National Trust

Sustainable technology case study

- Fröling 220kW turbomat boiler
- 4,500l thermal store
- rotary outfeeder
- top loading fuel store

Biomass boiler

Wood chip biomass boiler

October 2010

The project

Hughenden Manor is a Grade I listed building on the edge of High Wycombe. The mansion is located on top of a steep, wooded hill within the Chilterns Area of Outstanding Natural Beauty (AONB).

The brief for the project was to replace the two existing oil-fired boilers that provided most of the heat and hot water to the regional office, staff accommodation and a tenanted flat within the west wing of Hughenden Manor.

The aim was to use the biomass boiler as an exemplar project, showing how other National Trust properties could move away from oil-fuel, to more sustainable forms of energy.

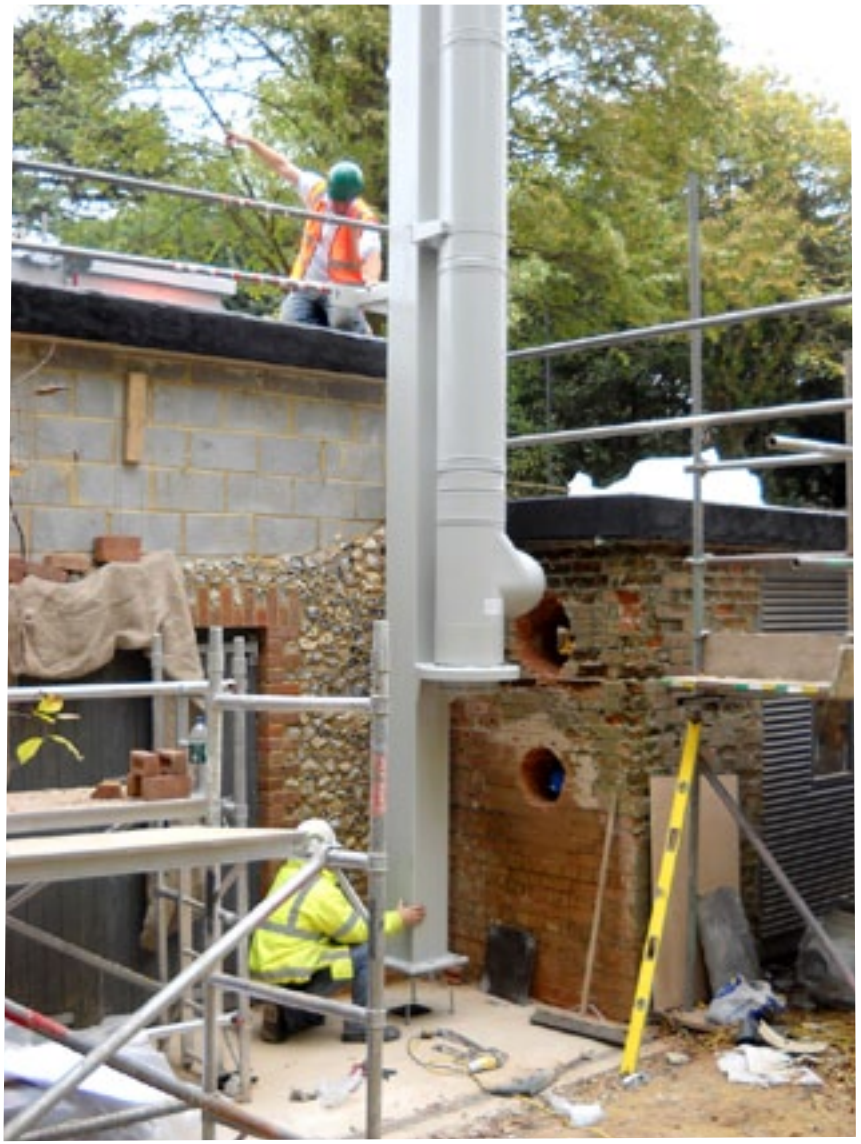
The existing system within the west wing comprised a LTHW system to three floors and electric storage heating to the top floor. Hot water was provided via the smaller of the two oil boilers and through electric immersion heaters in certain areas.

The two oil boilers had reached the end of their lives, with the larger boiler failing completely during the winter of 2009. The boilers were located in the sub-basement and accessed externally via a flight of steep, narrow steps.

Design

A feasibility study was carried out by Lorien Engineering Solutions. Their initial recommendation was to install a wood pellet boiler in the same location as the existing oil boilers. However, this solution was not felt to be the most sustainable as it did not utilise the extensive woodland that forms a part of the Hughenden estate. Therefore Lorien were asked to look specifically at wood chip solutions.

