NORTH SEA –
SUSTAINABLE ENERGY PLANNING

SAC CONSULTING
WOODFUEL PROCESSING CENTRE AT HAZLEHEAD PARK OUTLINE FEASIBILITY STUDY

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Outline Feasibility Study

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on behalf of SAC Consulting

Contents

1 Background

Aberdeen City Council (ACC hereafter) have accurately identified the many drivers for entering into the production of fuel from their woodland and street tree resources, and have commissioned SAC Consulting to examine the technical and business case in detail. Although mainly positive, the drivers for the project can be broadly classed as *'carrots'* and *'sticks'*, and are summarised below:

Carrots

- Desire to create new, better-paying, markets for low grade timber;
- Desire to inject confidence into the sector locally, creating the right conditions for market growth and the installation of boiler systems;
- Desire to create long term employment opportunities in woodland and tree management and fuel production;
- Desire to create long-term incomes from Renewable Heat Incentive payments across the Council property portfolio;
- Opportunity to upgrade thermal performance of housing stock and other Council buildings to reduce environmental impact and reduce the instance of fuel poverty or running costs;
- Displace fossil fuels from the city, contributing to sustainable development objectives and providing leadership in the transition to a low carbon economy.

Sticks (i.e. negative, generally legislative/compliance drivers)

- Find alternatives to fossil fuel for space heating in properties, reducing cost of heating and making properties more attractive to let;
- Respond to imminent restrictions on landfilling wood waste.

The decision was made to investigate the opportunity of modifying the largely redundant nursery site at Hazelhead Park to become a fuel processing and distribution depot in more detail. This report covers the various technical and economic aspects associated with the creation of a woodfuel processing and supply hub to serve the city and its immediate hinterland. The report examines both internal and external markets, and the supply of logs and chips to end users.

2 The Product Mix

Every wood fired boiler has a fuel specification that reflects how that plant is designed and built. For example, some power plants are designed to combust contaminated wood fuel or use pulverised pellets to create wood dust, and some small heating boilers must have very dry chips of even particle size. In practice, these variations in specification coalesce around 3 basic commodities:

- Conditioned wood chips for the heat market;
- Low grade wood chips for the power market;
- Pellets for the heat and power market.

Each commodity is described below:

2.1 Conditioned wood chips for the heat market

Wood chips supplied to the heat market need to be made from clean wood, chipped to small and regular particle sizes and dried to a specified consistent moisture content typically denoted as M.C. or MC. Often they must be delivered in specialist vehicles to purpose made hoppers and silos in relatively small volumes. The wood chips must always meet this standard to match the design parameters of the boilers, and any problems in the specification of the wood chips quickly affects the performance - either in the fuel recovery/feed system, or the combustion chamber. This generally means recycled wood cannot be used, and that round logs must be stored and air-dried for 12 to 18 months before chipping, although the exact length of time varies with the diameter of the material.

One aspect of this market is that wood chips under 35% moisture content can sometimes be difficult to achieve without mechanical drying, and so suppliers must choose if they intend to invest in mechanical drying equipment to meet the requirements of the sub 35% MC market.

Figure 1 - Conditioned Woodchip for Heat Market

(Image Taken : Kielder District Heating Scheme, 2005)

2.2 Low grade wood chips for the power market

Wood chips supplied to the power market can come from a variety of wood sources, including recycled or contaminated wood. They can vary in moisture content up to 55%. They can vary in particle size, and even quite large chunks of wood will be handled in a large power station. A high content of brash and branches could be included, and a portion of contamination is usually also acceptable. Deliveries are generally made in large articulated lorries with walking floors. Recovered wood can be used in this market, although standard specifications are still in the process of being agreed.

Figure 2 - Low Grade Wood Chips for Power Market

(Image Taken : SembCorp Power Station, 2012)

2.3 Pellets for the heat and power market

Wood pellets are generally made at the large scale, with plants typically producing in excess of 10,000 tonnes per annum by extruding fine sawdust through a die under high pressure to produce pellets. To manufacture pellets successfully, the raw sawdust has to have the correct particle size distribution, usually 3-5mm. This is achieved by passing the raw material through a hammer mill and continually recycling the larger fractions. Pellets can be manufactured from a range of materials, including:

- Virgin sawdust or from processing untreated timber;
- Whole tree chippings, including bark;

- Recycled wood;
- Other biomass material, including straw, coppiced wood, and recycled timber.

Generally however, most pellets are manufactured direct from sawdust arising as a by-product of sawmilling. Pellets are under 10% moisture content, and so contain more energy per tonne than wood chips. Despite this obvious advantage, in comparison to wood chips they are more expensive to produce and therefore more costly to purchase in terms of delivered energy cost.

In the UK, a large co-firing market has grown up, where pellets are mixed with coal and combusted in existing thermal power stations, which has triggered investment by a number of pellet manufacturers, including Verdo Renewables (Grangemouth and Andover), Balcas (Invergordon), Duffield (N. Yorkshire), Land Energy (Girvan), Puffin Pellets (Insch) and Arbuthnott Wood Pellets (Laurencekirk). The RHI is beginning to stimulate the market for wood pellets, and there is definitely an emerging opportunity for retailing bagged pellets to local customers, although the cost of market entry for bulk deliveries means there is a limited opportunity at this scale. Puffin Pellets, Arbuthnott Wood Pellets, Balcas and the Scot Heating Company are active in Aberdeenshire, with the Scot Heating Company generally delivering Verdo-produced pellets in their own branded delivery vehicles.

Figure 3 - Wood Pellets for Heat and Power Markets

(Image Taken: Clifford Jones Timber/Blazers, 2010)

There are a number of different specification standards for these three generic commodities. Those affecting the heating sector are listed in the next section. For both suppliers and buyers, any of these standards are likely to be commercially acceptable. The key point is that wood fuel supplied must meet the specific needs of the wood fuel boiler in which it will be will combusted.

For ACC, given the off-gas nature of many of the surrounding settlements and the presence of a number of off-gas Council properties, the market for seasoned firewood and fuel-grade woodchip is very considerable, and has the potential to far outstrip the entire output of the Council resource. To unlock this market and maximises incomes, ACC should focus on the production of high quality firewood and chip that meets the requirements of sub-199kW boilers, where there will be huge market growth as a result of the Renewable Heat Incentive.

3 Woodfuel Production

As a Council, ACC have responsibility for a far wider range of woodland than a traditional estate or other forestry owner, as street trees, small clusters of urban trees and ornamental trees in parks and gardens are also a feature of the Council resource. This creates both opportunities and challenges in management and processing, with the key characteristics summarised below:

Opportunities

- Wood available as a by-product of tree management at zero production cost (i.e. management is a requirement regardless of any potential end market);
- Material available close to potential market;
- Putting wood into a market removes disposal cost;
- Putting wood into a market contributes to meeting waste management targets.

Challenges

- Much wood currently chipped where it arises using inappropriate equipment;
- Scattered resource, meaning logistics are challenging;
- Wide range of diameters – from branchwood to 100+ year old hardwoods;
- Wood is wet (>50%) and can be rotten or have contaminants (e.g. metal, stones, etc…);
- Supply of material is seasonal - trees are managed for risk avoidance and amenity.

In the face of the above challenges and opportunities, ACC currently manage the timber resource on an *ad hoc* basis, but are already achieving more than the majority of other Council's in the UK, most of who do not achieve any return for their timber. The current approach involves taking the larger pieces of timber to a patch of unused ground adjacent to the Hazelhead Nursery site where they are stacked in lots and sold on, generally to local firewood merchants who are interested in the hardwood timber that the Council make available. This approach requires little, if any processing by Council staff, and provides a small return for the timber arisings.

