PRODUCING FUEL FROM LONDON'S TREES AND WOODLAND

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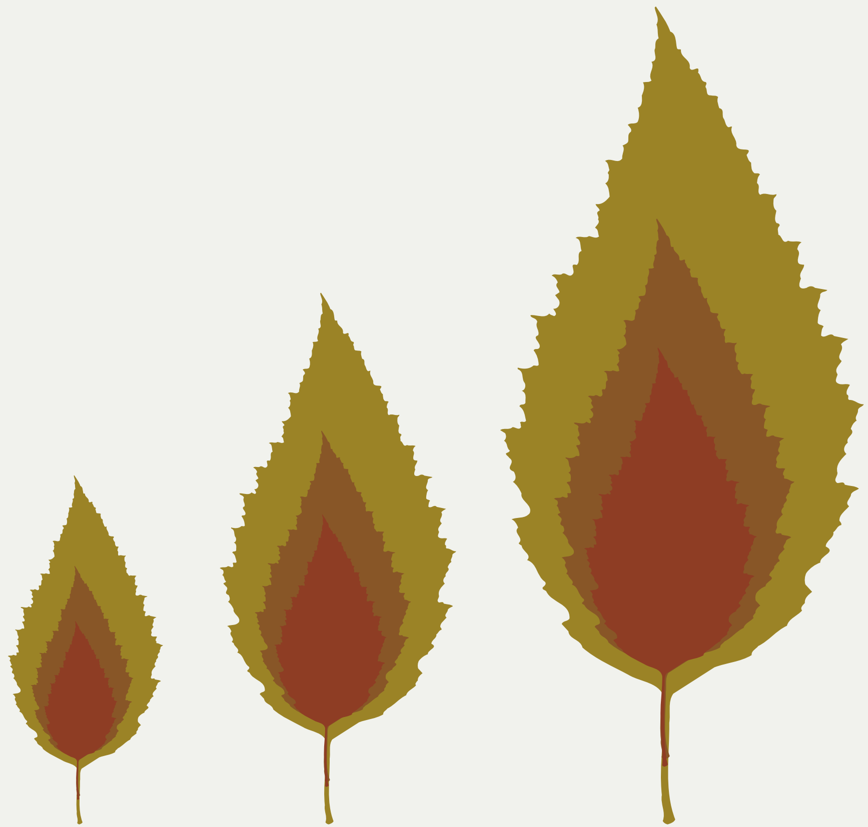

CONTENTS

CAPITAL WOODLANDS

Capital Woodlands is a three-year London Biodiversity Partnership project supported by the Heritage Lottery Fund (2006-2009). The project aims to raise awareness and appreciation of London's woodlands and increase public benefit and participation by undertaking access, biodiversity, community and training work in six 'flagship' woodlands and throughout the capital.

The dissemination of best practice in the management of London's woodlands is a key objective for the Capital Woodlands Project. These guidelines form a major contribution towards the sustainable management of London's woodlands providing a valuable resource for local authorities and other woodland managers.

The Capital Woodlands Project is managed by Trees for Cities, which works in partnership with the Greater London Authority, Forestry Commission, BTCV, the Peabody Trust and the London Boroughs of Bromley, Croydon, Haringey, Merton and Redbridge.

INTRODUCTION

A UK Biomass Strategy was published in May 2007 and A Wood Fuel Strategy for England was published by the Forestry Commission in March 2007. This envisages production of an additional 2 million tonnes of wood for fuel by 2020.

Within London there is also support in the Mayor's Energy Strategy[4] for biomass as a renewable fuel in boilers and combined heat and power (CHP) units.

The London Plan requires that larger developments produce 20% of their energy needs from on-site renewable sources. Wood fuel is often the most cost effective practical way of meeting this requirement.

OBJECTIVE

Trees in urban areas need regular attention to ensure their health and public safety. Management inevitably gives rise to logs and branches which might be left on site to decay in woodlands but have to be removed in parks and along streets. Use as fuel is an increasingly attractive option for disposal. It meets national and regional policies for renewable energy and a growing demand for wood fuel in London.

MODERN HEATING, COOLING AND CHP SYSTEMS

Biomass in general and wood fuel in particular did not receive much attention until the publication of the Biomass Task Force Report in October 2005. Prior to this the focus of government renewable energy policy was primarily on electricity production but the importance of heating as a source of CO^2 emissions and the suitability of wood as a heating fuel has now been recognised.

Wood can be used for heating at all scales from wood stoves in individual households to large scale district-wide heating schemes. Whatever the scale, modern wood heating systems are highly efficient with low emissions. Sophisticated automated fuel feeding and control systems are available for the larger wood chip and wood pellet boilers fitted in schools, offices and apartment blocks. Larger boilers use cyclone traps for effective control of particulates and employ exhaust gas recirculation to reduce NOx levels, although these cannot be completely eliminated. Small scale wood fuelled CHP systems are becoming available and are expected to increase in popularity over the next few years.

