Biomass prices in the heat and electricity sectors in the UK

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E4tech

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1 Executive Summary

This report gives the results of two short studies carried out in 2009 to estimate the prices paid for biomass by the UK heat and electricity sectors in 2010 and 2020. Current prices were obtained through literature research and interviews with suppliers and users, and considered to be valid for 2010. For the heat sector, prices in 2020 were calculated via a bottom-up approach, adding supply chain costs and margins to the production costs of marginal UK feedstocks and international imports. For the electricity sector, market structure trends were reviewed to give an indication of future prices.

Key findings for the heat sector

Pellets:

- Currently, most of the pellets used for heating in the UK are imported.
- Bulk delivery is significantly cheaper than bagged delivery, with current prices ranging from £188-240/odt for bulk, compared with £228-299/odt for bagged, including VAT.
- In 2020, imported pellets are estimated to be slightly more expensive (£204-276/odt for bulk, £242-317/odt bagged) than pellets from UK energy crops (£182-218/odt bulk, £213-249/odt bagged). Further analysis could use this full range of prices, although it is important to note that there could be be available UK resource towards the lower end.

Chips:

- Currently, all of the chips used for heating in the UK are UK-sourced, usually locally within a small radius.
- Margins for chip suppliers are currently very low.
- Chips are more expensive to transport than pellets (by mass or energy content), as they are less dense.
- Current prices seen by domestic/small commercial users are £107-159/odt, and £80-120/odt for larger commercial users, excluding VAT.
- In 2020, imported chips are estimated to be much more expensive (£164-220/odt) than chips from UK energy crops (£111-138/odt), hence are unlikely to be used for heating.

Key findings for the electricity and large CHP sectors

- Current delivered biomass prices for the UK electricity sector are £30-65 /odt (ex VAT) for UK feedstocks, which includes virgin woodchips from forestry residues, arboricultural arisings and roundwood logs, recycled waste wood and agricultural residues. Very few plants currently use energy crops or UK-sourced pellets.
- Current prices for imports were converted to delivered prices from CIF prices at a UK port by adding £15-25/odt. This gave a delivered price range of £105-135/odt for imports, which includes agricultural processing residues, wood chips and pellets. The UK is expected to be increasingly reliant on biomass imports in the future.
- The type of contracts varies between users:

  - Co-firers use a mixture of fixed contracts and purchase on the spot market. Spot market prices have been increasing, and this is expected to continue for both imports and UK feedstocks. However, the reduction in co-firing ROCs has significantly reduced UK co-firing volumes.
  - Dedicated biomass power plants prefer long-term contracts in order to secure supplies, and some larger plant developers are investing upstream and in local biomass supplies.
- It was not possible to project prices to 2020 using a similar bottom-up approach to that used for the heat sector. This is because the electricity sector uses a broader range of feedstocks and has far fewer players and less transparent supply contracts than the heat sector, making identification and modelling of a typical supply chain difficult. As a result, it would be more appropriate to use a scenario based approach based on insights from the analysis of current prices. The main uncertainties in the sector are how changes in the wholesale power price and ROC banding will alter plant economics and hence willingness to buy particular feedstocks, whether the many large planned projects proceed, and how successful plants are in building infrastructure and stimulating local biomass supplies, particularly of energy crops.

Use of these results

In both sectors considered, there are a range of supply chains for biomass feedstocks, and different structures within them. There is also considerable uncertainty over the potential for supply of biomass feedstock globally, and the magnitude of competing demands globally, and in the UK. These uncertainties mean that future analysis will need to rely on price ranges, as suggested here, to reflect different potential outcomes by 2020.

2 Introduction and scope

In early 2009, E4tech completed a project for DECC on biomass supply cost curves, which assessed the costs of biomass from UK and imported sources, out to 2030[1]. This analysis was based on production costs alone, for a large number of different feedstocks and end uses, and did not include storage costs in some cases, or profit margins. Modelling undertaken by NERA & AEA for DECC on renewable heat in the UK required current and future biomass prices, in order to assess the costs of biomass heating in domestic and industrial/commercial applications. As a result, a short piece of work was commissioned to estimate likely biomass prices for heat in 2010 and 2020. A further piece of work then assessed current biomass prices for the electricity sector, to feed into further DECC work on that sector. The approach taken was agreed with DECC in a series of meetings. This report combines the results of both pieces of work on biomass prices.

The UK Heat Sector

For biomass feedstocks used in the heat sector, we estimated prices at two points in time: 2010 and 2020. These prices are applicable for all heat-only plant, and for Combined Heat & Power (CHP) plants up to a scale of around 3MWe / 10MWth.

For 2010, we assumed that the current prices paid by biomass users for heating were the best estimate. We assessed prices for:

- Domestic heat – chips and pellets
- Industrial and commercial uses – chips

This was done based on publicly available market information, and discussion with those working in the sector. The reason for using this approach for 2010 is that a bottom-up analysis of prices for the feedstocks currently used in heat applications, such as residues from wood processing, arboricultural arisings, forestry residues and recycled wood from UK and imported resources could be very difficult. This is because for many feedstocks there are likely to be hidden costs that would be difficult to estimate accurately, and also because it would be difficult to assess the influence of competing demands on the price.

For 2020, a bottom-up analysis of prices was needed, as it would be difficult to project current prices forwards. This was done based on our previous cost model, with additional costs added for the biomass supply chains considered, and profit margins and subsidies added. This gives a 'willingness to supply' price, rather than considering potential higher prices as a result of competing uses for the feedstock. Additional costs were largely based on literature and industry data, and margins were based on industry data and interviews. We agreed to focus on the feedstocks that might be marginal in 2020, i.e. those most likely to set the biomass price. These were considered to be UK energy crops, and imported woody biomass, as these both have a proportion of their resource at the higher end of the cost curves previously developed, and have a large potential resource. Note that some of the forest biomass resource may have costs at the high end of the range, and this is also possible for

[1] DECC (2010) "The Renewable Energy Strategy (RES)" webpage, Available at: http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx

other resources if their hidden costs are very high, although they are likely to have a smaller resource.

The UK Electricity Sector

For 2010, the approach adopted could not follow that used for the heat sector, as biomass prices in the large scale electricity sector are much less transparent. To estimate prices currently being paid we therefore interviewed a range of power generators, including co-firers, dedicated biomass plants and the few CHP plants using biomass feedstocks. This gave a good coverage of UK large power plants across a range of scales. The prices gathered are applicable for all electricity-only plants, and for Combined Heat & Power (CHP) plants above a scale of 3MWe / 10MWth.

For 2020, it was not possible to use a bottom-up approach as in the heat sector, because of key differences in the market structure. For example, the prevalence of long term contracts, with companies establishing bilateral contracts with suppliers, makes it difficult to establish a clear relationship between price and feedstock costs. There are also far more feedstock types, and fewer generators in the electricity sector, hence a typical supply chain would be harder to define. Furthermore, it is more uncertain how this sector will develop in the future. As a result, it would be more appropriate to use a scenario based approach based on insights from the analysis of current prices.

3 The UK heat sector

3.1 2010 prices, based on current biomass prices for heating in the UK

3.1.1 Pellets for domestic heating

In this section, we review the prices currently paid by domestic customers for biomass pellets, and discuss the reasons for the range of prices seen. This section was informed by literature research, responses to the DECC consultation, and discussions with:

- National Energy Foundation and Pellets@las project (NEF, 2009)
- A major UK wood pellet supplier (pers. comm., 2009a)
- A UK woodfuel supply chain expert (pers. comm., 2009b)

Around 539,000 oven dry tonnes (odt) of wood pellets were supplied in 2008, of which around one sixth were produced in the UK (Forestry Commission, 2009a). Pellets are used for heating in the domestic and smaller commercial sectors, as a result of higher energy density, and so lower space requirements, and lower maintenance requirements than installations using chips.

Table 1 shows the range of pellet prices currently paid by domestic and small commercial heat customers in the UK. Note that these prices do not apply to large industrial uses, e.g. co-firing. The price paid ranges from £147-221/t for bulk pellets (orders of several tonnes of loose pellets) and £180-310t for bagged pellets (orders of 10kg bags on a pallet).

