County Clare
Wood Energy Project

A Guide to Wood Boiler Installation

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Who are we?

The County Clare Wood Energy Project (CCWEP) is a Forest Service funded project whose aim is to promote the installation of wood biomass boilers fuelled by wood chip from farm forests in the county. It is managed jointly by Rural Resource Development (the LEADER group in County Clare) and Teagasc.

Since the project was launched in late 2005, CCWEP has worked with a number of companies and organisations in County Clare to identify suitable sites/buildings for the installation of medium sized wood biomass boilers and has provided on-going technical support and training for boiler procurement and installation. Significant work on the establishment of a local wood chip supply chain has also been undertaken.

The service is independent of commercial interests and free of charge.

For more information see www.ccwep.ie

Published by
Clare County Wood Energy Project
Shannon Business Centre
Town Centre
Shannon
County Clare
www.ccwep.ie

Design: Optic Nerve Design Group, www.OpticNerve.ie

Funded by the Forest Service of the Department of Agriculture and Food under the National Development Plan, 2007–2013.

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Frequently Asked Questions

How much wood fuel is available in County Clare?

About 60,000 green tonnes pa of wood is currently available for wood fuel markets without impacting on existing markets, of which only 3.3% is currently being used. Supply figures will increase significantly in the years ahead.

What financial savings can wood energy systems offer?

Wood chip fuel is around half the price of oil for heating in Ireland, although capital costs to install the systems are high compared to fossil boilers. An annual heating bill of €100,000 could be reduced to €50,000.

How much CO_2 can I save?

Wood fuel heating emits the least $C0_2$ per unit of energy supplied of any energy technology.

How much renewable energy does wood fuel provide already?

50% of the EU's renewable energy is provided by wood fuel and 5.6% of the EU's total energy is obtained from wood fuel.

How are wood chips made?

Wood chips are produced by chipping solid wood into small particles. The solid wood is usually air dried down to a suitable moisture content and then chipped by a purpose made wood chipper before delivery to boilers. There are several wood chip suppliers operating in County Clare.

What type of wood boiler should I get?

There is an enormous variety of wood boilers on the market. Most are fully automated and have sophisticated controls. Specifying the correct mix of features and selecting the best supplier is a specialist task. However in principle there two basic choices. An underfed hearth system for smaller systems and drier fuels, and a moving grate system for larger systems and wetter fuels.

What are the maintenance implications of wood energy systems?

Ash will accumulate in the ash bin (under 1% by volume of the wood chip fuel input) and require periodic emptying (typically every 3 months). Boilers with pneumatic cleaning remove most of the airborne ash that accumulates on the inside of the heat exchanger. However a small ash build-up does occur and all boilers should be properly cleaned in accordance with the manufacturers instructions, typically every 500 to 1,500 operating hours.

How much energy does wood contain?

1 tonne of wood chips at 40% moisture content contains 2,929kWh of energy or 2.93MWh of energy. This would replace about 300 litres of oil.

How does wood energy benefit the local economy?

Wood chip energy creates more local employment than any other energy source. It is estimated that 171 people could be employed in the sector in Clare by 2020 if we meet our government target. The total contribution of wood energy to the local economy by 2020 is estimated at €9.8m per annum.

1. Objective of the Guidelines

1.1 Who are these guidelines for?

These guidelines are intended to help energy users prepare, plan and install wood energy heating systems. They cover the standards and best practice specifications for fully automatic stoker wood burning systems that utilise wood chips. They are intended to help any heat energy user in the commercial, industrial and public sector. This would include hospitals, large offices, hotels, educational institutions, process heat users and so on.

The guide has been produced as result of the knowledge gained by the County Clare Wood Energy Project since it commenced its work late in 2005. The CCWEP[1] has been working to facilitate and stimulate the uptake of wood energy in County Clare.

The aim is to provide a user friendly guide to purchasers who have limited knowledge of the technology. It is intended to help them decide what type of system is most suitable for them and to offer practical guidance on design and procurement that can be used to augment professional and specialist input.

The design and installation of wood chip heating systems tends to be more complex and time consuming than fossil fuel heating systems and should only be embarked on with full knowledge of the implications, in terms of the costs and resources required to make it happen successfully. However, these systems are extremely reliable, technically robust and offer substantial energy savings utilising a renewable energy source.

It is beyond the scope of this document to provide a full and detailed technical specification on the design and installation of wood energy heating systems. In all cases it is advised that specialist and expert help is secured as part of the investment and procurement process.

1.2 Why should they interest you?

Modern wood-fuelled heating systems have been developed as an alternative to either oil, LPG, coal or gas fired systems. In this regard they can usually be plumbed directly into existing systems.

They can be operated as independent stand alone boilers; can be installed in series with other biomass or fossil fired boilers; or can be installed in parallel with fossil boilers to operate as the lead boiler. They are fully controllable and entirely automatic using programmable timers and zone thermostats and can be incorporated into building energy management systems.

Wood heating systems are much more expensive to install than fossil heating systems. However they are much cheaper to operate as the cost of wood fuel is lower than all fossil fuels. This means that the existing energy bill (to be replaced) must be large enough to justify the capital investment.

Therefore these guidelines are designed to be used by ‘larger’ heat energy users in the commercial, industrial and public sector. They are appropriate for heat users such as hospitals, leisure centres, schools, offices, hotels, retail, industrial and commercial sites. This could include residential applications where homes are connected to a wood chip fired boiler via a heat network (district heating). It can also include all other forms of district heating where a number of individual buildings are connected via underground flow and return pipes to a central energy centre in the form of a wood fired boiler.

2 Introduction to Wood Heating Systems

2.1 Why does wood energy heating dominate renewable energy provision?

Wood energy dominates the provision of renewable energy worldwide and in the EU. Half of Europe's renewable energy comes from wood. In some countries (such as Sweden, Austria and Finland) about a quarter of all energy used is from wood and on average 10% of Europe's heating needs are met from wood in modern, automated and technically sophisticated wood fired boilers. In operational and commercial terms, wood fired heating is the most mature, reliable and well deployed renewable energy technology.

2.2 What savings can it offer?

Wood chip fuel is around half the price of oil for heating in Ireland, although capital costs to install the systems are high compared to fossil boilers. However wood fired heating is extremely cost effective in comparison with all other renewable energy technology, in terms of installed costs per Kilowatt (kW).[2]

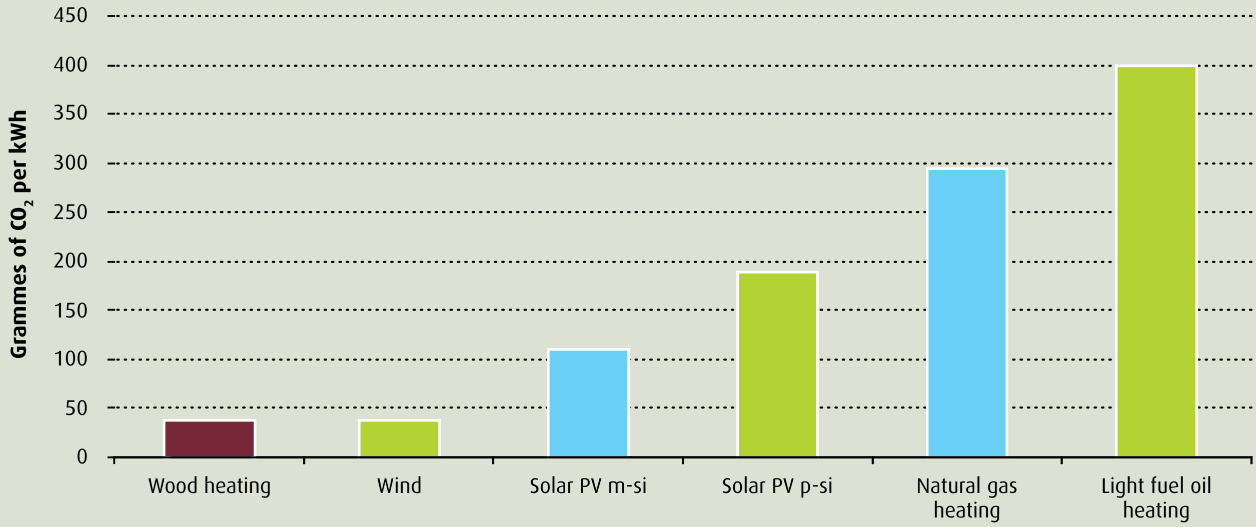
The table below illustrates these costs:

Technology	Cost installed €/kW
Wood Fuel Heating	350 – 700
Gas/Oil Heating	50 – 70
GSHP(geothermal)	1,200 – 2,250
Solar Thermal	3,000 – 4,500
Micro Wind	2,750 – 7,500
Micro Hydro	6,000
Solar PV	10,000

2.3 How much CO_2 can I save?

Wood fuel heating emits the least $C0_2$ per unit of energy supplied of any energy technology. All energy technologies emit some carbon—for example a wind turbine generates a finite amount of renewable electricity over its design life, but requires energy for it to be manufactured, erected and maintained (this part of the carbon footprint is usually termed the 'embedded carbon').