DEMAND GROWTH

The main application for wood fuel in London is for heating larger buildings with either wood chip or wood pellets. Use in CHP and absorption cooling systems is set to increase as technology improves.

Building integrated systems range in size from around 80kW to several MW. Some may be used to heat additional nearby buildings in mini-district heating systems. Prices for wood fuel are highest for these users, reflecting the increased cost of delivering relatively small quantities of fuel and higher specification needed. Local wood fuel production and use can work very effectively for building integrated systems. Larger scale district heating systems, often linked to CHP systems, draw fuel from a wider area. The price paid for fuel at these larger district systems may be lower, reflecting their ability to accept a wider range of fuel quality.

Demand is still small but set to increase rapidly. In the 3 years up to March 2008 planning applications referred to the GLA included wood boilers and CHP systems needing an estimated 40,000 tonnes of wood fuel annually. Nevertheless, in the short term new wood fuel producers may have to rely on bulk users of wood fuel outside London. These pay only around half what operators of smaller boilers are willing to pay so developing the local market is key to the long term success of wood fuel production. Nevertheless, bulk users provide an established demand that allows the development of new wood fuel production centres.

Table 1: Comparison of wood chips and pellet

Chip	Pellet
• Relatively low density, approx 200 – 330kg/m³ • Energy density approx 3,500kWh/t • Moisture content dependent on source and processing - between 15% and 60% • May be of variable quality and moisture content. Standardised description should be available. • Price dependent largely on moisture content, quantity delivered and delivery method, £40-85/t, equivalent to between 1.7 and 2.5p/kWh • Delivery normally by tipping or walking floor vehicle. May also be blown into less easily accessible store • Local fuel, supports local economy	• High density, approx 650kg/m³ • High energy density approx 4,700kWh/t • Moisture content of around 8-10% • Quality and moisture content much more standardised than wood chip. Several grades defined at European level • Price dependent upon quantity delivered and delivery method. Price range £120-220 per tonne, equivalent to 2.5-4.5p/kWh • Bulk deliveries normally by blowing from tanker. direct access to store not required

TYPES OF WOOD FUEL

Wood fuel comes in three main forms: logs, chip and pellets. Logs are suited for domestic scale boilers and are not considered further here. Wood pellets can be used in domestic stoves and boilers but are equally suitable for large boilers and CHP units. Wood chip is best used in boilers and CHP units at larger than domestic scale. Wood chip is less processed than wood pellet and costs approximately two thirds the pellet price. Thus where cost is a key consideration, wood chip will be favoured but where space is at a premium and delivery difficult, wood pellet is likely to be chosen. Analysis of planning applications in London showed an increasing preference for pellets which may be related to their established supply chain as well as reduced storage space and ease of handling. A comparison between the two fuels is given in Table 1.

THE RESOURCE

There are about the same number of trees as people in London. The 2001 census recorded almost 7.2 million people resident in London and the *Mayor's Tree and Woodland Framework for London* estimated the tree population at around 7 million:

- A quarter of these trees are in woodlands, the others are in parks and other open spaces, alongside roads and most importantly in private gardens
- Woodlands occupy eight per cent of London's land area
- An estimated 20 per cent of London's land area is under the canopy of individual trees.

There are a few large woodlands in London, most of them in the outer boroughs, but smaller woodlands and groups of trees are found throughout the city, though less frequently in the inner boroughs. New small woodlands have developed wherever land is left undisturbed, for example alongside railway lines. Most woodlands in London are in public ownership and are managed principally as places for recreation and wildlife conservation. Several ancient woodlands are sites of special scientific interest (SSSIs).

Most trees in parks, open spaces and lining streets are also publicly owned but the twenty percent of London that is private gardens holds more than two thirds of the individual trees in London.

POTENTIAL ANNUAL PRODUCTION

Management of woodlands and trees in London gives rise to products ranging from sawn timber to garden mulch. Only a small proportion of total output is suitable for higher value products, much is used for products where timber quality is not important, such as mulch and wood fuel. A significant part is still treated as waste rather than a resource. Many woodlands and trees are not actively managed. Bringing them back into management would improve their value as places of enjoyment and for nature conservation enhancement.

Table 2 gives an estimate of the total amount of timber that could be produced in London if all the tree resources were managed. This estimate should be seen only as a guide to the scale of potential production of fresh wood in London. It cannot be a precise estimate due to limitations of the data it is based upon. However it does indicate a large resource is potentially available.