Figure 4 - Timber Lots Stacked for Sale at Hazelhead Park

(Image Taken : Hazelhead Park, 2012)

The first step in any fuel production process is drying, which in the case of roundwood is best accomplished by air drying in the round. Wood is a hygroscopic material with two different types of porosity:

- *macroporosity*, which is created by the cavities of conductive vessels and parenchymal cells, and which contain *free water*; and;

- the *microporosity* of the actual wood, which contains a certain amount of *bound water*.

Wood begins to lose water from the moment it is cut down, with the free water the first to go from the outer layers of sapwood, and then from the heartwood. When fully seasoned, all the free water in the wood evaporates, and the bound water reaches a balance with the moisture in the external environment, typically reaching a moisture content of less than 20%. However, water is not lost from wood uniformly, and larger diameter timber in particular (>50cm diameter) will only dry effectively when split into smaller diameters.

For this reason, given the substantial volumes of large-diameter material available to the Council from its amenity trees, we recommend the purchase of a screw splitter as a key piece of processing equipment. Using the screw to quarter the larger limbs and sections, or reduce even further, will open up the timber and increase the surface area from which water can be evaporated. A screw, such as the type produced by Lasco would enable the Council to reduce the diameter of the large diameter material prior to seasoning and processing.

Figure 5 - Large Diameter (c. 850mm) Timber at Hazlehead Park

(Image Taken : Hazlehead Nursery, 2012)

The Lasco screw splitter is a robust, hydraulic-powered rotating cone which screws into the timber, ideally side-on, rapidly splitting it. They are available in a number of configurations, including as an extendable 'foot', mounted on a forwarding trailer, or as a stand-alone unit mounted on the three point linkage of a tractor. Both options are shown below.

Figure 6 - Trailer and 3 Point Linkage-Mounted Lasco Screw

(Images from internet)

We feel that whilst both configurations would be suitable for operations at Hazelhead, the 3 point linkage-mounted version would be the most versatile, as it would be able to split sections of timber that could not be lifted by a small tractor-mounted crane. Once split with the screw, the timber sections can then be lifted and either stacked for seasoning or loaded into a trailer using the crane and screw. It is not necessary to have a second crane on site, as the screw is simply inserted into the timber a small amount, and once 'locked' can be used to lift the split wood to the desired location before being reversed out.

The Hazlehead Nursery site provides a wide, accessible, well-drained space for drying large volumes of wood in the round, in a relatively open and windy position. Given the characteristics of the site and the local climate in Aberdeen, which is relatively dry, the following drying rates can be expected for timber to reach 20-30%, which is the optimum moisture level for most chip boilers.

Material	Drying Rate to 20-30% Moisture Content
Softwood ø <20cm	9-12 months
Softwood ø >20cm	12-18 months
Hardwood ø <20cm	12-24 months (species dependent)
Hardwood ø >20cm	24 months + (species dependent)

Hardwood and softwood dry at very different rates - hardwood can take more than twice as long to dry as softwood. We recommend that the stacks of softwood and hardwood are kept separate and records are maintained of the date stacks are established and their moisture contents. This will ensure that the wood in any one stack is of similar moisture content - helping ensure smooth running of the supply operation and conform with good practice required for woodfuel quality assurance schemes (which are covered later).

In all cases, the wood should be stacked on transversal bearers with the ends of the logs facing into the prevailing wind. This will ensure the fastest possible rate of drying. It will not be necessary to cover the stacks to achieve reasonable moisture contents, but it may be something that the Council wish to consider to accelerate the drying process. Good practice in woodfuel drying is shown below - the small diameter timber is destined for the 300kW chip boiler which heats the school, Youth Hostel, 6 houses, workshops and Forestry Commission visitor centre in Kielder, Northumberland.

Figure 7 - Timber Stacked and Drying on Bearers

(Image Taken : Kielder Forest, Northumberland, 2011)

There are a wide range of conversion technologies available for turning wood into fuel which is suitable for woodfuel boilers. The technologies have a range of characteristics which influence their price, size, appropriate feedstocks, the quality of fuel they are capable of producing, the speed of throughput and their overall complexity.

Chippers come in a range of shapes and sizes, from lightweight and compact disc chippers which can be mounted on the back of a Unimog or tractor or towed behind a pick-up, through to heavier-weight towed or trailer-mounted versions and, at the upper end, tub grinders and shredders which are transported to site using a low loader or are built around their own multi-axle trailer. Prices range from a few thousand pounds for a disc chipper, to a few hundred thousand pounds for a shredder or tub grinder.

3.1 Disc Chippers

When most people think of woodchips, they have in mind the kind of material produced by the brushwood chippers which are common in arboriculture operations. These chippers are highly efficient and well-engineered machines, designed to turn large volumes of wood into small volumes of wood for effective disposal either off site or at the point of origin. However, at all but the largest scale, the product from this type of chipper is generally unsuitable for use in chip boilers without further screening. That said, with the right chipper and an investment of time in trials, it is possible to get reasonably consistent fuel, albeit at the larger end of the classification scale, from a disc chipper.

In a disc chipper, logs are introduced to blades which are mounted on a heavy spinning disc. Under optimum operating conditions, disc chippers are capable of producing a regular chip, as the knives strike the wood at the same angle repeatedly, although some oversized material is inevitable. Chip size can be influenced in a disc chipper to some degree by varying the speed of the infeed rollers, increasing the number of knives, changing the angle at which the knives are mounted and changing the speed of the disc itself. This is very much a trial and error process however, and two chippers rarely deliver the same results.

In operation, disc chippers are more sensitive to wear as material is thrown to the outside of the spinning disc to be cut, causing uneven wear on the outside of the blade. Log ends also have a habit of ‘standing up’ against the disc, resulting in long transverse slivers during chipping. Chips are ejected from the chipper by the airflow created by paddles mounted on the rear of the disc. On some models, serrations on these paddles can serve as sliver and twig breakers, although they are never 100% effective.

To get the best from a disc chipper, it will need to be a larger capacity machine (12”+ infeed), have sharp knives, and have longer lengths of delimbed roundwood as its feedstock. With this combination of factors, a P64 chip, suitable for larger boilers, is a realistically achievable goal.

3.2 Drum Chippers

The second main type of wood chipper is a drum chipper, although in UK these are outnumbered probably 50:1 by disc chippers. Drum chippers differ considerably from disc chippers, with the knives mounted on a spinning drum and a screen often built in to provide a consistent chip. Drum chippers are less sensitive to wear than disc chippers, but do typically have a higher power requirement. It is the inclusion of a screen which has crowned it the chipper of choice for fuel production in the huge woodfuel markets of continental Europe, where wood accounts for over 50% of total renewable energy use.

Virtually all of the dozen brands of fuel chipper in use on the continent operate on the same principle, with the log introduced to a series of offset blades mounted on a steel drum. As these blades strike the log, uneven chips are produced, but are unable to exit the chipper until they are small enough to pass through the screen. Trapped in the space between the drum and the housing, the irregular chips are repeatedly struck by the multiple blades, sometimes against an anvil on the back of the housing, until they are small enough to exit via the screen. Where the chippers are well maintained and the blades sharp, the resulting product is virtually free of oversize chips and is remarkably homogenous.

Figure 7 - Heizohack Chipper Showing Blades and 'Drum'

(Image Taken : Woodfuel Quality Training Course, Northumberland 2007)

Drum chippers which are purpose-built for fuel production typically have an interchangeable screen, allowing the operator to select the grade of woodfuel required. Models including Heizohack and Mus Max share similar characteristics, and both of whom manufacture chippers at scales suitable for users ranging from farm foresters to pulp mills.

Drum chippers which are not specifically configured for fuel grade chip production are available from Bandit, Morbark, Vermeer and others, and although not purpose-built for fuel, can tackle large material, making them very productive. They are also easier on expensive cutter bearings and typically perform better while chipping branchwood.

