Fuel procurement publication



Biomass fuel procurement guide

Key considerations for successful procurement



Foreword

This guide is intended to cover the specification and procurement of biomass fuel and has been produced for the Carbon Trust by SAC Consulting and Black and Veatch.

The guidance should be read in conjunction with the contract templates and guidance available on the <u>Carbon Trust's biomass pages</u>.

Whilst every effort has been made to ensure that this guide along with the supporting online templates and guidance documents is accurate and reliable, this cannot be guaranteed. The Carbon Trust, its agents, contractors, and sub-contractors give no warranty and make no representation as to its accuracy and accept no liability in any way whatsoever for any omissions or errors nor for any losses incurred (either direct or indirect) as a result of the use of this guidance.

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1. Introduction – fuel procurement

This publication is intended to assist fuel procurement and purchase negotiations, and act as a guide for users in securing a sustainable supply of the right quality fuel for their biomass energy project.

Fuel has a major impact on project design and economics and is integral to any successful biomass project. Failure to recognise the importance of fuel may severely limit a biomass boiler's performance.

Fuel type and procurement should be considered as a key issue across all phases of the project, from initial feasibility, through to design and finally at implementation. Failure to do this can have serious adverse effects on the success of a project.

2. Biomass fuel

2.1 What is biomass?

There is a wide range of biomass fuels which can be broadly defined in terms of 'wet' and 'dry'. Under these two broad headings, the fuels can be grouped into five categories:











Virgin biomass

Dry – roundwood, harvesting residues (brash), bark, sawdust, crowns and residues of tree surgery.

Energy crops

Dry – woody energy crops (short rotation forestry, willow eucalyptus, poplar), grassy energy crops (miscanthus and hemp); oilseed crops (rape, linseed, sunflower); and hydroponics (lake weed, kelp algae).

Agricultural residues

Wet – pig and cattle slurry, sheep manure, grass silage. Dry – poultry litter, wheat or barley straw, corn stover.

Food residues

Wet – wastes from various processes in the distilery, dairy, meat, fish, oils, fruit and vegetable sectors.

Waste Wet – sewage sludge. Dry – wood residues from sawmills, construction, furniture manufacturing, chipboard industries, pallets. Much of the biomass material traded for the woodfuel heating sector is:

- Virgin biomass.
- Energy crops.
- Waste wood.

More detailed Information on the nature of these fuels is given in the Carbon Trust's <u>Biomass Heating Guide,</u> <u>CTG012 – Section 2.1</u>

The key to using biomass fuels successfully is to understand their characteristics and their impact on:

- The conversion technology i.e. the boiler.
- Fuel storage volumes and reception/ discharge design.
- Permitting requirements.
- Project economics.

2.1.1 Fuel characteristics

There are numerous characteristics affecting the properties of biomass fuel and these characteristics are often influenced by the source of the feedstock.

Feedstock characteristics that have a bearing on boiler choice, system design and overall project performance are:

- Moisture Content (MC) as a % of weight which directly affects the Net Calorific Value (NCV).
- Bulk density.
- Particle size or dimensions.
- Fines as a % of weight.
- Mechanical durability (pellets only).
- Additives (normally pellets only).
- Contaminants.

For easy reference the key characteristics of a number of biomass fuels are shown in Table 1 along with fossil fuel comparisons:

Table 1: Bulk and energy density of different fuels¹

Fuel	Calorific value	Calorific value	B dei	ulk nsity	Energy by vo	density lume	Energy by vo	density lume
	MJ/kg	kWh/kg	kg	J/m ³	MJ,	/m ³	kWł	n/m³
			low	high	low	high	low	high
Wood chips (30% MC)	12.5	3.5	200	250	2,500	3,125	694	868
Log wood (stacked – air dry: 20% MC)	14.6	4.1	350	500	5,110	7,300	1,419	2,028
Wood (solid – oven dry)	18.6	5.2	400	600	7,440	11,160	2,067	3,100
Wood pellets	17	4.7	600	700	10,200	11,900	2,833	3,306
Miscanthus (bale – 25% MC)	12.1	3.4	140	180	1,694	2,178	471	605
House coal	29	8.1	8	50	24,6	650	6,8	347
Anthracite	32.1	8.9	1,	100	35,3	310	9,8	808
Oil	41.5	11.5	8	65	35,8	398	9,9	972
Natural gas	_	_		_	3	6	10	.13
LPG	46.9	13	5	00	23,4	472	6,5	520

2.2 Where do woodfuel and biomass feedstock come from?

While Table 1 details the fundamental characteristics of some biomass fuels, their origin can influence their moisture content, likelihood of contamination, and cost to end users. Table 2 highlights these key characteristics of fuel prices for biomass material based on its source:

Table 2: Biomass feedstock – provenance and general characteristics

Feedstock/ biomass fuel	Source	General characteristics	Price	Competing markets for feedstock or processed material
Virgin wood pellet	Multiple pellet manufacturers using clean wood waste/timber processing co-product and sometimes virgin timber.	 Premium fuel suitable for all applications but more expensive than woodchip. 	+++	Panelboard manufacturers, paper sector, animal
	Available from:	• Suited to sites where fuel storage is constrained because higher energy density means less storage		bedding and litter.
	Established network of pellet producers	is required compared to woodchip.		
	 Franchised pellet suppliers. 	 Economically better suited to smaller scales of application (<200kW) where the cost differential between woodchip and wood pellets is less marked unless fuel storage space is an issue. 		
		 Homogeneous fuel therefore handles and burns predictably. 		
		• Very low ash content.		
		 Internationally traded commodity. 		
		• Closest to oil in terms of convenience.		

