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E-Futures

Mini-project report

Active woodchip drying trials

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Introduction

The UK bioenergy strategy identifies biomass as a key supply of low carbon energy (DECC, 2012), offering security and cost-effectiveness. There are 31 million ha of forest at present in the UK (Mathews *et al*., 2012) and the increasing attractiveness of woodfuel as a heat source (Figure 1) has identified this resource as a means for managing carbon emission levels. For this reason, woodfuel sector development is an objective of the Forestry Commission (Forest Research, 2011 b), both in relation to the area of woodland under active management and the production of a valuable bioresource (Forest Research, 2006).

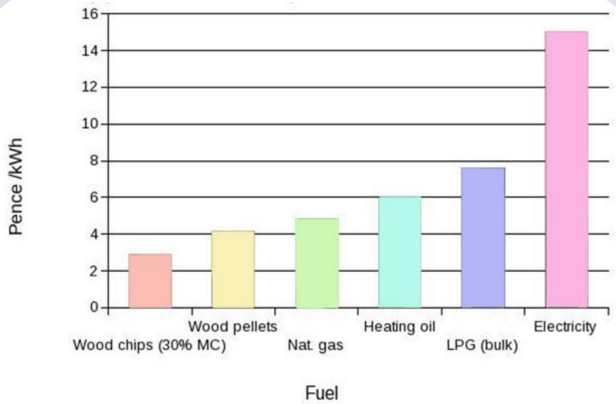

Figure 1. Typical domestic prices for fuels (Biomass Energy Centre, 2012).

Woodchip in particular offers a low cost alternative to conventional heat sources (Figure 1) and therefore has been the focus of a significant degree of research, development and investment in boiler technology and installation (Forest Research, 2011 b). However, the immature nature of the sector and small scale production of woodchip has caused prices to fluctuate, causing hesitation in the uptake of the fuel source by a wider customer base; for example, the reliance of woodchip suppliers on drying wood in the round to reduce moisture content (mc) for 12-18 months (Forest Research, 2010) before chipping increases the risk value of the cost of round wood, as markets have to be predicted in advance. The occurrence of extreme winters in 2009/10 and 2010/11 saw supply fall short and prices rise (Forest Research, 2011 b). For this reason an increase in interest in woodchip dryers (Figure 2) which use an active input of energy to dry woodchip quickly (Forest Research, 2012 a; b) suggests a move towards a more reactionary industry.

As identified by Forest Research (2011 b), there have been a limited number of academic studies into the efficiency and cost-effectiveness of active woodchip drying, especially in current academic journals. However, those studies that have been conducted have largely found active woodchip drying to not be economically viable, particularly in relation to the low unit cost value of the base product (Table 1).

Study	Energy balance
McGovern (2007, cited in Forest Research, 2011 b)	Energy used was 3-4 times the energy gained to take mc from 34% to 7.5%
Midlands Wood Fuel (Forest Research, 2012 a)	grain drying barn, found costs of £7.2-36.9 for a calorific gain of kWh 27-1417
Coscun *et al*. (2009)	an industrial drum drying system had an energy efficiency of 34.07% and an exergy efficiency of 4.39%
Angus Biofuels (Forest Research, 2012 b)	Overall energy balance of -252kWh/m^3, at a cost of £41/m^3 using an under floor hot air blowing system
Nordhagen (2010, cited in Forest Research, 2011 b)	Gained 3000kWh/t from a mc drop of 50% at a cost of 510kWh electricity

Table 1. Energy cost comparison of drying trials.

Figure 2. Special products dryer by Alvan Blanche – scale 5x5x15m (Alvan Blanche, 2012)

Aims

In the context of the current UK woodchip supply sector, use case studies to quantify the energy balance of actively drying woodchip, which in turn is relevant to the improvement and advancement of the UK woodchip supply sector.

Methods

Case studies to be quantified via rates of drying (moisture content), energy balance (calorific change and energy input) and cost balance (capital and operating costs and gain in product value). Moisture content and calorific value to follow BS 1016 part 5, and Forest Research defined standards where applicable, energy usage to be quantified from interviews. To place these in context, industry trends, items for inclusion in optimum performance and perceived risk factors to be quantified via interview.

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Results

Theoretical Optimum

Active woodchip drying is constrained by a maximum energy and cost limit beyond which it becomes uneconomic (Figure 3). For example, to dry woodchip from 50% to 20% mc, the average available energy is 1,800kW/t whilst an excess of £75 limits operating costs (Laurila and Lauhanen, 2010; Forest Research, 2011 a; English Wood Fuels, 2012; case study data).