In some instances, where fuel is being produced in the forest or a depot, drum chippers can be mounted on the back of a flatbed truck or even a forwarder, creating a highly productive and mobile chip production unit.

3.3 Screw Chipper

The final type of wood chipper, and one which operates on a completely different principle to the disc and drum chippers, is the screw or cone chipper, manufactured by Laimet of Finland. Technically, the Laimet is not strictly a wood "chipper", as it slices wood via its sharpened screw blade, rather than striking and chopping, even though the results are relatively similar.

In this type of chipper, the screw acts as both the infeed system (disc and drum chippers rely on belts and/or rollers) and the chipping mechanism. As the screw spins, the logs are draw in, and once engaged are dragged into the chipper and sliced into pieces against the outer casing.

Screw chippers require a higher-powered tractor to drive the screw or have their own in-built diesel engine, but are typically more energy efficient than a disc or drum, and can achieve higher throughputs. The screw can be sharpened in-situ, and is slower wearing thanks to its slicing rather than striking action. Chip size can be varied by changing the screw type, and varying the speed. Whilst screw chippers produce very consistent chip from roundwood, their performance on branchwood and similar feedstocks is poor, with lots of oversize chip. This is fine in a fuel handling system which is built to take this type of chip, but where small, consistent woodchip is required, then this combination of feedstock and chipper is not appropriate.

3.4 Shredders

Shredders can be found in across the UK, typically in applications where land clearance is the number one driver, or where a very large biomass boiler is the end customer. Shredders feature either a top or conveyor loading system, into which the raw biomass is loaded by excavators or a built-in boom crane. Once into the fuel reception system, the raw material is fed towards the processing point, which can employ a range of particle reduction technologies depending on the manufacturer.

Shredders are designed to process large volumes of problem feedstocks, particularly forest residues and materials from land clearance, and rely on lower-speeds than chippers. The actual processing technology may be a hammer mill, where a number of steel 'hammers' are mounted on a rotating drum, smashing the wood to pieces against an anvil; a toothed drum, where solid steel teeth cut and shear through the product; or a series of low-speed toothed rotors which grind the product down. Most shredders also incorporate a screen which is interchangeable to give products at a range of sizes, although the hammering and shredding nature of some processes can result in inconsistent fuel, with a high proportion of long pieces which can choke augers. Figure 8 shows shredded material at Hazlehead Park, which contrasts markedly with the material shown in Figure 9, which has been chipped.

Figure 8 - Shredded Wood at Hazlehead Park

(Image Taken : Hazlehead Park 2012)

Figure 9 - Chipped Wood at Hazlehead Park

(Image Taken : Hazlehead Park 2012)

The extremely robust construction and comparatively low speed of shredders means they are capable of processing a wide range of rough feedstocks, including forest residues, tree stumps, and post-consumer waste wood contaminated with tramp metal. Depending on the model and feedstock, shredders employ a range of technologies to remove contaminants, including overbelt magnets fitted to wide outload conveyors, built-in trommel screens and fans to remove fines.

Because of their size, shredders are typically built on or as a semi-trailer, or are tracked, and have a built-in diesel engine of anything up to 1,200 horsepower. This size means that shredders are extremely expensive, with even a well-used second-hand unit costing upwards of £150,000. For larger shredders, an annual production of 50,000 tonnes or more would be required to make investment in a shredders economic. The cost factor, and their inability to produce high quality fuel without further screening, means that shredders are unlikely to play much of a role in supplying fuel to boilers of less than 1MW.

3.5 Tub Grinder

Tub grinders share many features and characteristics with shredders, particularly their size, but are more primitive in design. Originally developed for reducing demolition waste prior to transport and disposal, tub grinders are notorious for hurling debris considerable distances from the tub. Essentially a large open grinder in the base of a metal tub, the system relies on the weight of the material in the tub to control the speed of throughput, meaning that heavier material, such as tree stumps and sections of trunk, are more rapidly processed than light material such as roundwood, branches or waste timber. Only by packing the material into the tub, or fitting some sort of cover can the incidence of ejected debris be reduced. The inclusion of a cover reduces throughput and increases the complexity and cost of a tub grinder.

Figure 10 - Vermeer Tub Grinder

(Image from Vermeer product brochure showing TG5000)

Tub grinders are typically used for first-pass grinding of problematic raw materials rather than creating a finished product, although fuel from a tub grinder would likely be suitable for a very large scale boiler, such as that found in a pulp mill, power station or similar application. There are several tub grinder manufacturers, including Diamond Z, Vermeer and Morbark.

3.6 Processing Technology Selection

Undoubtedly, having the right means of processing wood and knowing how to get the best from it will be critical to the success of supplying a wood fired boiler installation, and to the profitability of the fuel processing enterprise. Cold customers are not generally happy customers, but experience shows that warm, satisfied customers will often be the best catalyst for the installation of further woodfuel systems.

All the equipment listed above is capable of producing a fuel product, although drum chippers have clear advantages over the majority of disc chippers when it comes to particle size consistency and ease of operation. The size and cost of shredders and tub grinders means that only large boilers, such as the one installed at Aberdeen Royal Infirmary, will represent a viable market for this equipment, and given the capital costs and potential output of this equipment, there would need to be several boilers at this scale to justify such an investment.

Realistically, a mid-range drum chipper would be the best entry-level machine to purchase for use at Hazlehead. The costs section of the report is based on this option being pursued.

4 Woodfuel Quality

The issue of woodfuel quality standards is an important and evolving issue in the woodfuel industry, with recently published EU-wide standards now starting to underpin the supply chain at a local and national level. The importance of setting and meeting the quality standards specified cannot be overstated, particularly where external (i.e. non-Council) customers are being supplied, as not only will fuel which is outside the required specification lead to problems with the operation of the boiler (e.g. auger jams, elevated visible emissions, etc…), it may also invalidate any warranty - out-of-spec fuel has, in the recent past, been used as an 'excuse' for not honouring warranties on boiler equipment. A paper trail which demonstrates conformity with the required standard is a useful tool for customer and fuel supplier alike, and can go a long way to removing the finger pointing that can occur when boilers do not perform as required, as evidenced recently at the Duthie Park installation in Aberdeen.

Standards are only part of the picture however, and the fuel quality chain starts with *specifications*. Specifications are set by anyone, usually the customer, and set out what it is they would like to buy, something which is usually determined by the type of boiler and/or fuel reception and transfer system.

The specifications are mainly physical properties, but can include variables such as sustainability criteria and geographic origin. Moisture content, particle size and ash are the most commonly given specifications.

Next are the *standards*. Standards include specifications (a range, rather than a single specification) and also methods of testing that the fuel meets these. These are set by a recognised body, such as BSI or CEN. The UK has recently adopted the CEN standard for biomass, and this is overseen in the UK by BSI

CEN/TC 335 is a recently-developed EU-wide standard to describe all forms of solid biofuels, including wood chips, wood pellets, briquettes, logs, sawdust and straw bales. CEN/TC 335 allows all relevant properties of the fuel to be described, and includes both *normative* information that must be provided about the fuel, and *informative* information that can be included but is not necessarily required.

As well as the physical and chemical characteristics of the fuel, CEN/TC 335 also provides information on the source of the material. The fuel specifications and classes for all solid biofuels are set out in CEN/TS 14961:2005, which defines certain parameters and property classes. For example, the normative specifications for wood chips include:

- Origin;
- Particle size (P16/P45/P63/P100);
- Moisture content (M20/M30/M40/M55/M65);
- Ash content (A0.7/A1.5/A3.0/A6.0/A10.0);
- Nitrogen (N0.5/N1.0/N3.0/N3.0+);
- Net energy content (lower heating value (LHV)) as MJ/kg or kWh/m^3 loose;
- Bulk density in kg/m^3 loose;
- Chlorine content (Cl0.03/Cl0.07/Cl0.10/Cl0.10+);
- Nitrogen (N0.5/N1.0/N3.0/N3.0+).

