Community Woodlands
Information Leaflet 11b.

Fuelwood for Communities.

This leaflet is an introduction to the practicalities, techniques and equipment used to provide central heating from wood fuel for larger-scale domestic purposes and for community-level projects, e.g. for a large house or estate buildings, cluster of houses, business premises or community centre. For information on smaller-scale domestic heating and woodstoves please refer to the leaflet *Fuelwood for Homes*.

This leaflet is not intended to be a detailed technical guide to heating systems, but rather an introduction to the subject with information on the characteristics and practicalities of the different systems. The resources section of this leaflet gives sources and references for more detailed information and includes useful websites, addresses and contact details of heating equipment suppliers, consultants and project management organisations and sources of funding.

Whilst efficient woodfuelled heating systems have been developed in other parts of Europe, notably Scandinavia: their use has been very limited in the UK and experience in the design and use of such systems is scarce. Historical abundance of cheap coal and more recently oil and gas has led to the UK developing an energy economy dominated by fossil fuels to the detriment of renewable sources of energy.

In contrast, in Denmark 40 % of all domestic heating is wood-fired, coming from district heating plants, and in Austria 40% of domestic heating in rural areas is wood-fired.

The heating of larger houses, business premises, schools and community buildings is easily achieved using wood fuel and there is now growing interest in woodfuelled heating systems here, with the pioneering use of a woodchip fuelled heat and power plant at the Centre for Alternative Technology in Wales and the more recent installation of woodchip heating systems at the National Trust for Scotland Glencoe Visitor Centre, the Kinlochleven Community Centre and at the offices of Highland Birchwoods.

Existing buildings can be retro-fitted with wood fuelled heating systems, but there must be sufficient space for the equipment which is larger than oil of gas fired appliances, storage facilities for fuel are needed and also good vehicle access for delivery lorries or tractors and trailers.

With the introduction of the Climate Change Levy the cost of non-domestic fossil-fuel heating has risen; carbon-neutral fuels such as wood are exempt from this levy, and furthermore there are grants available to help with the funding of renewable energy projects (these are constantly changing and there are different bodies for Scotland and the rest of the UK).

The Climate Change Levy makes the price of wood fuel very attractive. However transport costs can reduce this advantage. If fuel can be sourced within around 25 miles, only mains gas is as competitive on price. Mains gas is not available in much of rural Scotland. The capital costs of automated wood burning equipment are greater than for gas or oil so it is important to calculate the payback time from the fuel cost savings. It has been estimated that woodfuelled systems can break even with fossil fuelled systems in six to nine years, which is about half the expected life of the equipment.

Fuels	Oil	Natural Gas	Coal (Anthracite or Smokeless)	Woodchips, 20%moisture content	Logs, air dry (25-30% moisture content)
Net Calorific value	43Mj/kg	34.8Mj/m^3	30Gj/T	14.7Gj/T	7.7Gj/m^3 solid volume
Equivalent amount of fuel to 1 tonne of woodchips	380l	4080kWh	490kg	1 tonne (4.5m^3)	2 m^3, solid volume
Price per unit as delivered	21p per litre	1.6p per kWh	£11 per 50kg bag	£30 - £50 per tonne	£30 -£45 per m^3
Price for 1 tonne woodchip equivalent	£80	£65	£110	£30 - £50	£60-£90

The above prices for oil and coal include average delivery costs of fuel. In remote parts of Scotland these charges may be higher and in addition it can be difficult to get good quality smokeless fuel in the Highlands. Prices for woodchips are based on buying timber at the roadside at a price of £15 to £20 per tonne. Chipping is estimated to cost £6 per tonne and drying from £5 to £10 per tonne. Transport has been estimated at 10p to 40p per mile per tonne for 25 miles.

Choice of fuel and heating systems.

When considering the heating requirements of larger premises, there are three practical choices of fuel: logs, wood chips or pellets, all of which can fuel highly automated heating systems.