CO_2 emissions per unit of energy supplied



The table[3] above illustrates CO_2 emissions associated with different energy sources based upon this principle.[4]

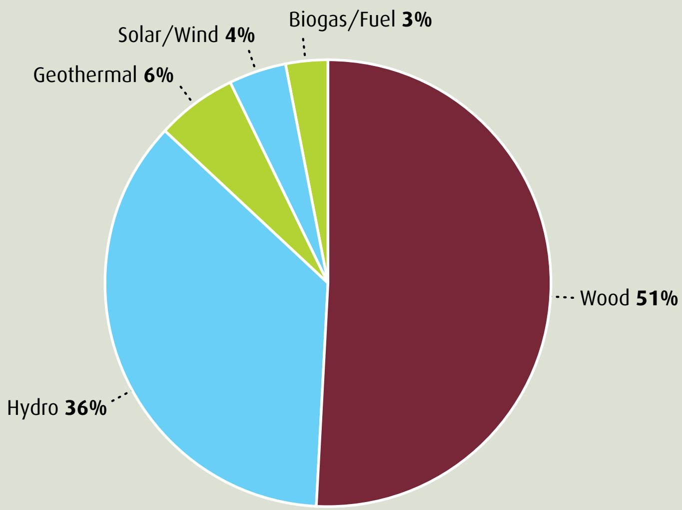
It can therefore be concluded that wood heating offers the best level of $C0_2$ savings of all energy options (renewable and non-renewable) and is the cheapest renewable energy to install per kW. Thus the least cost way of making carbon savings (apart from energy minimisation), is to invest in wood fuel heating.

2.4 How much energy does wood fuel provide already?

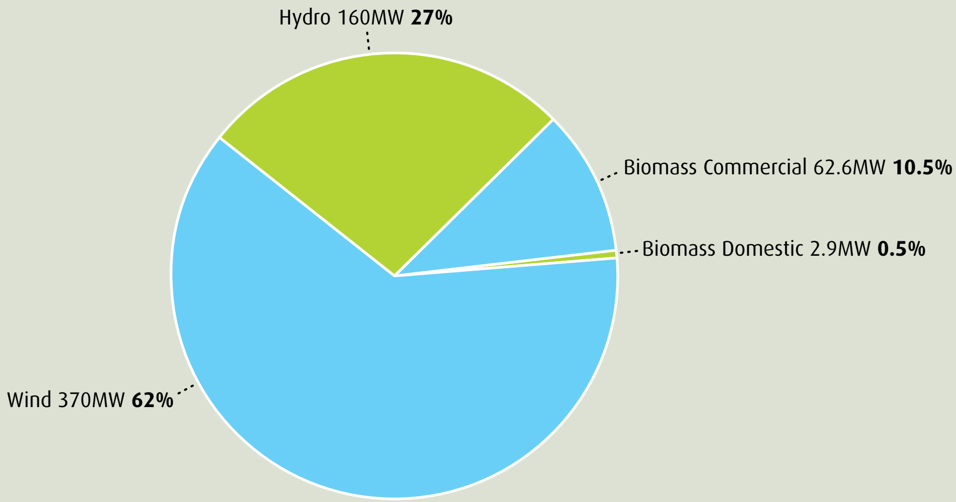
The figures above and the basic cost of fuel compared to gas and oil explain the dominance of wood fuel in the EU renewable energy market. Biomass now provides 7%[5] of Europe's total energy needs. About 80% of the fuel input for biomass is wood, so 5.6% of Europe's energy is obtained from wood.

In total some 100 million green tonnes per annum of wood are used for energy in Europe. The following pie chart illustrates that wood provides over half of all the renewable energy that Europe uses.

Renewable Energy by Sector (EU25)



Renewables installed in the Western Region (MW)



2.5 What is the market situation for County Clare and the Western Region?

Available data shows that for the Western Region (Clare to Donegal), biomass wood projects amount to 65.5MW – or 11% of the installed renewable energy technologies. County specific data is not available, although County Clare probably has a concentration of commercial scale wood chip boilers.

The biomass sector in the Western Region is broken down into three market types;

Large industrial scale (1MW+) 52MW installed

There are 5 large scale installations based at sawmills or panel board mills where the boilers provide process heat for drying or reducing wood chips to fibre. The installations consume about 125,000 tonnes of wood fuel per annum. Most of the fuel is co-product generated on site and a small proportion comes from recycled packaging material.

Medium commercial scale (60kW to 1MW) 10.6MW installed

There are about 30 commercial scale boilers (60kW to 1MW) totaling 10.6MW that have been installed or are contracted to be installed in nursing homes, leisure centres, schools, the agricultural sector and some public buildings. These boilers consume about 10,000 tonnes of wood chip per annum.

Domestic scale 2.9MW installed

The domestic sector, broadly defined as boilers under 60kW rated capacity, are largely installed in the private housing sector. At present there is an estimated 2.9MW of installed capacity driven by the SEI Greener Homes Scheme. The dominant fuel type is wood pellets.

2.6 How much wood fuel do we have in Clare?

15.63% of County Clare is forested, making it the fourth most afforested county in Ireland. It contains 6.8% of Ireland's total forestry resource — 45,000 hectares in total — about half of which is privately owned and half in state ownership. The most distinctive feature of this forestry is that about 70% of it is young conifers. This means that over the coming years the vast bulk of the timber harvest will be small diameter logs. Production forecasts[6] for the county estimate that the total amount of pulpwood timber available for wood chip is forecast to grow from the current 60,000 green tonnes pa to 70,000 green tonnes pa.

Much of this growth in production will be in small diameter logs suitable only for the board mills and fencing markets. This material has a low value and it is very unlikely it will be viable to transport such material to remote markets.

In addition, other production of wood is possible in County Clare and it has been estimated[7] that between 2007 and 2020, 15,000–20,000 green tonnes pa could be available as wood fuel from the tops of trees (under 7cm diameter). Overall it can be concluded that unless new markets for wood emerge in or near County Clare (in the form of new sawmills and board mills), that about 70,000 green tonnes pa of wood will be available for wood fuel markets without impacting on existing markets. The most likely scenario is that if the wood energy market does not emerge, all this available wood will stay in the forest estate.[8]

The local economic benefits of this will be that the county will rely less on imported fossil fuels and use a local resource that has no viable current market. The attendant $C0_2$ savings may also provide economic benefits as the trading of carbon credits becomes bedded into local and regional economies in the future.

2.7 Pellets or wood chips?

Pellets are produced by extruding raw sawdust through a dye. The energy produced in the process causes the natural lignin in the wood to melt forming a solid shiny outer coating. Some manufacturers also add starch or other lignin-based materials.

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 recycling the heavier fractions. In order to meet EU specifications the sawdust also has to be dried to the correct moisture level of approximately 10–13%, before entering the press.

