# Wood to Warmth – Fuel Delivery and Storage

## Notes to accompany Section 5 slides

Michael Beech, TV Energy

This paper provides background and additional information to accompany the presentation slides as Section 5 – 'Wood to Warmth', part of the 6 training seminars delivered in September and October 2010 by TV Energy and the Forestry Commission. These notes should be read in conjunction with the slides.

## Biomass Fuel Delivery, Storage & Transfer

Domestic systems can rely on manual transfer and loading of logs directly into the combustion chamber, or wood pellets from 10 to 15kg bags into the fuel store at the rear of a stove or boiler. For an application of any significant size consuming larger volumes of fuel and which therefore makes use of a larger storage volume not integral to the appliance there will be a need to transfer fuel into the storage area by automated mechanical means.

A fuel storage bunker would normally be located adjacent to the boiler plant enclosure. The fuel store can be either above or below ground, the former is generally simpler and cheaper, the latter more expensive but in the case of woodchip allows the greatest number of fuel delivery options and generally straightforward fuel deliveries.

In the case of woodchip, fuel is often delivered to the fuel store via a tractor-trailer vehicle. An above ground store will require the woodchip to be raised up and delivered in through a roof hatch or opening towards the top of one of the side walls of the store in order to fill the space. This will usually require some form of additional mechanism, usually either a chip blower (integral to the vehicle or a trough-type into which woodchip is tipped), a fixed (on-site) conveyor, a mobile conveyor, or a front loader vehicle to take woodchip offloaded from the trailer onto a hard standing or from an intermediate bulk store nearby. Alternatively, specialist delivery vehicles can be used where available, for example a scissor lift tipping trailer to raise the load to the required height and then tip into the store. All of these options require either the use of additional equipment which add to the overall cost, can be noisy, energy/ labour intensive and time consuming to operate, or requires greater space around the fuel store. The necessity to use a specialist delivery vehicle such as a scissor lift tipping trailer will usually limit fuel supplier options.

The simplest method involving the minimum amount of fuel handling is to chip seasoned roundwood stacked nearby straight into the store. This is usually only an option in cases where there is sufficient space for roundwood storage adjacent to the store and the noise associated with the use of a woodchipper can be tolerated.

A further alternative to deliver into an above ground store is to take advantage of height differences within the local terrain and tip from above, or use a specially constructed bank or ramp against one side of the storage bunker to allow a standard tipping trailer and tractor vehicle to reverse up the slope and tip into the store under gravity.



Supported by INTELLIGENT ENERGY EUROPE

A fuel store located below ground allows direct unloading of fuel from a standard tipping vehicle under gravity. This method provides the ability to accept fuel deliveries from all standard tipping/ moving floor vehicles, including tractor-trailers and tipping pick-up vehicles. An excavated waterproof pit is required in the area adjacent to the boiler house, with sufficient space allowed to auger fuel from the pit base at a maximum angle of around 3o degrees from the horizontal to above floor level inside the existing boiler room where the biomass boiler would be located. The pit would need to be ventilated to prevent moisture build-up (from woodchip drying out) and fitted with suitable hinged or sliding access doors to protect woodfuel from the weather and to allow for efficient deliveries.

Wood pellets delivered in bulk via a tanker vehicle can be simply blown into an above or below ground store, taking precautions to prevent damage of the pellets through impacting the side of the store. The wood pellet delivery tube from the vehicle should be as short and as straight as possible to minimise pellet damage which creates dust causing problems in the operation of boilers.

Biomass boiler installations below around 500kW capacity fuelled by woodchip will often make use of a rotary spring arm agitator enclosed by the fuel store walls, and a screw feed auger feeding woodfuel to the boiler through an aperture within the dividing wall between the fuel store and the main boiler house. This is a simple, effective and relatively low cost method of transferring woodchip from a storage bunker to the boiler, as it largely overcomes the problem of fuel bridging (woodchip does not flow easily) which would otherwise occur if the sweeper arm attached to the feed auger mechanism was not present. An amount of woodchip will remain built up within the corners of the fuel store, this is effectively dead space which should be taken into account within the calculation of the net storage volume of a woodchip store. The maximum storage area which can be accommodated using a rotary arm feeder is around 6m square, this dictates the size of the boiler which can use this type of arrangement as the time period between fuel deliveries and filling of the store would otherwise be too short. It is possible to link two rotary agitators side by side thereby doubling the storage volume; however, the feed auger arrangement becomes more complex. It is important to provide access to the floor area enable essential maintenance to be carried out in the event of auger feed problems.

An alternative arrangement is a walking floor type system operated by hydraulic rams via a power pack, linked to a screw feed auger which feeds the boiler. An above ground store of this type is enclosed on three sides and accessible for woodchip loading through the open side can be used; the woodchip delivery vehicle can reverse onto the walking floor system and either tip or offload from a moving floor inside the vehicle. This is a more expensive option due to the hydraulic equipment required and the need to integrate the walking floor structure into the foundations of the floor but it allows standard tipping trailers and moving floor vehicles to be used with an above ground fuel store. The walking floor mechanism used to convey woodchip is considered by some to be a more robust solution which allows far easier access for maintenance should fuel feed problems arise.