The first problem that this raised was that a wood chip boiler would not fit within the existing boiler room. A purpose built plant room and fuel store adjacent to the house was also discounted as inappropriate and unlikely to get planning permission.



Above **Flue being lowered into position**

A building known as the Apple Store was located approximately 75m from the mansion; this was identified as a possible location for both boiler and fuel store. The building was a mixture of nineteenth century vernacular estate building and 1940's extension (built by the RAF to house their photographic enlarging unit). The structure, partially sunk into the side of the hill was in a poor state of repair and although used as general storage by the gardening team, was under-utilised. The staff car park was immediately behind the building just above roof level. The building itself was unlisted although it sat within the curtilage of two different listed buildings.

The building had to be structurally sound and the concrete slab roof (a legacy of the RAF alterations), had to be made weather-tight so as to be strong enough to support a wood chip fuel store.

A structural report found that the building was able to take the additional load. However, as the design process progressed (and other installations were visited) the decision was taken to create a new fuel store adjacent to the exiting buildings. This would involve digging into the chalk rock of the hill, but would mean that the fuel delivery system was as simple as possible.

Delivery vehicles would have access into the staff car park, where they could reverse up to the fuel store, and empty their contents through the hatch in the roof. A rotary sweep and auger would then feed the woodchip into the boiler horizontally meaning that only one auger motor was needed, thereby reducing the risk of mechanical failure.

To satisfy planning and to sit unobtrusively within the Hughenden estate, the new fuel store was faced with brick and flint panels, a style common to the Chilterns. The bricks used were handmade using Chilterns clay and were supplied by one of the few remaining Chilterns brick makers.

Design

■ A single boiler solution was selected for the following reasons:

- There was no alternative fuel supply for a second boiler other than LPG or oil.

- Most problems with biomass boilers occur because of the fuel or the fuel feed. Unless we built a fuel store for each boiler a problem with the fuel feed on one would most likely mean shutting down the other as well.

- A single large boiler, as opposed to two smaller boilers proved more cost-effective.

- The loss of efficiency caused by only running a boiler at a small percentage of its capacity, as would be the case in summer, was overcome by increasing the size of the thermal store.

- The selected boiler could burn chip at G50 W40, something not possible in smaller boilers. This gave the property greater flexibility in fuel quality, something that was important as they were producing their own fuel.

■ The boiler was connected to the house by flow and return pipes. The insulation on these pipes was such that they claimed a temperature loss of 1°c/km. These in turn connected into a plate heat exchanger located in the old sub-basement boiler room. The other side of the heat exchanger connected into the existing wet heating system of the west wing. This method was chosen because of the concern that the old pipe system in the house would otherwise contaminate the new plant and reduce its lifespan.

■ Other works included:

- Repairs to the vernacular buildings

- Creating a bulk fuel store within an existing barn on a nearby warden's Estate Yard

- Creating an exhibit within the remaining unused area of the Apple Store

- Creating a replacement for the gardener's lost store

Right **View from car park**

Funding

■ This project was funded by the National Trust.

Carbon reduction

■ Before: Oil boiler – 58.9 tonnes per annum
■ After: Wood chip biomass – 5.52 tonnes per annum
■ A CO_2 reduction of 91%
(Source: Lorien Feasibility report 2010)

Review

Performance

■ Other than minor teething problems upon commissioning, the system has run smoothly.

■ Substantial savings on fuel have been achieved by purchasing wood chip. When the property starts to supply its own wood chip during 2011, these savings will increase. The National Trust will also be eligible for support from the Government's Renewable Heat Incentive Scheme.

■ In summer the boiler can be switched off and an immersion heater can supply the low volumes of hot water that are required. The immersion can act as a back up for hot water supply should the boiler breakdown. Mobile electric heating is available within the regional office in case of breakdown.

Energy generation

■ The boiler is currently under-utilised as the heat load requirement is only 103kW. Future plans for the property will allow it to use its full 220kW. This excess capacity was requested by the property during the design phase.