The best source of data on UK pellet prices is the Pellets@las project, which has complied monthly data on pellet production and use, and on prices across Europe over several years. These data are at the high end of bulk prices, and in the mid range of bagged prices. The UK data is provided by the National Energy Foundation, through surveys and internet research covering around 50% of the market for bulk pellets and 25% of the market for bagged pellets. The suppliers covered are considered to be representative of the market (NEF, 2009). These surveys are likely to cover the suppliers listed in the table below, but we also looked into the charging models of suppliers individually in order to assess the main factors that affect the price paid.

The main factors affecting the price of pellets are:

- Form: bulk delivery is significantly cheaper than bagged delivery. This is a result of lower costs (bagging, transport and unloading) and also of lower margins than those charged by some retailers of bagged pellets. Bulk delivery requires suitable storage at the customer’s site, which is not possible in some cases, as a result of space restriction, but also has not been a priority for those installing the systems. Installers are now moving towards encouraging customers to include storage, to be able to take advantage of the lower price of bulk deliveries, where this is possible. The current proportion sold bagged is not known (NEF, 2009), but is estimated to be around 2/3 of the market (pers. comm., 2009a). How this will change in the future will depend on the uptake amongst larger users with space for bulk deliveries e.g. off gas grid users, and uptake amongst smaller users requiring bagged pellets e.g. in urban areas.

Table 1: Current (valid for 2010) UK pellet prices for domestic and small commercial use

Form	Cost £2009/t inc VAT			Source	Date	Notes
	Low	Central	High			
Bulk	173		194	RHI response 2009a	Sep-09	Variation with order size: high is for 5-10t, low for 16t+. VAT added to data given
	179		221	4wood heating	May-09	
		194		Biomass Energy Centre, 2009b	Aug-09	VAT added to data given
		221		Pellets@las	Jun-09	50km delivery, 5t. Coverage is 50% of market.
		203		Forever Fuels	Sep-09	Standard price for 50km delivery, 5t.
	147		189	RHI response 2009b	Jul-09	5-20t blown delivery for commercial pellets, VAT added
Bagged		250		Pellets@las	Jun-09	Weighted average, covering 25% of market. £40/ t delivery added to data given (NEF assumption)
	184		236	4wood heating	May-09	Boiler supplier.
	210		260	RHI response 2009a	Sep-09	Variation with retailer and delivery distance
	275	275	310	Forever fuels	Sep-09	Standard bagged price, variation with delivery distance- the majority of regions pay the low price
	180		250	RHI response 2009b	Jul-09	Boiler supplier. Domestic delivery 1-5t. Assumed bagged

- Quantity: bulk delivery prices decrease significantly with the quantity ordered, for example, delivery charges may be applied per delivery, rather than per tonne, and discounts are available on larger orders
- Delivery distance: some suppliers have variable charges depending on the distance from their depots
- Feedstock and supply chain: lower price represent suppliers using lower cost feedstocks such as sawmill co-products, including pellets produced within the UK, and supplying directly to customers. Higher prices represent imported pellets (5/6 of the UK market (Forestry Commission, 2009a)), whose prices vary with exchange rates, and longer supply chains, including sale of bagged pellets to retailers.
- Quality: lower priced, lower quality pellets than the ranges shown above are available for larger systems that have a higher tolerance to variable feedstock quality

For further information on the UK pellet market, see the Pellets@las UK country report (NEF, 2009b).

We recommend using current prices shown in Table 2. Note that for commercial pellet users, VAT at 5% would need to be removed.

- Bulk prices
  - The low figure is the low end of the range given by a UK pellet supplier (RHI response, 2009a) – this particular supplier was considered to be one of the lowest price suppliers by other interviewees
  - The high figure is the Pellet@las price. This source has the best coverage of the UK market

  - The central figure is an average of the two, and is similar to the Biomass Energy Centre and Forever Fuels data.
- Bagged prices
  - The low figure is the low end of the range quoted by a UK pellet supplier (RHI response., 2009a) for supply of bagged pellets via distributors. The lower figures in the table above are from slightly older references, and are lower than the bulk prices, which seems unrealistic.
  - The central figure is the Pellets@las data
  - The high figure is the price paid by most customers of Forever Fuels, according to their website, with only a small proportion of areas with higher transport distances having higher prices
- Overall figures are calculated by assuming that bagged pellets make up 2/3 of the market

Table 2: Current pellet price summary (valid for 2010)

Form	Cost £2009/t inc VAT			Cost £2009/odt inc VAT			Cost £2009/MWh inc VAT			Cost £2009/GJ inc VAT		
	Low	Central	High	Low	Central	High	Low	Central	High	Low	Central	High
Bulk	173	197	221	188	214	240	37.7	42.9	48.0	10.5	11.9	13.3
Bagged	210	250	275	228	271	299	45.7	54.3	59.8	12.7	15.1	16.6
Overall	198	232	257	215	252	279	43	50	56	11.9	14.0	15.5

Assumes 8% moisture content and 18GJ/odt energy content

3.1.2 Chips for domestic and industrial/commercial heating

Around 1,121,000 oven dry tonnes (odt) of wood chips were supplied as woodfuel in 2008. Of these, 37% were obtained from wood processing, 36% from arboriculture, 18% from forestry operations and 9% from recycled wood (Forestry Commission, 2009a). Currently, all of the chips used for biomass heating in the UK are produced in the UK. A few companies are looking at importing chips, but only for electricity generation.

This section was informed by literature research, responses to the DECC consultation, and discussions with the Biomass Energy Centre.

Table 3: Current (valid for 2010) UK prices for chips for heating

Cost £2009/t ex VAT			Source	Date	Notes
Low	Central	High			
60	80	90	Biomass Energy Centre, 2009a	Sep-09	£80 on average, range £60-90 for 10t delivery at 30% moisture
88		119	Biomass Energy Centre, 2009a	Sep-09	Range given is for smaller boiler users
63	88	105	Biomass Energy Centre, 2009a	Sep-09	Data from a fuel supplier
80	90	100	Forestry Commission, 2009b	Sep-09	Guide price £80-90/t delivered, but 100 not uncommon
82.5		108.8	RHI response, 2009b	Jul-09	For 35m^3 wood chip delivery
48.8	93.8	112.5	UK pellet supplier pers. comm. 2009a	Aug-09	£25/MWh is a reasonable estimate, they have seen the range £18-30/MWh

Prices currently paid for chips vary depending on:

- Quality and size: larger systems can often accept lower quality chips, including clean waste wood, and larger pieces of wood.
- Supply chain: there is greater variation between chip supply chains than those for pellets, with a range of players, from sawmills concerned with removal of wastes from their site, and so requiring small margins, to very small suppliers dependent on a slightly higher margin to recover the capital costs of chipping equipment. Overall, margins are considered likely to be very low, partly as a result of the need to compete with suppliers with lower costs. Suppliers currently supplying at the low end of the cost range are unlikely to be breaking even e.g. at around £60-70/t (Duignan, 2009) or £49-75/t (pers. comm., 2009a)
- Transport distance: chips are less dense than pellets, and so more expensive to transport. Most chips used in the UK are transported over short distances (e.g. 10 miles, Duignan 2009)
- Quantity: larger systems can benefit from bulk discount. Note that electricity generators are currently paying much lower prices, with some reported pries down to £30-60/t

Prices have risen to the high end of ranges given previously, as a result of higher demand, leading to a lower proportion of low cost feedstocks such as sawmill co-products in the supply mix. Variation over time is also related to the availability of residues, which depends on the strength of the timber market, as a result of the construction market.

We recommend using current prices shown in Table 4. Note that no VAT has been added: for domestic chip users, VAT at 5% would need to be added.

