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Case Study 04

Greenwatt Way

Owner:
SSE

Architect:
PRP Architects

Location:
Slough, Berkshire, UK

Building Types:
Residential

Renewable and Low Carbon Technologies:

GSHP

ASHP

Biomass boiler

District heating

PV array

Solar thermal collectors

Project Description

This Code for Sustainable Homes (CSH) level 6 development in Slough was built by Scottish and Southern Energy (SSE), in order to better understand the real life, day to day experiences of low carbon living for their customers. The development incorporates energy efficient building design and a variety of renewable and low carbon technologies which results in net zero carbon emissions for these buildings. Since development of Greenwatt Way, the CSH definition of 'zero carbon' has altered so that now only 'regulated' emissions are considered. Consequently, Greenwatt Way surpasses the new requirements.

The project design team was appointed in the summer of 2009. Construction commenced in December 2009 and the project was completed in autumn 2010. Tenants including SSE staff, local key workers and local residents, have occupied the homes since autumn 2010.

The development is a pilot study, with trials undertaken to monitor the energy consumption of the homes and the performance of the renewable technologies.

Greenwatt Way Building Systems
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Key Drivers

SSE commissioned the Greenwatt Way development to investigate the various means by which the Code for Sustainable Homes (CSH) Level 6 zero carbon requirements could be achieved through renewable and low technologies. From 2016, Building Regulations will stipulate that all new homes should have zero carbon dioxide (CO_2) emissions from 'regulated' sources, in line with CSH Level 6. Consequently, there is a strong incentive for energy providers such as SSE to develop low carbon dwellings.

Key Features

- An air source heat pump (ASHP).
- A ground source heat pump (GSHP).
- A biomass boiler.

- District heating network, fed by the ASHP, GSHP and biomass boiler.
- Solar thermal panels.
- 63 kW photovoltaic array.

Scheme costs and finance

The budgeted scheme cost was £3.65 million including design fees, financed by SSE. It should be noted that while this would typically be considered as a relatively high cost for building 10 homes, the primary aim of the development was to investigate a variety of renewable and low technologies and the greater expense was due to a number of factors, such as:

- the high number of renewable energy technologies tested;
- research and development involved in developing the design;
- the variety of construction methods and technologies tested in the homes, limiting supply chain efficiency; and
- monitoring equipment for measuring performance and comfort over the 2 year post construction period.

Dwellings at Greenwatt Way
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Technology Selection Process

The design approach for Greenwatt Way was firstly to use energy efficient design to reduce energy demand and subsequently to satisfy residual demand through the incorporation of low and zero carbon technologies.

Energy efficient design measures included:

- high performance building fabric to meet the CSH Level 6 heat loss parameter requirement of 59% better than Building Regulations;
- rooflights to maximise natural daylighting and facilitate natural ventilation to minimise overheating;
- mechanical ventilation with heat recovery (MHVR); and
- energy efficient lighting/ appliances.

Other sustainable design measures included grey water recycling and a centralised rain water collection system.

Aside from the use of energy efficient light bulbs, CSH does not stipulate a reduction in electricity demand relative to Part L compliant homes, providing the electricity demand is offset by renewable electricity generation. The electricity demand for the Greenwatt Way development is therefore only slightly lower than for a Part L compliant 2006 development. The heat demand however is considerably lower due to high levels of insulation.

To ensure compliance with CSH Level 6, annual CO_2 emissions from Greenwatt Way dwellings were calculated during the design stage. These were compared against target CO_2 emissions for homes compliant with Part L of the 2006 Building Regulations. The calculations showed that, when biomass was utilised as a heat source, Greenwatt Way had significantly lower emissions than both the Part L compliant TER, and the minimum level for CSH Level 6. Further calculations indicated that the CSH Level 6 emissions levels could also be met when using the ASHP or GSHP for space heating.

'The average UK energy bill in 2010 for a 3 bedroom mid terraced house on dual fuel was £1100; ours was £500.'
Wendy Pringle
SSE Zero Carbon Homes Development Manager

Dwelling type and floor area	Part L 2006 compliant homes annual emissions (kg CO_2/year)	Dwelling emissions of Green Watt way dwellings (kg CO_2/year)
3 bed detached (93.84m^2)	2370	–2362
3 bed end terrace (93.84m^2)	2154	–2355
3 bed mid terrace (93.84m^2)	1943	–2190
2 bed end terrace (80.26m^2)	1842	–1582
2 bed mid terrace (80.26m^2)	1733	–1584
1bed flat (45.1m^2)	1312	–2657

Carbon dioxide emissions for Green Watt Way homes compared to Part L compliant dwellings
Data provided by Energy Saving Trust

The technology selection process at Greenwatt Way was unusual in that the aim of the development was to trial as many alternative renewable and low carbon technologies as possible. Consequently, several alternative heating strategies have been implemented at the site.
On completion of monitoring currently being undertaken by SSE, the suitability of each technology for the particular development will be evaluated.