A pellet dye

The capacity of the extrusion plants, known as pellet mills, can vary from 250kg per hour to five tonnes per hour. Large manufacturers will have several machines running continuously. After extrusion, the pellets are cooled and then stored in warehouses or silos ready for despatch either to delivery depots or the customer in covered trucks. Pellets can be manufactured from the following wood sources:

- Virgin sawdust from trees or from processing untreated timber
- Whole tree chippings, including bark
- Recycled wood
- Other biomass material, including straw, coppiced wood, and other recycled material.

Generally however most pellets are manufactured directly from sawdust produced as a by-product of the saw-milling industry.

The following table provides a simple comparison between wood chips and pellets;

Issue	Pellets	Wood Chips
Cost	Pellets are more expensive than chips due to the costs of production and the higher value of sawdust in other markets	Wood chips are usually 20% to 40% cheaper than pellets. This lower cost takes into account the lower energy content of chips per tonne
Energy Content	Pellets contain more energy per tonne than wood chips as they are drier (10% mc)	Wood chips cannot be easily produced below 20% mc and therefore contain less energy per tonne than pellets
Flow characteristics	Pellets flow like a liquid fuel and can be easily transported in lorries with blowers and gravity fed into boilers	Chips do not flow and must be transferred from silos to boilers in augers
Bulk	Pellets are less bulky than wood chips and require smaller less expensive silos	Chips are more bulky than pellets and require larger silos
Boiler requirements	Most commercial scale boilers will operate on pellets or chips. A system designed for pellets will not usually be easily convertible to chips because of the silo and augers required	Most commercial scale boilers will operate on pellets or chips. A system designed for chips can be made to use pellets with very simple modifications
Availability	Not locally produced – must be imported	Widely available
Quality	Main issue with pellets is disintegration in transport and storage. This causes dust that cannot be properly combusted by the boiler	Main issue with chips is particle size and moisture content. Both are fully controllable with purpose made wood chippers and screens, and good logistics in drying
Market applications	5% of the wood energy market is supplied with pellets. Due to higher cost, smaller storage needs and flow characteristics pellets are mostly used in the domestic heating markets	95% of the EU wood energy market is supplied with wood chips and for most public sector, commercial and industrial applications wood chips will be the most appropriate fuel choice

2.8 Special considerations for wood chip systems

1. What are the operational issues?

Properly specified wood chip systems will operate automatically and with the same degree of usability as fossil fuel boilers. However, because they use solid fuel their operation and design is a little different.

Fossil fuel boilers are capable of greater modulation than wood boilers, this means they can respond quickly to changes in demand for heating. However wood boilers cannot reach full power quickly and tend to operate less efficiently if the heating load modulates (has peaks and troughs).

If they operate less efficiently, because of variable load, they will use more wood fuel and this reduces the operational cost saving from switching fuels. To overcome this situation, wood boilers should be fitted with a large hot water storage tank sized by a specialist engineer for that load and heating requirement. This allows the wood boiler to charge the hot water tank and that tank then provides hot water—thus smoothing the load on the boiler. This has a further advantage of allowing the wood boiler to be sized on the average annual heat load and not the peak load. This means the boiler will be smaller and less expensive to install.

This issue also means that buildings with high and stable heat loads (swimming pools for example) tend to show a quicker return on the investment (than for example offices).

2. New Build or Retro-Fit?

Wood chip systems can be installed in a new build project or retro-fitted into an existing building that already has gas or oil boilers. In either case the wood chip system will be providing hot water[9] so the building should have a wet system of radiators.

There is usually an advantage in retro-fitting because the existing boilers can be retained to provide a back-up system and to provide 'peak load' heat. This helps to manage modulating demand on the wood chip system and allows it to be sized for the annual average heat load rather than the peak load.

If a wood chip system is being installed in a new build situation it is usual to install a stand-by fossil fuel boiler at the same time. This replicates the retro-fit situation where the existing boiler performs a peak load and back-up role.

In both cases it is usual to aim for the wood chip system taking 85% of the total heat load over the year.

3. Sizing wood boilers

Wood chip systems are expensive to install. For example a 500kW oil fired system might cost €30,000 to install, whereas a similar sized wood system could cost over €250,000 to install[10]. Traditionally the sizing of fossil fuel boilers has not been a big issue as the boilers are relatively inexpensive and because they modulate it does not matter if they are oversized relative to the heat load.

However with wood chip systems it is very important to match the boiler to the heat load and where there is a peak load back-up boiler, to undersize it. When combined with a hot water tank it is desirable to size the wood boiler based on about 85% of the total annual load.

Sizing should be undertaken by a specialist consultant who can take into account all the factors.

When sizing the heat load for a building in Ireland it is usually calculated to achieve 21°C internal temperature at minus 10°C outside. Typical heat loads are:

- 3 bedroom house = 15kW "peak load"
- Primary School = 50kW – 150kW
- Secondary School = 300kW – 700kW
- Hotel with pool = 500kW – 1,000kW
- Hospital = 800kW – 5,000kW

Full heat load calculations are carried out by calculating surface areas of buildings, calculating the 'U' values[11] of each type of surface (walls, windows etc.) and taking into account 'air exchange rates'. Computer programmes are available to do these calculations. However, a useful rule of thumb is to calculate the volume of the building (in m^3) and multiply by 0.035 to give an approximate heat load in kW.[12]

If historical heating bills are available they provide the most reliable guide to energy use and can be used by a specialist to size a wood chip system. Historical data should show monthly use in litres or therms over a 12 month period to be most useful. If the building is to be changed, extended or modified then this may impact on future energy use and this must be taken into account when sizing the system.

4. Location of the installation

Wood chip systems are much larger than fossil fuel systems and require access by a lorry for fuel delivery. The size of the system depends upon the capacity of the boiler and the size of the fuel silo (a large store that contains the delivered fuel and is connected to the boiler via feed augers), however it should be assumed that a large double garage would accommodate a typical 300kW to 500kW system. The silo would usually be sized by a specialist to contain 7 to 10 days of fuel at peak load conditions. This means that a silo of approximately 70 cubic metres is required for a typical commercial system.

The site should ideally have access to three phase power to operate the wood chip system. Those sites without three phase power can still specify a wood chip system with some modifications.

5. What type of wood boiler?

There is an enormous variety of wood boilers on the market. Most are fully automated and have sophisticated controls. Specifying the correct mix of features and selecting the best supplier is a specialist task. Section 3 of these guidelines deals in some detail with the components of a system. However, in principle there two basic choices;

- An underfed hearth system
- A moving grate system

Underfed hearth systems tend to be smaller and less expensive. They can only use wood fuel up to 35% moisture content as there is no system of pre-drying prior to combustion. For most systems under 500kW it is usually more cost effective to select underfed hearth boilers.

Moving grate designs shunt wood fuel along the combustion chamber and allow it to be dried prior to combustion. This means the boilers are larger and more expensive. However this allows the use of 'wet' fuels of up to 55% moisture content in some cases.

It is important to investigate the availability of fuels locally before selecting a system. Moving grate designs allow greater choice of fuel suppliers — but this comes at a cost.