- Domestic/small commercial prices – these would be at the high end of the ranges seen
  - The low figure is the low end of range given by the Forestry Commission
  - The central figure is the central price given by the Forestry Commission
  - The high figure is the high end of the range seen
- Industrial/commercial prices
  - The low figure is the low end of the range given by the Biomass Energy Centre. Given the comments about unsustainably low supplier margins, and the availability of the lowest cost feedstocks it is likely that the volume of supply at this level might be limited. It may also only be seen for larger orders.
  - The central figure is the central price given by the Biomass Energy Centre
  - The high figure is around the high end of the guide price from the Forestry Commission. It is lower than for smaller users, as a result of discount for larger orders

Table 4: Current chip price summary (valid for 2010)

<table>
<tr><th rowspan="2">Market</th><th colspan="3">Cost £2009/t ex VAT</th><th colspan="3">Cost £2009/odt ex VAT</th><th colspan="3">Cost £2009/MWh ex VAT</th><th colspan="3">Cost £2009/GJ ex VAT</th></tr>
<tr><th>Low</th><th>Central</th><th>High</th><th>Low</th><th>Central</th><th>High</th><th>Low</th><th>Central</th><th>High</th><th>Low</th><th>Central</th><th>High</th></tr>
<tr><td>Domestic/ small commercial</td><td>80</td><td>90</td><td>119</td><td>107</td><td>120</td><td>159</td><td>21.3</td><td>24.0</td><td>31.7</td><td>5.9</td><td>6.7</td><td>8.8</td></tr>
<tr><td>Industrial/ commercial</td><td>60</td><td>80</td><td>90</td><td>80</td><td>107</td><td>120</td><td>16.0</td><td>21.3</td><td>24.0</td><td>4.4</td><td>5.9</td><td>6.7</td></tr>
</table>

Assumes 25% moisture content and 18GJ/odt energy content

3.2 2020 prices, based on price build up for UK energy crops and imported feedstocks for heating in the UK

3.2.1 Imported feedstocks in the UK heat sector (2020)

This section examines the additional costs and profit margins to be added to the marginal biomass resources given in our previous analysis. Our previous study (E4tech, 2009) constructed a global supply cost curve for energy crops, forestry and wood industry residues. This was then intersected with estimated global demand for woody biomass, to obtain an international marginal biomass cost. After adding processing costs and 200km of road transport in the country of origin, sea transport of 1,500km and 50km of road transport in the UK were then added to arrive at a delivered cost for imported biomass.

The original approach was based on costs throughout, and did not include profit margins across the supply chain. In addition to this, some costs were not included, such as storage costs at various points in the supply chain, and some handling steps for pellets.

Our current approach still uses the global intersection of demand and supply costs, but now also includes profit margins and these additional costs, in order to build up to an estimated delivered price of imported biomass seen by UK customers. Supply chain structure and data were taken from literature and interviews with industry members. We have used our Central RES scenario throughout, as this corresponds to the values used by NERA in their analysis.

Furthermore, we have undertaken a sensitivity analysis to assess the influence of various factors, such as supply and demand scenarios and energy crop planting rates, on the international marginal biomass cost. The sensitivity analysis is used to construct four cost scenarios (Low, Central, High and Very High) for imports based on a Central RES demand scenario.

The international marginal biomass costs are summarised below:

Table 5: Summary of International marginal biomass costs

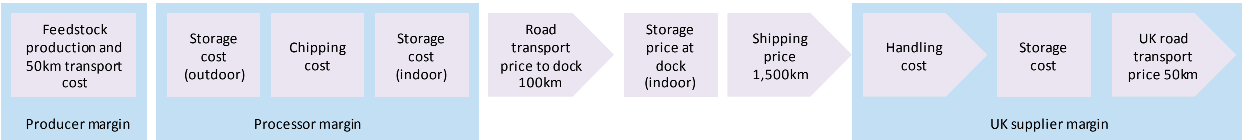
Import costs	International marginal biomass cost (£/GJ)					International marginal biomass cost (£/odt)				
	2008	2010	2015	2020	2030	2008	2010	2015	2020	2030
Low	4.47	4.28	2.33	1.77	1.25	80.5	77.1	42.0	31.9	22.5
Central	4.47	4.28	3.07	2.13	1.33	80.5	77.1	55.3	38.3	23.9
High	4.47	4.28	3.91	3.56	1.76	80.5	77.1	70.4	64.2	31.6
Very High				4.09					73.6	

This assumes 18GJ/odt. The Low scenario values are those resulting from our original analysis. The Very High scenario was considered for 2020 only.

3.2.1.1 Chips imported into the UK heat sector (2020)

Previous approach (for supply cost curve):

Current approach:



Feedstock production and 50km transport cost

The underlying feedstock cost has not changed from our previous analysis for 2010, and a range is provided for 2020 based on the Central RES scenario sensitivity analysis described in the previous section:

- In 2010, the cost of the global biomass available at the intersection of global demand and supply cost curves is £77 per oven dried tonne (odt). At this point on the supply curve, this value is set by energy crops, which have already been transported 50km to a central collection point – based on Hoogwijk (2004).
- In 2020, the marginal global biomass cost is between £32/odt (for the Low import cost scenario) and £74/odt (for the Very High import cost scenario). At these points on the supply curve, the value is set by energy crops, which have already been transported 50km to a central collection point. The decrease in costs from 2010 is due to projected increases in energy crop yields over time (Hoogwijk 2004), and because more forestry resources are extracted, and more energy crops are planted and harvested (E4tech 2009). Smaller decreases are due to global energy crop planting rate constraints.

The form of the imported biomass is not stated explicitly, as the supply curve incorporates forestry and wood industry residues, and energy crops. Hoogwijk's (2004) analysis is based on a number of different energy crops in different forms; we have assumed that the cost above is the cost of harvested whole crops (e.g. sticks or bales) and so further sizing is needed.

Producer margin

Hoogwijk gives no information on potential producer margins. We have assumed a 10% margin, lower than that considered for UK energy crops. This margin is the same in 2010 and 2020.

Storage cost (outdoor)

Requirements for open air storage at arrival at the processing site depend on the form and moisture content of the harvested resource, the harvesting window and processing capacity. We have used storage costs of £0.90/m^3/yr (Hamelinck 2005), and the density of biomass bundles, with an average residence of one month, giving a cost of £0.73/odt. Note that this step could happen before transport at the harvesting site or field.

Chipping

There are large differences in the scales at which chipping is applied, and different feedstock types and output particle sizes are possible, causing large differences in costs and energy use for the various chippers found in the literature. Values range from £1-3/odt (as used in our previous analysis), up to £9-14/odt (Alberici 2007), who concludes that a reasonable estimate for chipping cost is £10/odt, which is applicable regardless of the moisture content of the material – this is therefore the value we have used.

Storage cost (indoor) at processing site

Hamelinck (2005) consider that dried chips are stored in bunkers, costing €87/m^3/yr, with roofed, bunker, silo and tank storage having less or no influence on the biomass characteristics. Since chip density is 0.15odt/m^3, at 25% moisture content, and Suurs (2002) assumes that chips spend an average of 2 days in the bunker, this gives a storage cost of £2.62/odt. However, this cost is very sensitive to the assumption on residence time / annual utilisation.

Processor margin

A margin of 10% is assumed for the processor (storage and chipping steps).

Road transport price to port

There are four cost components: loading, charter costs, fuel costs, and unloading. The distance for the biomass to travel is 100km from the processing plant to the international port, and the empty return leg also needs to be considered. This distance is different from our original analysis (which used 200km one way distance from Suurs 2002) – this change was made to reflect more detailed logistical chains given by Hamelinck (2005). The Road Haulage Association (RHA 2009) suggest that all members should use at least a 10% margin for their quoted services – this 10% is used in converting costs in academic sources into prices for comparison with known haulage prices paid by biomass companies.

Our previous analysis using Suurs' original data from 2002, resulted in low transport costs. Hamelinck (2005), based on parameters from Suurs (2002), gives a breakdown of costs, and so allows the use of updated diesel fuel prices. Road transport of biomass chips 100km is priced at £0.219/odt/km, using a diesel price of £1.06/litre (UK current price, assumed applicable to European countries) and a 10% margin. Although these prices are lower than some seen in the UK, we used these values for this international step as they are applicable in countries with large scale operations and large truck sizes. This value is used for 2010 and 2020. NB: to get £/odt figures, £/odt/km values should be multiplied by the one-way distance, i.e. that travelled by the biomass.

Storage price at dock (indoor)

Assumed same cost as storage at processing site: 2 days bunker storage.

Shipping price

It is difficult to quantify a typical price per tonne for shipping biomass. Many factors, such as route, availability of return freight, contracts, and the demand vs. supply of freight capacity, determine the cost of transporting goods. The cost of international freight is mainly dependent on the supply and demand of vessels due to regional economic activity, and ports costs. Variable costs, such as fossil fuel prices and distance, have much less impact on total costs than for road transport. The Baltic Dry

Index (the spot price of shipping key dry commodities) spiked last year, crashed, and has slightly recovered in recent months. However, this only has a small impact on biomass shipping costs, as biomass is usually shipped under long-term US$ contracts (Hawkins Wright 2009).

