

## Woodland Biomass - Making it Pay

Intro (me and SLZ). 1. New since August. 2. In renewables for 20+ years, successful at taking immature and worthless to mature and valuable. 3. Had to wait 15 years before LFG got profitable, so we go in early and willing to wait until policy catches up. How long depends on politicians.

-----  
If you've got some trees, the best thing you can do is use them yourself. Failing that, the next best option is seasoning it and selling it as chip or log.

£6/tonne stumpage  $\hat{=}$  £30/wet tonne (50% moisture, £12/MWh) in the store.

After seasoning (35% moisture), used yourself  $\hat{=}$  £50/tonne (£16/MWh).

After delivery, sold to customers  $\hat{=}$  £70/tonne (£22/MWh)

Alternatively, could sell wet or seasoned wood to co-firer or industrial consumer (e.g. Slough H&P), probably at under £50/tonne.

Limiting factors:

- Capital cost of equipment to burn chip is more expensive than pellet.
- Substantial economies of scale for all biomass installations.
- Needs a lot of space for fuel-storage, so not suitable for tight spaces (e.g. most urban locations). Energy density of 0.9-1 MWh/m<sup>3</sup> (pellets  $\hat{=}$  3.1 MWh/m<sup>3</sup>, heating oil  $\hat{=}$  11.6 MWh/m<sup>3</sup>).
- Higher ash than pellet.
- Inefficient at modulating, because it needs heat to drive off the moisture, so it's not good for running up and down. Best running relatively steadily, with a large thermalstore/buffer tank.
- Higher particulate emissions than log or pellet – more difficult (but not impossible) to use for Clean Air Act properties.
- Limited practical radius of delivery.
- Need more robust handling, both in transport (e.g. harder to blow, but not impossible) and in boiler's fuel-handling system.

These factors usually mean that chip is best for larger applications with plenty of space on the estate, e.g. industrial or large commercial/public-sector use (hospitals, schools, leisure centres, etc.) or blocks of homes. Not all of them will have space. Limited numbers of opportunities within delivery range of forest.

Opportunities (for chip or pellet) could be increased by aggregating via district-heating network. However, rule-of-thumb cost for network is £100/metre, and typical network is several kilometres, making £100,000s additional capital cost. Need to sell a lot of heat, at a substantial saving relative to individual fossil-fired boilers, (and have firm contracts to supply) in order to justify investment.

Will come back to economics later.

Where no suitable local customers, pelletise to increase practical delivery range. We take deliveries from Sweden, and use 2-3% of the energy content of the pellets in transport from factory to customer.

Pellets also have bigger market and potential than chip: scales better (lower capital cost and less space required), easier for air-quality standards, low ash = less O&M, cover wider area from depot, simpler, larger deliveries.

### ***Small-scale:-***

2,000 tpa upwards (nominal, in practice rarely run at close to capacity)

3 just closed down (Welsh Biofuels, Bridgend, Fast Forward, Llandrindod Wells, and Renewable Fuel Co., Barking – was ours).

Higher operating and capital costs per unit of production, but closer to market.

Dryers do not scale down economically, so better to use dry sawdust (e.g. from joiners).

Securing reliable supply of material v.difficult, particularly in current climate where construction materials and furniture-making are in severe recession. A lot of demand for material, e.g. from board manufacturers and for bedding.

In countries like Sweden and Austria, with more experience of pellets, they regard minimum economic size as 40-60,000 tpa, because this will cover cost of dryer and allow much more flexibility about input.

Also, need energy source (electricity and heat). Not practical scale for biomass CHP, so typically use oil (if drying) or imported electricity. Consequently, higher carbon footprint than large plant using biomass CHP (20%?), even with more transport from latter.

Some small producers still OK: Rainworth (using own by-products, and higher-ash pellets) and Biojoule (using oil CHP), and some using recovered wood to produce industrial pellets (WID?). But need at least £120/tonne out of factory gate to break even if not using recovered material.