Many other properties may also be specified, including concentrations of other elements and volatile matter and ash melting behaviour. Different specifications are required for different fuels, and for pellets and briquettes these include mechanical durability and particle density.

The next link in the chain is *quality assurance*, which is a method which a supplier will use to ensure and document that all standards are met. Quality assurance is a relatively simple process, but is surprisingly rarely adhered to. The steps are summarised below:

1. Document the processes in the supply chain;
2. Define the specifications for the fuels using recognised standards (e.g. CEN 335);
3. Analyse the factors influencing fuel quality and production performance;
4. Identify and document *Critical Control Points* that could impact on compliance with the fuel specification (example below);
5. Select appropriate measures that give confidence to customers that the specifications are being met;
6. Establish and document routines for the separate handling of non-conforming materials and fuels.

A typical supply chain for chip production in Aberdeen City might look as follows:

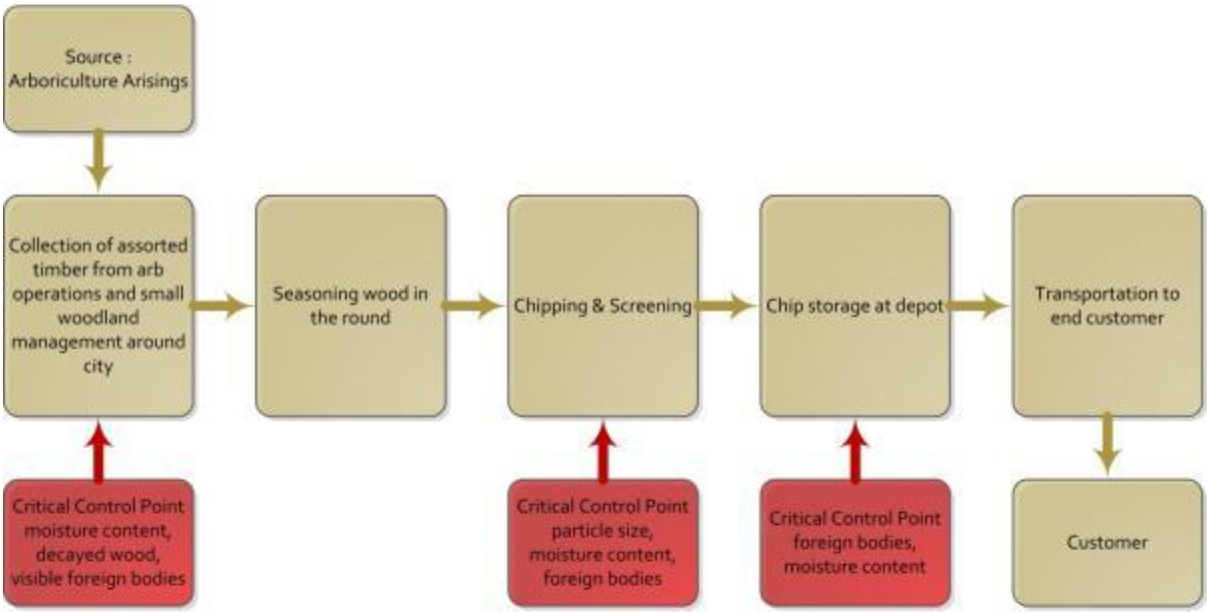


Figure 11 - Typical Supply Chain Showing Critical Control Points

The adoption of quality standards for the production of logs for sale is firewood is just as important, particularly given that word of mouth marketing will play a key role in growing the business. It would be worth considering, therefore, the adoption of one or more of the quality assurance schemes currently available, HETAS "Quality Assured Fuel" and Woodsure.

HETAS is the official body recognised by the UK Government to approve solid fuel domestic heating appliances, fuels and services. Its work includes approving products covers boilers, cookers, open fires, stoves and room heaters. As part of this role, HETAS have launched a quality assurance scheme for woodfuel suppliers, with a logo that acts as a stamp to reassure customers, being similar to the logo used for the certification of appliance installers. The cost of the HETAS scheme is £350-400 for the first year, and then £200-250 for annual renewal.

Figure 12 - HETAS Fuel and Installer Certification Logos

A competing scheme, operated by the not-for-profit body Westwoods, is the Woodsure scheme. Woodsure differ from HETAS in that they provide support for free to get producers to the point where they are ready to undergo accreditation, and have the option of not including sustainability criteria in the assessment, thereby lowering the paperwork requirement. The scheme covers much of the same ground as the HETAS scheme, and is free to join until 2013, after which fees will be chargeable. Woodsure also has the advantage of coming from the forestry sector rather than the installation end of the supply chain, and of the two schemes is probably the more user friendly. Woodsure also has a logo which can be used by accredited suppliers, but is less recognisable than the HETAS equivalent.

woodsure
assured quality woodfuel

Figure 13 - Woodsure Logo

5 Woodfuel Delivery

There are a range of options for the storage of woodfuel, each of which has a different impact on the mode of delivery of the fuel to the store. Stores can either be above ground, below ground or involve the use of removable hook bins.

Above ground fuel stores typically result when the boiler customer is constrained in some way, and cannot accommodate a below-ground store. These constraints can be financial (digging a hole in the ground is very expensive), physical (a high water table or bedrock can pose serious problems), or can simply result from their being insufficient room for the construction of an appropriately sized subterranean store.

Above ground stores can be created by converting existing buildings, as shown in Figure 14 - a modified coal store at a school, be part of a stand-alone energy centre, as shown in Figure 15 - a packaged boiler and store prefabricated unit, or as a stand-alone silo, as shown in Figure 16. Whilst usually the lowest capital cost option, above ground stores cause particular problems for fuel delivery, and a range of technical solutions have been developed in recent years. Most solutions still result in additional costs for the supplier (and consequently the customer), as the length of time taken to deliver chip using the technology available is considerably longer than a straightforward tip. This will not be such an issue for ACC on self-supply deliveries, but will have an impact when supplying to third parties, pushing up the delivered cost of the fuel and impacting on project viability.

One of the most common solutions is to use a chip blower which is kept *in situ* by the fuel store. Chip blowers consist of a trough with an auger mounted in the base which feeds chip into a spinning paddle, which in turn propels the chip up a steel pipe and into the fuel store. Blowers typically have a throughput of 20-30m^3 per hour, meaning they are not well suited to large or frequent deliveries, as higher costs will result from the time spent waiting by the truck. Blowers are not compatible with fuel over P45 specification.

The noise and dust associated with blowers is another characteristic which needs careful consideration, as significant disturbance can result when they are in operation, and they are not well suited to the vast majority of urban sites. Additionally, even with the most careful delivery driver at the wheel, they are prone to 'swamping' when large amounts of woodchip dislodge from the trailer. A brush and shovel are useful accessories.

Figure 14 - Mus Max Chip Blower

(Images Taken : Dunstan High School, NZ, 2009)

Where a store has access from the top, a lifting tipping trailer may be a good option. The cost of such trailers, around £36,000 for a 30m^3 model, compared to £15,000 for a standard grain trailer could be prohibitive unless there were a number of customers that required this form of delivery. Lifting tipping trailers are considerably faster to unload than blowers, but the driver does need to ensure that there is sufficient room in the store (which may be difficult to access) to receive the full load. The consequences of attempting delivery to a store which does not have sufficient room for the full load can take some time and effort to rectify. The Farquhar-Barker trailer, manufactured by Triffitt Trailers and shown in Figure 15, features a hydraulically-powered conveyor in the base of the trailer to discharge chip once the trailer has elevated.