The costs considered in both this, and the previous, analysis include capital and O&M costs, fuel, loading and unloading, and port charges. Taking a generic 1,500km travelled by ship from an international port to a UK port, for a dedicated dry bulk tanker, our costs include the return journey, and insurance and freight (CIF). These costs are from Hamelinck (2005), which uses Suurs (2002) parameters, giving a cost of £22-28/odt for shipping chips a distance of 1,500km. There may be some additional hidden costs for importing chips, as lower processing compared with pellets can mean that extra inspection is needed at the port for bio-security reasons.

These shipping costs are still generally applicable today, since prices for Heavy Fuel Oil (HFO) are similar to those used by Suurs (2002), and the Baltic Dry Index is back to a similar level to that in 2002. Margins are likely to be minimal due to competition, with many companies making losses this year with the recession reducing demand, and decreasing freight rates falling. Therefore, although we only have a cost estimate for shipping, this should not be significantly different from the observed price in 2010. For 2020, we assume the same prices still apply, because freight rates and economic activity cannot be estimated with any certainty.

As a comparison, and check on the figures used, an up-to-date source on biomass prices (Hawkins Wright 2009) gives typical biomass shipping prices, albeit for longer distances. This reference suggests that biomass suppliers tied into long-term contracts signed before the financial crisis are typically paying $55/t for trade from British Columbia and US West Coast to North Europe (~16,500km) and between $28-35/t for trade from the US Gulf (~8,800km). The spot rate for these routes went as high as $75-80/t during 2008, but collapsed to as low as $17-20/t by the start of 2009. It is understood that long-term contracts signed this year have been settled at below $25/t for trade from North America to Amsterdam/Rotterdam/Antwerp. Freight rates to Immingham, UK, are typically $3-4/t higher. Although it is not clear if these freight rates include loading / unloading or port costs, simply converting these UK freight prices into £/odt chips gives a range from £22-43/odt (with lower figures for the shorter distances), which are similar to the Suurs (2002) figures we have used.

Transfer and handling cost

Once onshore in the UK, imported biomass may be transferred to store a short distance from the dock (as dock storage rates are very expensive). This is the case for pellets, but as few chips are currently imported into the UK, data on this step was unavailable. This short haul has been estimated by using the pellet numbers from Forever Fuels (2009) at £1-5/t, with an additional £2.50/t for handling. This handling cost also agrees with Suurs (2002) for chips.

Storage cost at depot

The biomass will then be stored until it is delivered to the consumer, hence storage times may be longer than the 2 days assumed for the other bunker storage above. Depending on availability of buildings, indoor storage after chipping is about £0.05/day/m^3, or approximately £4/odt (Duignan 2009). This equates to 12 days storage on average. This is the value used for 2010, since storage is still somewhat informal, using existing buildings and space where available. However, for 2020, we choose to use a higher figure representing fully costed storage, of £15.7/odt, from Hamelinck (2005), using the 12 days storage assumed above.

UK road transport price

A higher price for UK road transport delivery is used compared with bulk transport in the country of origin as distances are shorter, and different (usually smaller) vehicles will be used. Chips are mainly delivered loose, in bulk, with a 50km journey to the customer assumed. Cost figures were again converted to prices using a 10% margin as above. Figures ranged from £0.35-0.69/odt/km (Rogers & Brammer 2009, Biomass Strategy WP1 2007, pers comm. 2009a), with an average value of £0.46/odt/km taken as applicable for the bulk chip delivery price.

These values are taken for both 2010 and 2020, since under DECC's Central fossil fuel price projection, diesel prices will only rise from £1.06/litre today to £1.23/litre by 2020. This could only increase the final delivery price of chips by a maximum of £1/t, and so has been ignored.

The inputs to the references used are generally in the similar range to the Department for Transport's Best Practice (2005), and the Road Haulage Association (2009), which both provide parameters and cost breakdowns for more general road freight costs.

UK supplier margin

Chips are currently imported into the UK as a feedstock for electricity generation, but not for heating. The majority of woody biomass imports are in the form of pellets, with only two companies (ROCFuel and Biomass UK) currently importing chips. Currently, suppliers can get cheaper imports if they buy a whole shipload, than buying by the container (pers. comm., 2009b). Those buying chips for electricity generation may sell off a proportion of their imports to the heat market, as it may be higher value. Nevertheless, margins for suppliers of imported chips are likely to be reasonably low, as there is little value added to the product in the UK, and margins for UK chip producers are currently very low (Duignan, 2009, Biomass Energy Centre, 2009a). We have considered this to be 10% - lower than that seen for pellets.

Biomass importing companies usually buy direct from the manufacturer in the country of origin, before storing it and distributing it in the UK. However, as trading platforms are being set up, in the future these companies may start to buy from a trader. In 2020, traders might be taking a cut (putting upwards pressure on prices), however, this is likely to be balanced by a more efficiently traded and competitive market (putting some downward pressure on prices).

Value Added Tax (VAT)

Commercial customers incur VAT at the standard rate, but this is recoverable, hence not added on to the price build-up for chips above.

Results

Results for chips delivered to an industrial/commercial customer are given below. For a domestic chip customer, 5% VAT would need to be added.

Table 6: Projected 2020 chip prices using imported biomass in the UK heat sector

	£/GJ	£/MWh	£/odt	£/t
Low	9	33	164	123
Central	10	34	172	129
High	11	41	207	155
Very High	12	44	220	165

The breakdown of these costs is shown in Table 9.

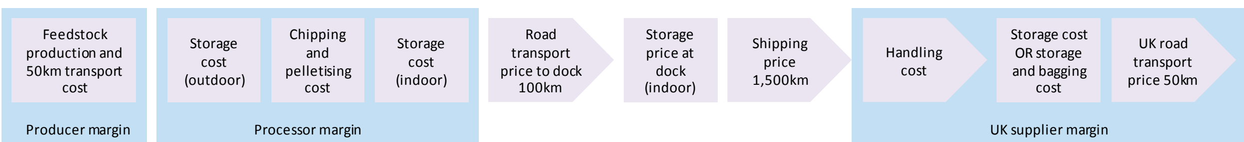
Table 7: Example breakdown of chip prices from imported biomass in 2020 – Central

Item	£/GJ	£/MWh	£/odt	£/t
International marginal biomass cost - Central	2.13	7.67	38.34	28.76
International biomass producer margin	0.21	0.77	3.83	2.88
Open air storage	0.04	0.15	0.73	0.55
Chipping	0.56	2.00	10.00	7.50
Bunker storage	0.15	0.52	2.62	1.96
Processor margin	0.34	1.23	6.17	4.63
Road transport	1.22	4.38	21.90	16.42
Bunker storage	0.15	0.52	2.62	1.96
Shipping from international port to UK port	1.40	5.03	25.14	18.85
Haul from dock to store	0.19	0.67	3.33	2.50
Unloading and handling at store	0.19	0.67	3.33	2.50
Storage in warehouse	0.87	3.14	15.71	11.79
Road transport from store to UK commercial customer	1.27	4.59	22.93	17.20
Margin of import company / chip seller	0.87	3.13	15.67	11.75
Chip price seen by UK commercial customer - Central	**9.57**	**34.47**	**172.33**	**129.25**

3.2.1.2 Pellets imported into the UK heat sector (2020)

Previous approach (supply cost curve):

Current approach:



The first few steps are the same as for chips:
Feedstock production and 50km transport cost
Producer margin
Storage cost (outdoor)
Chipping

Drying and pelletising
Again, the literature and interview cost data collected vary, since scales and feedstock costs vary considerably, feedstocks can be wet or dry, and in the form of logs, chips or sawdust. References considering pellet production from logs and sawdust are ignored as the feedstock is assumed to be in the form of wet or dry chips. Removing the cost of this dry or wet chipped feedstock leaves a range of values from £8/odt to £54/odt (Suurs 2002, Alberici 2007, Thek 2004, Andersson 2006, Uslu 2008, Schuller 2004, pers comm. 2009a). Due to differing harvesting seasons, types of energy crops grown, and differing collection areas, the plant scale and the moisture content of the feedstock will vary. We have therefore taken an average of the seven different wet and dry chip pelletising figures, which is £33.78/odt for the costs of drying and pelletising. This cost is also used in 2020.