Virgin woodchip	 Produced from forestry operations by chipping the low value material from existing timber operations, small diameter wood, branches, etc. Available from: Forestry management companies/ forestry contractors and other land-based businesses that have diversified into the biomass market. Dedicated biomass fuel brokers who pool woodchip from several different suppliers. 	 Not all virgin wood is the same quality or specification. Specification can vary according to moisture content and grade (size of chip). The price is typically influenced by moisture and size specification, and distance to the point of use, with specifications governed by an EU standard. Variable ash content. Established markets for regional fuel supply with national suppliers also able to service larger volumes (>1,000tpa +). 	++	Paper sector, panelboard manufacturers.
Energy crop woodchips	 Energy crops are specifically grown for fuelling energy facilities. Options range from woody willow crops to grasses such as miscanthus. Available from: Established producer groups which have a large established focus 	 Woody biomass crops can be used in biomass boilers for heating. Woody biomass crops are processed to a similar specification as woodchip (governed by an EU standard). Grasses such as miscanthus are not suitable for your your bailars due to problems with the second seco	++	Alternative use for land to produce conventional crops. Miscanthus can be used for equine bedding.
	market which supported their original establishment.	physical characteristics and volumes of ash.		

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Agricultural residues (dry)	 Most common feedstock is straw either for use in bale form or for further processing to produce pellets. Available from: Farmers and agricultural brokers with an established supply chain, 	 Straw has high alkali metal and ash content. Variable pricing in that price is lower than woodchip but this is subject to harvest & weather conditions which can inflate prices at times of poor harvest. Can only be cost effectively automated at the medium-large scale (500kW+). 	+	Animal bedding; some agricultural residues are used in animal feed production.
	with regional availability governed by the prevailing growing conditions (soil, climate etc).			
Waste wood	Clean wood waste is subject to permitting conditions (See <u>section 2.3.1</u>) and may comprise construction waste,	 Level of wood treatment will vary and may include such elements as fungicides and paints. 	+/- Animal bedding and mulch (high valu markets) Panel-boar	
	pallets and manufacturing off cuts.	 Treated wood falls under the Waste Incineration Directive. 		market (for better quality waste wood).
	 Authorised waste management companies that have diversified into biomass supply. 	 Clean wood waste free of contaminants may be used in wood boilers, but will be subject to LA/EA/SEPA permitting depending on scale (See <u>Appendix A</u> <u>section 2.3.3</u> for more detail). 		
	 Furniture manufacturers and other businesses working with wood 	• Dust may be an issue in processing.		
	or producing wood as a waste (e.g. cable drums).	 Low price but subject to quality control risks. 		
	 Dedicated biomass fuel brokers that have secured contracts for clean wood waste from a waste operator. 			

Mixed waste, solid recovered fuel (SRF) Mixed waste/SRF is again subject to permitting conditions (See <u>section 2.3.1</u>) and may containof wood products that have some level of contamination (e.g. paints, chemicals, treatment etc.).

Available from:

- Authorised waste management companies that have diversified into biomass supply.
- Biomass content is eligible for financial incentives but the biomass content of mixed waste is difficult to demonstrate and will be subject to on-going permitting audit.
- If contamination is present and cannot be controlled the conversion technology must be compliant with the Waste Incineration Directive (WID).
- Waste biomass may offer a low or negative price but any fuel price benefit may be eroded by the necessity to install WID compliant plant and on-going monitoring requirement; this is likely to make the use of mixed waste at small scale (<3MW) uneconomic.

Often already in long term contract to landfill or incineration.

SRF production is increasing.

2.2.1 Fuel standards

Table 2 shows that there is a wide range of biomass feedstock available for energy use however it is critical that all parts of the boiler and material handling system suit the characteristics of the fuel.

Whilst all biomass material can be burnt, one fuel specification is not necessary suitable for all boiler equipment or fuel handling. It may, for example, cause blockages in the fuel feed system, inefficient operation, emission problems, condensation in the flue, or automatic shutdown of the equipment as it moves outside its design operating parameters.

To facilitate selection and equipment compliance, a set of European biomass fuel standards has been developed, and fuel quality assurance schemes have been set up to ensure compliance with these standards by the suppliers accredited under these schemes.

2.2.1.1 Standard fuel specifications

The European Committee for Standardisation (CEN, under committee TC335) published 27 technical specifications for solid biofuels during 2003-2006. These technical specifications have now been updated to full European Standards (EN). The two primary technical specifications deal with:

- i. Classification and specification (EN14961); and
- ii. Quality assurance for biofuels (EN15234).

Within these standards there are multiple sub-standards dealing with specific issues but Part 1 – General Requirements of EN 14961-1 includes all solid biofuels and is targeted at all user groups. This should be used as a key reference guide. The classification of solid biofuels is based on their origin, and the fuel production chain should be clearly traceable from source to the point of use.

Normative specifications for wood chips include:

- Origin.
- Particle size (P16/P31.5/P45/P63/P100).
- Moisture content (M20/M25/M30/M40/M55/M65).
- Ash content (A0.7/A1.5/A3.0/A6.0/A10.0).

Normative specifications for chemically treated wood or used wood include:

• Nitrogen (N0.5/N1.0/N3.0/N3.0+).

Informative specifications for wood chips include:

- Net energy content (lower heating value (LHV)) as MJ/kg or kWh/m³ loose.
- Bulk density in kg/m³ loose.
- Chlorine content (CI0.03/CI0.07/CI0.10/CI0.10+).
- Nitrogen (N0.5/N1.0/N3.0/N3.0+).