Table 2: Potential timber production from London's woodlands and trees

Source of timber	Estimated potential production (green tonnes per year)
Woodlands[a]	23,338
Parks and street trees[b]	127,000
Private gardens[c]	150,000
Total	**300,338**

a. Based on the National Inventory of Woodlands and Trees area and 4 t/ha/yr growth
b. 2005 survey of tree surgeons working for local authorities carried out by BioRegional and the London Tree Officers Association
c. Derived from proportion of individual trees in private gardens reported in the 1993 London Tree Survey

Not all of this potential will be realised, some woods and trees are inaccessible, some may be left as long term non-intervention areas and others will remain unmanaged because owners decide to leave them untouched. Alternative uses further reduce the amount that will be available for wood fuel production. These uses include horticultural mulch, surfacing for horse rides and footpaths, and use in composting systems for sewage and food waste. Increasing costs for disposal to landfill and restrictions on land filling unprocessed organic waste encourage alternative uses such as fuel production. Growth in demand and price for wood fuel will influence how much of London's potential timber production is used as wood fuel.

The reasons to use London's timber as fuel include:

- Reducing waste disposal costs and avoiding landfill
- To facilitate woodland management for amenity and biodiversity by creating a new income stream for woodland and tree owners
- A diversification for existing tree surgery and similar companies or an opportunity to set up new enterprises which increase employment
- For local authorities, using wood fuel helps meet CO_2 emissions reduction, renewable energy and recycling targets, as well as keeping energy bills down
- A price to users that is lower than fossil fuels with security of supply. This can contribute to overcoming fuel poverty.

TIMBER CHARACTERISTICS

Lower Image © Andy Aitcheson

There are a huge range of tree species in London, reflecting a long history of introductions and planting. Despite this most trees in London are broadleaved native species: oak, ash, birch and beech. Sycamore is also common and can be invasive. All, whether they grow in woodland or elsewhere, can be used for wood chip fuel production. The similarities and differences between timber from woodlands and other sources are summarised in Table 3.

Table 3: Timber quality from woodlands and other sources

Woodland timber	Timber from other sources
• Available in larger amounts at each site	• A dispersed resource
• Size variable, but diameter usually less than 100 cm. Often in standard lengths.	• Size very variable, diameter may be more than 150 cm. Logs tend to be short.
• Logs tend to be straighter than for non-woodland trees. Stack well in woodland or on lorry.	• Logs often twisted, forked, with pruning wounds and decay. Branch wood normally included. Trees may be cut into rings.
• A small proportion of potentially valuable logs	• A very small proportion of potentially valuable logs.
• Tops and branches normally left on site to decay.	• Tops and branches chipped on site for easy removal. High bark and leaf content gives high ash content. Up to 67% of tree surgery arisings are chipped on site.
• Low risk of contamination with included metal but higher than for rural woodlands.	• Contamination with included metal and similar objects very likely to be encountered. Stones, grit and litter from the worksite often found.

NEED FOR A CENTRAL PROCESSING SITE

Woodlands and parks in urban areas are heavily used, in contrast to most rural woods. On site production of wood chip is problematic, not only because of concerns over safety and noise but because moving the chippers and other equipment is slow and expensive. A central processing site is to be preferred for several reasons:

A convenient drop off point for tree surgeons: Having a permanent yard can provide a visible disposal point for tree surgeons. In urban areas where alternative disposal routes are limited to waste transfer stations a gate fee can often be charged. This provides additional income for the wood fuel producers. The level of fee charged will depend on local conditions.

Economies of scale: The large diameter of some logs and the rings that are produced by tree surgeons require large chippers and perhaps log splitters to process them. The capacity of this machinery is high and maximising its use is essential to the viability of wood fuel production in urban areas. At least 10,000 tonnes a year throughput is required. High production also improves utilisation of other equipment.

Security and safety: A yard with secure fencing and no casual access to the public has obvious advantages for both the security of equipment and the safety of the operation.

Amenity and lowering environmental impact: A central site gives the opportunity to erect screening or plant trees and shrubs on the boundary. Location where it is unlikely to cause a noise or other nuisance to neighbours is required. Waste water run off which might cause a problem in watercourses can be contained and treated.

Access: One of the criteria for a permanent site is that large articulated vehicles can access them for collection of chip. Many woodlands lack the road infrastructure that would permit this.

Quality control: A central production unit makes monitoring of production and quality standards easier. If necessary, regular sampling to check quality can be implemented.

A comparison between wood chip production from rural woodlands and in urban areas is given in Table 4.

