Wood fired heating solution for the new Greenshop HQ

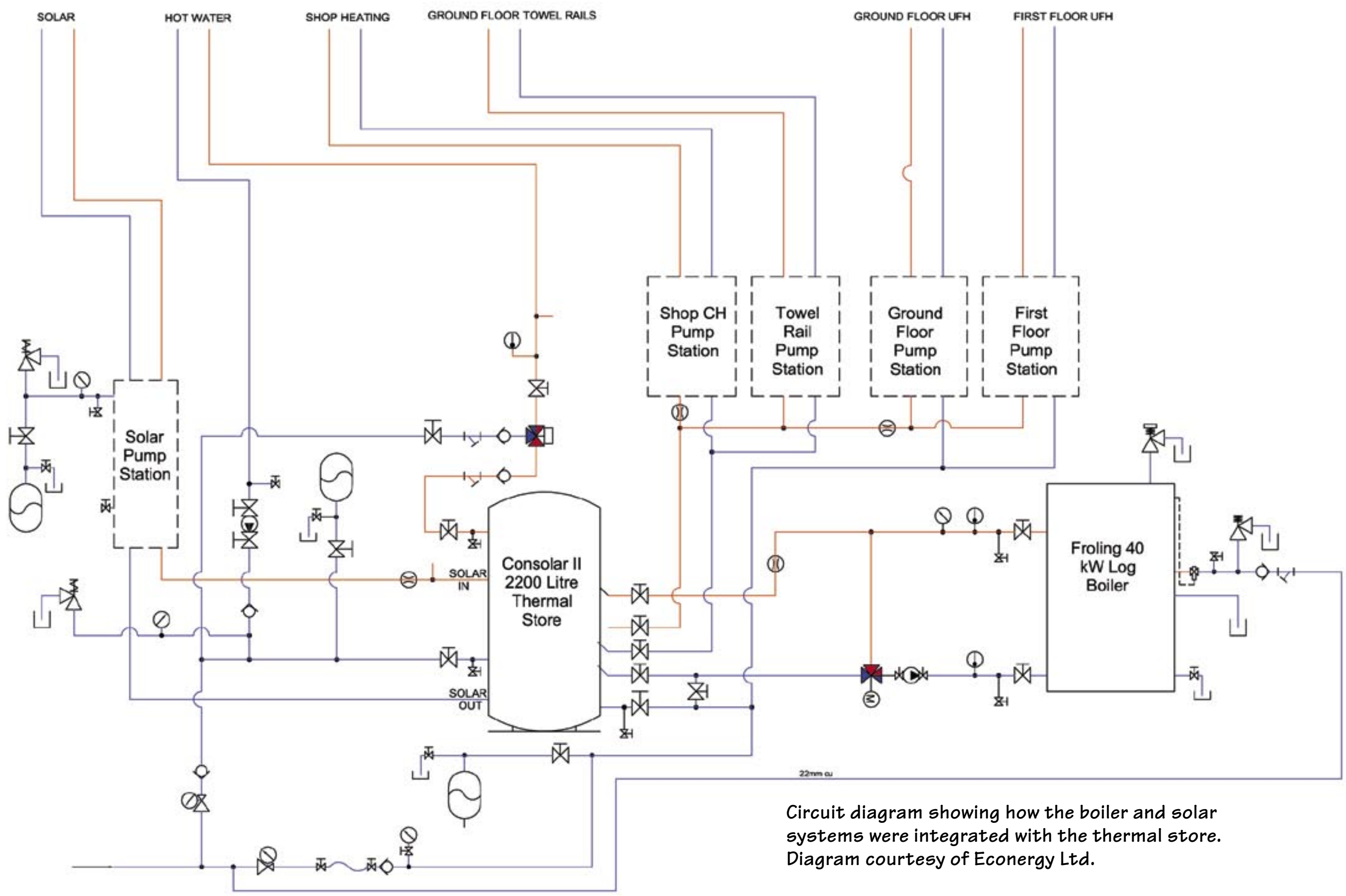
The Greenshop Group is a forward thinking and highly successful group of companies set up in the early 1990s to serve the fledgling green building products' sector, as well as offering organic, local and natural products to the public. The group has recently opened its new super-insulated headquarters and a log burning heating system was chosen to provide sustainable, underfloor heating. Roger Budgeon, MD of the company, gives us early feedback ...