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

EN14961-1 covers the following traded forms of solid biofuel:

- Briquettes.
- Pellets.
- Woodchips.
- Hog fuel.
- Firewood.
- Sawdust.
- Shavings.
- Bark.
- Bales (straw/miscanthus/reed canary grass).
- Energy grain.
- Olive residues.
- Fruit seeds.

When investigating fuel options, it is important to:

- i. Establish whether prospective fuel suppliers are familiar with the CEN fuel standards and supply to the stated standards.
- ii. Understand what standard fuel specifications are available as this will impact the type of equipment used.
- iii. State the standard fuel specification in the fuel procurement contract.

Table 3: Example fuel specification

Specification of fuel to be supplied

Fuel to be supplied must be from legal and sustainable sources to BS EN 14961-1:2010

	Specification	Tolerance
Size	P45B ²	Main Fraction ³ (min 75% w%) shall be: 8 < Particle size < 45mm ⁴
		Coarse fraction as a w% and max. length of particle, (mm): ≤ 6% > 63mm
		Maximum of 3.5w% > 100mm: All < 350mm
Moisture	M50 ≤ 50	Minimum 40%
	At point of commissioning	Average 45%
	and for all supply thereafter	Maximum 50%
Ash content/weight	A1.5 ≤ 1.5%	
Fines content by weight	Fines fraction (< 3.15mm) to be < 8%	
Material density	BD350	

Further information –

on these standards may be found at the **Biomass Energy Centre**

Since the introduction of these standards in 2010, any previous national standard has been withdrawn or adapted to suit the new pan European EN standard. Previous national standards which have been used and whose reference may still be in circulation include:

- ÖNORM The Austrian Standards Institute is ÖNORM. Many Austrian boilers have been installed in the UK and specify fuel according to ÖNORM M7 133 for wood chips (Woodchips for energy generation: quality and testing requirements) and ÖNORM M7 135 for pellets.
- DIN The German Standards Institute (Deutsches Institut fur Normung) also developed its own biomass fuel standards DIN 66 165, and these are sometimes encountered.

- ² Property classes P45B, P63 and P100 are for industrial appliances.
- ³ The numerical values (P-class) for dimension refer to the particle sizes (at least 75 w-%) passing through the mentioned round hole sieve size (CEN/TS 15149-1). The cross sectional area of the oversized particles shall be P45 < 5cm².
- ⁴ For logging residue chips, which include thin particles like needles, leaves and branches, the main fraction for P45B is 3.15 < P <45mm.</p>

2.2.1.2 Fuel quality assurance

In parallel with the fuel standards, as the market has developed there are two quality assurance schemes that have emerged and these are:

- i. HETAS Solid Biofuel Assurance Scheme

 HETAS have developed an assurance scheme built on the CEN standards from CEN/TC 335, that allow the consumers to identify suppliers who have been accredited as operating a quality assurance scheme compliant with the fuel standards.
 (www.hetas.co.uk/fuel-guality).
- Woodsure Woodsure is a UK-wide woodfuel quality assurance standard. This not-for-profit scheme provides a straightforward, thorough procedure for assessing the quality of woodfuel supplied for use in biomass boilers. (www.woodsure.co.uk/index.htm).

These are voluntary schemes that fuel suppliers sign up to and are intended to provide reassurance to customers purchasing biomass fuel that the material being supplied has been accredited as quality compliant by an independent third party.

2.2.1.3 Fuel sustainability

Biomass fuel from unsustainable sources risks the undermining of the environmental case for solid biomass use for heat and power. For this reason sustainability standards are gradually being developed to ensure that biomass is only derived from sustainable, legal sources.

This is especially important in the procurement process for larger sites seeking to secure Renewable Heat Incentive (RHI) payments, as RHI participants are obliged to provide sustainability reporting for all solid biomass combustion plants with an installation capacity of 1MW and above, including those which are not using ancillary or contaminated fuel (i.e. the installation uses only virgin biomass materials).

RHI participants will be required to report on sustainability information on a quarterly basis, as part of the RHI Participant's periodic data submission, and will be obliged to provide information against the criteria detailed in Table 4. This requirement should also be addressed in any fuel supply discussions.

Table 4: Sustainability reporting for ofgem

Element	Detail	Example
Biomass type	The material from which the biomass was composed.	Wood
Biomass form	Manufactured form of the biomass.	Wood pellets
Mass		Numeric figure
By-product	Whether the biomass was a by-product of a "process" (as defined in the Regulations).	By-product of the paper production process
Biomass derived from waste	Whether the biomass was derived from waste.	n/a
Country of origin	Where the biomass was plant matter or derived from plant matter, the country where the plant matter was grown.	Spain
Country of purchase	Where the information specified in the row above is unknown or the biomass was not plant matter or derived from plant matter, the country from which the participant obtained the biomass.	Germany
Energy crop (including types and proportions)	 Whether any of the consignment was an "energy crop" (a term defined in the Regulations) or derived from an energy crop and, if so: The proportion of the consignment which was or was derived from an energy crop. The type of energy crop contained in the assignment. 	n/a
Environmental quality assurance schemes	Whether the biomass or any matter from which it was derived was certified under an "environmental quality assurance scheme" as defined in the Regulations and, if so, the name of the scheme.	UK Forestry Standard/UK Woodland Assurance Standard (UKWAS)
Land use	Where the biomass was plant matter or derived from plant matter, the use of the land on which the plant matter was grown since 30th November 2005.	Used for forestry purposes

2.3 Fuel designation – permitting

When procuring fuel it is important to understand its classification for permitting reasons, as this may impose conditions on boiler plant and flue gas cleaning equipment.