Table 4: Comparison of wood chip production in rural and urban areas

Urban wood chip	Rural wood chip
• Many people in woodlands makes immediate extraction and removal of timber desirable • Limited space on site for stacking timber. Operation of machinery on site kept to a minimum to avoid safety issues with the public and noise nuisance • Limited space restricts opportunities for drying timber or green chips. Timber processed and dispatched as soon as possible • Trees more often grow around metal and other debris leading to included metal. Contamination with litter, grit and stones from 'sweepings' a potential problem • Timber may be available free or at low cost as part of management contract for woodland. Potential to charge gate fees for arboricultural arisings • Chipper output low due to small log size and awkward shapes. Chip quality relatively low with higher incidence of slivers • Delivery distances short (usually less than 10 miles) but expensive due to time taken.	• With fewer people timber can be safely stacked and left to dry near woodlands • Normally no restrictions due to people pressure, but bird nesting and other conservation considerations may limit times for felling and extraction • Timber can be stacked in an exposed position for 9 – 12 months and dried to below 30% moisture content • Logs unlikely to have included metal. Chipping directly into delivery vehicles avoids other contamination • Timber has to be bought at a price set by competing markets e.g. for logs or fencing material. • Relatively long, straight uniform logs lead to high throughput and high quality chip with fewer oversize and slivers • Delivery distances up to at least 25 miles economic.

QUALITY WOOD CHIP FUEL

Whatever the raw material the fuel produced must meet the specifications for the boiler in which it is used. Smaller boilers with underfed hearth fuel systems generally require finer grade wood chip with a moisture content of 30% or below. This can be achieved by stacking timber to dry before chipping, or by chipping green timber and then drying it with passive or active methods. Restricted space in London limits drying options and may make it impossible. Larger boilers (over say 180kW) fitted with step grate systems can normally make use of coarser undried chip with up to 50% moisture content.

There are two systems of wood fuel classification in common use in the UK. The Austrian ONORM system has been widely used to date since many of the boilers were imported from Austria and the system is simple to understand and apply. It covers the size distribution of the chips, their moisture content, bulk density and ash percentage. A European system of classification for biomass fuels was agreed in 2005 by a working group (CEN 335) and is the basis for a forthcoming British Standard. Further information about both these classifications is given in Appendix 1.

Combined heat and power systems, particularly those based on gasifiers, and other equipment may require different wood chip specifications.

High quality chip can be produced directly from woodland timber, but where tree surgery arisings are used short logs are liable to give rise to oversize slivers. Chip made from tops and branches contains leaves giving an unacceptably high proportion of fines. To meet the specification for most boilers screening to remove oversize and fine chip is required.

The outputs from a wood fuel processing centre include:

- Fuel grade chip to a range of specifications
- Oversize chip which can be re-chipped to final product specification
- Fine material under 5mm. Chip made from tops and branches can contain over 25% of fines by volume. This can be added to composting systems, or composted on its own for use as a soil amendment or mulch
- Waste including plastic bottles, tin cans and other foreign objects received with incoming chip.

Alternative markets for wood chip may be required until local wood fuel markets grow. The chip is suitable for mulches and surfacing. It can also provide the feedstock for wood pellet production despite high moisture content and bark percentage.

SITE SELECTION

Once the availability of sufficient raw material has been established and the potential market identified a production site can be selected. Essential features of good sites include:

- Size: enough space should be available to process a minimum of 15,000 tonnes a year. At the Croydon TreeStation only 0.85ha is available. This has proved insufficient to allow drying of logs received
- Concrete hardstanding: this can be costly to install but is essential to prevent contamination of the chip with grits and stones
- Covered storage for final product: open sided to allow easy access for loading equipment and ensure unrestricted airflow to aid chip drying
- Security to minimise vandalism and unauthorised access
- Water available in case of fire
- Access for articulated vehicles
- Location close to main roads to facilitate drop off of tree surgery waste and aid distribution of finished chip.

Other desirable features include:

- Co-location with green waste composting site which can act as a source of logs and disposal site for fines and other reject material
- Location next to a waste transfer station or similar facilities to enable sharing of equipment and resources such as a weighbridge or loading equipment
- Proximity to areas of high demand for wood chip minimising transport distance
- Sufficiently far away from houses and other buildings to avoid complaints of noise, dust or smells
- Mains power available to increase options when selecting machinery.

SATELLITE COLLECTION POINTS

Local collection points for tree surgery arisings can increase the area served by a wood fuel production site. They offer a convenient drop off point for local tree surgeons and can utilise equipment such as hook lift bins and lorries that are already available at the main site. The site will need manning to ensure low contamination levels and book in loads. Unless they are set up alongside existing facilities that can share staff and management, satellite sites may prove uneconomic.

EQUIPMENT FOR WOOD CHIP PRODUCTION

Both logs and material chipped by tree surgeons at roadside need further processing. Manual labour input should be minimised to keep production costs low and reduce health and safety risks.