The new Greenshop HQ is located adjacent to a busy rural petrol station, garage workshop and car sales business, where the the Greenshop was originally based. The Greenshop Group outgrew the space that the garage business could offer and required its own space, so the new HQ building was conceived. The site is quite exposed and is set at an altitude of nearly 1000 feet on the edge of the Cotswolds overlooking Stroud.

When considering the design of the new building I tried not only to reduce the need for energy (heating and electricity), but to look at what alternative options were available to us to provide our own or at least some of the power it needs.

The building was actually conceived in 2005 and the spec at that time called for walls with a U-value of 0.12W/m^{2}K, windows - 1.1W/m^{2}K, and roof - 0.09W/m^{2}K. We (the architects and I)

A wintery view of the new Greenshop Group HQ in Gloucestershire. The main picture shows the evacuated solar collectors on the walls and, inset: a picture inside the boiler room, showing the boiler and the consolar accumulator tank



Circuit diagram showing how the boiler and solar systems were integrated with the thermal store. Diagram courtesy of Econergy Ltd.

were also keen to ensure an airtightness spec of better than $3.5m^3/hr.m^2$ but the finished building bettered this, coming out at $2.8m^3/hr.m^2$.

As with any building, heating was certain to be the largest part of our energy load, so I looked at what we have on site, what is waste as part of our work process and what we can use as fuel, as well as what is sustainable into the future. I am also a firm believer in localisation and love the idea of each building supplying its own requirements, from both the environmental and fuel security points of view.

The garage workshop and associated offices are heated by waste oil. In fact the burner is very advanced and will burn virtually any sort of oil, vegetable or mineral, but there was not likely to be enough waste oil generated from the garage business to heat another big space, especially as the amount of waste oil has been reducing with advancing motor technology. Whatever I chose must be available locally and with little effort to either obtain or utilise. With this in mind, I turned my attention to recent technological advances in more traditional forms of heating - wood fuelled. After some consideration I chose to install a log boiler that would charge a stratified thermal store, which means we get heat on demand but only need to fire the boiler when the store is low on heat - once per day maximum.

The prime consideration, though, was how much wood might we need to heat the $700m^2$ building? The system has been designed with a large amount of solar panels built in (see main photo on page 47). These are wall mounted on the south and east walls so as to capture solar radiation when we need it, in the autumn, winter and spring but less so in the summer. We were not sure just how much the solar would actually contribute, so the building team (the Architects - Architype, energy consultant - John Willoughby, and client - me) commissioned a survey to calculate the heat load over a typical year. This was carried out by consultant, Rob Gwillim, who calculated a heat load of 19.5kW per day at an outside temperature of -3^0C and he concluded that this would equate to a hardwood log consumption of just under 3 tonnes per heating season for the whole new building. I deemed that this quantity would be achievable in practical terms with the majority of this quantity burnt in December and January, and as the year progressed less heat would be required as outdoor temperatures warmed and a greater heat input would be contributed by the solar input.

Real time data

The boiler was commissioned on 5th November 2007 and this charged the thermal store with heat. This, in turn. conveyed the heat into the underfloor heating pipes. At this point the building was not occupied, and we needed to dry moisture from the floor screed and plaster, which meant the boiler was fired every other day, with vents and windows open to allow the moisture to leave the building. The hot water secondary circulation, timer and control system was commissioned at the beginning of December. We started moving in on 5th December. This is a long process and as I write this, at the end of January, we

Table 1 . Snapshot of the wood fired heating system at the new Greenshop HQ on from 3rd - 10th February 2008