Production not consistent and reliable – difficult for customers to install boilers if relying on small-scale production. Need distributors supplying pellets from reliable large-scale producers to give confidence to customers to invest in boilers. Distributors can then incorporate smaller producers into their supplies when critical mass and confidence is established. Maybe look for higher-value niches, such as bagged pellets. Maybe some premium available for local/English pellets, but customers usually want local at no premium (or cheaper). Marketing benefit.

### ***Large-scale:-***

40,000 tpa upwards.

SLZ looking at plant in Scotland, where bought 2000 ha, and working with community to secure several thousand more. Stranded timber, so low value.

(Other plants in UK: Balcas in Enniskillen and Invergordon, Clifford Jones in Ruthin, others under development, but need density of woodland, preferably softwood, not too many opportunities in UK – Sweden has 60% forest with nearly double land area and 8x fewer people, compared to our 6.5%

forest. 74 times more per capita, can't use it all efficiently. Also Finland, Baltics, Germany, Central/East Europe, Russia, Canada, USA, South America, Africa, etc. – large resource (see display).

Typically done with timber mill, using heat and power for timber and pellet processes, and using by-products from timber processing. Need big timber mills for this – limited opportunities in UK.

Because of decline of other timber uses, and increased emphasis on biomass energy, producers now looking at whole-tree harvesting for energy. Higher cost of input, because not by-product, but some efficiencies possible (e.g. not de-barking if higher ash OK), and value of timber not high. Looking at stumpage of £6/tonne in N.Scotland. Economics would not stand higher stumpage – so not worth much to forestry owners.

Biomass CHP helps economics, esp. in UK where policy is biased so heavily towards electricity production and away from heat. Cheap input and ROC income make energy costs lower. However, high capital cost for co-gen rather than simply heat-raising. And distorts financial decision, because most efficient option is heat-led, but because of bias to electricity, prob. better to run electricity-led, and shed heat when not in use. And distorted even further by CHPQA rules, which get extra half-ROC if you can comply (which is expensive).

Can use steam-turbine or ORC (e.g. Turboden) for electricity generation.

At modest scale (1 MWe) and cost, not efficient: ORC 16% net, Turbine 17.5% net, but more expensive.

A lot of waste low-grade heat may be available, depending on sizing. Few opportunities and minimal value for use in the UK.

Typical 40,000 tpa plant:

Input: 65,000 tpa (@35-50% moisture, £6/tonne stumpage, £30/tonne delivered to plant)

Heat consumption: 30,000 MWh p.a.

Electricity consumption: 5,500 MWh p.a.

Peak elec. demand (import capacity): 2,500 MW.

*Pellet plant ex. CHP*

Capital cost: £6-7m

OR&M costs: £4-4.5m p.a. (pellet plant inc. nominal energy costs from CHP plant)

Pellets need to be min. £120/tonne (£4.8m p.a.) from factory gate to start breaking even. *Come back*

*CHP plant ex. pellets*

Capital cost: £7m (ORC) - £8.5m (turbine)

OR&M costs: £800k (ORC) - £900k (turbine) p.a.

Energy sales (@ £120/MWh[e], £30/MWh[th]): £1.4m (ORC) - £1.5m (turbine)

CHP plant OK (before tax) but pellet plant not. Combination not viable.

At larger scale (3MWe+) and with specialist steam-turbine and drying kit, can do much higher electrical efficiency (30-35%), but capital costs much higher (£40-50m for 8-10 MWe, massive economies of scale). Or use cheaper but less efficient kit at large scale, like Balcas (£30m – not viable without massive grant).

Target must be to produce pellets out of gate for no more than £90/tonne (25% cheaper than above). Cheapest plants claim £70/tonne, but poor quality and needs subsidy. By time hauled from factory to dock, loaded on ship, shipped to nearest port to customers, and offloaded, will be over £120/tonne if factory price is £90/tonne.

### ***Infrastructure/logistics/delivery:-***

#### ***Bulk:-***

Price of quality 6mm pellets from dock or local, small-scale factory = £120/tonne (industrial pellets = <£100/tonne).