Figure 15 - Triffitt High Lift Scissor Trailer

(Image Courtesy of Paul Barker, Bristol City Council)

In some instances, it may be desirable to use an elevating auger as a means of filling above ground fuel stores, such as the example in Figure 9 below, which is a twin-stacked container system incorporating an auger and chip spreader. These systems get round many of the problems associated with chip blowers, and can achieve significantly higher throughput - up to 50m^3/hour - with much lower dust and noise levels. As the units incorporate augers, there is always a danger that these could be jammed by oversize chip, and where the elevating auger is positioned inside a fuel store, this could pose serious problems should a blockage occur - this should be an issue which is considered when putting in place a fuel supply contract.

In Figure 16, the red disc at the top of the elevating auger is a ‘chip flicker’, which rotates at high speed to spread the chip throughout the fuel store in a predetermined arc. Configured correctly, these units can give exceptionally good capacity in an above ground store. Because of the auger issue, these units are only really suitable for small grade chip - P45 or smaller.

Figure 16 - Elevating Auger Showing Trough and 'Flicker' Head

(Images Taken : Thames Centennial Pool, NZ, 2010)

Some fuel suppliers have invested in blower vehicles for woodchip, although these are relatively rare because of the capital cost involved. Blowers can either come integrated as part of a truck body, or be integrated into a tipping agricultural trailer - the type chosen will depend on the local market and the distance from the proposed depot at Hazlehead. Vehicle/trailer mounted blowers suffer from some of the same issues as the trough blowers covered earlier - noise, dust and the time taken for deliveries - but as the blower is integrated within the trailer body, the issues of stray chip and swamping are avoided. As with other forms of blowers, P45 is about the maximum size of woodchip that can effectively be handled.

To modify a grain trailer to blow woodchip costs between £18,000 and £25,000, and requires a tractor of around 100hp to power the blower unit.

Figure 17 - Blown Delivery from Modified Grain Trailer

(Image Taken: Aske Estate, 2008)

Mobile hook-lift bins are an elegant solution for many sites where there is space above ground but where other constraints have prevented a below-ground store from being constructed, and are particularly well suited to urban areas. Based on standard hook-lift containers, these mobile bins effectively act as cassettes of fuel which can be removed and swapped for full ones as they empty. Taking only slightly longer than tipped deliveries, hook bins are typically delivered to the following pattern:

- In-service bin empties;
- Fuel supplier arrives with full replacement bin and sets this down on hardstanding;
- Fuel supplier unhooks hydraulics from empty bin, and removes this to hardstanding;
- Fuel supplier picks up full bin and sets this on the reception plinth, hooking up hydraulics;
- Fuel supplier picks up empty bin and returns with this to the depot.

Deliveries of single bins typically takes between 5 and 10 minutes for a competent operator, and clearly sufficient space must be available for shuffling between the bins on changeover. The bins themselves feature a hydraulically powered walking floor which discharges the chip from one end of the unit and into a waiting conveyor. In most instances, the bins 'belong' to the boiler, that is the client owns the bins and they are moved around and refilled by the fuel supplier. 2 bins are more commonly used than a single bin, as the 2 units side by side provide an element of supply security. Some high-consumption sites may have 3 bins connected in parallel to one or two recovery augers.

In operation, hook bins have a range of benefits - they enable a quick turnaround; they are sealed units, greatly reducing the chances of dust and loose chip escaping; they push some of the capital cost of delivery equipment onto the customer; and in more developed markets, they could form the basis of a very sophisticated supply chain. Hook bin designs are still evolving however, as the industry learns how best to use them. There have been some instances where poor bin design has resulted in chip 'bridging' the walking floor, resulting the boiler running out of fuel. Extreme cold conditions have also had the same impact on wet-chip boilers fed from hook bins, as the uninsulated steel bins have effectively allowed the chip to freeze together in a solid block which the walking floor cannot recover to the boiler.

For any supplier working with hook bins, an additional bin with a barn door rear to allow straightforward tipped delivery to other customers is a wise investment.

Figure 18 - Hook bins at boiler and in depot
(Images Taken : Swansea Leisure Centre, 2010 and No 1 Woodfuels, Consett, 2011)

From both a supplier and customer perspective, below ground fuel stores are the most desirable option in almost all circumstances. Assuming they are designed correctly and are accessible, below ground stores offer delivery drivers the opportunity to simply reverse up to a hatch in the ground, tip or push out their load, and then move off. Tipped deliveries are typically swift, clean and trouble free, although issues can arise when there is insufficient room in the store to accommodate the volume of chip being delivered, or when stores are poorly designed, e.g. when the planned-for volume of fuel cannot be accommodated in the fuel store.

Because tipped delivery is so straightforward, there are a wide range of vehicles at a range of sizes that are suitable for a business to invest in, and the Council already has a substantial fleet of suitable vehicles. For supplying a large system, perhaps in a hospital or college, a walking floor trailer such as the one shown in Fig. 19 could be an option. With a capacity of up to $130m^3$, a walking floor trailer is slower than a straightforward tip, but can make up for the added time on site by delivering a very large quantity of fuel. There are also less issues than with tipping in terms of height restrictions, as in some cases, tipper bodies can make contact with the top of fuel store doors or with roofs, causing damage to structures and vehicles, with the attendant costs this would incur. A trailer of this design would cost around £40,000 to £45,000 new, with few second hand examples on the market.

Figure 19 - Walking Floor Delivery
(Image Taken : Crichton Hospital, Dumfries, 2009)

Almost any tipping vehicle can be put to use delivering chip, from an $80m^3$ bulk tipper to a tipping Transit van or a grain trailer, and obviously each has its own operational benefits and constraints. Thankfully there is a large second hand market for tipping vehicles of all types, with tipping vans available for as little as £4,500, 10 year old 6 x 4 tippers from £5,000 and 4 x 2 tippers from a similar price. Clearly, the price will depend on the mileage, condition and model, but there is plenty of choice in the marketplace.

Figure 20 - Tipped Delivery
(Images Taken : Dunstan High School, NZ 2009 and Barnsley MBC Offices, 2007)

The other factors that affect the costs of chip are haulage volumes and distances from the source of the chip to the customer. Typically, once chip is on a vehicle there is not a great deal of variation in the haulage cost as mileage increases, although costs vary over time, and are significantly affected by the current price of diesel. During May 2011, when the pump price of diesel averaged around £1.40 per litre, the following haulage costs were established for bulk deliveries of woodchips. These should be viewed as indicative figures only, as they will change almost constantly and could be negotiated over time. Given the impact of transport on the delivered cost of fuel, there are clear benefits to the Council in developing the local market.

- 130m^3 walking floor delivery
- For 25 miles £8.50 per tonne
- For 50 miles £8.50 per tonne
- For 100 miles £13.50 per tonne

- 70m^3 bulk tipper delivery
- For 25 miles, £7 per tonne
- For 50 miles, £7 per tonne
- For 100 miles, £10.50 per tonne

The figures assume loading within an hour and unloading within an hour. It is worth noting that in a bulk tipper, woodchip will not reach the weight limit of the vehicle, and a haulier is likely to charge the 'cap load' of 28 tonnes as opposed to the actual weight of the load, which in a 70m^3 bulk tipper is likely to be around 20 tonnes (working on 3.5m^3 of chip to the tonne). This would increase the effective cost per tonne in a bulk tipper to £11.60 per tonne for up to

50 miles in a bulk tipper, and is done to avoid the haulier losing out on transporting lower bulk density goods. Whilst this is the accepted norm in the haulage industry, there is generally some room for negotiation.

The woodchip supply sector in the Aberdeen is insufficiently developed to be able to produce reliable metrics for haulage costs at the micro-scale, i.e. from local sawmills and depots to small scale customers, with early participants in the industry quoting a very mixed range of haulage/delivery costs either by the hour, by the cubic meter, by the load (which is usually unspecified) and occasionally by the tonne. There is also a strong element of charging what the supplier feels the customer can bear in the local market, which adds further uncertainty and distortion. Nor is there any consistency across vehicle types, with some suppliers delivering in 7.5t lorries, while others use Transit tippers, grain trailers or their equivalent.