Logs

Most people associate burning logs with open fires or woodstoves, and although larger wood burning stoves can run a whole house central heating system, it is laborious to keep them fuelled all day. A solution to this is to use a log fired boiler, such as those made by Veto or Tiesen. These boilers need to be loaded with logs only once or twice each day, depending on heating load. The stoking process should take no more than ten minutes each time. These boilers burn the logs at a high temperature and the energy is used to heat water which is stored in a highly insulated storage tank. This stores around 1000 to 2000 litres of water at 80 to 90^{o}C and needs to be sited

close to the boiler. This water is then circulated around the house in a similar way to a conventional central heating system, and can be used to heat domestic hot water. A very high degree of control over room and water temperature can be achieved with the latest controllers.
Logs, however, are not really a practical option for larger premises with a peak load of 50kW or more as the boiler will require more frequent manual re-fuelling. Log systems cannot be automatically stoked, and if this is a requirement then either a pellet or a woodchip heating system should be considered.

Log supply, storage and drying.

Logs are usually sold by solid volume, which is the volume of the wood excluding the air spaces. Roughly one cubic metre of wood (solid volume) will occupy around 1.5-1.8m^3 when carefully stacked (the lower figure refers to chopped logs) and around 2.5m^3 when piled in a loose heap. When ordering logs it is important to be clear about what your supplier delivers!
Trees should ideally be felled in the winter and logs spilt and left to dry for at least a year and preferably two years before use. Air drying should bring the moisture content down to around 25 to 30%. Logs should be split so that they are less than 10 cm thick, and dried, neatly stacked, under cover in a woodshed with open or slatted sides to allow plenty of ventilation.
In terms of manual handling, it takes roughly 12 wheelbarrow loads to move a solid cubic metre of unchopped logs. Storage of logs will take up a considerable space, bearing in mind that you will need a supply for current use and a further year or two years supply drying in the woodshed. Prices of logs vary from £30 to £45 per cubic metre, depending on supplier and whether they have been split and dried.

	Peak heat output of appliance/kW	*Annual energy requirement/Gj*	*Solid volume of logs required/m^3*	*Volume when stacked neatly/m^3*
Living room stove	*4-10kW*	*20-50*	*3-8*	*6-15*
3-4 bedroom house	*10-20kW*	*50-100*	*8-16*	*15-28*
Larger house	*15-30kW*	*70-140*	*11-22*	*20-40*

Log requirements. These figures are based on burning air-dry beech logs in an appliance which is 70% efficient. For softwoods allow 25-30% more

Pellets

Wood pellets are made from sawdust and ground up waste wood which has been dried, crushed and highly compressed so that the energy density per unit of weight is greater than logs or woodchips. In Europe, pellets can be delivered by tanker and are pumped or blown into storage hoppers which automatically feed the boiler. In Scotland, at present, there is no such delivery system and pellets are only available in 15kg bags, with a minimum order of one tonne. There are pellet manufacturing plants in Durham and South Wales and a new plant in Ireland, but most pellets currently used in the UK are imported from Austria and Germany.

Pellet boilers are highly efficient and are as automated as any gas or oil boiler. They are probably the most user-friendly form of automated wood-fuelled heating system

and can be fitted to an existing pumped water heating system, provided there is sufficient space for the boiler, which, in a larger domestic situation, is around twice the size of a floor-standing gas or oil boiler. In addition, a dry shed is required for pellet storage. The ideal installation site would be in a garage or outbuilding immediately adjacent to the main building. The advantages of pellets over woodchips are: a ready to use dry product is delivered, they are more energy dense so a smaller storage space is needed and less manual handling is required. Pellets are of a more uniform size than woodchips and consequently cause fewer blockages in mechanical boiler-feed equipment.

Pellet manufacture however, is currently a large-scale industrial process requiring expensive manufacturing plant and, as we have seen, the transport implications at present rather lower the otherwise green and sustainable image of wood pellets. This could change if pellet plants opened in Scotland. There is the possibility that smaller-scale pellet production facilities could be developed, and small pellet mills can be bought for under £100,000. However the wood to produce pellets still needs to be chipped, dried and ground, and the capital and running costs of such equipment, mean that woodchips are a better option for estates or rural communities wishing to supply their own fuel or at least source it locally. Setting up a small pellet mill may be a viable proposition for a sawmill or a joinery factory to process and add value to waste sawdust and woodshavings.

Woodchips

Woodchip-fuelled heating systems have already been installed in a number of locations in Scotland; consequently there is a greater body of knowledge and experience of the issues involved in supplying and burning woodchips than exists for pellets. The production and supply of woodchips is more suited to community management than is the production of wood pellets.