2.3.1 Permitting - fuel classification

For permitting reasons, biomass fuels generally fall into three categories, depending on whether the fuel is classified as waste, and whether it falls under the Waste Incineration Directive (WID):

- i. Virgin fuels e.g. fuels derived from fresh timber.
- ii. Waste or waste derived fuels which are exempt from WID e.g. agriculture residues.
- iii. Waste or waste derived fuels which are covered by WID e.g. treated wood waste.

Extensive guidance on the WID and classification of material in relation to WID is available from Defra⁵. The Waste Framework Directive (WFD) is the overarching legislation that governs this issue. It states that 'for the purposes of the WID, waste is "any substance or object... ...which the holder discards or intends or is required to discard" (Article 1(a)) EC Waste Framework Directive (WFD) ⁶'.

To complement the WFD Defra has published separate guidance on the definition of waste⁷ and the associated publication ⁸ states in paragraph 3.28:

"Plants treating only wood waste, with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood-preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste, are excluded from the WID"

Separate information from NetRegs (the official guidance for small and medium-sized businesses advising on how companies can comply with environmental law) confirms that there are a number of specific wastes excluded from the scope of WID, some of which apply directly to the biomass sector ⁹.

These are:

- Vegetable waste from agriculture and forestry;
- Wood waste (with the exception of wood waste which has been treated with wood preservatives or coatings containing halogenated organic compounds or heavy metals).

Finally, the Environment Agency has confirmed their position on the use of biomass, stating¹⁰:

Virgin timber is timber from:

- Whole trees and the woody parts of trees, including branches and bark derived from forestry works, woodland management, tree surgery and other similar operations (it does not include clippings or trimmings that consist primarily of foliage, although these make very poor fuel).
- Virgin wood processing (e.g. wood off cuts, shavings or sawdust from sawmills) or timber product manufacture dealing in virgin timber.

⁵ Environmental Permitting Guidance The Directive on the Incineration of Waste – <u>http://www.defra.gov.uk/environment/policy/permits/documents/wid-guidance.pdf</u>

⁶ Environmental Permitting Guidance – Waste Framework Directive (Updated October 2009) – <u>http://www.defra.gov.uk/environment/policy/permits/documents/wfd-guidance.pdf</u>

⁷ Available at www.defra.gov.uk/environment/waste/topics/index.htm#what

⁸ <u>http://www.defra.gov.uk/environment/policy/permits/documents/wid-guidance.pdf</u>

⁹ <u>http://www.netregs.gov.uk/netregs/62987.aspx</u>

¹⁰ <u>http://www.environment-agency.gov.uk/static/documents/ps005_2077240.pdf</u>

Virgin timbers are not waste and are not subject to waste regulatory controls, provided they are certain to be used for purposes to which virgin wood is commonly put. These include use as:

- Fuel in an appliance.
- Woodchip in gardens or on pathways.
- A raw material for composting.
- Animal bedding.
- A raw material for the production of wood-based products.

However, if virgin timber is mixed with waste timber or any other waste, the mixed load is classed as waste. Non-virgin timber may be either treated or clean.

- Clean non-virgin timber is any timber/timber product that has not been treated.
- Treated non-virgin timber is any timber or timber product that has been chemically treated (e.g. to enhance or alter the performance of the original wood).
 Treatments may include penetrating oils, tar woil preservatives, waterborne preservatives, organic-based preservatives, boron and organo-metallic based preservatives, boron and halogenated flame retardants and surface treatments.

The implications of these classifications for permitting are given in <u>Appendix A</u> <u>section 2.3.3</u>.

2.3.2 Permitting – thermal rating of plant

The thermal rating of the plant dictates the required permit. The regulatory thresholds apply to the thermal input of the plant and to the cumulative total of the combustion plant on a site regulated under a single permit In England and Wales the Environmental Permitting Regulations (EPR) came into force on 6 April 2008 (replacing 2000 PPC Regulations). The regulatory regime applicable to different biomass plant and fuels is shown in section 2.3.3. Elsewhere in the UK the comparable regulatory system is referred to as Pollution Prevention and Control (PPC). In Scotland all installations are regulated by the Scottish Environmental Protection Agency (SEPA), with no Local Authority (LA) involvement¹¹.

2.3.3 Permitting regime

Fuel scenario	Plant size	Pollution regulation applicable	Regulator
Virgin biomass – biomass fuels	< 20 MWth	Clean Air Act	Local authority
e.G. Coppice willow, and fuel residues of a similar nature	20-50 MWth	LA-PPC (Part B PPC)	Local authority; SEPA/NIEA
arising from the manufacture of these fuels	> 50 MWth EPR	EPR (Part A1); PPC (Part A) in Scotland & NI LCPD also applies	Environment Agency/SEPA/NIEA
Waste or waste derived biomass	<0.4 MWth and <50 kg/hr	Clean Air Act	Local authority; SEPA
exempt from WID and fuel residues of a similar nature	0.4-3 MWth or 50-1000 kg/hr	LA-PPC (Part B PPC)	Local authority; SEPA/ NIEA
arising from their manufacture	> 3 MWth and/ or 1000 kg/hr	EPR (Part A1); PPC (Part A) Scotland & NI	Environment Agency/SEPA/NIEA
	> 50 MWth	PR (Part A1); PPC (Part A) Scotland & NI. LCPD applies	Environment Agency/SEPA/NIEA
Waste or waste derived biomass	< 3 MWth	WID applies: LA-PPC (Part A2)	Local Authority; SEPA; NIEA
to which WID applies	> 3 MWth	WID applies: PPC (Part A)	Environment Agency/SEPA/NIEA

Notes:

a) The above is true for stand-alone combustion plant and incinerators.

b) All plant rating is thermal capacity; figures apply to the thermal input of the plan.

c) LA-PPC:Local Authroity Pollution Prevention and Control.

d) EPR: Environmental Permitting Regulations.

e) WID: Waste Incineration Directive.

f) LCPD: Large Combustion Plant Directive.