Discharge from ship: £5-7/tonne.

Haul from dock to store: £1-5/tonne (depending how close store is to dock, closer = more expensv.)

Handling at store (transfer from truck to store): £2.50/tonne

Storage on farm: £10-20k p.a. + rates? 500-5000 tpa = £4-20/tonne

(Storage in warehouse: £30k p.a. + £18k rates. 500-5000 tpa = £10-100/tonne.)

Storage at dock: £100k p.a. + rates? 5000+ tpa = <£20/tonne (ex rates)

Screening and loading onto delivery truck: £3-5/tonne

Haul from store to customer in specialist truck: £1.90/mile driven

Overheads: ?

Return on investment/profits: ?

Early days (<1000 tpa from store) operating costs: £150/tonne + delivery

As scale-up: (>1500 tpa from store) operating costs: £140/tonne + delivery

5-tonne delivery to 50 miles from store (100-mile round-trip) = £38/tonne.

Delivered cost (without overheads/profits) = £180-190/tonne for above.

Worse for parts of country away from dock or factory – need extra haulage, handling and storage step. Prob. £25/tonne extra.

Very seasonal – employees and assets v.busy 6 months of year (mid-Oct – mid-Apr), v.quiet other 6 months. Cash-flow, employment and asset-sweating nuisance. Other uses for assets in summer?

Pellets have to cost customers £200+/tonne on average. Cheapest near factory, next cheapest near store (< £200/tonne). >£40/MWh for most customers.

## **Economics:-**

Chargeable price determined by alternatives (mainly fossil-fuels):

Residential heating-oil price: 32.5p/litre (£28/MWh)

Industrial heavy fuel-oil prices: 3-4p/kWh (£30-40/MWh) incl. duty

Residential gas price: 3.5p/kWh (£35/MWh)

Industrial gas price: 2.4-2.7p/kWh (£24-27/MWh) excl. CCL (0.17p/kWh)

Installed cost of residential oil-fired boiler: £3-5,000

Installed cost of residential gas-fired boiler: £1.5-3,000

Installed cost of residential biomass boiler: £7-20,000

Industrial boilers get closer in price between technologies as they scale up.

Chip (£22/MWh) saves £2-15/MWh compared to fossil fuels (more vs LPG). Typical applications use 100 MWh p.a. upwards. 100 MWh saves £200-1800 compared to fossil fuels. Boiler and installation would cost > £30k for this size installation (50 kW?). Long payback.

Pellet (£40/MWh) more expensive than gas and oil (at the moment). Dependent on grants and Merton Rule. Neither works well. V.small spur to growth.

How come other countries do so much, if it's so uneconomic? See graphs. (East Europe anomalous because of Communist legacy).

Most successful in countries with high energy costs (esp. domestic inc. district heating). Sweden, Denmark, Austria, Germany, Italy, Portugal (& Switzerland & Norway) all seeing strong increases in biomass, significant contributor to overall displacement of fossil fuels (much more than wind etc.).

Feed-in tariff or grant plus tax/high prices (Germany & Austria) not performing better than simple tax/high-prices (Denmark and Sweden).

One high-cost country (Netherlands) not doing so well (but better than us). Dominated by gas network (even more than us). Expensive biomass, so not enough differential to justify investment.

One low-cost country (Finland) doing well. V. cheap biomass, so differential justifies investment. And has carbon tax, albeit against lower base costs. Minimal availability of gas for heating, so limited alternatives. Similar climate and conditions to Sweden, but use more energy per house.

Swedish energy and carbon taxes offer fewer exemptions than Denmark. Swedes rely most on stick (tax), other nations with high green-heat levels rely on carrot (subsidy) and stick, which makes green (and district) heat cheap as well as making fossil-fuels expensive. Result can be seen in energy-intensity of domestic heating relative to heat requirement. The Swedes are comfortably the best. Danes and Germans – supposedly the leaders – are not very good by that measure.