CHIPPERS

The choice of chipper depends on source of logs. For relatively long straight logs or trees from woodlands well adjusted disc, cone and drum chippers will all give good quality chip. In most cases the chip can be delivered straight to the user. With poorer quality feedstock such as that from tree surgery, drum chippers with internal screens have been found to give the best quality chip. They are able to process large diameter ‘rings’ found in arboricultural arisings. However, chip is lower in quality than for woodland chip. A higher number of long slivers and greater proportion of fines are often found, requiring screening before delivery to smaller boilers.

Large logs, up to 1 metre or more in diameter are common in urban areas and if labour intensive log splitting is to be avoided machines capable of chipping them are required. To justify purchase of large machinery throughput on the site has to be increased, or one chipper has to service several sites. In order to make effective use of large chippers additional equipment to load the chippers is required. For longer logs from woodland, crane feeding is a good choice but for tree surgery arisings an excavator fitted with a clamshell grab or a bucket which can sift out debris has been found to improve output. Production rates of up to 40 tonnes per hour are quoted for the larger chippers.

SCREENING CHIP

Chip received into the production centre and that made from tree surgery logs will require screening before use in all but the largest boilers. Oversized chip and excessive fine material must be removed. Both trommel screens and vibrating flat screens have been used successfully. A three way screen that can produce the final product in a single pass reduces operating costs. Careful site layout and the use of conveyors will minimise the amount of handling that has to be done with a loader for all three products. A flat screen with round holes of 35mm for oversize and another of 6mm for fines produced a good quality G50 fuel from chip delivered by tree surgeons

The oversize chip can be reprocessed once litter and other debris has been removed. Fines, up to 25% of the total volume, cannot be used as fuel in conventional boilers and contain a higher proportion of leaf, bark and grit than is desirable. They can be added to green waste composting or used on their own as a soil amendment once they have been matured

Drum chipper processing tree surgery waste at Croydon.

BioRegional Development Group

Passive drying of wood chip
Semi permeable fabric coverings have been successfully used to aid woodchip drying at several sites around the UK.

South Yorkshire Forest Partnership

Screening wood chip to improve chip quality
Bristol City Council installed wood chip boilers at several locations using chip arising from management of the city's trees as fuel. With unscreened fuel the boilers were liable to smoke and malfunction. Once screened chip was made available boiler performance and reliability improved and fuel consumption reduced.

BioRegional Development Group

DRYING WOOD CHIP

Passive drying relies on the heating up of wood chip as decomposition starts to drive off moisture in the wood chip. Active drying requires an input of energy to speed drying, normally by forcing either ambient or heated air through the wood chip pile.

Passive drying has been successful where the quantity of chip is relatively large, with piles 4m high or more. It can be done in a covered, well ventilated store or outside on concrete hardstanding by covering the pile with a semi-permeable fabric. This allows water vapour to escape yet prevents rain going into the chip. In practice chip is dried to below 30% moisture content after 3 or 4 months. It is cheap to implement and is becoming more popular but depends on a large area of hardstanding being available.

Active drying has been done on a fairly small scale to date in the UK. There are several methods employed. Perhaps the most common is to adopt a similar system to grain drying with the air being forced by a fan through a slatted floor and the chip piled on this. This can achieve rapid drying rates even with ambient air but the energy input required reduces the carbon saving from using wood chip. Capital and running costs are also increased. The improved quality of the wood chip increases its potential market and its expected price.

QUALITY CONTROL

Consistent high quality is essential to build confidence in wood chip as fuel. Achieving this depends on committed management and attention to detail as well as testing of finished wood chip to verify both size assortment and moisture content. The latter is more likely to vary so requires more frequent monitoring.

For both size assortment and moisture content care must be taken to ensure that sampling is representative with samples taken from several places in the chip pile. Sampling protocols for wood chip fuel are available. The size assortment can be checked by using a series of sieves with mesh sizes corresponding to the size class limits of the specification. This is time consuming but does not have to be repeated often and gives a good insight into chip quality.

Several different types of moisture meter are available giving almost instant results. They are of varying accuracy and careful checking and calibration is required for new equipment. The simplest and most reliable way to check moisture content is to dry a sample of chip in an oven at just over 100°C until constant weight is reached. This normally occurs within 24 hours.

MATERIALS HANDLING EQUIPMENT

Commonly available equipment such as front end loaders or telehandlers are normally used to move chip and load delivery lorries. If large logs have to be moved around the site frequently a timber trailer and loading crane may be required. Conveyors can be used to move chip short distances or pile it into heaps.