2.4 How much biomass fuel will the system use?

The amount of fuel used by the facility and the seasonal variation in demand for biomass will depend upon the overall heat profile and the sizing strategy applied when designing the wood-fired boiler installation. Table 5 shows the energy content of common fuels.

Table 5: Calorific value of fuel

Fuel (as received)	Calorific value		Energy densi	Energy density by volume	
	kWh/tonne	kWh/litre	kWh/m³ (low-high)	
Wood chips (30% MC)	3,500	-	694	868	
Log wood (stacked – air dry: 20% MC)	4,100	-	1,419	2,028	
Wood (solid – oven dry)	5,200	-	2,067	3,100	
Wood pellets	4,700	-	2,833	3,306	
Miscanthus (bale – 25% MC)	3,400	-	471	605	
House coal	8,100	_	6,847		
Anthracite	8,900	-	9,	808	
Oil	11,500	11.2	9,	.972	
Natural gas	-	-	1	0.13	
LPG	1,300	7	6,	520	

3. Engagement with fuel suppliers

It is important that the developer of a biomass heating installation discusses the needs of the heating system with fuel suppliers as early as possible in the process.

These discussions should cover the amount of biomass required, the demand profile, the locally available resources and quality requirements. The fuel supplier should also provide details of his fuel supply, delivery vehicles and preferences for notice period and contract type. These elements need to be discussed from the outset, as they have an important relationship to the design and installation of the facility.



Figure 1: Fuel supply interactions with design

3.1 Boiler selection and permitting

Liaison with the fuel supplier is essential to define the most appropriate boiler specification and comply with any consenting requirements. It is important to understand:

• The types of biomass fuel available

Depending on geographic location, the selection of biomass fuels may be limited, or there may be specific concentrations of a biomass type which may suggest one fuel type should be considered over another e.g. straw rather than more conventional woodchip. Not all boilers can burn all types of fuels, and therefore it is important that you understand what fuels are available to you, and select the boiler accordingly.

 Grades of fuel available – The grade of a particular fuel will also dictate boiler choice and the fuel feed mechanism. The higher the grade, the easier the fuel will be to handle and the lower the overall cost of the system. Any competent fuel supplier should be able to provide a listing of the fuel standards that they supply. If this is not the case, it raises doubts about their ability to provide a consistent fuel supply and their overall quality assurance and control systems. It is vital that any fuel delivered to your system is within with the boiler specification. Failure to adhere to fuel specifications mayinvalidate equipment warranties.

- Moisture content (MC) and likely variance Biomass boilers often have a limited MC tolerance for the fuels which they can burn and therefore not only should one consider the stated MC of the fuel supply but the likely variance. Boilers are often categorised according to the type of grate, and this dictates the moisture tolerance of the fuel that they can burn:
 - Smaller boilers with underfed grates often have a maximum fuel MC of 30-35%.

- Reciprocating grate systems can accept fuel with a MC of up to 60%.
- Stoker burners have a maximum fuel tolerance of around 25%.
- **Source of the material** Provenance will be important on three counts:
 - Sustainability reporting for systems over 1 MW to draw down Renewable Heat Incentive payments.
 - Permitting requirements if the material is derived from a waste stream (See <u>section 2.3.1</u>).
 - An indicator of the likely level of contaminants (e.g. stones in straw and brash chip from forestry operations, or plastics and nails if the source is from the waste sector). The higher the probability of contaminants, the more robust the fuel handling and combustion system required.

• Details of quality assurance procedures –

If the fuel is sourced from a feedstock where the risk of contamination is high, you should explore how well that risk is managed by the fuel supplier to limit damage to any equipment. Ask if quality assurance is accredited by a third party or if it is managed internally. When sourcing clean wood waste from a licensed waste operator this is especially important, as any contravention will render a biomass installation illegal and may significantly harm the internal parts of the boiler (e.g. if plastics are included then the higher combustion temperature may cause damage to the grate, or result in harmful chemical reactions with the combustion chamber refractory).

 Contact existing customers of the biomass supplier – Request references and ask customers supplied by the fuel supplier whether they are happy with the level of service provided and the quality of the fuel.

Guidance on boiler options and relevant permitting is provided in the Carbon Trust's <u>Biomass</u> <u>Heating Guide, CTG012</u>.

3.2 System design – fuel storage and reception area

Engagement with the fuel supplier is essential to inform the requirements for fuel storage, reception and discharge. Consider:

- The types of delivery vehicles used The access requirements for an 8 wheel tipping trailer are quite different to the requirement for an articulated walking floor truck. Each delivery vehicle will have practical requirements which will need to be considered as part of the general arrangement of the reception area, and the design for vehicle discharge of fuel into the store, including:
 - Weight requirements (e.g. loading for a drive-on walking floor).
 - Height requirements (e.g. for tipping trailers).
 - Axle and clearance requirements (e.g. for tipping trailers).
 - Delivery reach (e.g. for blown pellet deliveries).
 - Safe turning circles and manoeuvrability (e.g. articulated or rigid lorries).
 - Safe access for the vehicle to site.