Our previous analysis took an example of a large-scale Canadian pellet plant using sawdust (Nordicity 2007), and hence costs in our current analysis are much higher than the £13.90/odt previously used.

Storage at processing site
Hamelinck (2005) states that pellets are stored in bunkers, costing €87/m3yr, with roofed, bunker, silo and tank storage having less or no influence on the biomass characteristics. Since the pellet density is 0.6t/m3, at 8% moisture content, and Suurs (2002) assumes that pellets spend an average of 2 days in the bunker, this gives £0.71/odt. However, this cost is very sensitive to the assumption on residence time / annual utilisation.

Processor margin
Pelletising plant margins (as a % of the total ex-works pellet price) are given by some of the references above and industry, and fall in the range of 10-25%. We therefore assume a profit margin of 20% of the total ex-works price, which is added to the sum of the processing costs and feedstock costs (which vary between 2010 and 2020).

Road transport price to port
As above, Hamelinck (2005), based on parameters from Suurs (2002), gives a breakdown of costs, applicable to large scale operations and trucks, and allows the use of updated diesel fuel prices. Road transport of biomass pellets 100km is priced at £0.094/odt/km for pellets, using a diesel price of £1.06/litre and a 10% margin. NB: to get to £/odt figures, £/odt/km values should be multiplied by the one-way distance, i.e. that travelled by the biomass. Again, these values are taken for both 2010 and 2020.

Storage price at dock (indoor)
Assumed same as storage at processing site: 2 days bunker storage.

International shipping

As above, taking a generic 1,500km travelled by ship from an international port to a UK port, for a dedicated dry bulk tanker, our costs include the return journey, and insurance and freight (CIF). Hamelinck (2005) uses Suurs (2002) parameters, which give £11-13/odt for shipping pellets 1,500km. This number is, as above, taken as a 2010 price due to low margins, and is also used for 2020.

We compared these data with several other references for pellets, for longer transport distances, which give results that seem comparable to those used:

- IEA Task 40 (2009) generic sample calculation for a large pellet cargo transported an unspecified distance but taking 21 days (and therefore around ~13,000km) gives a freight rate of $40/t (£25.7/odt), including all the costs considered above.
- Junginger et al. (2008) gives a price of €3.2/GJ (£39/odt) for road transport to a Canadian port, storage and overseas shipment to Western Europe, but does not specify the transport distance. If we assume that it is from Western Canada, it is comparable to the other figures

Transfer and handling cost

Once landed onshore in the UK, the biomass may be transferred to store a short distance from the dock (as dock storage rates are very expensive). This short haul for pellets has been estimated by Forever Fuels (2009) at £1-5/odt, with an additional £2.50/odt for handling. As a comparison, pers. comm., 2009a estimated that other pellet suppliers might be paying around £4.3/odt for the loading and transfers cost to this storage based on 27t trucks making 4 trips/day to a store 5-10 miles away.

Storage (indoors) at depot

The biomass will then be stored until it is delivered to the consumer, hence storage times may be longer than the 2 days assumed for the other bunker storage above. As storage is volume limited, using the chips indoor storage factor of £0.05/day/m^3 with 12 days storage (Duignan 2009), gives a storage cost of £1.09/odt. This is the value used for 2010, since storage is still somewhat informal, using existing buildings and space where available. However, for 2020, we choose to use a higher figure representing fully costed storage, of £10/t, from the low end of the range given by Forever Fuels (2009), based on a pellet storage warehouse costing £48k/year with high annual utilisation (5,000t/year).

Screening

This sieving process ensures that any dust and broken pellets are separated out, for both bagged and bulk deliveries. Forever Fuels (2009) give a cost for screening and loading of pellets onto a delivery truck of £3.3-5.5/odt. Therefore, using Suurs (2002)'s loading costs of €0.5/m3, leaves £3.65/odt remaining as the screening cost.

Bagging

For domestic customers, especially small scale customers, 10kg bags of pellets are the most likely form of delivery. Alberici (2007) gives £10/odt costs for pellet handling and packaging, with £1.5/odt for handling, leaving £8.5/odt for bagging, which we assume does not include the cost of screening as it is not explicitly mentioned. Forever Fuels (2009) charge an extra £49.5/odt on top of their bulk price for bagged pellets, but this is likely to include many additional factors including administration, marketing, dealing with hauliers for delivery etc. Both screening and bagging are carried by the pellet supplier, hence profits for these steps are included in the overall company's profit margin.

UK road transport
As above, we consider 50km delivery distance from the warehouse storage to the customer, and the empty return leg also needs to be considered. Pricing structures (per mile or per delivery) for pellet delivery vary between companies, with different vehicles used for bulk deliveries and bagged deliveries on pallets.

For pellets delivered in bulk (loose blown via tankers, or in 1 tonne sacks), prices range from £0.27-0.51/odt/km (Forever Fuels 2009, TreeEnergy 2009), depending on the average load delivered. Forever Fuels (2009) assumes an average 5 tonne delivery, giving an average bulk pellet road transport price of £0.39/odt/km.

More is charged for bagged pellet delivery to smaller domestic customers (usually via a 1tonne pallet of 10kg bags). Some biomass suppliers also use contract hauliers for this service (such as Forever Fuels), and therefore prices charged may include a margin for both supplier and haulier. Prices are generally expensive, ranging from £0.4-1.1/odt/km (TreeEnergy, PureGlo, and Forever Fuels 2009), due to load size differences. An average of £0.84/odt/km is used for bagged deliveries in the UK. NB: to get to £/odt figures, £/odt/km values should be multiplied by the one-way distance, i.e. that travelled by the biomass.

UK supplier margin
In addition to the margin of the feedstock producer (and pelletising plant), a final profit margin for the importing company/pellet seller is required. This has recently this has been squeezed to 15-25% (pers. comm., 2009b). We therefore take a 20% profit margin for bulk transactions – this % gives a range of final profit margins of £30-42/t, depending on the feedstock price. This corresponds with with bulk suppliers still "needing to make £20-30/t minimum margin on top as pellet seller" (pers. comm., 2009a). Smaller volume domestic customers can be charged more in profit, which may correspond with bagged suppliers making margins at the top of the range – we therefore take 25% for bagged pellets.

This is applied differently for bagged and bulk pellets:

- For bagged pellets, this margin is applied to the cost of pellets before delivery, assuming that delivery is by a separate haulier.
- For bulk pellets, this margin is applied to the delivered cost, as the delivery is likely to be by the supplier themselves.

Value Added Tax (VAT)
VAT for domestic customers (both for bagged and in bulk pellets) is charged at 5%.

Results

Results for pellets delivered to a domestic customer are given below, in bagged form, in bulk, and as an average, assuming a 50:50 split in the domestic market. For a commercial pellet customer, 5% VAT would need to be removed.

Table 8: Projected 2020 pellet prices from imported biomass used in the UK Heat sector

		£/GJ	£/MWh	£/odt	£/t
Low	Bagged	13	48	242	222
	Bulk	11	41	204	187
	Overall	12	45	223	205
Central	Bagged	14	51	253	233
	Bulk	12	43	215	198
	Overall	13	47	234	215
High	Bagged	17	60	300	276
	Bulk	14	52	259	239
	Overall	16	56	280	257
Very High	Bagged	18	63	317	292
	Bulk	15	55	276	254
	Overall	16	59	296	273

The breakdown of these costs is shown below. Note that due to the changing moisture content in the supply chain, the £/t column cannot be used to add up the total costs. However, the other three columns (based on energy content) can be totalled, and are used to calculate the final £/t total.