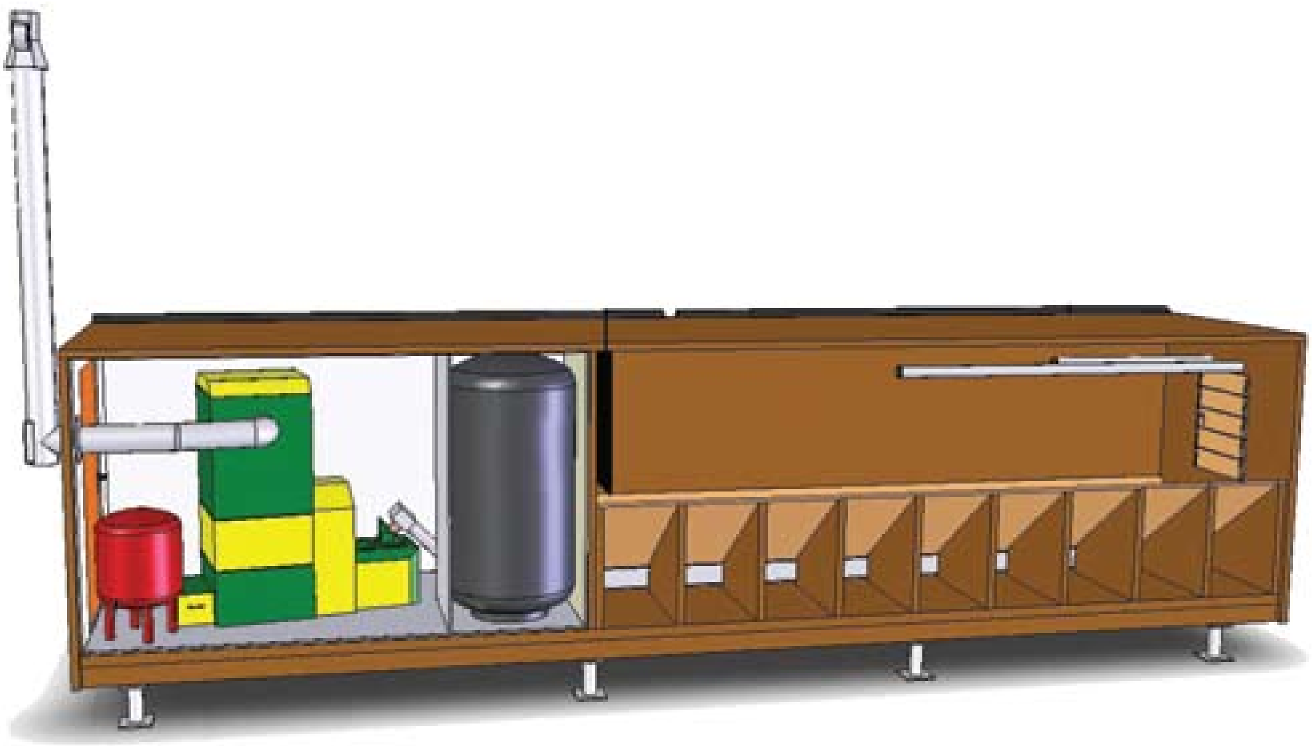
Once the boiler type has been selected and the moisture content of the fuel is known it is important to ensure the boiler control settings are set appropriately for that type of boiler and fuel. Incorrect settings will reduce the efficiency of the system and increase the use of wood fuel. In some cases incorrect settings can cause the boiler to stop working.

A common problem is that fuel is combusted at too high a temperature and causes the ash to fuse into lumps of clinker that can cause mechanical damage to the boiler and ash augers. During the commissioning period these settings can be determined and fixed.

A containerised solution?

Wood chip systems up to about 500kW can be purchased pre-fabricated and fully installed in shipping containers. They come with all the components and include a fuel silo. All that is required is that they are placed onto a concrete plinth and plumbed up and connected to mains power.

Such systems tend to be less expensive than those constructed on site as most of the works can be completed in factory conditions. However they do not provide the optimum solution in terms of the fuel silo as fuel must be dropped into the silo from above and this must be achieved by a blower, conveyor, clam grab arm or other arrangement. This is time consuming and less efficient than direct tipping of fuel into a subterranean (underground) silo.



6. Fuel delivery, storage and handling

The reception, handling and storage of wood fuel in the silo are crucial to the successful and cost effective operation of the system. There are a range of options and designs. The preferred option will be developed in the context of each site and its physical characteristics and be dependant upon the type of fuel supply available locally. Once the fuel has arrived at the boiler site it must be quickly and simply deposited into the silo. This can be achieved in different ways.

Delivery vehicle options[13]

It is important that an investigation is undertaken to determine what types of delivery vehicles are available locally. This might include a tipping wagon, or a tractor and trailer like the images below.

These lorries and the tractor and trailer can contain 7 to 10 tonnes of fuel which would be sufficient for one week in a typical 500kW boiler. Tipping deliveries require a silo or a trough to tip into. A delivery vehicle with a clam grab arm can deposit fuel into an above ground silo where it is not possible to install a silo or trough for tipping deliveries. Using this method increases the time taken for fuel delivery and therefore has an impact on the cost of wood fuel.

Clam grab arm fuel delivery

Fuel handling options

Conveyer or Blower Systems

In simple terms fuel must be tipped into a trough or silo, or dropped or blown into a silo. Wood chip fuel does not tend to blow well and generally this method should be avoided. Because tipping deliveries are simple and effective, some designs provide a trough linked to a conveyor that brings the fuel into a fuel silo. Examples of this type of design are shown below.

Fuel being conveyed

Fuel being blown

These types of fuel handling systems can be noisy to operate and again are not as simple, effective and rapid as tipping fuel delivery.

Hook Lift Bins

Another method of fuel handling is via hook lift bins.

Hook lift bins are delivered filled with fuel and simply attached to a feed auger. The empty bin is then taken from site and refilled off site as needed; therefore two bins are required for continuous fuel supply. For larger boilers a bank of three or more hook lift bins can be installed to provide larger fuel inputs.

Tipping

Delivery of fuel direct into a silo by tipping is usually the most effective method. Below ground silos can be very neat, unobtrusive and can be located in public areas as needed.

2.9 Planning and Regulations

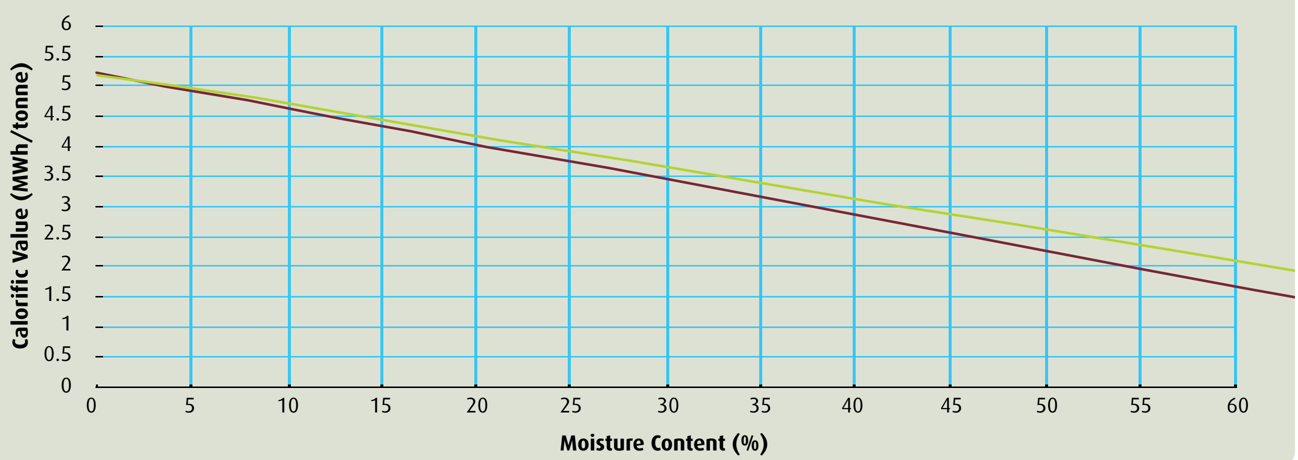
A wood chip system may currently require planning permission. However it is anticipated that most projects will become formally exempt from the need to secure planning permission under proposed changes to the planning regulations in 2008.

If the wood fuel is free of contaminants (i.e. not recycled wood) then there shouldn't be any emissions issues.

2.10 Fuel specification and quality

Moisture Content

The most important fuel quality factor is what kind of moisture content is available locally. The chart below illustrates the impact of moisture content on the energy value of wood fuel.



It shows clearly that the wetter the fuel, the less energy it contains. In practice this means the boiler uses more fuel if the fuel is wetter[14]. Wood fuel is usually purchased according to its energy content rather than by weight or volume. The moisture content of the fuel also affects the bulk density of the fuel. In other words, wetter fuel requires more space in a silo. For example 650 tonnes of wood fuel at 30% moisture content equates to 1,000 tonnes of wood fuel at 50% moisture content, for the same energy content.