Woodchip heating systems will require a dedicated shed or adjacent outbuilding to house the boiler and hopper; in addition, storage facilities for chips will be needed together with sufficient access for delivery vehicles. Woodchips can be delivered by tipper truck and stored loose on a concrete floor under cover, or can be delivered in $1m^2$ or $2m^2$ bulk bags, which also need to be stored under cover. From this store, the hopper of the boiler will need to be filled manually or by tractor front loader once each day or several times each week, depending on size. As woodchips are not as dense as pellets, a larger storage facility will be needed and more manual handling is required. Large systems, e.g., for schools, factories or district heating schemes will require silos or bunkers into which large loads can be pumped or tipped; the hoppers of the boilers can be fed automatically. As a very rough guide to required outputs, the heating system in the Kinlochleven Community and Sports Centre has a 120kW boiler, whereas a large comprehensive school could require 800 to 1000kW output.

Whereas wood pellets are currently supplied from plants in England and further afield there is considerable opportunity, in Scotland to source woodchips locally. Scotland currently has a large, unused, standing timber resource, much of which is too remote from timber markets and of too low quality for sawlogs. Utilisation of this wood as chips would help the local economy by providing employment, it could contribute to better management of neglected plantations and woods by providing an economic

return from managed thinning, and it would contribute to a reduction in fossil fuel use.

There are several stages in the supply chain for woodchips, from felling and extraction of the timber to chipping and drying, transport and delivery. For a recent appraisal of the elements in the supply chain and the economics involved in the North of Scotland, the North Highland Forest Trust has published a useful information note (See Resources section).

It is worth noting here that transport costs will be an important factor in the success of any fuelwood scheme, other important elements are the need for chipping machines, a chip drying facility and matching the size and dryness of the chips to the correct burning equipment. For more information on these subjects the Ecodyfi and the British Biogen websites have very good detailed information (including downloadable documents) and issue 28 of the Reforesting Scotland journal contains detailed articles on the need and techniques for drying woodchips.

Briefly woodchips can be divided into three quality grades according to chip size distribution in a scheme devised by British Biogen: super, fine and coarse. Woodchip burning appliances work best when chip size is between 2 and 25 mm and smaller scale equipment for domestic use tends to operate best on the super and fine grades of woodchip.

Some sort of forced draught facility will be needed to dry the woodchips to increase their calorific value and to stop them rotting in storage. Dry wood can be chipped: for example, old pallets or wood from demolition can be recycled to provide useful fuel, but the drawback is that more powerful chipping machines are needed to process dry wood. In addition nails and other foreign bodies can damage the machinery. Smaller boilers (below 100kW) require much drier fuel (less than 35% moisture content) than larger systems. Larger boilers can burn wetter woodchips (up to 70% moisture content it has been claimed).

When wood burns, some of the energy released is used to dry the fuel, consequently the drier the fuel the more energy there is available for heating and therefore a smaller volume of chips is needed to produce an equivalent heat output. In addition to reduced heat output, burning wet fuel will cause corrosion and condensation problems in boilers and flues. This applies to log burning boilers and woodburning stoves as well.

Moisture content	Calorific value Gj/T	Bulk density kg/m^3	Volume of 1 tonne /m3	Energy content of 1m^3 /Gj	Energy content of 1m^3 /kWh
0	19.0	185	5.4	3.515	875
5	18.0	194	5.15	3.492	970
20	14.7	222	4.5	3.263	906
30	12.3	242	4.13	2.976	826
40	10.2	261	3.83	2.662	739
50	8.3	278	3.6	2.307	641
60	6.1	296	3.38	1.806	501

For those of you interested in supplying your own chips, $1m^3$ of freshly-felled green timber, which weighs around one tonne, will produce around $3m^3$ of wet woodchips (around 60% moisture content). Machinery to produce chips from round logs of up to 6 inch diameter costs from £6,000 upwards, and will need a large (over 100 HP) tractor to power it. Self-powered chippers cost from around £14,000 upwards. It should be noted that not all woodchipping machines are designed to give fuel quality chips, some of the smaller machines are intended only for waste reduction and to produce mulch quality chips. For the really self-sufficient it has been estimated that 4.5 hectares of fast growing hybrid poplar, grown on a short-rotation coppice system, could provide enough fuel for a 20kW woodchip boiler annually. However, there are very few sites in Scotland where short rotation coppice is financially viable.

