FORESTRY COMMISSION SCOTLAND

Huntly Wood Fuel System

CASE STUDY

January 2005

Forestry Commission Scotland

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Introduction

In December 2004, Forestry Commission Scotland (FCS) commissioned a wood fuel heating system at its offices at Huntly, Aberdeenshire drawing on the experience and role models from within a number of European countries where the use of wood fuel systems is well established.

The following is a brief case study that summarises the aims and objectives of the Huntly wood fuel system, the decision making process regarding specification and design, external funding, installation and fuel supply. It also highlights some of the key issues and experiences gained from the project to date. The purpose of the case study is to help demonstrate to a wide audience the capability and benefits of small scale wood fuelled heating systems whilst highlighting some of the practical issues to be addressed, as well as helping to promote and stimulate development of the associated fuel wood market and supply chain in North East Scotland and beyond.

Background

The development and use of wood fuelled heating systems is now well established in other parts of Europe notably in parts of Scandinavia such as Denmark and in Austria where some 40 % of all domestic heating is wood fired. By contrast, experience in the design and use of such systems and development of the wood fuel supply chain in the UK remains scarce. However, promotion of renewable energy strategies is now part of Scottish Executive policy, with grant incentives available for approved woodfuel installations in Scotland. The ability of wood fuel to heat domestic houses, business premises, schools and community buildings has already been demonstrated at a number of locations including the Centre for Alternative Technology in Wales, woodchip heating systems at the National Trust for Scotland Visitor Centre at Glencoe, the Kinlochleven Community Centre and at the offices of Highland Birchwoods.

The Huntly Woodfuel Project - Aims & Objectives

Against this background, Forestry Commission Scotland decided to establish its own woodfuel heating system with the overall strategic aims of:

- **Providing a demonstration wood fuel heating scheme that will help catalyse replication of similar schemes in the north east of Scotland**
- **Helping to stimulate the development of local woodchip processing and a sustainable market for small roundwood in the public and private sectors**
- **Contributing to the Scottish Executive's renewable energy targets**

Through the process of considering, specifying and installing its own wood fuelled heating system, FCS's objectives were:

- **To achieve measurable savings in fossil fuel consumption in the Huntly office**
- **To stimulate a reliable local wood chip supply chain**
- **To contribute towards reduction in CO_2 emissions**
- **Provide a publicly available case study to those seeking to replicate the wood fuel scheme**

Project Summary Programme

From conception to commissioning, development of the Huntly wood fuel heating system has taken place over a period of two years and involved a number of key project phases, individuals, organisations, funding bodies, suppliers and contractors. These are summarised in the table below:

FCS Huntly Wood Fuel Heating System : Summary of Project Programme

Project Phase	Timing	People / Organisations Involved
Conception	Early 2003	FCS Grampian Conservator FCS Area Land Agent North East
"Investigative" tendering	Mid 2003	FCS Grampian Conservator FCS Area Land Agent North East
Evaluation & Design	October 2003	FCS Grampian Conservancy FCS Area Land Agent North East FC Research (Technical Development)
Planning Permission / Building Warrant		Allowable as "permitted development" – did not require planning permission. Building warrant obtained.
Selection of Technology, Infrastructure & Suppliers	December 2003-June 2004	FCS Area Land Agent North East FC Research (Technical Development) FCS Huntly staff FCS Policy Group
Energy Audit	December 2003	Scottish Energy Efficiency Office *[Scottish Executive]*
Boiler House Construction & Office Wet System	January – March 2004	Local building contractors - C Brown / A G Morrison / R Bagrie
External Funding	May - July 2004	FCS Area Land Agent North East Scottish Executive Scottish Community & Household Renewables Initiative (SCHRI)
Boiler Installation	October - November 2004	Econergy (UK agents for KWB boilers)
Fuel Procurement	Commenced 2003 On-going	FCS Area Land Agent North East FCS Huntly staff FCS Policy Group
Commissioning	December 2004	Econergy FCS Huntly staff

Conception & "Investigative Tendering"

FCS Offices Huntly

Front entrance

Office Location & Description

The Forestry Commission Scotland's offices are located about 2 miles north of Huntly off the B9022 Portsoy road and approximately 40 west of Aberdeen (see map insert). Built in 1987, the offices accommodate 25 staff and comprise a single storey timber frame and blockwork construction with an internal floor area of 330 square metres providing an entrance lobby, eighteen rooms off a central corridor, toilets and a kitchen. The building is double-glazed and well insulated.