Containerised (hook lift) bins are designed to be filled with woodchip off site, delivered by a dedicated vehicle to a concrete pad suitable for plugging in to a fixed feed auger to the


Supported by INTELLIGENT ENERGY EUROPE

boiler. Sufficient space is needed for 3 bins, alternating between one in situ feeding the boiler, one full and one available to be collected and delivered full as required. The bins are specially adapted and fitted with a walking floor mechanism to ensure the full volume of fuel is used. This type of combined woodfuel storage and feed arrangement is expensive but removes the need for transfer of woodchip from a vehicle into a fuel storage bunker at the site. This operation must be carried out at a fuel transfer station elsewhere, from intermediate fuel store to the container. Containers are prone to damage of the moving floor system and feed auger connection point during everyday handling.

A wood pellet fuelled boiler installation can make use of a vee or cone shape within the lower portion of fuel store which allows fuel to flow under gravity to an auger at the base which then feeds the boiler. Wood pellets flow relatively easily compared to woodchip, the particle size is smaller and of consistent size and fuel feed equipment is consequently lighter weight and less costly.

The woodfuel storage volume within the fuel bunker should be sized to take account of significant demand for heat during a continuous cold spell, as well as the capacities of woodfuel delivery vehicles likely to be used. Each site varies and has its own characteristics however the fuel bunker should ideally be sized to hold a minimum of two weeks fuel supply during a continuous cold period. In the case of woodchip its low energy density may mean that a number of separate deliveries of fuel will be needed during a bunker fill, certainly for larger boiler capacities.

Woodchip delivery vehicles vary in capacity from below 10m$^3$ for a small tipping pick up vehicle, up to 90m$^3$ for an articulated bulker truck with an internal moving floor. Wood pellets can be delivered in bulk in a specially designed tanker vehicle of 16 tonnes (25m$^3$) capacity, or in larger vehicles up to 25 tonnes capacity, each with an integral blower.

| **Woodfuel storage** | | | |
|---|---|---|---|
| | Woodchip (30%MC) | Wood pellet | |
| Estimated peak heat demand (winter design condition) | 12.0 | 12.0 | hrs/day at full load |
| Heat output capacity | 500 | 500 | kW |
| Biomass boiler seasonal efficiency | 88% | 88% | |
| Maximum woodfuel input rate | 568 | 568 | kWh/hr at full load |
| | 172.2 | 120.9 | kg/hr at full load |
| | 2.07 | 1.45 | tonnes/day |
| Estimated bulk density of woodfuel | 0.24 | 0.6 | kg/cu.m |
| | 8.61 | 2.42 | cubic m/day |
| Woodfuel delivery vehicle minimum capacity (min. storage capacity) | 5 | 15 | tonnes |
| Woodfuel delivery vehicle type | tractor/trailer | pellet tanker | |
| | 21 | 25 | cubic metres |
| No. of days of operation at peak heat demand per delivery | 2 | 10 | days |
| Approximate number of deliveries required | 73 | 17 | /yr |
| Depth of woodfuel store | 4.0 | 3.5 | m |
| Internal width of woodfuel store | 6.0 | 5.0 | m |
| Internal depth of woodfuel store | 6.0 | 5.0 | m |
| Internal volume of woodfuel store (gross) | **144.0** | **60.0** | cubic metres |
| Estimated usable volume of woodfuel store | 105.9 | 51.0 | cubic metres |
| | 25.4 | 30.6 | tonnes |
| No. of days of operation at peak heat demand | 12 | 21 | days |



Supported by INTELLIGENT ENERGY EUROPE

In the example above woodfuel storage is sized using a combination of estimated biomass boiler full load operating hours per day/ week and the types and capacities of delivery vehicles likely to be used. The maximum daily number of hours of operation of the biomass boiler is not likely to occur for more than 5 days at any one time and therefore the number of days of operation per woodfuel delivery will be greater than 12 consecutive days (woodchip) or 21 consecutive days (wood pellets), based on the net woodfuel storage volumes shown. A 5tonne delivery of woodchip would be required every 2 days on average during peak heating demand periods, a larger capacity vehicle would ideally be required and this may present difficulties in accessing the site of the biomass boiler. A wood pellet boiler would require a 15tonne delivery every 10 days during a continuous peak heating demand period, this would fill the store as sized above when available to accept a delivery with the store half full with around 16tonnes of wood pellets remaining.

There a number of problems associated with woodfuel storage which can affect the efficient operation of a biomass boiler installation, including:

- Storage capacity too small - requires frequent deliveries
- Difficult access to fuel store – increases delivery times, smaller than optimal capacity vehicles used
- Poor design of access opening into fuel store – chip spillage
- Inadequate ventilation within fuel store – condensation from chip causes drips from roof onto top layer causing wet chip
- Double handling of chip (offloading then delivering into store)
- Inadequate provision made for maintenance access to fuel store, woodchip agitator/ transfer equipment, feed augers
- Fuel delivery and storage are most likely areas for failure of biomass systems, due to poor planning and design





Supported by INTELLIGENT ENERGY EUROPE