Particle Size

The other major factor in fuel specification is particle size. Wood fuel must be provided to a given range in terms of particle size. This is easily achieved by purpose made wood fuel chippers that use purpose made chipping mechanisms and screens. General purpose forestry and agricultural chippers cannot produce properly specified wood fuel. If wood fuel is not chipped to the required particle sizes it will not be able to pass smoothly through the feed augers connecting the silo to the boiler. In particular over size particles can cause augers to block. Equally a high content of undersized particles and dust can create combustion problems as fine particles tend to circulate—rather than combust—in the combustion chamber and cause ash formation and clinker build up.

Contaminants

The other important issue with fuel specification is to ensure the wood chips are free of contamination. In terms of recycled wood this could be nails, metal and other objects, or it could be paints and preservatives in the wood. Clearly, contaminated wood fuel can cause mechanical damage to the boiler system or result in pollution from chimney emissions.

The two most widely used wood fuel standards are the CEN and Onorm specifications. The boiler manufacturer will confirm what wood fuel specification is required by their particular boiler and this specification will normally conform to the CEN or Onorm standards. It is likely that the boiler warranty would be invalidated by the use of incorrectly specified fuel.

2.11 What are the fuel supply options?

There are three basic fuel supply models:

1. A simple wood chip supply contract

2. A wood heat supply contract

3. An energy services contract (ESCo)

1. Wood Chip Supply Contract

In this model the customer owns and maintains the wood fired boiler plant and purchases wood fuel as they might purchase oil. It is normal to buy wood chips per oven-dried tonne (ODT) at a fixed price per ODT. The fuel would need to comply with the boiler's warranty in terms of chip dimensions and moisture content (m/c) and be free from contamination.

2. Heat Supply Agreement

In this model the customer owns and maintains the wood fired boiler plant and a wood heat supplier provides fuel. The customer pays only for heat used. Payment is made via a heat tariff in €/kWh measured at a heat meter attached to the boiler. Sometimes there is also a standing charge for the fuel supplier to maintain the plant.

This model can be varied to suit the customer's needs including the term of the contract, depending on who is responsible for maintenance. It creates a commercial incentive for the wood heat supplier to provide high quality and reliable fuel supply as they only receive payment if the boiler is providing heat. Low moisture content fuel means fewer deliveries and correct chip size means no maintenance call outs, thus keeping the heat supplier's costs down. In this arrangement the heat supplier must be aware that they are paid on the 'boiler side' of the system. This means that they must be confident that the boiler system is performing to a consistent efficiency. The customer is responsible for ensuring that the boiler is serviced and capable of operating at optimum efficiency.

A standard Wood Heat Supply Agreement which is available from the CCWEP can be modified and used to secure tender offers and a fuel supply contract.

3. Energy Services Contract (ESCo)

In this model the supplier finances, owns and operates a wood fuel boiler plant on behalf of the energy customer. Contracts like this usually extend over 5 to 7 years and at the end of the contract period the boiler reverts to the ownership of the customer. The heat tariff is higher as it includes pay-back of the capital cost of the plant. The customer avoids any up-front capital cost. This model might suit customers who cannot finance the heating plant. From the suppliers point of view it requires confidence that the wood heat customer is reliable and able to enter into a long-term contract.

3 Case Study: Clare County Council Headquarters

3.1 How the project was planned

In late 2006, as the construction of their new corporate headquarters in Ennis was underway, Clare County Council approached the CCWEP for assistance with investigating a wood energy heating system. CCWEP provided ongoing assistance in developing project options and by the summer of 2007 the Council had committed to the construction of a wood fuel boiler system to heat their new headquarters. This involved the Council in developing an understanding of the technology and the business case. Part of that process including visiting similar installations in another country.

As this was a new build project being developed under a 'Design and Build' contract with the construction company McNamaras, it afforded the opportunity to fully integrate a wood boiler system into the new development. McNamaras elected to appoint Clearpower Ltd (a specialist wood energy installation company) as the design and install subcontractor for the wood boiler. Large parts of the civils works associated with the installation were undertaken directly by McNamaras.

The system that resulted is a 540kW Kob Pyrot biomass boiler, burning wood chip. The wood chip is stored in an underground fuel silo that allows wood chip to be automatically fed into the boiler via a fuel transfer auger. The system has a gas boiler as back-up.

3.2 How the system works

The wood fuel is automatically moved from the underground silo by means of a feed auger that conveys the material to be burned diagonally from below into the firing system. The material to be burned is then ignited automatically by an electric heat gun. The ash falls into a moveable ash bin below.

The combustion gases rising from the combusted wood fuel in the combustion chamber are swept up by a rotating airflow. The thermal energy from the combustion gases is transmitted to the boiler water in a horizontally positioned pipe-type heat exchanger. A microprocessor control system adjusts the heat output of the furnace in a modulating fashion. It allows:

- Automatic ignition
- Modulating output operation (25–100%) so that low and high demands for hot water can be accommodated
- Automatic re-supplying of fuel by the feed auger from the silo
- Optimised air supply through motor-operated air vents for the best possible incineration, using a lambda sensor

The underground fuel silo allows tipping fuel delivery from a tipping trailer fuel delivery vehicle. This is an efficient and effective method of delivery. The silo has a capacity of 130m^3, which gives a usable volume of 85m^3. This is because the silo is designed with a cone shaped bottom to allow fuel to drop into the augers and because it should have an air gap at the top to ensure the fuel does not become anaerobic and start to decompose. At the maximum specified moisture content of the fuel (at 45%) this is equivalent to 23.5 tonnes of wood chips when full. This amount of fuel equates to approximately 100 full load hours of heat for the boiler. Therefore, during peak heating months the silo will require filling every 10 days.

3.3 How the fuel is sustainably supplied

Following a competitive tender process managed by the CCWEP, the County Council entered into a heat supply agreement with Clare Wood Chip Ltd based in Flagmount in the north east of the county, who supplies all the wood fuel and takes away the ash. The fuel supplier is paid in €/kWh as measured by a heat meter. This means the fuel supplier is fully responsible for the energy content of the wood chips and the County Council only pays for the actual energy it uses.

The boiler will use an estimated 375 to 400 tonnes of conditioned wood chips per annum. This is equal to 550m^3 of round logs. This material is sustainably sourced from locally owned plantations. The delivery distance is 27 miles. The fuel supply is planned on a five year cycle and a total of 135 hectares of forestry is required to ensure that the five year fuel cycle is met[15].

3.4 How the fuel is dried

The timber from forest thinnings is harvested as small diameter logs and transported to the local wood fuel depot in Flagmount. Here the logs are stored outdoors with the cut ends facing south so that the prevailing wind can penetrate the timber stacks. The stacks are also covered with a reinforced, recyclable paper cover to prevent rainfall wetting them.

Fresh timber logs have a moisture content of 50–55%, so the logs must be air dried down to a suitable moisture content of 30–35% before they are chipped. The time required to achieve this is about nine months, although this depends upon site specific factors and climatic conditions. Once the desired moisture content is achieved, the logs are chipped using a fuel wood chipper (Musmax) and stored in a dry shed for onward delivery with a tractor and trailer to this boiler and other customers locally.


HI

4 Procurement Guidelines

4.1 Development of Invitation to Tender documents

The design, installation and commissioning of a wood chip system is a complex and specialist task. It should be undertaken by a specialist wood energy installation company. The complete works should be procured under a turnkey design and build contract. Like any other large capital item it is necessary to secure competitive quotations to ensure value for money and to obtain a reliable and professional company to specify, design and install the system.

To achieve this it is necessary to develop an Invitation to Tender (ITT) document. This should set out in as much detail as possible what is required and seek budget cost estimates and outline design proposals from a range of wood energy installation companies. Ideally the development of ITT documents should be completed by specialists; however it is possible to develop such documents using the information below in these guidelines.

The ITT should cover requirements for tender companies to provide a complete turnkey design and build tender offer for the installation of a wood fired system.

The ITT seeks tenders that provide a budget cost estimate and other quality based details.

Responses to the ITT are used to evaluate tenders and appoint a preferred specialist installer to develop and finalise a design solution as a turnkey package.