(retail value + available renewable heat incentive (RHI) + saving in transport cost) – (base value of chip + payback of dryer + dryer operating costs + company operating and profit) = £ available for drying costs

energy available at target mc – (original energy + proportion system efficiency) = maximum energy available for drying

Figure 3. Theoretical energy and value conversion.

Case studies

Two case studies were examined to analyse whether the energy and cost input into active woodchip dryers is equal to, greater or less than the energy/value gained (Table 2). Site 1 uses a small 10 cubic metre/5 hour static drying system at a capital cost of £1-2,000, whilst Site 2 processes an artic lorry load of woodchip/working day at a capital cost of £150,000. Site 1 produces dried woodchip at an energy and real cost less than that of the final product, and therefore does not make a loss on actively dried woodchip. Site 2, with the RHI accounted for, also produces dried woodchip at a cost less than that of the retail value of the chip. Further energy balance data has not been included due to industrial confidentiality.

Industry trends

Of 12 companies involved in this project, 6 are actively drying woodchip or seeking to install active drying systems, and 6 are not pursuing this means of woodchip supply, relying instead on drying in the round (Figure 4).

	MC before (%)	CV before (MJ/kg)	MC after (%)	CV after (MJ/kg)	Energy gained (MJ/kg)	Approximate value gained (£/tonne)
Site 1	49.67	9.71	6.36	17.06	7.35	65
Site 2	45	10.1	25	13.77	3.67	57.5

Table 2. Energy and cost balance of active woodchip drying at Site 1 and 2. MC: moisture content; CV: calorific value.

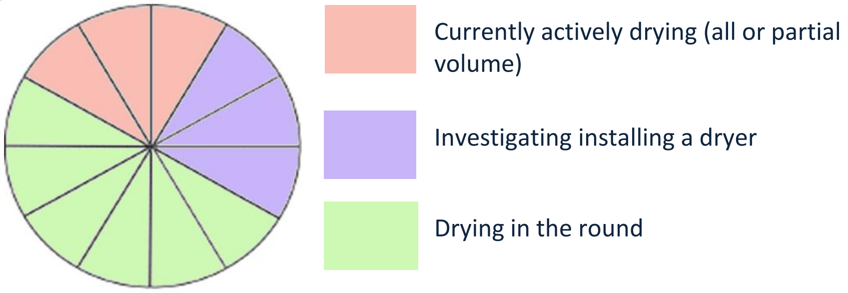
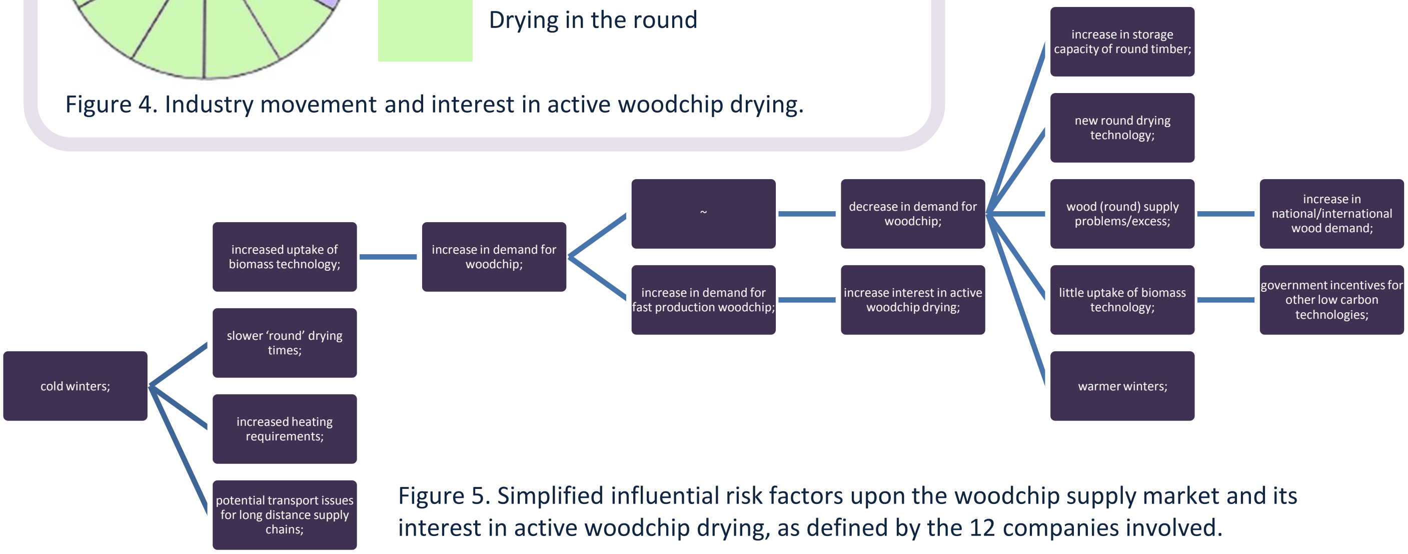