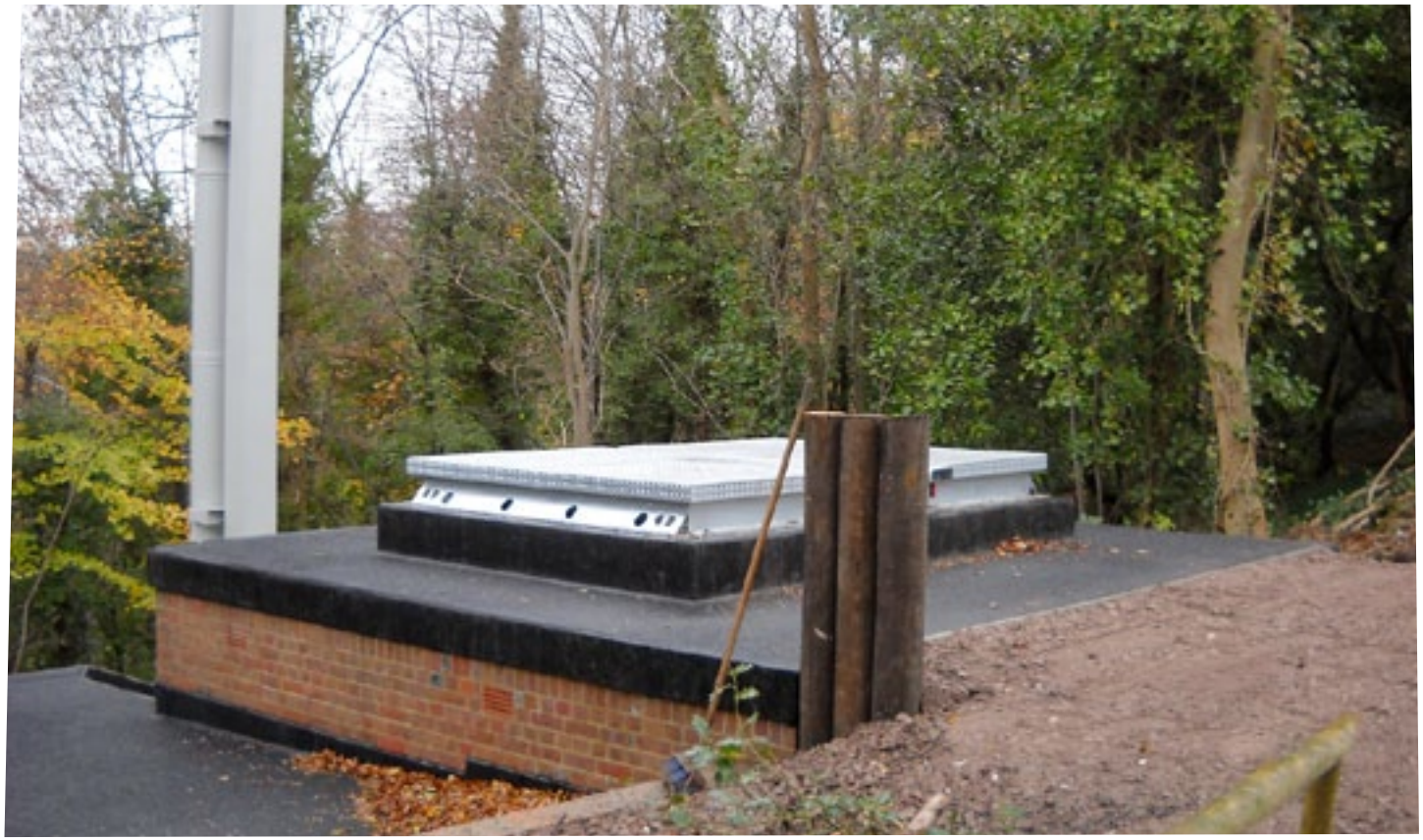
Maintenance

■ The forestry team are responsible for overseeing fuel deliveries and checking the boiler plant several times a week.

■ The Building Surveyor for the property has access via a laptop to the Building Management System (BMS) and can check performance remotely.

■ There is a maintenance contract in place that includes twice yearly visits and a four hour response time for emergency calls.

■ The initial problems with the installation related to the software interface between the boiler controls and the BMS. These were dealt with over the phone and have not been a problem since. Mechanically the system has performed very well; there have been no issues with either the boiler or the fuel feed system.



Above **Lid to fuel bunker**

Engagement

■ The doors opening into the boiler room incorporate glazed panels, allowing visitors to see the plant. An interpretation panel explains how the installation works.

■ The Project Team have shown round several groups who are interested in biomass systems, including groups from Austria, the Forestry Commission and Reading University.

Lessons learnt

■ It is important to think very carefully about how the wood chip will be delivered and stored, as this is a key factor in the success of a scheme – simple is best.

■ Consider how much energy will be required to deliver the chip into the fuel bunker, eg using blowers, plus how many augers are needed to move the fuel from the bunker to the boiler. The more moving parts there are – the more that can go wrong.