Table 9: Example Breakdown of pellet prices from imported biomass in 2020 – bagged – Central

Item	£/GJ	£/MWh	£/odt	£/t
International marginal biomass cost - Central	2.13	7.67	38.34	28.76
International biomass producer margin	0.21	0.77	3.83	2.88
Open air storage	0.04	0.15	0.73	0.55
Chipping	0.56	2.00	10.00	7.50
Drying and pelletising	1.88	6.76	33.78	31.08
Bunker storage	0.04	0.14	0.71	0.65
Processor margin	1.20	4.33	21.63	19.90
Road transport	0.52	1.88	9.40	8.65
Bunker storage	0.04	0.14	0.71	0.65
Shipping cost from international to UK port	0.66	2.39	11.95	10.99
Haul from dock to store	0.15	0.54	2.72	2.50
Unloading and handling at store	0.15	0.54	2.72	2.50
Storage in warehouse	0.60	2.17	10.87	10.00
Screening	0.20	0.73	3.65	3.36
Bagging	0.47	1.70	8.50	7.82
Road transport from store to UK customer - bagged	2.33	8.38	41.90	38.55
Margin of import company / pellet seller	2.22	7.98	39.89	36.70
VAT for domestic customers	0.67	2.41	12.07	11.10
Pellet price seen by UK customer – bagged – Central	**14.08**	**50.68**	**253.41**	**233.14**

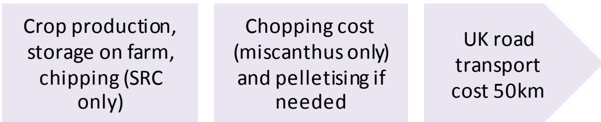
Table 10: Example Breakdown of pellet prices from imported biomass in 2020 – bulk – Central

Item	£/GJ	£/MWh	£/odt	£/t
International marginal biomass cost - Central	2.13	7.67	38.34	28.76
International biomass producer margin	0.21	0.77	3.83	2.88
Open air storage	0.04	0.15	0.73	0.55
Chipping	0.56	2.00	10.00	7.50
Drying and pelletising	1.88	6.76	33.78	31.08
Bunker storage	0.04	0.14	0.71	0.65
Processor margin	1.20	4.33	21.63	19.90
Road transport	0.52	1.88	9.40	8.65
Bunker storage	0.04	0.14	0.71	0.65
Shipping cost from international to UK port	0.66	2.39	11.95	10.99
Haul from dock to store	0.15	0.54	2.72	2.50
Unloading and handling at store	0.15	0.54	2.72	2.50
Storage in warehouse	0.60	2.17	10.87	10.00
Screening	0.20	0.73	3.65	3.36
Road transport from store to UK customer - bulk	1.08	3.88	19.42	17.87
Margin of import company / pellet seller	1.89	6.82	34.09	31.37
VAT for domestic customers	0.57	2.05	10.23	9.41
Pellet price seen by UK customer – bulk – Central	**11.93**	**42.96**	**214.80**	**197.61**

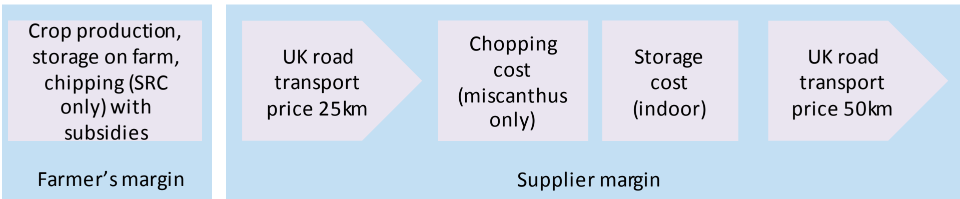
3.2.2 UK energy crops in the UK heat sector (2020)

Our previous analysis (E4tech, 2009) considered the costs of production of energy crops in the UK, plus the costs of processing, and transport to the end user. To estimate the delivered price of energy crops for domestic and industrial/commercial heat users in 2020, we have modified the analysis to include energy crop producer margins, energy crop subsidies, storage costs, and supplier margins. We have also changed some of the processing and transport costs, as a result of new data, in line with the analysis for imports above.

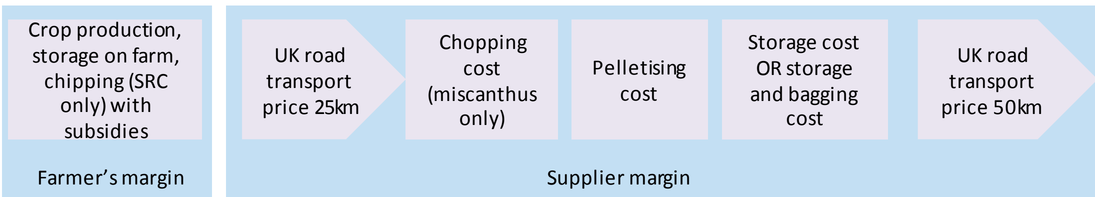
Previous approach (supply cost curve):



Current approach (Chips):



Current approach (Pellets):



Information used is referenced below. We also had useful discussions with individuals within DECC, FERA, NNFCC and the Biomass Energy Centre.

3.2.2.1 Energy crop feedstock production

Our energy crop cost modelling approach takes the fixed and variable costs of energy crop production per hectare, for short rotation coppice (SRC) willow, poplar and miscanthus, based on modelling by Alberici (2007). This is then combined with a model using spatial analysis of the UK, based on work by Southampton University and Rothamsted Research (Pepinster, 2008). This model determines the most suitable crop for each grid square, and the yield on that area. It then combines the production cost per hectare with the land rent and yield to give the ex-farm cost. The land rent used is dependent on the land class. Changes to the analysis are described below:

- Establishment, harvesting and on farm storage costs: the costs are based on Alberici (2007). These were briefly compared with those used in the NNFCC Energy crops calculator (FERA/NNFCC 2009) and in DECC modelling, and comments invited from NNFCC and the Biomass Energy Centre.

- Production subsidies were only used in a sensitivity analysis in our previous work. The values used were changed after discussion with DECC:
    - Establishment grants: these were set at £1000/ha for SRC and £800/ha for miscanthus (Alberici, 2007) in the subsidy analysis in our previous work. Whilst these values are used as a rule of thumb by some producers, the grant was actually set at 40% of pre-planting and establishment costs, a lower figure than those used. This grant is now being increased from 40% to 50% of establishment costs, and will be maintained until 2013. It is not yet known what policy will be used after 2013, but it is likely to be at least the same level of support. As a result we have now used 50% establishment costs grants of £998/ha for SRC and £891/ha for miscanthus.
    - The EU energy aid payment of €45/ha/yr has been removed
    - Single Farm Payment has not been included
- General management cost: kept at £87/ha/yr as in Alberici, 2007.
- Land rent: kept at £105-167/ha/yr depending on land class, as in Pepinster (2008).

Further research was undertaken to try to determine the margin that would be expected from an alternative crop, such as wheat, and therefore might be required in order for farmers to plant energy crops. This was difficult, for several reasons:

- Despite the considerable amount of work that has been done on energy crop costs and comparison with other crops, this has generally compared the margins of each option, for given yields and prices of each crop (e.g. NNFCC calculator, DECC analysis). However, the result that would be needed from these models in order for a farmer to make the change to growing energy crops is not known. It is likely to be higher than the point at which the margins of growing the energy crop and the alternative would be equal, as a result of many factors including the risk of growing new crops, delayed returns from growing crops that are harvested after several years, reduced utilisation of agricultural machinery for the remaining conventional crops, and flexibility to produce higher income crops if prices increase.
- The terms 'gross margin', 'net margin' and 'enterprise margin' are not well defined in studies, industry data and other sources, in terms of which fixed costs are included and excluded, in particular land costs, and some labour. As a result, it is difficult to compare margins from different sources.
- The margins from different crops are hard to compare when the management model for each is different: for example, many energy crop analyses include prices for contracted out planting, spraying etc, to a greater extent than analyses for wheat. As a result, the gross margin for wheat would need to be higher in order to cover more labour costs than the gross margin for energy crops.

The second two factors are common to all crop comparisons, and the difficulties of calculating net margins or profits for crops are discussed in more detail in Nix (2007). In particular, Nix points out that taking a gross margin, and subtracting a share of the whole farm's fixed costs to give a 'net profit', ignores several factors including the how the farms' different enterprises may interact.