4.2 CCWEP Tender Experience

By undertaking this formal process it is possible to secure a better price and verify that the supplier is reliable and experienced. From our experience of managing tenders over the past two years, the CCWEP has learnt that there can be large variation in costs and that this is often associated with the omission of site specific civil engineering and mechanical and electrical works. This is partly because the installers will want to offer what appears to be a low price, but is also because site specific items are much more difficult to price than off the shelf equipment such as boilers, augers and buffer tanks. The areas in which it is advisable to look out for omissions are:

- District heat mains and connections to and from the wood boiler to buildings or existing plant rooms
- Fuel silos and the related feeder mechanisms to the boiler

Another factor which can impact on costs in the tendering process is boiler capacity and type. It is important to look for evidence that the tender has considered the capacity of the boiler and how it will operate in terms of the required heat load. Related to this is that less expensive boilers may be unable to use wood fuel over 40% moisture content. The tender should make clear what range of fuel the boiler can use.

As a result, it is often difficult to make simple price comparisons. Clarity over what is required does help to remove omissions from tender returns—however it remains an issue in how installers respond to tendering opportunities.

4.3 Contents of an ITT

The ITT shall normally contain as much detail as possible on the site of the proposed wood chip system and all details on planned or existing energy use. As a minimum it should contain plans and photos of the site and full details of existing energy bills. It shall state what the tender company must submit, including;

1. Company background and experience

This shall include written details of company history, turn over, range of clients and a description of similar installations. The total number of installations the company has completed shall be provided.

It shall describe the management structure of the company and how it will manage the design and installation of this project if successful. The names of the project engineer and project manager shall be provided along with copies of their CV's. At least two references for similar projects shall be provided. Details of Professional Indemnity and Public Liability insurance cover shall also be submitted.

The company shall confirm that it has the capacity to undertake the design and installation contract to the required timescale.

2. Outline design proposal

This shall include a clear and comprehensive written description of the type of system the company proposes to install, together with a schedule of items and products, and product references for major design items. See page 25 of these guidelines for further details of the design proposal that can be included here and that should be looked for in terms of tender replies.

A schematic layout plan shall be provided, and if relevant, indicative civil works drawings (such as cross sections).

3. Budget cost estimate

A cost breakdown shall include all the main items of the design. It is important to appreciate that most of the cost of a wood chip heating system is not associated with the boiler itself; the fuel handling, storage and reception design is usually more costly. To secure a turnkey price it is important to seek a budget cost estimate that covers all of the required construction works.

4. Other information required

The estimated annual consumption of wood fuel and the specific wood fuel specification shall be provided.

4.4 Tender Assessment Criteria

The tender returns to the ITT should be assessed using pre-agreed criteria. A maximum score of 100% can be achieved and scores can be allocated as follows. It is good practice to state the tender assessment criteria in the ITT.

- **40%—Company background and experience**
  A full and detailed response is required.
- **30%—Outline design proposals**
  Demonstration of a clear design and install intention based upon an effective and well designed solution.
- **30%—Budget cost estimate**
  Value for money and cost minimisation to avoid an over engineered or over designed solution.

4.5 The Procurement Process

The ITT process can provide a budget cost estimate and outline design, and of course identify a specialist installer who is capable of undertaking the work.

Tender Evaluation

The first step after the tenders are returned is that using the criteria above, the tenders should be assessed and a preferred specialist installer should be identified. It is useful to record the tender assessment process. This can be used to demonstrate that a tender process was undertaken as part of applying for the SEI grant. It is often necessary to develop a list of tender questions to clarify missing or unclear aspects of the tenders. On occasions, one or two tender companies can be invited for interview to aid in the selection process.

Tender Process Steps and Timescale

The timescale for tendering should be a three to five week period (depending on size and complexity). It would sensible to allow at least three weeks for tender review and evaluation—mostly because tender questions almost always arise.

This means in practice that the identification of a specialist installer will normally take at least six to eight weeks.

It is important to note that the subsequent appointment of a company to develop a detailed design and finalise a fixed cost as a turnkey package, will take between four to eight weeks. This means that a typical timescale simply to have a final design and fixed cost is generally three to four months.

Furthermore, not all companies are willing to undertake detailed design development ‘at risk’. At that stage a small fee payment could be made to secure commitment and input. Such a payment can be helpful but is not by any means mandatory or widespread. Its greatest benefit is that it should ensure that a period of genuine design development is undertaken so that all the technical issues are resolved before contracts are signed.

Contract Stage

Once a satisfactory and complete design has been produced and assuming the fixed price remains within budget, a contract for installation can be entered into. The installers generally have their own standard contracts and these should be carefully examined for payment terms and exclusions. Most reputable installers use well worded and fair contracts.

SEI Grant

By this stage agreement should be reached on how the SEI grant is to be applied for. Usually the installer will be happy to provide all the technical details for the grant application forms, and indeed, make the application on behalf of the customer. Agreement should also be reached on who is applying for planning permission, should this be required.

The timescale for grant application can impact on when a contract can be signed and commence, as a formal grant offer should normally be secured before a contract is signed.

Ordering and Lead Time

Once the contract is signed the installer will be able to place orders for the long lead time items. This can include the boiler itself and other specialist equipment such as district heating pipes, augers and so on. The lead time of these items will vary—but is typically 10 to 16 weeks.

Construction works for a typical commercial scale boiler will involve approximately 8 to 12 weeks on site.

The whole process of ITT preparation, tendering, design development, grant application, contract finalisation, ordering and site works usually takes between 8 and 12 months.

Boiler Installation and Commissioning

Once the boiler system has been installed it will need to be commissioned. It is important that the installation contract covers this part of process and requires the installer to provide a full commissioning of the boiler system. This will require some liaison with the selected fuel supplier so that a load of wood fuel can be delivered for the commissioning phase and to ensure that the boiler is set up to operate with the particular fuel.

The installer should supply training in the operation and maintenance of the system and hand over a full set of operating manuals. Boiler set up, combustion settings, remote monitoring and integration into existing (or new) building heating systems should be carefully considered. If the boiler is not set up properly, it may not operate efficiently and will use more wood fuel than necessary.

As wood boilers cannot 'modulate' like fossil boilers because they take longer to respond to heating demand in the building, care must be taken to decide when the boiler is set up to start. For example the system might be designed to operate with a buffer tank or in conjunction with a fossil fuel boiler to reduce modulating demand. The settings that allow for this system of operation should be clearly identified by the installer for the building user.

4.6 The Design of 'turnkey' Wood Chip Systems

This part of the guidelines provides a more detailed non technical summary of each aspect of the wood chip system. It can be used to provide a list of details in the ITT that can then be used to secure a cost breakdown. This will allow a fair cost comparison between tender replies. It can also be used to confirm that all aspects of the project are being developed and included by the selected installation company. In seeking quotations it is important that all necessary parts of the system, from the boiler itself to the fuel silo and civil works, are included.

Design, project management and commissioning

The ITT should allow for all design, project management and commissioning costs incurred by the installation company. This would include design of the plant layout, pipe schematics and wiring. It should also include site attendance and production of construction drawings. It should allow for all project management during site construction stage, including management of sub contractors and full commissioning and training. The installation as a whole should include a full warranty that should at least exceed 12 months. Many of the better boiler models now come with five or ten year standard warranties, although this cannot be applied to the installation as a whole.

Make and capacity of boiler

The ITT should seek a detailed description of the make and model of boiler proposed. The following is basic list of standard features for a fully automated wood chip boiler suitable for commercial heating applications. It is important that the design proposals cover each of these or the specifier should be asked to explain why they are to be omitted.

- Stoker auger to transfer fuel from the silo to the boiler
- Burn-back flap to prevent fire in the fuel silo
- De-ashing screw and motor to allow automatic de-ashing of the boiler
- Mobile ash container—300 litres typical for 500kW system
- Auto-cleaning of heat exchanger with a pneumatic cleaning option to reduce the need for frequent manual cleaning
- De-ashing screw and motor to allow automatic de-ashing of the heat exchanger
- Ash box(es) for heat exchanger—60 litres typical for 500kW system
- Auto-ignition system—often x 2 if using wetter fuels on larger systems, to avoid manual start up.
- Induced draft fan to improve efficiencies in combustion of the fuel
- Furnace casing air recirculation to improve efficiencies
- Flue gas recirculation to improve efficiencies and reduce emissions
- Electronic control system for fully automatic operation of the whole system
- Combustion temperature controller to improve efficiencies
- Modem to allow remote monitoring and adjustments

The costs should allow for shipping, delivery, offload and positioning, and connection of the boiler.