DELIVERING WOOD CHIP

There are several options for delivery of wood chip and the one chosen will depend mainly on the requirements of the end user. Table 5 lists some of the more common wood chip transport and delivery systems.

Table 5: Common wood fuel delivery systems

Vehicle type	Approximate size (m^3)	Comments
• Walking floor trailer for articulated lorry	75	• Only for largest projects with adequate access and turning room
• Tipping hook lift bin	35	• Likely to be the standard for small to medium boilers in London. Maximum height of tipped body approximately 8.2m
• Hook lift bin fitted with walking floor	35	• Doubles as on-site fuel store and plugs into the boiler fuel feed system. More costly than a standard hook bin but avoids need for extensive civil works on site
• Agricultural trailer and tractor	up to 25	• Only for delivery very close to production site. Great range of trailers available, including high sided, side tipping and scissor lift variants which deliver into above ground stores. Not many available in London
• Chip blowing vehicles	around 30	• Useful for difficult to access sites. Chip store can be up to 20m from access point. But delivery time extended (on site up to 45 minutes) and noisier than tipping. Oversize chip or too many fines can lead to blockages. Not yet available for London but can be put in place quickly. Most chip blowing vehicles can also deliver wood pellets.

Standard vehicles and equipment such as walking floor articulated lorry trailers and hook lift bins can be hired in as required. As production increases it may prove cost effective to have a dedicated vehicle on site.

In urban areas the limiting factor on delivery is the time it takes to reach a site rather than the distance involved. The carbon emissions due to transport of the finished chip are a minor consideration. For example, a delivery of chip at 30% moisture content to a boiler 10 miles from the production site in a hook lift bin uses just 0.23% of the energy delivered as wood chip. Even where longer distances are involved the penalty is small. Delivering an articulated lorry load of chip to a boiler 75 miles away uses the equivalent of just 1.9% of the energy embodied in the wood chip. Details of the calculations are given in Appendix 2

Standard vehicles and equipment such as walking floor articulated lorry trailers and hook lift bins can be hired in as required.

SKILLS AND TRAINING

Significant investment is required to set up in wood chip production at the scale envisaged in this leaflet. Committed management is required at this early stage of market development. The manager not only organises on site activities, but must be proactive in promoting wood chip as fuel, seeking out new customers, and encouraging decision makers to commit to using wood as fuel.

Labour with suitable skills and qualifications for most of the operations is available through the established tree surgery industry. Further training specific to wood chip production and quality control may be needed. Providing information about the wider development of the wood chip fuel market can put the job in context and provide motivation.

Training courses are available ranging from one day courses covering most aspects of wood fuel production (for example, in SE England see www.sewf.co.uk). More in-depth courses such as the LANTRA accredited Ignite training courses are run at various locations around the UK.

All the courses are practically based and draw on the experience of industry leaders.

REGULATORY FRAMEWORK

In a regulatory position statement issued in October 2007 the Environment Agency defined 'virgin timber' as: ". . . of the type from forestry works or virgin wood processing such as wood off cuts, shavings or sawdust from sawmills or timber product manufacture dealing in virgin timber or cuttings and brash from tree felling or other forestry management operations." The Environment Agency also stated that: "Virgin timbers are not waste and will not be subject to waste regulatory controls provided that they are certain to be used for the purposes to which virgin wood is commonly put. These uses include use as wood chip in gardens or on pathways, as a raw material for composting, as animal bedding, as fuel in an appliance or as a raw material for the production of wood based products or in paper production. However, if virgin timber is mixed with waste timber, it will all be classed as waste."

This clearly indicates that virgin timber includes the timber from woodlands and arboricultural work which is the feedstock considered in this leaflet and that it falls outside the scope of waste regulation. A registered waste carriers licence is not required for transport of this material and it is exempt from control under the Waste Incineration Directive (WID).

Chipping of virgin waste wood such as tree surgery waste and its processing is also an exempt activity under paragraph 21 of the Environmental Permitting Regulations. These came into force on 6th April 2008 replacing the Waste Management Licensing system. The amount which can be processed is limited to 1000 tonnes a week and no more than 1000 tonnes is permitted on site at any time. This is sufficient for an urban wood fuel production centre.

However, it is not exempt from controls on environmental pollution and nuisance exercised by Local Authorities and any developments must be in compliance with land uses permitted under the local planning regime. Issues that need to be considered in planning a site include:

- Noise; some large wood chippers can operate at over 80 dB
- Dust and odour
- Visual intrusion
- Protection of water courses from siltation or run off containing high levels of nutrients or organic matter.

