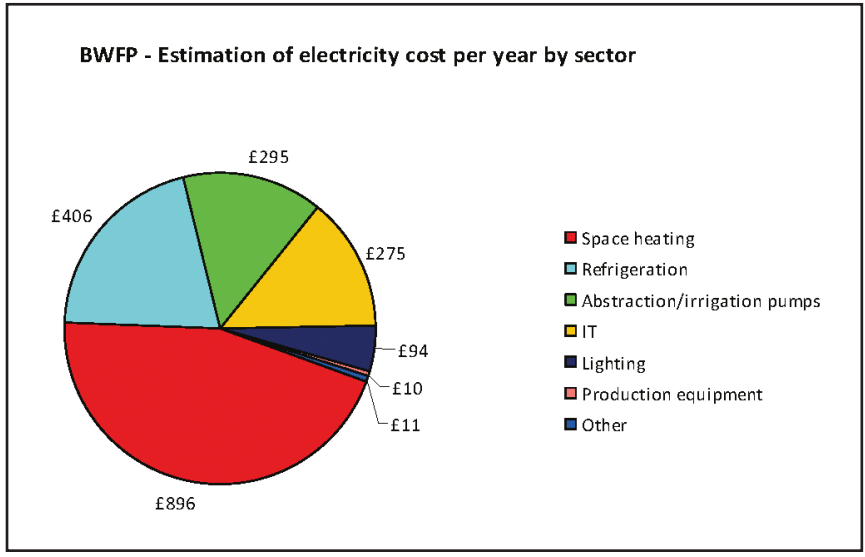

Figure 3. Estimated cost of electricity by sector at British Wild Flower Plants.

- Re-wire lighting controls to ensure that unoccupied areas of the site are not illuminated.
- Fit energy efficient lamps to existing light fittings.
- Replace and rationalise the existing refrigerated appliances with new A+ energy rated refrigerators.
- Purchase and install foil backed polyurethane insulation and fit to the inside of the existing office roof.

The great majority of these recommendations were no or low cost measures and the overall payback period was 2.3 years. It is estimated that implementation of these measures will reduce carbon dioxide emissions by 7.5 tonnes per year.

Given the nursery's energy demands and site specific constraints it was considered that the most applicable renewable energy technologies were solar hot water, solar photo-voltaic electricity generation, and air-to-air source heat pumps (the latter to provide space heating to the proposed new office).

It was estimated that a solar hot water system fitted to the proposed new office would reduce water heating costs by up to £100 per year and generate RHI payments of up to £90 per year. The estimated payback period was 10 years without financial assistance. In the UK, Enhanced Capital Allowances, resulting in a 100% tax allowance, are available for certain energy saving equipment in the first year following investment. More details can be found at <http://etl.decc.gov.uk/etl/default.htm>.

Solar photo-voltaic (PV) panels could provide a proportion of the site's electrical needs. However there was limited roof space available that was suitable for the location of the panels. It would be possible to install the panels on ground-mounted stands and connect their output to the site's existing electrical supply. It was estimated that a 3.69 kW peak PV system would reduce the cost of electricity from the

National Grid by £243 and generate £1,330 in FiT payments in the first year following investment. Such a system would cost approximately £14,800 to purchase and install and the estimated payback period would be 10 years.

An air-to-air source heat pump was considered to be viable to provide space heating to the proposed new office block on the understanding that the construction of this building would meet the insulation standards required by current building regulations. It was estimated that this would reduce heating costs by £63 per year and have a simple payback period of 3.2 years. At time of writing this type of technology is not eligible for payments from the RHI although specific models of air to air source heat pump can be eligible for 100% Enhanced Capital Allowances (ECA).

Biomass heating was not considered a viable option as the site has very limited and seasonal requirements for heat and there was insufficient fuel locally available.

Ground source or air-to-water source heat pumps were not considered to be viable due to the added investment cost associated with the installation of a wet radiator type or underfloor heating system and the relatively high cost for electricity, which would increase operating costs.

While the average annual wind speed in the area was greater than 5 m per sec, the speed at which wind turbines start to become financially meaningful, the presence of mature woodland surrounding, but not owned by, the nursery would cause significant local turbulence so the nursery was not considered to be a suitable location for a small-scale wind turbine. The site was not connected to the mains gas distribution network and had a relatively low and sporadic heat demand and therefore combined heat and power would not be appropriate at this site. The site was not on a river or watercourse suitable for small-scale hydro-electricity generation.

CONCLUSIONS

Since the completion of the study, British Wild Flower Plants has ensured that time controls fitted to space heating have been reset and that timings of abstraction and irrigation have been altered to maximise the consumption of electricity supplied at off-peak rates. In addition the company has ensured that the feedback control to turn off irrigation in the event of sufficient rainfall is fully operational. All of these measures were relatively easy to implement at no cost to the business and will yield immediate financial benefits.

Many of the results and recommendations relating to energy management made in this project can be readily transferred to other horticultural businesses. Where horticultural companies operate heated greenhouses there can be significant opportunities to improve the overall energy efficiency of space heating by a variety of means including making improvements to boilers and their insulation, improving and insulating heat distribution networks, improving efficiency of pumps and pump controls, improving thermostatic controls, and use of well fitted and maintained thermal screens. If artificial lighting is used there are opportunities to improve its efficiency through improved control, spacing and use of innovative low energy light emitting diode lamps.

The opportunities for site-based renewable energy technologies at British Wild Flower Plants were relatively limited by the spatial constraints, the relatively limited and sporadic requirement for space heating, and the lack of a suitable hydro resource. However it would be possible for the nursery to generate a proportion of its electrical needs through investment in a PV system which would generate income

from the feed in tariffs and reduce the cost of imported electricity. This site-specific financial assistance is available to UK businesses seeking to improve energy efficiency. This includes 100% ECA that are available for specific energy and water saving equipment, loans available from the Carbon Trust in partnership with Siemens finance and, if the business is in Scotland, interest-free loans available for energy saving and small-scale renewable energy technologies which are available through the Carbon Trust.

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