Accumulator tank

Accumulator tank is a term for a hot water tank or 'thermal store'. In most installations this will be required to iron out heat load demands on the boiler. Sometimes existing hot water systems have the capacity to carry out this function.

The size should be specified in litres by the installer according to the design and operation of the system. Between 2,000 litres and 8,000 litres might be required for a commercial scale wood chip system.

The costs should allow for shipping, delivery, offload and positioning, and connection of the tanks.

Fuel extraction and transfer

The system should come with a mechanical system for fuel extraction and transfer from the silo to the boiler. This is usually a spring operated extraction system with an extraction auger and motor appropriate for the boiler control system and a safety limit switch. A proven fire protection device should be installed in the down pipe to mechanically separate the combustion chamber from the fuel silo.

The equipment should all be designed, fitted and commissioned within the costs.

Flue / chimney

The installer should size a chimney that is acceptable to the planning authority and allow for supply, erection and installation sized to the boiler.

Mechanical and electrical services

The installer should undertake all required mechanical and electrical services including electrics and wiring from 3 phase power.

All pumps and valves should be provided and installed, together with a heat meter (to measure energy output from the system).

In the plant room all pipe work and insulation should be provided, together with any site specific connections and pipework/pumps.

In cases where the wood chip system is connecting to existing hot water systems the installer should allow for all modifications of that existing system to ensure the proper operation of the heating system.

Builders works

This will usually cover:

- Site preparation
- Construction of the fuel silo
- Foundation / slab
- Steel frame portal barn or other suitable structure (if building boiler house)
- Heat mains trenching

Builders works are of course highly site specific, however the installer should detail out, cost and provide all builders work and if required employ and manage domestic sub contractors to complete these works within the turnkey solution.

It is advisable to allow the installation company some guidance on the fuel silo design, based on developing an outline plan of what could be required. Subterranean fuel silos are usually the most costly approach, but

allow effective tipping trailer fuel delivery. Hook lift bins, or above ground silos are alternatives that usually cost less to install but might not offer the same degree of ease in fuel delivery. The ITT can allow differing options to be priced up for comparison purposes.

4.7 Maintenance and warranty issues

Wood chip systems require a higher degree of routine and annual maintenance than fossil fuel boilers.

Ash will accumulate in the ash bin (under 1% by volume of the wood chip fuel input) and require periodic emptying (typically every 3 months). The material is inert and can be spread back in forests or for other horticultural uses. The fuel supplier can be made responsible for this task at a small cost.

The main task of routine maintenance associated with wood chip systems is cleaning. Boilers with pneumatic cleaning remove most of the airborne ash that accumulates on the inside of the heat exchanger. However a small ash build-up does occur and all boilers should be properly cleaned in accordance with the manufactures instructions (typically every 500 to 1,500 operating hours depending on the task). Routine cleaning includes:

- Cleaning light barriers and inspection windows
- Cleaning of heat exchanger, grate slots
- Cleaning flue fan
- Cleaning re-circulating gas line
- Clean exhaust gas de-duster

These are non technical tasks that could be undertaken by a member of the site staff, or they can be contracted out to the fuel supply or installation company.

An annual service is also required and this is a specialist task to be undertaken by the installation company. The ITT should secure costs for this. It should include:

- Inspection and overhaul of fuel and de-ashing system
- Inspection and overhaul of boiler
- Inspection, overhaul and testing of control system functions
- Boiler run-up test
- Replacement of worn parts as necessary

An optional aspect of a maintenance contract is the provision of remote monitoring. Remote monitoring can avoid costly call outs for faults and increase the operating efficiency of the system. This requires the installation of a remote monitoring kit. Typical items monitored can include;

- Exhaust oxygen levels—operating efficiency
- Exhaust gas temperatures—indicating abnormal running conditions such as burning of unsuitable fuel
- Water flow and return temperatures
- Hours run—indicating requirement for next service
- Other operating temperatures and pressures, level sensors, indicating blockages or other faults

Parameters on the wood chip system may be adjusted remotely as required to maintain optimum efficiency according to changing conditions. Operating inconsistencies are reported to the client for correction.

Appendices

Appendix 1: Wood Energy Conversions

The following table shows the amount of energy in one tonne of wood chips at differing moisture contents. This is shown in GJ's (Gigajoules) and kWh (kilo watt hours). The corresponding solid volumes of wood are also shown in m^3/t.

The 'basic density' of wood varies according to species and growing conditions, fast growing trees tend to have low densities, which has a slight impact on the energy content of the wood fuel. For example at 50% moisture content, conifers have an energy content of about 2.15MWh (megawatt hours) per tonne whilst hardwood has a slightly higher energy content of 2.18MWh per tonne.

MC %	GJ/t	kWh/t	m^3/t
20	14.9	4131	2.00
21	14.7	4071	1.98
22	14.4	4011	1.95
23	14.2	3951	1.93
24	14.0	3891	1.90
25	13.8	3831	1.88
26	13.6	3770	1.85
27	13.4	3710	1.83
28	13.1	3650	1.80
29	12.9	3590	1.78
30	12.7	3530	1.75
31	12.5	3470	1.73
32	12.3	3410	1.70
33	12.1	3350	1.68
34	11.8	3290	1.65
35	11.6	3229	1.63
36	11.4	3169	1.60
37	11.2	3109	1.58
38	11.0	3049	1.55
39	10.8	2989	1.53
40	10.5	2929	1.50
41	10.3	2869	1.48
42	10.1	2809	1.15
43	9.9	2749	1.43
44	9.7	2688	1.40
45	9.5	2628	1.38
46	9.2	2568	1.35
47	9.0	2508	1.33
48	8.8	2448	1.30
49	8.6	2388	1.28
50	8.4	2328	1.25
51	8.2	2268	1.23
52	7.9	2208	1.20
53	7.7	2147	1.18
54	7.5	2087	1.15
55	7.3	2027	1.13

Appendix 2: Explanation of Terms

Auger
An Archimedes screw used to transfer fuel or ash in a wood boiler.

Biomass energy
Biomass can be defined as the biodegradable fraction of products, wastes and residues from agricultural, forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. There is no common definition of biomass fuels, but the following list summarises the main sources[16]:

- Cereal and agricultural crops (straw/Oilseed Rape/ sugar beet etc)
- Spent cooking oils
- Animal slurries
- Solid municipal waste and refuse derived fuels
- Industrial and commercial wastes (particularly from the food sectors)
- Wood

Biomass energy specifically refers to the conversion of these fuels for heat, heat and power and transport fuels.

Blower
A mechanical device attached to a fuel silo or delivery vehicle that is capable of blowing wood fuel into an above ground silo.

Buffer tanks
Also known as a thermal store or an accumulator tank. Used to store hot water produced by a boiler before it is circulated as heating or domestic hot water.

Conveyor
A mechanical device attached to a fuel silo that is capable of conveyng wood fuel into an above ground silo.

District heating
A network of insulated underground flow and return pipes connected to numerous individual buildings supplied with hot water from a central boiler plant. Hot water use is usually metered at each building.

Energy crops
Biomass fuels produced from purpose grown agricultural crops such as sugar beet, straw and fast growing willow coppice.

Fuel silo
A storage container used to store wood fuel before it is automatically transferred into the boiler for combustion.

Gigajoule
A gigajoule (GJ) is a metric term used for measuring energy use. One GJ is equal to:

- 277.8 kWh of electricity
- 26.9 m^3 of natural gas
- 25.9 litres of heating oil

So for example, one tonne of wood chips at 40% moisture content contains 10.54GJ of energy.