Previous Heating System

The previous heating system was provided by electric storage radiators on a white meter tariff. Domestic water heating was by a small electric geyser and there are small tube type heaters in the toilets. Typical annual consumption up until installation of the wood fuel system was 69,000kWh, of which 46,000kWh were used at the night time rate generating an average annual cost for heating of £3,940, inclusive of standing charges and VAT.

Conception and Investigative Tendering

The driving force behind the Huntly project arose jointly from Forestry Commission Scotland's North East Area Land Agent and the Grampian Conservator's enthusiasm for wood fuelled heating systems and awareness of the establishments of such systems both in European countries and in Scotland, against the background of the FCS Director's endorsement of the potential application of woodfuel heating technology within FCS properties. Together these factors led to FCS running an "investigative" tender in mid 2003 inviting five UK-based companies to price for a wood fuel system suitable for the FCS Huntly offices.

However, the results of the tender varied widely both in terms of recommendations and price and were too diverse to allow conclusive comparison. With the benefit of hindsight it was realised by FCS that the tender brief had lacked the necessary clarity in terms of precise specification for the proposed heating system and associated fuel supply and expectation of the potential contractors in terms of post-installation support.

Evaluation & Design

From the outcome of the investigative tender, FCS recognised the imperative to seek independent advice on design and specifications for the heating system in order to achieve a more conclusive tendering process. FCS therefore commissioned Forestry Commission Research (Technical Development Branch) to undertake a feasibility study that would evaluate and make recommendations as to the required design, procurement and installation for the heating system in terms of:

- **boiler specification – matching capacity and quality to requirements;**
- **specifications for and location of a back up heating system;**
- **fuel specification, supply, access to site and storage facilities;**
- **who to invite to tender in terms of technical capability and support and who to chose.**

Recommendations

The recommendations that emerged from FC Technical Development Branch's feasibility study were as follows:

(i) Boiler specification & back up system

Specifying the appropriate type and size of boiler, together with a suitably designed installation system, to enable it to run efficiently and sustainably at high output, with a reasonably easily obtainable fuel quality, is the basis of "best practice" for the design and installation of wood fuel heating systems. For combustion efficiency and low emissions the advice provided was that the woodfuel boiler specification should be such that it runs at, or close to, its maximum rated output.

Given that the FCS Huntly building is equivalent to a large house or bungalow and the existing insulation is to a high standard, Technical Development Branch advised that a **30kW boiler unit** would be sufficient. In combination with FCS's stated requirement for a "backup" LPG boiler within the overall scope of the scheme, the chosen boiler for this location would also have to be capable of adjustment to cope efficiently with various grades of fuel material. Any such adjustments should not be overly complex or expensive to implement.

(ii) Infrastructure to accommodate the boiler and fuel

The installation design must complement the specified boiler size and the 'backup' boiler system, for the anticipated range of fuel quality available, as well as providing responsiveness to weather-induced variations in heat demand. The recommendation was therefore to incorporate a heat 'accumulator' (hot water storage vessel) in the boiler house, fed by both the principal and back up boilers in parallel. The woodfuelled boiler supplies hot water only to the accumulator, which in turn supplies hot water, via a pumped circuit, to the office. Normally the woodfuelled boiler alone would be operational, with the back-up boiler arranged to cut in automatically in the event of any failure of the principal boiler.

The siting and layout of the infrastructure to house and support the woodfuel system would require the following:

- **a suitably sited boiler house ideally close to the office building and allowing the most convenient plumbing layout (wet system required for the offices) and installation;**
- **a large, weatherproof fuel silo sited in close proximity to the boiler house and designed to facilitate fuel deliveries;**
- **metalled access to enable HGV and trailer deliveries to be tipped directly into the fuel silo or hopper.**

Other considerations included the need to ensure that the external appearance of the system would fit in with the present building and its surrounds and that existing facilities in and around the office building should not be compromised.

(iii) Fuel specification & supply

Of the three main types of woodfuel (chips, logs and pellets), it was recommended that only chips would be relevant for the Huntly system. Pellet availability is as yet undeveloped within north east Scotland and in UK generally, so supplies at an economic level could not be assured in the foreseeable future, whilst woodchips are more readily available and suited to a greater degree of automatic running than log fuel.