- Volume of fuel deliveries possible Delivery vehicles will have varying volume payloads and this will affect both the price of the fuel and the overall fuel storage requirement. Delivery vehicles will need to discharge a full load, as part load delivery is not practical (with the exception of pellet blown deliveries or bale deliveries). The fuel store should offer sufficient volume for a full load delivery, and a minimum of 30% extra to ensure that a buffer of fuel can be retained while a full load is delivered.
- Practical aspects of fuel behaviour For instance, when discharging woodchip, the material has a natural angle of residence rather than spreading evenly like a liquid. This should be factored into the fuel store design so that any calculation of storage volume accounts for "dead spaces" which result from the fuel flow characteristics.
- Mechanical durability of the fuel This is a particular issue for wood pellets where a fuel store may have to accept blown fuel deliveries and mitigate the risk of fuel disintegration at the point of fuel charging (e.g. install impact sheets to reduce pellet damage and the resulting dust).

- Health and safety requirements Fuel store reception areas and storage should take account of the mitigation requirements to manage the risks associated with:
 - Explosion risk for pellet deliveries.
 - Underground bunkers/confined spaces.
 - Working at height.
 - Reversing and tipping.
 - Manual handling etc.

These practical considerations will influence the design and arrangement of the biomass fuel store and reception area, and will consequently influence the long term cost of the biomass fuel. Whilst developers may seek to minimise costs by accepting the lowest capital cost design, an assessment of the whole-life costs of a project will show that the cost of the fuel in most cases will outweigh the capital cost over the lifetime of the boiler installation. Guidance on differing fuel delivery methods and their physical requirements are provided in the Carbon Trust's **Biomass Heating Guide, CTG012**.

3.3 Economic appraisal and contract negotiation

When assessing the economics of a biomass installation is is important to engage with the fuel supplier. The fuel cost is an important consideration as it is the biggest expenditure over the lifetime of the plant, often far outweighing the original capital cost of the installation. Information to gather from the fuel supplier includes:

- The price of the delivered material.
- How the material is to be priced (£/tonne or £/kWh).
- The minimum delivery quantity/payload to achieve competitive pricing.
- The difference in fuel costs between optimal delivery sizes and deliveries constrained by reduced fuel store storage volumes.

Finalising the contract with a supplier can take several months from the first contact to signature. If there are particularly complex contractual arrangements (e.g. forward pricing), then purchasers are advised to engage with prospective fuel suppliers well before the proposed installation date.

For significant volumes of fuel, purchasers are advised to conduct a financial check on the supplier to ensure that the company is able to service the contract and is financially reliable.

Very simple practical considerations will ensure both the success of the biomass system and minimise the lifetime cost of the fuel supply.

3.4 Needs of the fuel supplier

During the procurement process, prospective purchasers should be conscious of the needs of the fuel supplier. Biomass fuel is a bulk commodity and it may be subject to significant lead times due to:

- The scale of the fuel demand for any one contract – Larger contracts for fuel supply will have longer lead times as fuel suppliers will have to arrange forward purchase of material to give confidence of supply.
- Higher specification fuel (e.g. fuel with lower MC) – Freshly felled timber needs to be seasoned to achieve lower moisture contents. Timber can require several months of seasoning (it can often take 12 months or more to reduce the MC of freshly felled timber to 30% MC, although this varies with local conditions). If a fuel contract requires a lower MC specification then the fuel supplier will have to plan several months or even a year ahead to ensure the specification is met.

Other areas of discussion:

- What notice period is required by the fuel supplier to ensure that they are able to deliver fuel? A biomass installation may have a set delivery schedule but should extra deliveries be required, for example as a consequence of unusually high heat demand, then a purchaser should understand what notice period is required by the supplier to be able to service any unscheduled deliveries. This is particularly important in the winter months when fuel suppliers with several customers will experience high demand.
- What are the preferred contract terms and minimum contract length? – This is particularly important if the fuel supplier has to invest in forward purchase of feedstock material and increased chipping or storage capacity or new delivery equipment. The fuel supplier may request a minimum of 3-5 years contract length if this is the case.

3.5 Procurement is a gated process

At the initial appraisal stage several fuel suppliers should be contacted to understand what type and grade of biomass feedstock is available as well as which transport logistics, payloads and prices are realistically achievable. Information about how to identify suppliers is given in <u>Section 4</u>.

The information gathered at this initial appraisal stage will then dictate the optimum fuel store volume, reception arrangement and boiler choice to give the most cost effective biomass installation. Prospective fuel purchasers should be aware that installation contractors are sometimes on a fixed price contract, and may be incentivised to select the lowest cost option. In some instances this may incur higher long term costs by restricting fuel supply options.

As the project moves from feasibility to design and then to final fuel contract award, the field of potential fuel suppliers reduces as part of a managed process avoiding poor design and planning. This process is described in Table 6 on page 27. During this process the fuel purchaser's understanding of the design and cost consequences of their fuel selection increases.



Figure 2: Gated process of fuel discussions and procurement

It is highly recommended that an element of flexibility is built into the design of a system, otherwise the choice of fuel supplier is constrained. The fuel purchaser may be tied into a monopoly situation for several years if alternative fuel suppliers are not able to meet the needs of a particular boiler, for instance low moisture content specification or a particular fuel store/reception arrangement.