Woodchip storage and handling.

How much fuel to store will depend on the size of the boiler. A small boiler of around 20kW output, a suitable size for a large domestic situation, will burn around $0.6m^3$ each day. Therefore a hopper of $1m^3$ capacity will require topping up or filling once a day, a larger hopper of $5m^3$ may last for a week. The annual requirement will be around $200m^3$, which is a large volume to store. Monthly deliveries of around $20m^3$ would be a better option, though this still represents a considerable storage space and will need a shed of 4m x 5m. When considering the amount of manual handling required each day, you will need to fill and lift five or six plastic dustbin loads to fill the hopper with $1m^3$ of chips.
A boiler of 100 kW output will require around $3m^3$ per day, which represents a lot of shovelling and lifting! Unless you enjoy manual labour or have a willing team of workers then either a tractor with a front loader or some form of blower or auger system will be needed to lift the chips into the hopper of the boiler. This of course adds to the complexity and expense.

Summary This could be presented as a diagram.
For heating applications below 20 kW a log system is the best solution.
The 'overlap' between log and woodchip systems is between 20 to 75kW. Unless you have your own woodchips then a log system would be the easier and cheaper option up to 50kW, above 50kW woodchip systems will be more convenient.

Resources Section

Advice information and support
Government and Trade supported organisations

British Biogen www.britishbiogen.co.uk/. The trade association for the biomass industry in the UK. Website has useful information on all aspects of heating with wood from logs to chips and information on equipment suppliers; very useful downloadable documents.

Ecodyfi www.ecodyfi.org.uk. Local regeneration organisation for mid-Wales with many interests including a community renewable energy project. Excellent downloadable document on all aspects of wood fuel.

National Energy Foundation, hosts of the Logpile Project. www.greenenergy.org.uk/logpile Project to promote the use of wood fuelled heating systems. Useful information on stoves and heating systems and good links to suppliers. Database of log suppliers for England and Wales, at time of writing no information for Scotland.

Scottish Community and Householder Renewables Initiative (SCHRI). Hosted by the Energy Savings Trust www.est.org.uk/schri . Grants, advice and project support to assist the development of community and household renewable energy schemes in Scotland. Information on wood fuel, solar and wind energy. Managed jointly by Highlands and Islands Enterprise and the Energy Savings Trust.

NGOs National and Local.

Reforesting Scotland www.reforestingscotland.org.uk. Further information can be obtained by contacting the office. Issue 28 of the journal has several in depth articles on wood fuelled heating as well as information on equipment suppliers and other resources.

Highland Birchwoods, www.highlandbirchwoods.co.uk. Partnership initiative to promote the development of a woodland economy in the Highlands. Web pages and downloadable documents on woodfuel.

Centre for Alternative technology, www.cat.org.uk. Welsh-based NGO provides advice on all aspects of renewable energy and sustainability, pioneers of alternative energy systems in the UK. Excellent demonstration site in mid Wales. Mail order calalogue of books and publications on all aspects of renewable energy including wood fuel.

North Highland Forest Trust, www.nhft.co.uk. Independent organisation giving advice and assistance on sustainable forest management in the North Highlands. Very useful downloadable document on woodchip supply chain. (at time of writing North Highland Forest Trust have ceased to exist, but the website is still operational)

Suppliers and installers of burning and processing equipment

3G energi http://www.3genergi.co.uk/ Suppliers of log and woodchip burning equipment. Consultancy and advice on wood processing and drying. Allesudden, Charlesfield, St Boswells, Melrose TD6 0HH. 01835 824201

Fuelwood Harvesting, Supplier of log and chip boilers and stokers. Wood processing equipment: log spliters and wood chippers. Abbey St Bathans, Duns, Berwickshire. TD11 3TX. 01361 840251

Wood energy Ltd. www.woodenergyltd.co.uk. Design, installation and service of wood fuelled heating systems. Information and supply of small scale pellet mills. Pinkworthy Barn, Oakford, Devon EX16 9EU. 01398 351166.