Date & time	Boiler output kWh	Solar output kWh	Underfloor heating kWh	Towel rail in old shop kWh	Hot water kWh	Store temperature			Boiler temperature		Boiler run time hours	Outside temperature
						Top	Middle	Bottom	Flow	Return		
3/2/08 12.05hrs	6482	144.96	4840	7.885	59.320	58° C	21°C	20°C	38°C boiler off	28°C boiler off	292	5°C
3/2/08 13.05hrs	6504	144.964	4840	7.885	59.320	57°C	44°C	21°C	72°C boiler on	59°C boiler on	293	5°C
3/2/08 16.45hrs	6560	144.964	4888	7.885	59.619	62°C	30°C	21°C	64°C boiler off	60°C boiler off	295	5°C
8/02/08 17.30hrs	6940	181.900	5186	7.917	65.707	51° C	41°C	31°C	48°C boiler on	33°C boiler on	310	6°C
9/2/08 08.00hrs	7055	181.900	5198	7.917	65.818	79°C	79°C	44°C	63°C boiler off	50°C boiler off	313	3°C
9/2/08 18.00hrs	7055	203.261	5231	7.917	66.789	70°C	60°C	38°C	52°C boiler off	36°C boiler off	313	8°C
10/2/08 10.00hrs	7055	204.598	5247	7.917	66.919	66°C	48°C	26°C	41°C boiler off	31°C boiler off	313	3°C
10/2/08 18.00hrs	7055	223.488	5274	7.917	67.468	52°C	41°C	31°C	38°C boiler off	31°C boiler off	313	8°C

are still moving in! The solar thermal was commissioned on the 17th December. Table 1 shows the heat energy production and use so far, although this is not necessarily an indication of what the building would use in normal occupation! The figures started at zero when each part of the system was commissioned. These will be set to a starting point again when we are properly in the building.

Two snapshots of the operation and outputs of the heating system.

On the 3rd February, the boiler was charged with one barrow load (about 20kg) of waste building softwood, left over from construction. The day was overcast – no solar input. The interior building temperature was 20ºC. It can be seen in Table 1 that the three hour burn of softwood delivered 78kWh of heat - 48kWh to the building heat, 0.299kWh to the hot water and the rest into the store.

Further down on Table 1 it can be seen that the boiler was charged with one and a half barrow loads of waste building softwood left over from construction, on the 8th February (Friday evening) and left burning. The following day, Saturday, was bright and cold. Sunday was similar but with wispy cloud cover. The building interior temperature was maintained at 20ºC.

Again it can be seen that the boiler delivered 115kWh of heat in a three hour burn on Friday evening and 41.586kWh from the solar over the three day period. The building appeared to pick up a lot of passive solar heat through the windows on Saturday and Sunday and vents were opened to maintain the temperature between 20ºC and 22ºC. Over the 48hrs the building took 88kWh of heat, the hot water 1.761kWh (low because it was weekend staff only), totalling 89.761kWh. The surplus charge of 66.83kWh is retained in the store for future use.

A couple of points that stand out are:-

1. The solar system output is higher than the hot water demand (nearly four times higher), despite the fact that the solar was commissioned two weeks after the hot water, it's the depth of winter, and it has been a very overcast one at that!
2. The boiler is being fired on waste building timber at present because we have it left from the construction process. This has a lower output than hardwood logs, so the boiler will not deliver so much heat energy per burn. This is because there are less kilowatt hours of heat energy in softwood than hardwood. This is not an issue as the thermal store controls and delivers the heat energy requirements. As can be seen the boiler is only fired when heat energy is required.

The store control can be set to preserve the hot water supply charging (top) section and so it will then cease to deliver space heating when the middle and lower sections fall below a useful temperature. To maintain a consistent hot water delivery temperature the output flow has a regulating blend valve fitted.

Conclusion

In operation, so far, this has proved a good solution. We have burnt some logs from the 3 acre site land management, a lot of waste wood from the timber build program and a few pallets. The boiler firing is carried out by our site maintenance man and occupies less than an hour on alternate days when the weather is cold, usually first thing. A typical burn is about a wheel barrow load of wood up to 0.5m long and takes about four hours. We do add more to keep the burn going if its cold. Our maintenance man, John, is very enthusiastic about the system and is keen to keep us all warm, but he has discovered he can't overload the thermal store. As the store fills with heat, the hot water part at the top first, the thermal gradient point moves down the store. When the store is full with heat the boiler modulates down. This happened at the end of a Friday afternoon when John tries to 'fill up' to last over a cold weekend, but when heat is taken out of the store to the underfloor heating on Saturday morning the burn continues. It's very impressive!