6 Capital Investment Required

The level of capital investment required at Hazlehead is entirely a function of the scale at which ACC wish to enter the biomass market, and with what products. We have modelled 2 scales of entry :

1. Self-supply of just 1,000 tonnes of woodchip at 30% to an ‘internal’ Council market and 300 tonnes of split mixed species firewood to firewood merchants and re-sellers on a ‘delivery only’ basis using an existing tractor and trailer;

2. Supply of 5,000 tonnes of woodchip to internal and external markets and 1,000 tonnes of mixed species firewood to external markets on a delivery and ‘cash and carry’ basis.

To avoid unnecessary capital expenditure, and given the low volumes of chip required under Scenario 1, it would be more cost-effective to use a contract chipping service, such as that which can be provided by NEWfuel Ltd using their Heizohack chipper, for the production of fuel-grade woodchip. Given the low volume, little in the way of capital works would be required on the site at Hazlehead, with little more than upgrades to hardstanding and the provision of covered storage for fuels.

6.1 Scenario 1

Under Scenario 1 we estimate 362 x 6 tonne tractor & trailer loads of roundwood will be delivered into the depot (2,167 green tonnes) - and 167 loads of chip at 30% MC and 29 x 10 tonne loads of logs at 30% MC will be sent out, exclusively to wholesale markets, making a total of 558 vehicle movements per year (equivalent to 11 vehicle movements per week). It is considered highly unlikely that the Council will require any upgrading of the entrance to the site – current operations see significantly more movements than this in a normal day, with over a dozen deliveries observed to site during 2 hours spent there.

The costs associated with upgrading access been omitted from this option. Nor would the existing dilapidated buildings need to be removed - the aesthetics of the site will not be important with no public access - and existing buildings could be used as a site office with this volume of material through the depot. These costs have also been omitted.

Scenario 1 would therefore require investment in the following site upgrades and equipment:

Yard	
Concrete pad	£8,000
Chip Storage	
Concrete block and 'tent' chip store (see Figure 21)	£12,500
Lighting	£2,000
Contingency	£2,000

Figure 21 - Concrete 'Tent' Store
(Image Taken from www.eildonconcrete.com)

6.1.1 Equipment

Moisture meter (Exotec MC460)	£2,000
14" Firewood processor (e.g. Fuelwood Transaw 350XL)	£22,000
Large bucket for tractor	£7,000

NB : Tractor and trailers assumed already available from Council sources.

The total cost of building refurbishment and equipment purchase for a low-level entry into the woodfuel market is therefore likely to be in the region of £55,500. Of this sum, £31,000 is associated with the purchase of equipment, and £24,500 with the partial upgrading of the Hazlehead site.

In calculating the cost of production and delivery, the following assumptions have been made :

Cost of production of feedstock[1] £16/tonne

Feedstock required to produce 1,300 tonnes/fuel 2,168 tonnes

Total cost of production[1] £34,688

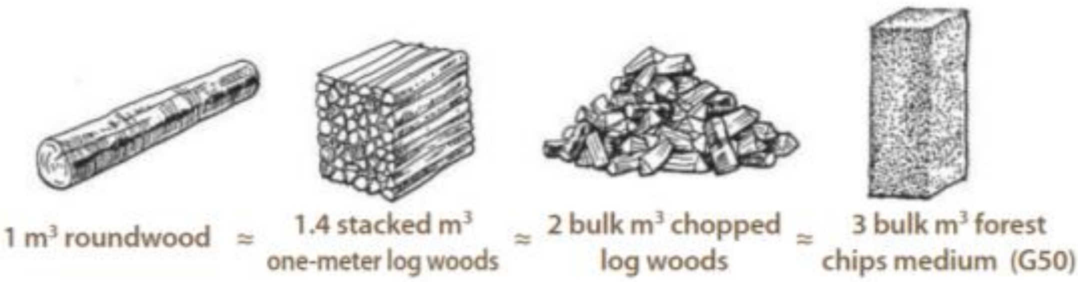
Average moisture content of timber in 50%

Average moisture content of fuel sold 30%

Weight per m^3 timber 1 tonne av. (oak 1.169t/m^3 / pine 0.86t/m^3)

Quantity of woodfuel sold 1,300 tonnes

Volume and weight conversions for roundwood and wood fuels :



Sale price per tonne £90

Cubic capacity of delivery vehicle (in) 21m^3 (e.g. flat trailer with bolsters)

Tonnage capacity of delivery vehicle (in) 6 tonnes

Cubic capacity of delivery vehicle (out) 21m^3 (e.g. tipping trailer)

Tonnage capacity of delivery vehicle (out) 10 tonnes firewood / 6 tonnes chip

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A cost of production of £16/tonne has been used, which is the standard cost for the production of roundwood from a moderately efficient forestry harvesting enterprise. In reality, the cost of production is likely to be considerably lower, as the majority of the material brought into the site arises as the product of tree and woodland management operations that are undertaken for amenity and health and safety reasons.

Average time per load delivery	1 hour
Average distance per return journey	12 miles
Fuel consumption	22 mpg
Fuel cost (white diesel)	£1.40 litre
Fuel cost (red diesel)	£0.74 litre
Labour cost per hour	£7.99 (Grade 4 Agricultural Minimum Wage)
Cost attributed to delivery vehicle upkeep	£300/yr (based on tractor & trailer)
Cost attributed to delivery vehicle repair	£500/yr (based on tractor & trailer)
Delivery vehicle insurance	£270/yr (based on tractor & trailer)
Transport fuel costs	£1,145/yr (based on £1.40/litre)
Contract hire chipper rate per day	£1,575 + VAT (incl. positioning costs)
Output per hour	20 tonnes (based on NEWfuel Heizohack)
Output in 7 hour working day	140 tonnes (based on NEWfuel Heizohack)
Hours required to chip 1,000 tonnes	50
Days required to chip 1,000 tonnes	8 (rounded up from 7.14)
Firewood processor output (Transaw 350XL)	5.5m^3 or 2.75 tonnes/hour

Output in 7 hour working day	19.25 tonnes
Hours required to process 300 tonnes	109
Days required to process 300 tonnes	16 (rounded up from 15.6)
Firewood tractor PTO operating hours	109
Firewood tractor fuel consumption	6 litres/hour
Fuel cost for firewood processor	£484 (based on £0.74/litre)
Firewood processor repair and upkeep	£300/yr
Labour for yard work / loading	100 hours
Cost of yard work / loading labour	£799 (based on £7.99/hour)
Yard telehandler/tractor operating hours	80 hours/year
Yardwork vehicle fuel consumption	8 litres/hour
Fuel cost for yard work	£474 (based on £0.74/litre)
Cost attributed to vehicle upkeep	£100/yr
Cost attributed to vehicle repair	£300/yr
Vehicle insurance	£130/yr

NB: No allowance made for depreciation & premises are assumed exempt from business rates.

Based on the cashflow produced using these assumptions (and supplied as an Excel file), Option 1 pays back in just under a year of operation, and thereafter could show a net profit of £4,000 - £6,000 per month, although in reality the business will be highly seasonal, as it is linked to the heating season. Exploring other markets, such as charcoal production (which requires chopped hardwoods), restaurants cooking with wood-fired ovens or tandoors, garden chimneas, etc… would provide income in the summer months, as would encouraging firewood merchants to purchase part-seasoned firewood during the spring, summer and autumn, ready for the winter.