Table 6: Staged process – the procurement of biomass fuel

Stage of project	Suppliers engaged	Nature of engagement	Impact of information
Feasibility	Several	Several suppliers are contacted to gauge available fuel supply and the details of their supply capability (type of fuel available; grade and specification, delivery vehicles, prices).	Informs the preliminary design of the system, with the boiler selection and general arrangement allowing sufficient flexibility so that c.3 fuel suppliers may still be engaged.
Design	c.2-3 suppliers	Further information is sought from fuel suppliers to allow more detailed design work and to establish the performance specification of the system which will be released to installers/primary contractors for the installation.	Engagement will centre around all the items addressed in sections 3.1 to 3.4: the design of the fuel store volume, arrangement for discharge into the fuel store, manoeuvring requirements for vehicles, cost effective payloads and the variance of the fuel grade that will need to be accommodated by the boiler.
		and it is strongly recommended to engage with fuel suppliers throughout this design process as they are experienced in what will or will not work and the implications for fuel supply logistics and cost.	This information will serve to refine the final specification to ensure that a value engineered solution is chosen.

Stage of project	Suppliers engaged	Nature of engagement	Impact of information
Procurement	c.2-3 suppliers	The purchase of fuel is subject to competitive tender to ensure that the best price is provided by the fuel supplier. To assist the purchaser to set out the specification for the fuel supply the Carbon Trust has prepared a qualification document which may be appended to any formal tender procedure (available from the <u>Carbon Trust website</u>).	The tendering process will be the purchaser's opportunity to solicit a competitive price from the fuel supplier and this will inform the final business case for the biomass system. Within this tender, the final fuel grade can be selected with acceptable variances as described in <u>section 2.2.1</u> . Tender responses can then be evaluated.
Contract Award	1 supplier	Following the selection of the preferred supplier the final contract is negotiated and then signed.	The scope and the conditions of supply can be incorporated in the final contract and this will tie
		A number of fuel suppliers have standard contracts, however in the event that these are not suitable or are absent, template fuel contracts can be downloaded from the <u>Carbon Trust website</u> .	both parties to mutually acceptable terms to which they must adhere.

4. Identifying suppliers

There are a number of websites signposting prospective purchasers to fuel suppliers providing logs, wood pellets and woodchip, as well as other fuel options (e.g. briquettes and straw). Fuel supply signposts include:

4.1 The national biofuel supply database

The National Biofuel Supply Database

is a search engine based on Google Maps which has been developed by the Carbon Trust and the Forestry Commission's Biomass Energy Centre. The database is the most comprehensive list of fuel suppliers in the UK, and builds on the central and regional efforts of the Forestry Commission and various forestry trade associations.

Fuel suppliers can upload their details of log, wood pellet, woodchip and briquette supply across the UK into the interactive database, allowing users to locate biomass fuel supplies according to type and location. Contact details are held for each supplier and they may include details of their delivery payloads, vehicle delivery options, contract options, grades of chip and pellet as well as the typical moisture content

Figure 3: National biofuel supply database



of their chip supply. Any designations or accreditations with which they comply, such as the HETAS Solid Biomass Assurance Scheme, Woodsure and the ENplus designation for wood pellets are also included. The databse is intended to help biomass developers locate fuel, and to assist in raising the key issues that should be considered when designing and installing a biomass boiler and fuel reception/storage arrangement.

4.2 National market places

Other national based websites signposting prospective purchasers include:

- www.nef.org.uk/logpile
- www.bigbarn.co.uk/logpile
- www.pelletcentre.info
- Forestry Commission Biomass Energy Centre links to regional databases include:
 - Woodfuel Wales
 www.woodfuelwales.org.uk
 - Wood Energy Scotland
 www.usewoodfuel.co.uk

4.3 Regional activities

If there is not an obvious or established fuel supply available, further investigation at a regional level will usually identify one or more suppliers. There are a number of organisations which may assist in locating an appropriate fuel supply. These include:

- The <u>Forestry Commission</u> via their regional offices.
- The <u>Confederation of Forest Industries'</u> <u>Woodfuel Suppliers'</u> Group.
- Country Land and Business Association

4.4 Private timber companies

If none of the above suggest fuel suppliers in the area, prospective fuel purchasers could contact local forestry related businesses such as:

- Sawmills.
- Forestry contractors.
- Tree surgeons.
- Agricultural machinery rings.

If these potential suppliers are not already producing biomass fuel, then they may not be familiar with the requirements of the market. A prospective fuel purchaser should establish the supplier's ability to provide fuel which is compliant with market standards (<u>section 2.2.1</u> and <u>section 3</u>).

4.5 Straw

Straw and other agricultural residues are alternative biomass fuels to woody feedstock. The British Hay and Straw Merchants Association can be contacted at <u>www.hay-straw-merchants.co.uk</u>

5. Prices – what to expect

5.1 Price trends

2011 prices for biomass fuels fall between just under 1p/kWh for fuel derived from the WID waste wood to over 4p/kWh for premium wood pellets. The figures in <u>Table 7</u> should be considered as a broad benchmark; it should be noted that there are short and long term trends that will impact these prices:

- The short term trend suggests slowly increasing prices due to:
 - Increasing supplier/transport costs.
 - Fuel demand will increase as a consequence of the RHI.
 - There will be an increase in competing uses for the raw material.