Heat exchanger
A system of hot water pipes mounted above the boiler combustion chamber that uses the combustion gases thermal energy to create hot water.

Heat meter
A small electronic device to measure and record the amount of heat energy a boiler has produced based upon flow volumes and return temperature. The output is shown in kWh or MWh.

kW or MW hours
One watt-hour is the amount of energy expended by a one-watt load (e.g. light bulb) drawing power for one hour. For example a 100W light bulb (0.1kW) left on for 10 hours per day will consume 1 kilowatt-hour per day (0.1kW x 10h).

The table below shows the most common multiples and terms:

Multiple	Name	Symbol
1	watt-hour	Wh
1,000	kilowatt-hour	kWh
1,000,000	megawatt-hour	MWh
1,000,000,000	gigawatt-hour	GWh

So for example, 1 tonne of wood chips at 40% moisture content contains 2,929kWh of energy or 2.93MWh of energy.

Mean load
The average load of heat required by a building over a 12 month period. The mean load will be much lower than the peak load. Mean and peak loads are expressed numerically in kW's or MW's.

Oven Dried Tonne (ODT)

As wood chips can be produced and supplied to differing moisture contents it is usual to purchase fuel in ODT's. This means that wood fuel can be purchased according to its energy content. For example 1 tonne of wood chips at 50% moisture content contains much less energy than 1 tonne of wood chips at 30% moisture content. Therefore to provide equal amounts of energy, wetter wood fuels must be used in greater quantity. Purchasers of fuel therefore agree to a price based upon the weight of fuel as if it was being supplied bone dry—although of course in practice it will be delivered and used with a percentage of moisture in it.

Peak load

The maximum load of heat required by a building (usually in winter and with high occupancy) or the maximum output of a boiler. The peak load will be much greater than the mean load. Mean and peak loads are expressed numerically in kW's or MW's. Wood boilers are not normally sized on the peak load. Buffer tanks or back up boilers are used to meet peak loads.

Subterranean fuel silo

An underground storage container used to store wood fuel before it is automatically transferred into the boiler for combustion. Allows fuel to be simply tipped when delivered in lorries.

Wet systems

A system of pipes and radiators to provide space heating in buildings.

Wood energy

A subset of biomass energy. Across the EU 85% of the biomass market is supplied with solid wood biomass—this is about 100 million tonnes of wood.[17] There are four possible sources of solid wood biomass fuel:

- Forestry
- Co-products of sawmill industry
- Post consumer wood waste
- Purpose grown energy crops

Appendix 3: Useful websites and Contacts

Agriculture and Forestry Biomass Network (AFB-Net)	www.afbnet.vtt.fi
Austrian Biofuels Institute	www.biodiesel.at
Bernard Carey	biorenewables@gmail.com
Bioenergy in Finland	www.finbioenergy.fi
Bioenergy Information Network	http://bioenergy.ornl.gov
Bord na Mona Energy	www.bnm.ie
Caddet	www.caddet.co.uk
CARMEN	www.carmen-ev.de
CCWEP	www.ccwep.ie
Charles Parsons Initiative at UL	www.cpi.ul.ie
Clare County Enterprise Board	www.clareceb.ie
Clare Wood Chip Ltd.	www.clarewoodchip.com
Clearpower	www.clearpower.ie
COFORD	www.coford.ie
Coillte	www.coillte.ie
Conness Building Services	ms@conness.biz
Dept. Agriculture, Fisheres and Food	www.agriculture.ie
Energy 4 U	www.energy4u.ie
Environmental Protection Agency	www.epa.ie
ESB Networks	www.esb.ie/esbnetworks
ETSU	www.etsu.co.uk
Farrelly Brothers	farrellybros2@eircom.net
Forestry Commission Scotland	www.usewoodfuel.co.uk
Fraber Enterprises	fraber@indigo.ie
Froeling	www.froeling.com/en/
Geoff Dooley	jgdooley@eircom.net
Green Energy Growers Association	www.gega.ie
Green Planet	www.greenplanet.ie
GreenTec	www.greentec.ie
Imperative Energy	www.imperativeenergy.ie
Igneus	www.igneus.ie
International Energy Agency	www.ieabioenergy.com
Irish Bioenergy Association	www.irbea.org
Irish LEADER Network	www.irishleadernetwork.org
Irish Timber and Forestry	www.irishforests.com
John Torpey	johntorpey@eircom.net
Joule Power	david.joule@joulepower.com
Kane Heating	CathalMcMullan@kaneheating.com
Kedco Power	www.kedco.ie
Kob boilers	www.koeb-holzfeuerungen.com
Limerick Clare Energy Agency	www.lcea.ie
Limerick Institute of Technology	www.lit.ie
Natural Power Supply	www.nps.ie
Newfuels	www.newfuels.org.uk
Powertech	www.powertechireland.com

REIO	www.irish-energy.ie/reio.htm
REMS	www.rems.ie
Renetech	www.renetech.net
Renewable Energy Skills Network	www.renewableenergy.ie
Robin Tottenham	rtotts@iol.ie
Roto Spiral	dpellet@eircom.net
Rural Generation	www.ruralgeneration.com
Rural Resource Development	www.rrd.ie
SEI	www.sei.ie
Shamrock Solar Energies	www.shamrocksolar.com
Stoker	www.stoker.ie
The Sustainable Land Use Co.	www.esatclear.ie/~tbecht/
Teagasc	www.teagasc.ie
Technical Energy Solutions	www.tes.ie
Tekes	www.tekes.fi
University of Limerick	www.ul.ie
Wood Energy	www.woodenergy.ie
Wood Energy Ltd.	www.woodenergyltd.co.uk

Footnotes

1 CCWEP is funded by the Forest Service of the Department of Agriculture, Fisheries and Food (DAFF) and provides commercially impartial advice and help to energy users. The project is jointly managed by Rural Resource Development and Teagasc (www.ccwep.ie).

2 A kW is a term to describe the rated capacity of a boiler, or the amount of heat energy it is capable of providing. Appendix 2 of this guide provides further details.

3 GaBE Project: Comprehensive Assessment of Energy Systems; Dr Thomas Heck, Paul Scherrer Institute, Switzerland, March 2002.; http://gabe.web.psi.ch/lca.html.

Greenhouse Gas Balance of Bioenergy Systems—A Comparison of Bioenergy with Fossil Energy Systems; G Jungmeier, Joanneum Research, University of Graz, Austria, 1999.; Gerfried.jungmeier@joanneum.ac.at.

4 These figures exclude Ground Source Heat Pumps (GSHP's). It can be assumed that due to the need to use mains electricity a GSHP would not improve upon solar. The wind figure relates to large scale wind and so would not be as effective as suggested by this table if micro wind was deployed.

5 EU 25.

6 'A Study of the County Clare Farm Forestry Market' (December 2004), published by Rural Resource Development and written by Purser Tarleton Russell Ltd. in association with Robin Tottenham.

7 By Electrowatt-Ekono and Tipperary Institute 2003—'Maximising the potential of wood energy use for energy generation in Ireland'.

8 This would have serious implications for the forest industry as the forestry would not be properly managed or thinned, adversely impacting on the quantity and quality of the final timber crop.

9 Wood chip systems can also provide 'forced or hot air' blown systems and cooling.

10 This cost is typical and based upon 2007/8 tender returns to the CCWEP.

11 The thermal insulation properties of roofs, walls etc.

12 For example a $200M^2$ house with average ceiling height of 2.2M gives a volume of $440M^3$ and a heat load of 15.4kW. Taking 85% of this load would give a boiler size required of 13kW.

13 On a larger scale delivery wagons with 'walking floors' can be used. These are not covered in this guide as they are usually only viable for very large projects.

14 With more frequent deliveries and or a larger silo required.

15 After 5 years the cycle can be re-started as the woodlands thinned at year 1 will then require a further thinning.

16 It should be noted that woody energy crops are not part of this mix at present.

17 Renewable Energy World July 2005.

County Clare
Wood Energy Project

County Clare Wood Energy Project
c/o Rural Resource Development
Shannon Business Centre
Shannon, County Clare
T: 061–361144
www.ccwep.ie