6.2 Scenario 2

Under Scenario 2, with 5,000 tonnes of chip heading to internal markets and 1,000 tonnes of logs sold, we estimate 454 x 22 tonne trailer loads of roundwood would be delivered into the depot using timber wagons (10,000 green tonnes), and that 500 loads of chip at 30% MC (5,000 tonnes/15,000m^3) will be sent out to local markets in a 30m^3 trailer. Coupled with this, we have worked to the assumption that half of the logs produced will delivered as 30m^3 (15 tonne) bulk loads to wholesalers and large users (e.g. large suburban houses with log boilers) and that half will be sold in small "cash and carry" loads to the public from the depot. This equates to c. 34 vehicle movements of bulk loads of logs, and assuming a 1 tonne "cash and carry" load, 500 additional movements of private vehicles.

The total anticipated vehicle movements for this volume of sales and this product mix is therefore 1,488, and whilst this is just 4 per day, the highly seasonal nature of the market will create a 'bulge' in movements during the winter, particularly of product out.

Because of this volume of traffic movement, some of which already exists in the form of wood deliveries to site from tree removals, and the addition of a public cash and carry function, consideration should be given to incorporating log pick up/loading space as part of the planned recycling centre, which is designed around providing access for private vehicles. Opening the site to the public would require additional works, including the construction a site office, provision of a drained concrete yard area and parking bays. The benefits of cash and carry sales are that much of the labour costs are pushed onto the customer, as they load their own trailer from frames providing a measured volume of firewood. The estimated costs for a depot at this size are presented below :

Yard		
Concrete pad	£20,000	
Chip Storage		
Large concrete block and 'tent' chip store (see Figure 21)	£25,000	
Lighting	£4,000	
Site office	£10,000	
Yard and Parking		£20,000
Upgrade nursery site hardstanding for timber drying	£40,000	
Contingency	£4,000	
Total Site Works		£123,000

Figure 22 - Pick Your Own Firewood
(Image Taken : Garden Centre, Virginia USA, 2004)

An alternative to cash and carry firewood sales is the free trailer rental option pioneered by City Firewood in Christchurch, New Zealand. This minimises the amount of stacking and sorting by site staff, although increases the capital investment required at the outset, although this could be phased. Customers buying a 'trailer load' get free use of the trailer for 2 hours and are purchasing a measured volume of firewood. Benefits for the Council would principally accrue from the ease of handling and the staff time savings associated with this operational model, as well as the ability to move larger volumes of firewood to customers who do not possess a large trailer. Charges would be set to include the capital and depreciation costs associated with the trailer.

Figure 23 - Free Firewood Trailer Loading

(Image Taken : City Firewood, Christchurch NZ, 2009)

Increased throughput of material from a larger operation would also require further investment in processing equipment for the depot, in order to process larger diameter material for fuel, and to give more control over the fuel production process, rather than relying on contract chipping services. The additional equipment (over and above the £31,000 of expenditure listed under Scenario 1) would be as follows :

Lasco screw splitter (Model M3)	£8,800	
Firewood bagger (for "cash and carry" sales)	£1,000	
Cleansing drum (for removing bark and slivers)	£6,000	
Chipper (Heizohack 8-500 PTO driven)	£55,000	
Dedicated 30m^3 lifting trailer for delivery	£37,000	
Total Equipment		£107,800

NB : Tractor and telehandler assumed already available.

The total cost of building refurbishment and equipment purchase for a more meaningful entry into the woodfuel market is therefore likely to be in the region of £261,800.

The following additional/alternative assumptions have been made around costs/rates of production, etc… for the larger scale operation (where alternatives are not given, assume the original assumptions remain accurate) :

Feedstock required to produce 6,000 tonnes/fuel	10,000 tonnes
Total cost of production at £16/tonne	£160,000
Quantity of woodfuel sold	6,000 tonnes
Cubic capacity of delivery vehicle (in)	$22m^3$ (e.g. standard timber trailer)
Tonnage capacity of delivery vehicle (in)	22 tonnes
Cost attributed to timber delivery (in)	£5 tonne
Delivery miles	16,000/yr
Delivery transport fuel costs	£4,582/yr (based on £1.40/litre)
Output per hour	14 tonnes (based on Heizohack 8-500 K)
Output in 7 hour working day	98 tonne
Hours required to chip 5,000 tonnes	357
Days required to chip 5,000 tonnes	51
Chipper tractor fuel consumption	6 litres/hour
Fuel cost for 357 hours chipping	£1,665 (based on £0.74/litre)

Chipper O&M Cost	£1.42 hour (dealer figures) so £507
Firewood processor output (Transaw 350XL)	5.5m^3 or 2.75 tonnes/hour
Output in 7 hour working day	19.25 tonnes
Hours required to process 1,000 tonnes	363
Days required to process 1,000 tonnes	52
Firewood tractor PTO operating hours	363
Firewood tractor fuel consumption	6 litres/hour
Fuel cost for firewood processor	£1,611 (based on £0.74/litre)
Firewood processor repair and upkeep	£700/yr
Labour for yard work / loading	400 hours
Cost of yard work / loading labour	£3,196 (based on £7.99/hour)
Yard telehandler/tractor operating hours	500 hours/year
Yardwork vehicle fuel consumption	8 litres/hour
Fuel cost for yard work	£2,960 (based on £0.74/litre)
Cost attributed to vehicle upkeep	£600/yr
Cost attributed to vehicle repair	£1,200/yr
Vehicle insurance	£130/yr

NB: No allowance has been made for depreciation.

The premises are assumed to be exempt from business rates.

Based on the cashflow produced using these assumptions (and supplied as page 2 in accompanying Excel file), Option 2 has the potential to pay back the entire capital investment in 10 months of operation, assuming there is a market for all the material produced from the outset. Thereafter, the enterprise could show a gross operating profit of around £30,000 per month, although again, income will be highly seasonal.

To meet the winter demand for fuel, the Council would need to hold significant stocks of timber at Hazlehead, and there is ample space to hold buffers around the site. From plans of the site, stocks in the tens of thousands of tonnes could very easily be accommodated. Once dried, the round timber would then need to be chipped to the correct specification for boilers and placed into covered storage.

Figure 24 - Hazlehead Nursery

There are many suitable locations, but those identified as the best include the north east corner, which has the best access from the current entrance but is currently grassed (marked A on the aerial photo), and the area occupied by a number of end-of-life cold frames. This second location (marked B) has the advantage of being partially concreted, and is well served by access roads.

Figure 25 - Location A (looking west to east)

(Image Taken : Hazlehead Nursery, March 2012)

Figure 26 - Location B (looking north to south)

(Image Taken : Hazlehead Nursery, March 2012)

Both parts of the site are exposed enough to encourage good drying of the stacked timber through the action of wind and sun, and could be expected to see timber reach moisture levels of 35% and below within 12 months if good practice drying techniques are adopted.

To increase flexibility and speed their ability to supply fuel to the market, some chip and log suppliers have invested in drying floors which use artificial means to increase the rate at which chip and logs dry out. Either diesel or woodfuel-fired, these drying floors can take chip and logs from freshly felled trees to the required moisture content for fuel within a two to three day period, and some of the more established producers in Scotland consider them a vital part of their supply infrastructure - particularly towards the end of the heating season, when suppliers are running low.

With the RHI now in place, a drying floor which is provided with heat from a wood-fired boiler installation would not only provide the estate with the ability to put fuel to market much more rapidly when stocks of dry wood were running low, but it would also generate an income from the RHI as an eligible use of heat.

Based around a 133kW ETA HACK woodchip boiler, coupled with a 60kW ETA SH log boiler and incorporating a 3m diameter feed hopper, 6,600 litres of accumulator capacity, all the necessary controls and pipework and a 5 x 5m drying floor, an annual income in the region of £21,000 could be generated from drying chip and/or logs. This assumes the boiler is run to the RHI tariff cut-off point of 1,314 hours per annum. The reason for using a chip and log boiler, rather than a 199kW chip boiler, is that the log boiler - which is manually fed and has a fuel chamber of 223 litres capacity - could be used to dispose of the large quantities of waste wood that would arise as part of the fuel production process. This would take the form of oversize chip, yard sweepings, bark and slivers from the billet screen, pallets and other clean packaging waste. Rather than being disposed of in a regular bonfire as is the norm, this material would earn the estate c. £348 tonne in the form of heat through a heat meter. The chip boiler would take standard chip from the production process, and provide an automated drying function as and when required.