The recommended grade of woodchip for the Huntly system is the "**G30***" grade - an established EU woodchip standard. Whilst woodchip producing machinery is reasonably well represented in the UK, many of the existing woodchipping machines cannot produce chips precisely to this standard. Thus, until appropriate technology is developed there will inevitably be a compromise solution in terms of sourcing supplies of chips of at least a minimum quality (in terms of dimension and moisture content) that can be accommodated by the specified type of boiler. Furthermore, as chips are a bulky, low-density fuel, sourcing of supplies is best suited to localised production and delivery for economic and other sustainable rural development reasons.

*** G30 grade** – max cross sectional area 3cm2, max length (long thin material) 8.5cm

(iv) Technical capability & support

Woodchip boiler systems now have a long and established track record in Scandinavia and most of Europe, except for the UK, where expertise in smaller chip boiler installations, such as that proposed for Huntly, is very limited. This represents a significant constraint on the tendering process and post installation support, particularly where European and Scandinavian-based boiler manufacturers do not have local UK-based agents and technical support.

Selection of Technology, Infrastructure & Suppliers

With the above issues in mind and based on the recommendations provided by Technical Development Branch, FCS ran a further tender process in February 2004. Tenders were invited from the following companies:

Fuelwood Harvesting
3G-energi
Binder GmbH
Reka
Ala-Talkkari
Koeb & Schaefer KG
Econergy

The installation of the wet radiator system and construction of the boiler house and other infrastructure was undertaken by FCS under separate arrangements with local contractors.

Tender Requirements

The above companies were required to tender against the following FCS specifications:

- **Fully automated boiler with 30kW output.**
- **Boiler to be capable of economic adjustment to burn different grades of woodchip with up to 35% moisture content.**
- **Boiler to be capable of conversion to burn wood pellets.**
- **Weatherproof fuel silo of 20-25m^3 capacity, with tall height/base ratio.**
- **Boiler to be maintained by the supplier (or local agent) apart from ash emptying.**
- **Reliable and responsive after sales service delivering prompt rectification of faults.**
- **All equipment, Manufacturer's guarantees and conditions of installation are to be met under the terms of the contract, under an agreement with the Manufacturer relating specifically to this installation.**

In addition, prospective suppliers were required to include the following in their tender prices:

- **Delivery to site.**
- **Installation on a concrete pad already in situ.**
- **Supply, delivery and installation of fuel silo to above requirement, including auger and chip feed mechanism.**
- **Provision of all pipework, valves and controls connecting boiler to heat accumulator.**
- **Provide suitable connections to existing LPG boiler so that it provides secondary back up to the woodfuel boiler.**
- **All other incidental fittings.**

Tender Outcome

Only two offers were received of which one supplier (REKA) could not meet the specification criteria in terms of providing installation and post-commissioning support, having no local (or indeed UK) agent. This was considered essential.

Econergy (based in Cambridge) thus emerged as the only contenders meeting the tender criteria and were duly appointed by FCS in August 2004 to supply and install the boiler system based on a KWB (Kraft & Wärme aus Biomasse) USV Wood Chip Boiler with a rated output of 30kW.

Capital Funding & Costs

Capital Funding

During mid 2004, FCS applied for and was successful in obtaining capital funding support for the Huntly wood fuel heating system under the Scottish Executive's **Scottish Community & Householder Renewables Initiative** (SCHRI). As part of the due diligence of the application requirements, an energy audit was carried out on behalf of FCS by the Scottish Executive's "Scottish Energy Efficiency Office".

Total funding provided through the SCHRI was £21,996 or 50% of total project costs of £43,993 (inclusive of VAT). The balance was funded directly by Forestry Commission Scotland. A break down of the overall projected costs is shown below.

Running Costs

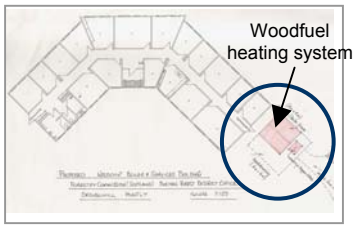
At the time of the case study, clearly insufficient time had elapsed to allow a meaningful comparison of costs between the wood fuel system and the previous heating energy costs. To date, daily consumption of woodfuel from commissioning in mid-December through 1st February 2005 was 0.5 m3 per day. This means one net hopper load of 17 m3 provides 6-8 weeks supply at a cost of £250 (delivered and chipped directly into the hopper).