More generally, concern has been expressed over the impact of the installation of a large number of wood fuel appliances across London on air quality, in particular from emissions of particulates (PM10 and PM 2.5) and nitrogen oxides (NOx). Whilst the impact of any individual boiler is insignificant the fear is that collectively they will have a significant deleterious impact. An initial report completed for a group of London councils showed this may be the case but the assumptions this was based on were questioned. Work is ongoing to clarify the potential impact of biomass use and draw up guidance for biomass use.

If this concern is shown to be justified, restrictions on the installations of new boilers may be imposed by pollution control departments in local authorities. The effect of this may be to encourage the installation of fewer, but larger plants where more sophisticated pollution abatement can be implemented cost effectively.

COSTS AND BENEFITS

Assuming a production site processing 12,000 – 15,000 tonnes of timber annually, experience at the demonstration Croydon TreeStation and further analysis indicates the following costs and benefits. The analysis assumed a stand alone site with no shared facilities or equipment.

INVESTMENT REQUIRED

Initial capital investment is significant, for both physical infrastructure and equipment. Savings can be made by careful site selection and by purchasing second hand equipment. Savings have to be balanced against likely increased downtime and maintenance costs when using older equipment. Table 6 lists the items most likely required to start wood chip production. The total cost for investment in 2007 was estimated at £250,000 if all second hand equipment is used and limited investment made in site infrastructure. Where new equipment is purchased and a bare site developed this may rise to £600,000 or more.

Table 6 Infrastructure and equipment for a wood chip production site

Physical infrastructure	Plant and equipment
• Concrete hardstanding to prevent contamination of chip • Covered store • Access roads for articulated lorries • Secure fencing • Site office • Water supply • 3 phase power	• Chipper • 3 way chip screening system • Log splitter • Material handling equipment, e.g.:excavator for loading chipper front end loader for chip handling • Hook lift lorry and 35 m^3 bins for local deliveries • Geotextile for passive chip drying • Weighbridge

RUNNING COSTS

Staffing is estimated at 2 full time operatives and one manager, also full time, at least until the site is fully established with firm markets.

Site rental and rates are a major cost item, particularly in central London. Other costs include fuel and maintenance for equipment and hire of delivery vehicles where required. Disposal of fines and other waste may also be a cost item.

1. Analysis by the Enhance London programme and BioRegional.

INCOME

There are two sources of income, gate fees from at least some of the incoming material and sale of chip. Gate fees for tree surgeons have to be set at a level that attracts them. Increasing landfill tax and waste transfer station fees should allow gate fees to rise. However, alternative uses and informal disposal routes, for example by giving chip away free as mulch, leaving logs on site as firewood or taking the arisings out of London for spreading on farmland, mean that the scope to increase gate fees is limited.

The price for wood chip fuel varies according to the specification, market sector and quantity required. Sales to bulk users, such as large power stations are normally through agents or aggregators. The delivered price in most cases is in the range of £20 £25 per tonne. Taking off the transport costs gives an ex-yard price of £5 - £15 per tonne, dependent on the transport distance and aggregator's fee.

Sales within London to smaller boiler operators are essential for long term viability of wood chip fuel production. The price allows for the extra capital cost of a wood chip boiler compared to a gas boiler to be recouped over 5 - 7 years. The delivered price of £50 - £85 per tonne depends on moisture content but is equivalent to around 1.7- 2.5p/kWh.

KEY VARIABLES

The key variables in profitability of wood chip production are:

- Proportion of chip sold to smaller boiler users or for other uses at a similar price
- Land rental and business rates is the single most important cost, with rental at between £2 to £4 per square foot, and even higher near to central London. That is equivalent to up to £400,000 per year for a 0.93 hectare site in outer London. Partnership with a key end user such as a local authority or making use of space at an existing business premises may help contain costs
- Making the scale of operation as large as possible without increasing collection or delivery costs. Maximising throughput and minimising downtime allows the fixed costs, such as rental and depreciation on equipment and machinery, to be spread as far as possible.

Financial projections with conservative assumptions about the growth of the higher value local wood chip market show that a new TreeStation is a long term investment. It would take almost 18 months to reach a positive cash flow and 7 years to repay the initial investment. Despite this it is projected to generate an internal rate of return of 9% over 10 years.

APPENDIX 1 WOOD CHIP CLASSIFICATION SYSTEMS

AUSTRIAN STANDARD

The definitions below are extracted from ONORM M7 133 and DIN 66 165 specifications for wood chip fuel.