Figure 4. Industry movement and interest in active woodchip drying.

Risk factors

Multiple factors cause the investment in a significant woodchip dryer of large initial value to be of considerable economic risk (Figure 5).


cold winters;
increased uptake of biomass technology;
slower 'round' drying times;
increased heating requirements;
potential transport issues for long distance supply chains;
increase in demand for woodchip;
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increase in demand for fast production woodchip;
decrease in demand for woodchip;
increase interest in active woodchip drying;
increase in storage capacity of round timber;
new round drying technology;
wood (round) supply problems/excess;
little uptake of biomass technology;
warmer winters;
increase in national/international wood demand;
government incentives for other low carbon technologies;

Figure 5. Simplified influential risk factors upon the woodchip supply market and its interest in active woodchip drying, as defined by the 12 companies involved.

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Discussion

Woodchip supply is an increasing proportion of the wood production sector, with an increasing amount of companies branching out into woodchip supply from both other wood supply services and micro renewable installation. The attractiveness of active woodchip drying as an element of woodchip supply has considerably increased in lieu of the renewable heat incentive (RHI), which allows a dryer of £150-250,000 capital cost to be paid back within 4-6 years, allowing for dramatically increased market reactivity and consequent stability. However, the method of drying is constrained by the low pence/kWh value of woodchip (Figure 1, 3) enforcing a requirement for very efficient drying methods and technology (Johansson *et al*., 1997; Le Lostec *et al*., 2008).

Trials at Sites 1 and 2 indicate that active woodchip drying can be efficient enough to dry woodchip at an operational cost less than the value of the chip. Uncertainties in the operational costs at site 2 are likely to be displaced once the RHI is in place. The energy inputs in each drying system vary significantly, and demonstrate that similar drying results can be achieved using very different drying methods, and with extremes in capital set up and operating costs, although at different production scales. The added influence of the RHI payments provided indicates that both systems are economically viable. These findings however contradict the findings of the active drying trials 1 and 2 (Forest Research, 2012 a; b), which both found a loss of energy and cost. This does indicate therefore that greater detail and continued monitoring of the drying systems at site 1 and 2 would confirm this finding by taking measurements of the energy used in the drying systems rather than relying upon interview based data collection. In addition to this, further involvement with the three additional companies currently investigating the viability of active woodchip drying (Figure 4) would demonstrate the direction the companies are deeming the most secure and profitable.

However, at a long term industry sustainability scale, future weather predictions for 80-95% reduction in non-mountainous snowfall and winter daily temperature increases of 2.1-3.5°c (Jenkins *et al*., 2009) indicate a greater tendency towards the decreased future demand for woodchip (Figure 5). Despite this, the risk factor of investing in active woodchip dryers is significantly more complex than the probability of not getting cold winters x the costs of the dryer, with the greatest influence over the risk factor exerted by the development of other low carbon technologies, a factor that is in turn specifically influenced by the introduction and weighting of government tariffs, incentives and grants. As a low value product, woodchip is also susceptible to national and international supply and demand changes, although, dependent upon an increase in woodchip reliant systems and increases in conventional fuel source prices, a buffer from higher return wood markets could develop.

Conclusions

Drying trends are dependent upon the drying technology available and used, and the market demand for woodchip. Site 1 and 2 both demonstrated a viable method of drying woodchip, despite very different structures and operations. It must be noted though that both sites only use the dryers for essential drying based on customer demand, not as a customary procedure. The inclusion of the RHI in current evaluation, as well as advances, largely from the continent, in drying principles, technology and efficiencies, places the two drying trials carried out by Forest Research (2012 a; b) in a different context, and therefore necessitates a review of the current summaries relating to active woodchip drying, dependent upon the confirmation of the drying costs based upon independent measurement.

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