Assuming that heat used (46,000kWh costing £3,940) at the FCS Huntly offices is approximately constant year on year, a comparative per kWh equivalent cost using the wood fuel system can thus be evaluated and performance measured against the project's target annual saving of £1,100.

FCS Huntly Wood Fuel Heating System : Project Costs
(as funded by SCHI)

Item		Cost (££)
Boiler		16,382
Installation	(plumbing)	1,620
	(electrical)	1,436
Boiler house construction		5,156
Hopper, installation & commissioning		8,532
Heat accumulator		1,013
Design & Project Management		1,634
Deliver & offloading		250
Fuel delivery access road		2,613
Sub Total (before VAT)		38,635
VAT		5,357
TOTAL		43,993

FCS Wood Fuel Heating System
Site lay out



Completed Boiler House

Fuel hopper under construction

Installation, Commissioning & Fuel Supply

Construction, Internal Plumbing & Installation

Construction of the boiler house and the concrete plinth to support the 22 cubic metre wood fuel hopper, plus the plumbing works for the wet radiator system in the offices, were all carried out by local contractors between January and March 2004 prior to, and independently of, the tender process for the heating system itself.

The boiler house (timber constructed) and hopper were sited within space available adjacent to the western end of the office building (see sketch plan opposite).

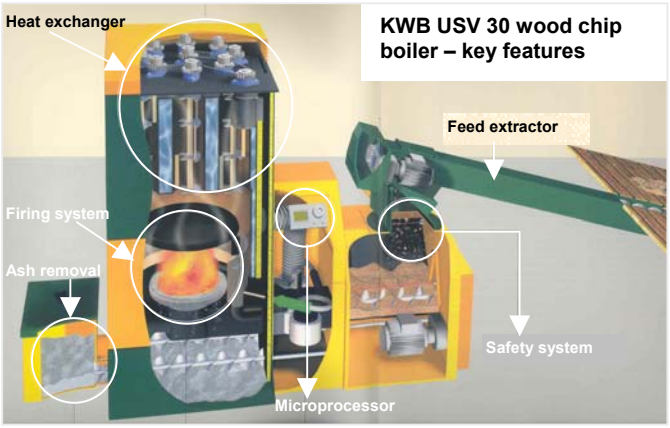
The boiler house and hopper were sited at the same ground level as the office. As the ground level rises slightly between this point and the nearby car park area, the creation of a short metalled access road from the car park has provided the advantage of allowing future tipping of chips directly into the hopper from a “ramped up” position.

The internal office plumbing work involved installing plumbing pipe runs to each room from above the respective ceilings, descending down internal walls, to serve wet radiators to replace the previous storage heaters.

The Boiler

The KWB USV 30 is a high specification boiler, fully automated and controlled by a microprocessor. It features a heat exchanger, firing, safety and ash removal systems and an auger feed extractor. These are highlighted in the schematic diagram below: The boiler is highly efficient with very low emissions and minimal generation of ash. It is capable of burning chips up to 30% moisture content and can be adjusted to accept pellets.

KWB USV 30 boiler as installed at Huntly



Commissioning

The system was commissioned by Econergy and FCS Huntly staff in December 2004.

Fuel Supply

The fuel supply strategy for the Huntly heating system progressed through a number of phases leading up to final commissioning. The initial strategy was to base the operation of the system on fuel supplied from shredded pallets from a source in Aberdeen. However, the combination of the lack of suitability of sample material (in terms of dimension - the shreds being too long - and level of dust and other contaminants) and the long haulage distances involved, mitigated against this fuel option at an early stage.

The next option explored was the supply of very low moisture content, chipped offcuts from the James Jones & Son "I-Beam" factory in Forres, Moray. Samples of the chips were delivered and tested in the boiler, but it was again found that the dimensions of the chips rendered the fuel unsuitable.

FCS local staff then sourced a supply of standing deadwood (with a moisture content of about 20%) from local FC woodlands and chipped this on site at Huntly using a hired in 8" disc chipper. This had the capability to directly fill the fuel hopper's 17 m^3 net capacity in four hours. This fuel supply has been working well, but has the disadvantage of not being readily replicable

Key Issues

A number of key issues have arisen from the various phases of the Huntly wood fuel heating system project. These are summarised below.