Solar photovoltaic panels were selected for electricity provision as the dense built environment surrounding the site made the use of wind turbines unfeasible.

An ASHP, GSHP and biomass boiler, each sized to independently meet the full heating demand for the site, are all located in a central on–site energy centre. Each heating system is currently being trialled in turn to assess its effectiveness at providing heat to the development. Results of this study will not be available until completion of SSE trials in 2012. However, initial evidence indicates that the GSHP, which was used independently throughout the winter period of 2010–2011, is sufficient to provide all heating for the development.

The three heating systems are then connected to a district heating network which supplies the buildings with low grade heat. Heat exchangers in each dwelling use the district heating network to provide domestic hot water on demand. Space heating of the buildings is achieved via radiators, directly connected to the district heating network in series. Each house has a single radiator in the living area and a heated towel rail in the bathrooms.
The first floor flats also require a radiator in the bedroom due to their higher heat loss parameter. Heat circulation around the homes is achieved through the MVHR system.

A number of initial observations have been made since occupation of the homes in September 2010. The highly efficient building envelopes retain heat very well, thus minimising heating requirements. Consequently, the winter 'heating window' of the development appears to be shorter relative to that of a development of typical, non highly–insulated, homes.

Radiators were selected in preference to underfloor heating as the homes were developed based on a mass market private developer model. Minimising costs were therefore a main developer priority and radiators are typically cheaper than underfloor heating.

The Energy Centre houses a large stratified thermal store which stores the heat generated by the renewable energy technologies and then supplies this to the homes via the district heating scheme. A hydrogen fuel cell CHP will be trialled next year.

Solar thermal panels are mounted on the Energy Centre roof to supply a hot water top up to the thermal store and 63 kWp of photovoltaic tiles are integrated into the roof of the homes. During periods of low electricity demand, any surplus electricity generated by the PV array is exported to the grid, with residents utilising grid electricity when the PV array is not generating electricity (e.g. at night).

Monitoring and Operation

Tenants moved into the dwellings in September 2010 and a 2 year monitoring period is currently underway. Operational energy usage is monitored using smart metering, in addition to resident questionnaires. Additional ongoing studies include the following:

- a mechanical ventilation and air quality assessment, jointly funded by SSE in collaboration with BRE and the NHBC Foundation; and
- study on the performance of the district heating schemes, being carried out by a PhD researcher occupying one of the dwellings.

Operational costs to residents are significantly lower than for conventional homes, due to the free electricity generated by the PV panels and reduced heating demands of the houses.

Energy centre at Greenwatt Way
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Lessons learnt

Technical

- The incorporation of energy efficiency into building design reduces the size and cost of renewable and low carbon technologies required to satisfy residual energy demand.
- Allowing space for new technologies to be integrated into the energy system at a later date is a good way of future proofing through allowing flexibility to change to a different fuel source.
- The district heating system has allowed trials of the three heating systems to be remotely undertaken without disruption to residents.
- Connecting radiators in series has facilitated greater operational efficiency by minimising the water return temperature to the energy centre. Associated benefits of this include: a reduced heat loss from pipe work; a reduced pipe size and cost; and reduced pumping costs.

Occupant involvement

- Behavioural changes are a key part of successful operation of the buildings; residents had to adjust to the low termperature district heating scheme, and are encouraged to use natural ventilation in summer via windows rather than using fans.

Awards and Achievements

- Code for Sustainable Homes Level 6.
- Design estimates expect heating demand to reduce by up to 80% compared to homes built to 2006 building regulation standard and by 90% compared to typical existing homes.
- Reduced energy and water bills for occupants and opportunity to generate revenue from electricity.

Further Information:

SSE
www.ssezerocarbonhomes.com

The Energy Saving Trust
www.energysavingtrust.org.uk

Acknowledgements

Wendy Pringle, SSE Zero Carbon Homes Development Manager
Helen Stimpson, Energy Saving Trust

References

Energy Saving Trust, 'Greenwatt Way: A zero carbons homes newbuild case study', January 2011, Energy Saving Trust ®

These case studies are presented to show examples of how buildings can be designed and built to be low carbon and incorporate renewable and low carbon technologies. This case study is part of a series of case studies supporting a separate practice guidance document on low carbon buildings. **For further information see www.wales.gov.uk/planning**

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