Whilst this operation is not ideal because shutting down the burn can produce carbon deposits, it is a useful process that is facilitated by the design of the boiler that uses both primary and secondary air controls. Carbon deposits can be simply cleaned from the heat exchanger by moving the cleaning lever on the side of the boiler through 90 degrees and back, which moves scouring springs within the boiler tubes. If the boiler load reduces and the store is nearly full, then the heat output will modulate back and trickle feed the current heat load. The top zone of the store supplies the hot water.

Roger Budgeon

Everything will be monitored and recorded. The data will be available on display in the shop and at: www.greenshopgroup.co.uk

Specification:
Fröling 40kW log boiler
18.8m^2 vacuum tube Consolar collectors.
Consolar 2,200ltr stratifying thermal store
The domestic hot water circuit is on a timed heating main
The building is two storey, floor area 700m^2
U-values, walls - 0.12W/m^{2}K, roof - 0.09W/m^{2}K
Airtightness 2.8m^3/hr.m^2.

Consolar UK (thermal stores and solar systems) from Greenshop Solar Ltd
www.greenshopsolar.co.uk

Fröling log boiler from Econergy Ltd
www.econergy.ltd.uk

Design and installation of the boiler
Eco Engineering 01453 883988

Insight

Gideon Richards

Confusion in clarity

When you consider the amount of money spent by government departments and local authorities on reports and data evaluation, one would expect clarity to be provided about the issue being reviewed. However, increasingly these reports are published in a style that leads the reader to believe the author is sufficiently authoritative not to warrant questioning. The consequences of this for the renewables sector has been particularly painful recently. For instance, recent reports into air quality in urban areas have created such a stir, that councils across the UK are stopping or holding back planning applications due to the perceived impacts of what could happen in 2026, based on air quality modelling that even the authors of the report say is only as good as the data they could get hold of!

My point is, that while communication has to be clear, it is critical that the reader gets a clear interpretation of the facts being presented. A good example of this was at a recent planning hearing where a council environmental health officer stated that a biomass system would be "the equivalent to a road carrying 10,000 vehicles a day"[1].

Without any quantification it was a shocking statistic that may or may not have been accurate. Based on that, the findings of the planning committee go on to report "... Although this proposed plant, in isolation, would not breach aforementioned standards, it would contribute to the cumulative effect should other businesses in the area follow suit and install biomass combustion plant"[2]. However, the effect, whether desired or not, was the planting of the seed of doubt in the minds of the committee members, that the proposal was equivalent to a constant excessive flow of cars passing the site daily. Not surprisingly the planning application was turned down.

Similarly a recent consultation came out of a government department suggesting that over a three year period 30,000 biomass primary heating boilers and 12,000 secondary heating stoves - CERT (carbon emissions reduction target) illustrative mix - could be installed in England and Wales; a tall order in the industry's view. However, the argument that this was only an illustrative mix, and therefore did not really have any weight and was not perceived like that by the industry or many of those potentially looking to deliver the CERT programme. The potential consequence is that biomass systems are avoided.

We have just had an announcement that a new nuclear power station programme must start if we are to keep our lights on and industry functioning. We are assured that there will be plenty of uranium available and from places that we can feel happy about; that the price will be acceptable when we need it in about 15 years and that there are answers to the nuclear waste concerns.

David Flemming in an article a few years back called 'No more uranium' (Prospect, June 2005), commented that with the world's growth demand as it was (and think of what has happened over the last few years) there was enough high grade uranium for 6 years worth of power generation, There is low grade uranium, however, it is energy negative (i.e. it takes more energy to produce than it releases).

Meanwhile we all stand by waiting for nuclear to suck up all the pots of money and stall many better developed ideas. If that same effort and money was put into the development of renewables and resolving all the perceived issues renewables have, how far do you think the £60+ billion would go to replace the 18% of electricity currently being produced from nuclear power.

So... for those that write reports and present data as factual statements, the comment has to be, please ensure that not only have you got your facts correct, but that the presentation of those facts are quantative and clear, BUT please leave the subjective interpretation to the reader! After all, the truth is only as good as the interpretation?

1. www.thecourier.co.uk/output/2007/12/18/newsstory10702503t0.asp

2. www.dundeecity.gov.uk/reports/agendas/ecd171207.pdf