■ Research the quality of wood chip available in the area and ensure the chosen boiler is sufficiently flexible to use it. The accepted standard G30 W30 is often difficult to source and to achieve if you intend to provide your own fuel.

■ Ensure a back-up plan (or range of options) is in place, in case of a boiler breakdown.

Review

Future plans

■ Hughenden's boiler has the capacity to accommodate further heat load. Additional savings could be made by extending the wet heating system to the second floor of the regional office.

■ If the regional office were to be relocated the boiler has capacity to provide sufficient heat load for eight residential apartments.

Recommendations

■ Wood chip biomass installations make more sense if you can supply your own fuel.

■ Getting the fuel delivery and storage solution right should be a key part of the design.

■ Visit as many other installations as you can and talk to the people responsible for their upkeep to get a feel for issues that are likely to arise.

Further information

Hughenden Manor High Wycombe, Buckinghamshire HP14 4LA

Contractors

Civil engineering: Lawfield Contracts Ltd.
M+E: Instatherm Combustion Services Ltd.

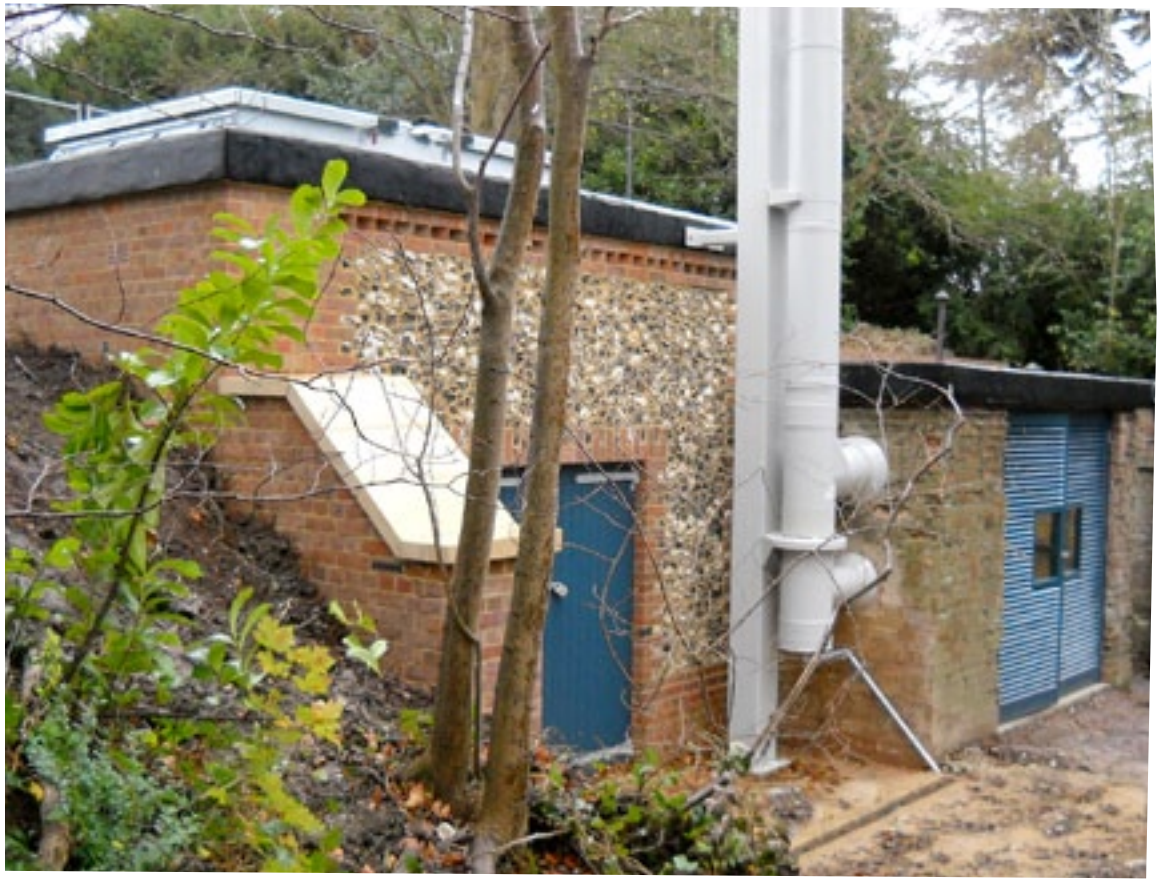
Products

Boiler: Fröling boiler supplied and installed by Econergy

Services

M+E Consultants: Lorien Engineering Services

Below **Boiler room and new fuel store**



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