The ability to dry chip and logs quickly to be ready for market is difficult, if not impossible to quantify, as it confers operational advantages rather than direct financial benefits, but the potential £21,000 per year income from the RHI alone makes this an attractive investment proposition. Costs for such an installation would be :

Boilers and ancillary components	£42,000
Flues	£6,500
Assembly and electrical installation	£8,500
Mechanical installation	£16,000
Heat exchanger	£3,000
Drying floor, fans, etc…	£22,000
Structural alterations	£7,000
TOTAL INSTALLED COST	**£105,000** (ex. VAT)

Assuming no cost of capital, this investment would pay back in 5 years, and show a 20 year income of c. £420,000 (4 times the original cost), as well as providing robustness and flexibility to the fuel supply operation and a disposal route for unmerchantable timber and out-of-specification woodchip (a requirement of both the HETAS and Woodsure schemes).

7 Business Models and Funding

There are many possible routes to structuring and funding the proposed woodfuel processing enterprise at Hazlehead, and of these, three emerge as the strongest:

- Direct Council ownership and operation;
- Social enterprise in partnership with the Council;
- Private enterprise in partnership with the Council.

It may also be possible to create a hybrid of the second and third options, with social and private enterprise playing different roles within an expanded operation, perhaps to include a tree nursery, green woodworking and a training/intermediate labour market operation. The site is certainly still large enough to operate as a tree nursery, and in fact still has a large number of trees on site that had been grown originally as nursery species. These are long-past the point (in size and form) at which they could be regarded as useful as nursery trees, but are ideal as feedstock for chip boilers or as firewood.

Figure 27 - Trees on Hazlehead Nursery Site

(Image Taken : Hazlehead Nursery, March 2012)

7.1 Direct Council Ownership

There are positive and negative aspects to the direct council ownership of a woodfuel processing enterprise at the Hazlehead nursery site, and many political unknowns around the appetite of the Council for this model of delivery. These aspects can be summarised as:

Positive

- Straightforward ownership structure of site, with not need to transfer leases, etc…;
- Ability to use existing staff in the relevant Council departments to deliver services;
- Financial 'muscle' of Council could underpin initial establishment phase of depot;
- Straightforward administrative and banking arrangements;
- Able to draw on other Council services and support at lower cost, e.g. accountancy, etc…
- Council able to secure grant aid as a public body;
- Wider Council asset base, e.g. vehicles, trailers, etc… could be placed at disposal of depot on an as-and-when basis.

Negative

- Nature of trading activities may be bound by relationship with Council, particularly if in competition with private sector operators;
- Limitations may be placed on structure, staffing, etc… because of Council requirements;
- Possibility that Council priorities change, threatening future of enterprise;
- Site remains in Council ownership, with temptation to sell or develop for housing at some point in future;
- Profits could be taken by Council to support other services, reducing sums available for reinvestment/expansion;
- Council involvement may be a barrier to tendering on some contracts - particularly where Council premises are involved.

On the whole, the positives probably outweigh the negatives, but the decision is ultimately likely to be a political one.

7.2 Enterprise in Partnership with Council

Social enterprise, where an existing body is either found or a new one is created, working in partnership, has the potential to offer a range of benefits to the Council in terms of the operation of the proposed depot. Social enterprises are becoming increasingly important in Scotland and the rest of the UK, as alternative company structures, cooperatives, community interest companies and other non-traditional business types become increasingly important.

An enterprise which has a strong social dimension, such as the desire to provide training opportunities, incubate and spin-off other businesses, and deliver other non-commercial outcomes - the triple bottom line of economic, social and environmental objectives - is a very attractive potential model for the Council and the Hazlehead depot. The pro's and con's are summarised below :

Positive

- Creates wider range of opportunities for engagement with communities and increases the opportunity to 'do good', bringing about social change, particularly in deprived communities;
- Provides increased employment and training opportunities for local people;
- Strong links with Council retained, delivering many of the benefits of the Council-owned model;
- Fewer constraints and bureaucracy than working wholly within the Council;
- Enhanced ability to attract grants on the basis of the social and environmental goals of the social enterprise.

Negative

- Competing with private sector working to deliver purely financial objectives, i.e. commercial performance;
- Perceptions in some quarters that social enterprises are somehow not 'proper' businesses;
- Links with Council retained, with possible negative connotations mentioned previously.

7.3 Private Enterprise in Partnership with Council

This is a model which has been tried successfully elsewhere in Scotland in a similar sphere, with North Lanarkshire Council foremost in creating a partnership with industry to deliver an effective woodfuel supply chain in their area. The partnership involved the Council tendering for a commercial partner to take on and operate a Council-built woodfuel depot, and at the same time taking on the management of Council-owned woodlands which had historically received very little management. The resulting fuel from the woodland management and chipping operations is then supplied into an existing set of woodchip boilers in Council properties. North Lanarkshire saw some of the earliest systems deployed in Scotland, and now have 5 systems installed, consuming around 800 tonnes of woodfuel per annum.

The positive and negative aspects of this approach to establishing and running the proposed depot are explored below :

Positive

- A considerable amount of the risk associated with entering the woodfuel supply chain is shared with the private sector;
- Private sector expertise in the various technical aspects of woodfuel production is gained from the outset – avoiding some of the pitfalls;
- Capital expenditure could be reduced, as private sector partner could bring specialist machinery;
- Business aligned more along commercial lines, increasing likelihood of success in the long term.

Negative

- Opportunity for delivering social objectives is lost or diminished;
- Limited pool of competent partners could lead to reduced competition in the marketplace as a whole;
- Risks associated with financial performance and ongoing viability of partner should market conditions change;
- Requirement to renew contracts, and possibly re-tender, could reduce attractiveness of business opportunity to the private sector;
- Possible lack of willingness on the part of the Council to adopt such an approach.

8 Recommendations

In order to progress the opportunity which woodfuel production and use offers to Aberdeen City Council, we recommend the following steps towards realising the ambition of moving into woodfuel production. The principles underpinning the recommendations are: that the financial resources available to the Council are limited; whilst there is considerable expertise in forestry and urban woodland management, there is limited experience of the production processes associated with quality-controlled wood fuel; the Council is keen to explore partnership approaches to delivering this project.

We recommend that:

1. The Council analyse the findings of this report, and establish a position on exactly what it is that they wish to take forward and over what timescale;

2. The Council give serious consideration to the lessons learnt from the Duthie Park woodchip boiler project, and public-sector schemes elsewhere in Scotland, and determine the extent to which they wish to see woodchip boilers deployed across the Council property portfolio, starting by determining the suitability or otherwise of all properties in Council ownership (similar assessments have been made of many other Councils in Scotland, particularly in the Central Belt, and elsewhere in the UK);

3. The Council examine how Energy Supply Company models might mitigate against the risks associated with installing woodchip (and pellet) boilers in Council properties;

4. In common with Councils and public sector bodies elsewhere in the UK, that Aberdeen City Council considers wood-fired boiler systems as the default option for new-build and refurbishment properties in Council ownership;

5. In taking forward the Hazelhead site, the Council adopts a partnership approach, working with a private-sector partner to put in place the infrastructure, staff and expertise necessary for delivering the project. Examples elsewhere in Scotland will help formulate an approach.

6. That a competitive tendering process be used to select the partner with the necessary technical and business expertise to effectively deliver the project.

Neil Harrison