Size Classification

Chip	Maximum % Particulate Size				Maximum Extremes	
Designation	<4%	<20%	60-100%	<20%	Area cm²	Length cm
G30	<1mm	1 - 3mm	3 - 16mm	>16mm	3	8.5
G50	<1mm	1 - 6mm	6 - 32mm	>32mm	5	12
G100	<1mm	1 - 11mm	11 - 63mm	>63mm	10	25
G120	<1mm	1 - 63mm	63 - 100mm	>100mm	12	30
G150	<1mm	1 - 100mm	100 - 130mm	>130mm	15	40

Moisture Content Classification

Chip Designation	Moisture Content in % (wet basis)	MC Definition
W20	<20	Air Dried
W30	20-30	Undercover Stored
W35	30-35	Limited Undercover Stored
W40	35-40	Wet
W50	40-50	Green

Material Density Classification

Chip Designation	Material Density in kg/m³	Density Definition
S160	<160	Low
S200	160-250	Medium
S250	>250	High

Ash Content Classification

Chip Designation	Ash Content as % of fuel weight	Ash Content Definition
A1	<1	Low
A2	>1	High

Taken from information provided by Wood Energy Ltd.

EUROPEAN STANDARD

The European standards working group, CEN 335, published a proposal for wood chip grades as part of DD CEN/TS 14961:2005 Solid biofuels - Fuel specifications and classes. This is expected to be adopted as the British Standard and an extract is given below.

	Master table			
Normative	**Origin:** According to clause 6.1 and Table 1.		Woody Biomass (1)	
	Traded Form:		Wood Chips	
	Dimensions (mm)*)			
		Main fraction > 80% of weight	Fine fraction < 5%	Coarse fraction max. length of particle,
	P16	3,15 mm ≤ P ≤ 16 mm	< 1 mm	max 1 %* > 45 mm, all < 85 mm
	P45	3,15 mm ≤ P ≤ 45 mm	< 1 mm	max 1 %* > 63 mm
	P63	3,15 mm ≤ P ≤ 63 mm	< 1 mm	max 1 %* > 100 mm
	P100	3,15 mm ≤ P ≤ 100 mm	< 1 mm	max 1 %* > 200 mm
	Moisture (w-% as received)			
	M20	≤ 20%	Dried	
	M30	≤ 30%	Suitable for storage	
	M40	≤ 40%	Limited for storage	
	M55	≤ 55%		
	M65	≤ 65%		
	Ash (w-% of dry basis)			
	A0.7	≤ 0,7%		
	A1.5	≤ 1,5%		
	A3.0	≤ 3,0%		
	A6.0	≤ 6,0%		
	A10.0	≤ 10,0%		
	Nitrogen, N (w-% of dry basis)			
	N0.5	≤ 0,5%	Nitrogen is normative only for chemically treated biomass	
	N1.0	≤ 1,0%		
	N3.0	≤ 3,0%		
	N3.0+	> 3,0% (actual value to be stated)		
Informative	Net calorific value $q_{p,net,ar}$ (MJ/kg as received) or energy density, E_{ar} (kWh/m³ loose)		Recommended to be specified when retailed.	
	Bulk density as received (kg/m³ loose)		Recommended to be stated if traded by volume basis in categories (BD200, BD300, BD450)	
	Chlorine, Cl (weight of dry basis, w-%)		Recommended to be stated as a category Cl 0.03, Cl 0.07, Cl 0.10 and Cl 0.10+(if Cl >0,1% the actual value to be stated)	

*NOTE. The numerical values for dimension refer to the particle sizes passing through the mentioned round hole sieve size (3,15 mm, 16mm, 45 mm, 63 mm and 100 mm). Dimensions of actual particles may differ from those values especially the length of the particle.

APPENDIX 2 ENERGY USED IN WOOD CHIP TRANSPORT

Energy content of wood chip:
@ 45%mc wood chip has 9.46GJ/t equivalent to 9.46 x 1000 ÷ 3.6 = 2627 kWh/t

@ 30%mc wood chip has 12.71GJ/t equivalent to 12.71 x 1000 ÷ 3.6 = 3530 kWh/t

1. Local delivery with medium sized rigid lorry

Lorry with hook lift bin 35m3 capacity carries 8.5t chip at 30%mc.
Fuel consumption 20.0 l/100km (Department of Transport website). Boiler 10 miles distant.
20 mile (32km) round trip.
Total fuel use 6.44 litres with energy content of 10.7 kWh/l, that is
6.44 x 10.7 ÷ 8.5 = 8.11 kWh/t delivered.

Energy used in delivery is 0.23% of energy in wood chip delivered.

2. Delivery with articulated lorry

Lorry with 75m3 capacity carries 25t chip at 45%mc
Fuel consumption 48.1 l/100km (Department of Transport website). Boiler 75 miles distant.
150 mile (241km) round trip.
Total fuel use 116.11 litres with energy content of 10.7 kWh/l, that is
116.11 x 10.7 ÷ 25 = 49.69 kWh/t chip delivered.

Energy used in delivery is 1.89% of energy in wood chip delivered.

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