Conception & Investigative Tendering

- Enthusiasm needs to be matched with availability of specialist expertise to evaluate the most appropriate wood fuel system for the project concerned;
- Precise, objective specifications are needed to facilitate a tendering process that offers a level playing field to prospective suppliers;
- The need to identify and source an economically and environmentally sustainable supply of suitable wood fuel (preferably based on EU accepted standards for woodchips) to meet the requirements of a wood fuel system, at conception.

Evaluation & Design

- The need for specialist advice *independent* of the wood fuel system supplier;
- For a "retro" installation (such as at Huntly) can the infrastructural requirements to accommodate the wood fuel system be met practicably and financially – eg space, 3 phase electricity supply, scope for connecting with / converting internal plumbing
- Accessibility to fuel hopper for fuel deliveries
- The need to install a system that is replicable for other schemes
- The lack of a metering system attached to measure heat energy consumption by the office under the new system

Funding & Costs

- Is funding available to support the capital costs of supply and installation. A public body such as FCS would not normally qualify for public sector funding assistance, but this was possible at Huntly in view of its objectives of providing a demonstration model?
- Need to demonstrate comparability of revenue costs involved in running and maintaining the scheme against the costs of the previous system.

Selection of Suppliers

- The availability in the UK of specialist expertise in the supply and installation of smaller scale woodchip boilers is a limiting factor;
- The shortage of prospective suppliers that can provided local installation expertise and post-installation support.

Fuel Supply

- Knowledge of "fit for purpose" wood fuel types and specifications;
- Method of fuel delivery;
- Security of supplies of the required specification;
- Damaging impact of poor quality chips on operational efficiency of the boiler – eg burn back and extinguishing problems (due to wet chips), and overloading of the auger drive motor;
- The need to develop fuel supply options that are replicable for other schemes
- Take delivery of specified chips directly into the hopper;
- Need for local fuel wood "clusters" of suppliers and users to support a local woodfuel market.

Commissioning

- Confidence in the reliability of the installed wood fuel system to counter negative perceptions about the substitution of fossil with wood fuel.

Lessons Learned

Despite a number of initial teething problems at tendering and subsequent installation stages, the FCS Huntly wood fuel heating system is now successfully up and running and meeting the heating needs of the office. The KWB system has so far proved to be efficient and reliable. There have been some "snagging" problems but to date these have mostly been attributed to issues associated with quality control of the wood fuel.

A number of key lessons have emerged from the project, namely:

- At the initial planning stage it is imperative to seek specialist advice on matching a boiler that first and foremost services the building's needs but can also operate using the available fuel supply.

- Capital funding support for supply and installation is needed.
- Having installed a high quality boiler, the residual problems now faced by the FCS Huntly system are mostly related to the need to source and maintain quality control on reliable supplies of woodchips, together with an efficient method of delivery. Sub-standard chips have already led to reduced efficiency of the boiler through down time, added costs of in-house management and monitoring of the fuel supply and external maintenance.
- At present the market and supply chain for woodchips (and pellets) within Scotland and UK wide is very underdeveloped and the expertise in wood chip boiler supply and installation is also scarce. It is therefore vital to ensure that from the start a prospective wood fuel heating scheme is designed to take account of this weakest point in the chain. In the meantime there is an urgent need to address the issues associated with stimulating, establishing and supporting a sustainable wood fuel market and supply chain at the local level, clustering actual and prospective wood chip customers with resource owners and wood chip suppliers and hauliers.
- There is also the parallel need to address the current gaps that exist between wood chipping machinery and boiler fuel requirements. Specialised machinery has been developed in countries such as like Finland and Austria that can be supplied in the UK. There is thus a need for improved information dissemination and capacity building among suppliers.
- The FCS Huntly staff's experience to date has demonstrated that virgin roundwood probably provides the optimum raw material for fit for purpose woodchips, provided that this can be dried to acceptable levels of moisture content and the appropriate chipping machinery is used to produce chips that meet the G30 EU grade. However, there is also a parallel need to explore and appraise other suitable wood fuel supply options in order to demonstrate readily replicable solutions.
- There is a need for locally available technical support from the wood chip boiler suppliers.
- Installation of a meter connected to the wood fuelled boiler to measure heat energy consumed by the office under the new system would a beneficial addition to the demonstration project that would enable systematic evaluation of wood fuel performance and overall cost benefits of the system.

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