After discussion with NNFCC, DECC, the Biomass Energy Centre and FERA, we decided to use a farmers margin of £200/ha/yr, as used in Alberici (2007), in addition to the contractor costs, land rent, and general management cost. This may not be a true 'net' margin, if the management cost does not include all of the farmer's fixed costs. This is comparable with figures found from several other sources:

- We looked at the enterprise gross margins of wheat in the NNFCC model, which, for a wheat price of £100/t and yield of 8.25t/ha are £331/ha/yr. This enterprise gross margin includes costs of cultivation, with some labour costs, but no wider fixed costs, and no land rent. Subtracting an average land rent of £150/ha (Nix, 2007) gives a margin of £180/ha. This could be taken as the 'net profit' needed for energy crops. However, more detailed analysis to match the wheat yield and land rent, and further analysis of the costs included and excluded in the margins for each crop would be needed. Note that other reviews which may include different costs give very different results. For example, Defra (2009) gives a range of gross margins for wheat across different farms of £580-1057/ha in 2007, with corresponding net margins (after fixed costs and labour) of -£341 to £393, with an average of £76 per ha.
- In 2004/5, it was estimated that wheat net margins ranged from -£400 to £400, with the median being £80 or £160, depending on the method used (Cambridge, 2006)
- Analysis carried out to assess the impact of Entry Level Stewardship payments for typical 300ha arable farm currently in ELS, showed that farm net margin under the new ELS was £204/ha, compared with £223/ha under the old ELS, or £189/ha outside the scheme (FWI, 2009).
- E4tech interviews with energy crop producers in 2007 on the margins that would be required also gave little data. One figure given for energy crops was £100-120/ha, but this was on poor land types.

A figure of £200/ha was also thought to be a reasonable assumption by those interviewed, in the absence of further information. Further analysis on this, based on analyses already carried out by those listed above, would be very valuable in order to get a better idea of future energy crop prices.

Running these new costs through the model combining them with yields and land rents gives ex-farm prices for chipped SRC or baled miscanthus of between £38 and 98/odt using 2010 yields, with the bulk of the resource being in the £55-80/odt range, and the median (50% of the resource) at £70/odt. The shape of the cost curve has not changed from our previous analysis. The median prices are higher than those currently being paid for energy crops; current supply may be at the low end of the cost curve, or producers may be willing to produce with a lower margin, for reasons including lower management requirements, and interest in new crops.

2020 costs were calculated by keeping the production costs and margins constant, but increasing the energy crop yield by 1% p.a. This approach was considered to be reasonable by the interviewees. Using 2020 yields, the costs reduce to £33-87/odt, with the bulk of the resource being in the £51-75/odt range, and the median (50% of the resource) at £62/odt.

Land rents and margins could change to 2020, if the price of alternative crops increased or the availability of land decreased. However, given the uncertainties surrounding the current margin, and in predicting future crop prices and land values, we have not made further assumptions on changes to 2020. The impact of increases in price could be large, however; increasing the wheat price from £100/t to £150/t in the NNFCC model increases the enterprise gross margin from £331 to £744. Wheat prices will depend on demand, yield increases, and land use worldwide; the models used to calculate land availability in our previous work projected availability of abandoned agricultural land,

and use of poor quality land for energy crops, implying that the pressure to grow food crops may not be so large, and prices and margins may not increase significantly.

3.2.2.2 Chips supplied to the UK heat sector (2020)

The following steps were added to the ex-farm energy crop price calculated above.

UK road transport 25km
Transport from the farm to a centralised storage point of 25km is included. For simplicity, a single transport price for chips is used, as the spatial model gives the majority of the resource as chipped SRC (78%), and there is little difference between transport costs for SRC chips and miscanthus bales.

Chopping (miscanthus only)
This was previously estimated at the cost of chipping, as data on chopping costs was not available. However, this cost has now been removed. Several papers assessing the costs of miscanthus production compare the options of harvesting the miscanthus as bales and as chopped material (Styles et al 2007, Venturi et al 1998). Both options have very similar costs, as the slightly lower transport and storage costs of bales are offset by increased costs of baled harvesting. As a result, we now assume that chopped miscanthus could be provided at the same price as baled material at this point, and no further chopping cost is added.

Storage (indoor)
Storage at a distribution site as for imported chips.

UK road transport 50km
Transport from storage to the consumer of 50km is included, using data as for imported chips.

Supplier's margin
As discussed for current chip prices, and imported chips, suppliers margins are likely to be very low. We have assumed a 10% margin at this point

Results
Results for chips delivered to an industrial/commercial customer are given below. For a domestic chip customer, 5% VAT would need to be added. The range is a result of variation in the feedstock cost alone, with no other variation in the transport and processing data.

Table 11: Projected 2020 chip prices from UK energy crops used in the UK Heat sector

	£/GJ	£/MWh	£/odt	£/t
Low	6	22	111	83
Central	7	25	123	93
High	8	28	138	104

The breakdown of these costs for central prices is shown below.

Table 12: Example Breakdown of chip prices from UK energy crops in 2020 – Central

Item	£/GJ	£/MWh	£/odt	£/t
Energy crop price – Central	3.45	12.42	62.12	46.59
Road transport from farm to central storage	0.64	2.29	11.47	8.60
Storage indoors	0.87	3.14	15.71	11.79
Road transport from store to UK commercial customer	1.27	4.59	22.93	17.20
Margin of import company / chip seller	0.62	2.24	11.22	8.42
Chip price seen by UK commercial customer - Central	**6.86**	**24.69**	**123.46**	**92.59**

3.2.2.3 Pellets supplied to the UK Heat sector (2020)

The following steps were added to the ex-farm energy crop price calculated above.

Steps as for UK energy crop chips:
UK road transport 25km

Steps using the same data as for imported pellets:
Pelletising and drying cost
Storage (indoor) at a distribution site
Screening and bagging
UK road transport 50km

Supplier's margin
The supplier's margin was calculated in two steps:

- We assumed that the supplier's margin on the pellet production is 20% of the ex-works pellet price. This is the same as used for the production of imported pellets
- We then assumed that the supplier makes a 15% margin on the costs of the supply chain as a whole. For bagged pellets, this margin is applied to the cost of pellets before delivery, assuming that delivery is by a separate haulier. For bulk pellets, this margin is applied to the delivered cost, as the delivery is likely to be by the supplier themselves. The 15% margin used is at the low end of the ranges given by interviewees, and is lower than the 20-25% used for supplying imported pellets, as we assumed that a supplier producing pellets themselves would be profitable with lower margins in distribution than those supplying imported pellets.

For low energy crop costs, this gives an overall margin of around £37/t, equivalent to 21% of the bagged pellet price, or 26% of the bulk pellet price. However, it is likely that some of the profit included in the delivery price for bagged pellets will also be taken by the supplier, rather than the haulier alone.

Results
Results for pellet delivered to a domestic customer are given below, in bagged form, in bulk, and as an average, assuming a 50:50 split in the domestic market. For a commercial pellet customer, 5% VAT would need to be removed. The low/central/high range is as a result of variation in the feedstock cost alone, with no other variation in the transport and processing data.

Table 13: Projected 2020 pellet prices from UK energy crops used in the UK Heat sector

		£/GJ	£/MWh	£/odt	£/t
Bagged	Low	12	43	213	196
	Central	13	46	229	211
	High	14	50	249	229
Bulk	Low	10	36	182	168
	Central	11	40	199	183
	High	12	44	218	201
Overall (50:50 split)	Low	11	40	198	182
	Central	12	43	214	197
	High	13	47	233	215

The breakdown of these costs for central prices is shown below.