- The long term trend suggests that market activities will stabilise prices:
 - Overseas pellet production is increasing dramatically (e.g. 6M t/pa from Canada over 2011).
 - Vast quantities of good quality chip is available from overseas.
 - Import opportunities for biomass fuels will limit UK price increases for wood fuels over medium term.
 - Economies of scale and production efficiencies will help to lower production costs.

Table 7: Typical input prices for a range of heating fuels (2011)

Fuel Type	£/tonne delivered	p/kWh input
30% m.c. roundwood chip (G30/P16)	80-110	2.3-3.1
40% m.c. roundwood chip (G100/P63)	45-75	1.8-2.3
50% m.c. whole tree chip	40-60	1.8-2.7
30% SRC chip (G30/P16)	90-115	2.6-3.3
Good quality pellets – 10 tonne blown deliveries winter (10% m.c.)	170-200	3.6-4.3
Seasoned Softwood Logs	80-150	1.9-3.6
Seasoned Hardwood Logs (20%)	90-180	2.2-4.4
20% m.c. clean (non-WID) waste wood chip (G50/P45)	25-50	0.7-1.2
WID waste wood chip (20% m.c.)	20-25	0.5-0.6
Wheat straw (20%)	50-60	1.4-1.7
Heating Oil	55-72p/litre	5.2-6.8
LPG	45-62p/litre	6.3-8.7

5.2 Delivery distance versus discharge time

Delivery cost is not necessarily proportional to delivery distance, the time taken for one full delivery can have a more significant impact on the overall cost of the fuel and influences fuel suppliers' pricing strategy. Prospective fuel purchasers should aim to achieve the minimum overall delivery times to achieve competitive fuel pricing.

The design of the facility and discussion with the fuel supplier should inform the most cost effective solution for filling the fuel store from the delivery vehicle. Vehicles will have a range of discharge rates depending on the size and model, and therefore this should also inform the final selection of fuel supplier (subject to the space restrictions on the site).

Figure 4: Correlation of logistic discharge & cost



Example:

Take an example of a pellet blower lorry where:

- Fixed Costs = c. £300/day often spread over first 2 loads/day.
- Variable cost = fuel plus O&M costs c. £1/mile + £40/hr for blowing.
- Case 1 30 mile round trip (= 1 hour loading/ unloading, 1 hour driving). Cost to operator = \pm 120 fixed cost plus \pm 50 variable cost = \pm 170/ load.

Case 2 – 60 mile round trip (as above but two hours driving) = £180 fixed plus £80 variable costs = £260/load.

Conclusion: Total time taken for deliveries is most important factor for delivery costs.

5.3 Seasonal variations

Variations in the cost of biomass fuel supply will be most pronounced for fuels which require undercover storage, such as wood pellets or woodchip of <35% MC because suppliers have limited storage and want cash flow in the summer months when there is a reduced demand for the biomass fuel.

If a purchaser has storage capacity on site there is a cost advantage to purchasing fuel in the summer and holding this on site for use later in the year. For instance, bulk deliveries of wood pellets in summer can sometimes be bought at a 20% discount to winter prices. In some applications, where there is a year-round fuel demand, good discounts can be negotiated in the overall price of the biomass if the purchaser has significant fuel consumption outside the peak heating season. This is particularly the case for the pellet market.

5.4 Fuel contracts

The Carbon Trust has prepared template fuel contracts to assist in the final contract award. These are available at the <u>Carbon Trust website</u>.

These guidance templates and associated notes are intended to assist with the completion of the specimen supply contract for biomass by weight or volume. Neither the specimen contract nor the notes are intended to be prescriptive, and consideration must be given to site specific issues and the supplier/end user relationship.

Both parties are advised to seek legal advice before entering into a legally binding contract.

General points to consider within the negotiation and contract terms are:

- Agreement on the most appropriate indexing for the cost of the biomass fuel over the course of the contract.
 Possible indexing metrics may be:
 - Diesel costs, as these are a significant factor within overall production and delivery costs.

- CPI (non-energy industrial goods) price inflation which is a common index metric.
- Raw materials (major cost to chip producers) with some agreed method of evidence, e.g. the Forestry Commission timber price index.
- The length of contract term, as some woodchip suppliers are willing to sign up to 5 year contract terms with indexation. Examples include:
 - Base Price is current chip price +10% (margin allows producer to lock-in wood producers using back-to-back contracts);
 - 10-15% of Base Price index linked to diesel costs.
 - 85-90% of Base Price index linked to CPI (NEIG).

6. Defintions

Calorific value is a measure of the energy content of the fuel. It is the quantity of heat generated from a unit of fuel by its complete combustion. The calorific value of a fuel is expressed either as:

- Gross Calorific Value (GCV) (or Higher Heating Value HHV).
- or Net Calorific Value (NCV) (or Lower Heating Value LHV).

Net Calorific Value (NCV) is the quantity of heat released by the complete combustion of a unit of fuel when the water vapour produced, as a consequence of the combustion of the hydrogen atoms in the fuel and the vaporisation of the moisture in the fuel, remains as a vapour and the heat of vaporisation is not recovered. This can be calculated by subtracting the heat of vaporisation of the water produced from the GCV. This value is generally the key parameter for biomass heating systems. **Gross Calorific Value** (GCV) – is the quantity of heat released by the complete combustion of a unit of fuel when the water vapour produced is condensed, and the heat of vaporisation is recovered. The water is condensed by bringing the products of combustion (flue gases) below 100°C (as in a condensing boiler). This generally does not apply for biomass as the flue gases cannot be cooled below ~130°C, and hence the water vapour cannot be condensed. For wood, GCV is usually 6-7% higher than the NCV.

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