Table 14: Example breakdown of pellet prices from UK energy crops in 2020 – bagged – Central

Item	£/GJ	£/MWh	£/odt	£/t
Energy crop price – Central	3.45	12.42	62.12	46.59
Road transport from farm to central point	0.64	2.29	11.47	8.60
Drying and pelletising	1.88	6.76	33.78	31.08
Supplier margin on processing	1.48	5.31	26.57	24.45
Storage in warehouse	0.60	2.17	10.87	10.00
Screening	0.20	0.73	3.65	3.36
Bagging	0.47	1.70	8.50	7.82
Road transport from store to UK domestic customer	2.33	8.38	41.90	38.55
Supplier margin on distribution	1.09	3.91	19.56	17.99
VAT for domestic customers	0.61	2.18	10.92	10.05
Pellet price seen by UK customer – bagged – Central	**12.74**	**45.87**	**229.35**	**211.00**

Table 15: Example breakdown of pellet prices from UK energy crops in 2020 – bulk – Central

Item	£/GJ	£/MWh	£/odt	£/t
Energy crop price – Central	3.45	12.42	62.12	46.59
Road transport from farm to central point	0.64	2.29	11.47	8.60
Drying and pelletising	1.88	6.76	33.78	31.08
Supplier margin on processing	1.48	5.31	26.57	24.45
Storage in warehouse	0.60	2.17	10.87	10.00
Screening	0.20	0.73	3.65	3.36
Road transport from store to UK commercial customer	1.08	3.88	19.42	17.87
Supplier margin on distribution	1.18	4.24	21.20	19.50
VAT for domestic customers	0.53	1.89	9.45	8.70
Pellet price seen by UK customer – bulk – Central	**11.03**	**39.71**	**198.54**	**182.66**

3.2.3 Conclusions on projected prices for 2020 in the UK Heat Sector

Table 16: Projected 2020 chip prices

Feedstock		£/GJ	£/MWh	£/odt	£/t
UK Energy crops	Low	6	22	111	83
	Central	7	25	123	93
	High	8	28	138	104
Imported biomass	Low	9	33	164	123
	Central	10	34	172	129
	High	11	41	207	155
	Very High	12	44	220	165

Table 17: Projected 2020 pellet prices

Feedstock			£/GJ	£/MWh	£/odt	£/t
UK Energy crops	Bagged	Low	12	43	213	196
		Central	13	46	229	211
		High	14	50	249	229
	Bulk	Low	10	36	182	168
		Central	11	40	199	183
		High	12	44	218	201
	Overall (50:50 split)	Low	11	40	198	182
		Central	12	43	214	197
		High	13	47	233	215
Imported biomass	Bagged	Low	13	48	242	222
		Central	14	51	253	233
		High	17	60	300	276
		Very High	18	63	317	292
	Bulk	Low	11	41	204	187
		Central	12	43	215	198
		High	14	52	259	239
		Very High	15	55	276	254
	Overall (50:50 split)	Low	12	45	223	205
		Central	13	47	234	215
		High	16	56	280	257
		Very High	16	59	296	273

Tables 18 and 19 above show that:

- For chips, imported biomass is projected to be significantly more expensive than chips from UK energy crops in all 2020 import scenarios, as a result of the low density of chips, and therefore high transport and storage costs.
- 2020 pellet prices from UK energy crops are projected to be on average lower than those from imported woody biomass; the Low and Central imported biomass prices overlap with the Central and High UK energy crop prices, and the High and Very High imported biomass prices exceed the UK range of prices.
- The projected prices for chips from UK energy crops in 2020 are around the same as current prices for chips for smaller users, but higher than the lower prices seen by industrial and commercial users. Future prices for imported chips are higher than current prices, with only the Low import cost scenario close to the high end of the range currently seen for smaller users. The Central, High and Very High 2020 import scenarios are significantly higher than current prices.
- The projected prices for bulk pellets from UK energy crops in 2020 are very similar to current pellet prices, with the low end of the range very close to the lowest current prices, and the high end around the central value for current prices. The projected prices for imported bulk pellets in 2020 fall within the range of current pellets prices in the Low, Central and High import scenarios, with the Very High scenario imported prices being above the current price range.
- The projected prices for bagged pellets from UK energy crops in 2020 are on average lower than current pellet prices, with the low end of the range about £10/t cheaper than the cheapest current prices, and the high end falling between Low and Central current prices. The prices for imported bagged pellets in 2020 fall within the range of current pellets prices in the Low, Central and High import scenarios, with the Very High scenario imported prices being above the current price range.

As a result:

- Given the much higher prices for imported chips than those from UK energy crops in 2020, the large potential supply of the latter, and the fact that chips are not currently imported for the UK heat sector, we consider it unlikely that imported chips will be used for heating in 2020 in the UK. We therefore recommend using the Low to High range of chip prices based solely on UK energy crops as the 2020 chip prices for the UK heat sector, with the import prices only used to test sensitivity.
- Given the large proportion of pellets currently imported, and the overlap of projected import pellet prices with those from UK energy crops in 2020, we recommend using the full range of pellet prices from the Low value for UK energy crops, to the Very High value for imports. However, it is important to note that a significant resource will be available at the lower end of this range.

4 The UK Electricity Sector

4.1 2010 prices, based on current prices in the UK electricity sector

The approach adopted for the UK electricity sector could not follow that used for the heat sector, as there is much less information about biomass prices in the large scale electricity sector in the public domain. To estimate the prices currently being paid for biomass, we therefore interviewed a range of power generators, utilities and traders, including co-firers, dedicated biomass plants and the few CHP plants in the UK using biomass feedstocks. This gave a good coverage of UK large power plants across a range of scales. The prices given below are therefore applicable for all electricity only plants, and for Combined Heat & Power (CHP) plants above a scale of 3MWe / 10MWth.

We asked each interviewee:

- What are the outputs of your plant (MW_e and MW_{th})?
- Which feedstocks do you use, and their form, moisture content, and annual volumes (t/yr)?
- Where does the feedstock come from, and what is the supply chain?
- How much do you pay (£/t), and is this on the spot market, or via a contract (with what conditions)?
- What impact have changes in the ROC banding had on the prices paid to biomass suppliers?
- Do you see any of these answers changing in the future, and if so, how?

In general, interviewees were very helpful – a few were cautious about giving exact prices, but gave indications within a range. The interviews were conducted under the agreement that any specific prices they provided would remain confidential, hence the results presented below have been aggregated to create a current price range for UK feedstocks (excluding energy crops), and a current price range for imports.

Table 18: Current UK feedstock and import price summary for the UK electricity sector (valid for 2010)

	Cost £2009/odt			Cost £2009/MWh		
	Low	Central	High	Low	Central	High
UK feedstocks (excluding energy crops)	30	50	65	6	10	13
Imports	105	120	135	21	24	27

All prices are quoted as delivered to the power plant, and exclude VAT

Very few plants currently use energy crops, and even then only nominal amounts. The few prices obtained were above the UK range in Table 18, but were more of an indication of what plants would offer to pay, rather than what they are actually paying, and are hence not suitable for inclusion as a current biomass price. Plant developers we interviewed are using UK chips, but not imports, and conversely are using imported pellets, but not UK sourced pellets.

Many data points were collected for UK virgin wood chips and small roundwood logs, and these prices were fairly evenly distributed across the whole UK range given in Table 18, with no trends with volume, location or feedstock source. In general, plants taking in recycled waste wood were paying prices at the low end of the range, and those using straw were paying prices at the higher end of the range (dependent on location).

Most of the import prices were quoted as CIF (cost, insurance and freight) at a UK port. These prices were converted to a delivered to plant price by adding £15-25/odt. Within the imports range, feedstocks such as palm, olive and sunflower residues were generally towards the lower end of the range, imported chips around the Central price, and pellets usually towards the top end of the range.

Interviewees also gave useful information about contracts, supply chains and future plans:

- In the UK electricity sector currently, a long term biomass contract would be 5-15 years (usually 10), medium term 3-5years, and short term 1-3 years. Only a couple of large biomass suppliers in the UK are able to offer long-term or index-linked contracts.
- Some co-firers have contracts for a steady biomass supply, whilst others solely buy opportunistically on the spot market. The halving of the biomass co-firing ROC has significantly reduced the volumes bought in the UK on the spot market.
- The majority of dedicated biomass power plants either have, or are looking for, long term contracts in order to secure supplies, with only small amounts of spot buying. Several of the larger power plant developers are starting to look up the supply chain, investing in infrastructure or local biomass supplies.
- A few plants are already planning on a large expansion in wood pellet use, and most plants saw increased UK reliance on imports as inevitable, given the competition for feedstocks already reported in some areas of the UK.
- The spot prices for all feedstocks are now higher than those of the long-term contracts held by existing plants.

4.2 2020 prices in the UK Electricity sector

For 2020, it was not possible to use a bottom-up approach for the large scale UK electricity sector as in the UK heat sector, because of key differences in the market structure. The prevalence and preference for long term contracts, with companies establishing bilateral contracts with suppliers, makes it difficult to establish a clear relationship between price and feedstock costs. There are also far more feedstock types, and fewer generators in the electricity sector, hence a typical supply chain could not be constructed. Furthermore, it is more uncertain how this sector will develop in the future.

We therefore recommend that the current prices (valid for 2010) should be used as the best available estimate of biomass prices for the UK electricity sector going forward, as the basis of a scenario-based approach. Note that values for new contracts and the spot market in 2020 are most likely to be found in the Central to High region of the price ranges given above.

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