Encourage low-carbon production by making it cheap, you get high consumption of low-carbon energy, but not necessarily efficient use of that energy. Make all energy expensive, but low-carbon less so, then you get lots of low-carbon and lots of energy-efficiency.

Danes and Swedes also have relatively cheap industrial energy, so they have a lot more manufacturing, and much higher Industrial Value Added per capita. But the Swedes do it with lower CO2 emissions than us. Our policy is back-to-front.

**Example:**

Biomass heating for two blocks of housing-association flats (54 in total) in South Wales. Very close (across car-park), so relatively low district-heating network costs. 2 x 100kW boilers, plus gas/oil standby for peak (not priced in).

<b>Capital cost</b>	
Biomass boilers, buffer tank, ancillaries and install	£107,929.00
Standby boiler	£0.00
Fuel storage room and fuel handling	£24,000.00
Heat distribution between blocks (£100/m x 300m)	£30,000.00
Heat pipes (inc. insulation) within ducts, mains to meter	£10,000.00
Interface units and meters	£40,500.00
Hot-water storage tanks	£8,100.00
Extra for underfloor heating	£27,000.00
<i>Subtotal:</i>	<b>£247,529.00</b>
<b>Capital saving</b>	
Gas main	£10,000
Gas boilers	£54,000
<i>Subtotal:</i>	<b>£64,000</b>
<b>Net capital cost</b>	<b>£183,529.00</b>

Housing Association to contribute 50% of net capital cost (£91,764,50) without return!

Year	0	1
Capital cost	-£91,764.50	
Heat demand (MWh)		410
<b>System efficiency</b>		<b>70.00%</b>
Energy content of fuel (MWh)		585.71
CV of fuel (MWh/tonne)		3.4
Tonnes of fuel		172.27
Fuel price (£/tonne)		£75.00
Cost of fuel		-£12,920.17
O&M cost		-£2,000.00
Professional fees	-£5,000.00	-£1,000.00
Management charges		-£3,000.00
Metering, billing & collection		-£1,000.00
<i>Total costs:</i>	<b>-£96,764.50</b>	<b>-£19,920.17</b>
Price for heat (£/MWh)		£44.00
Heat sales		£18,040.00
Standing charges		£10,800.00
<i>Total revenues:</i>		<b>£28,840.00</b>
Net cash flow	-£96,764.50	£8,919.83
Heat sales per flat		£334.07
Standing charges per flat		£200.00
Total cost per flat		£534.07
IRR:	6.70%	
Net cash flow:	£81,632 (0% disc.)	£33,109 (3.5% disc.)

Additional housing-association contribution required, at given heat price and standing charges, with IRR of 6-7%, payback in 12-15 years in discounted cash-flow (DCF) analysis, and value of project over 20 years on DCF analysis of 125-150% of initial capital, assuming Gwalia provide standby oil-fired boiler (add £10,000 if not)

<b>Pellets (4.6MWh/tonne) @ £150/tonne</b>			
<u>Heat price</u> <i>(£/MWh)</i>	<u>Standing charge (per flat p.a.)</u>		
	£0	£100	£200
£30.00	-	-	-
£32.00	-	-	-
£34.00	-	-	-
£36.00	-	-	-
£38.00	-	-	£186,000
£40.00	-	-	£177,000
£42.00	-	-	£168,000
£44.00	-	-	£159,000
£46.00	-	-	£150,000
£48.00	-	-	£141,000
£50.00	-	-	£132,000
£52.00	-	£182,000	£123,000
£54.00	-	£173,000	£114,000
£56.00	-	£164,000	£105,000
£58.00	-	£155,000	£96,000
£60.00	-	£146,000	£87,000
£62.00	-	£137,000	£78,000
£64.00	-	£128,000	£69,000
£66.00	£178,000	£119,000	£60,000
£68.00	£169,000	£110,000	£51,000
£70.00	£160,000	£101,000	£42,000

<b>Chips (3.4MWh/tonne) @ £75/tonne</b>			
<u>Heat price</u> <i>(£/MWh)</i>	<u>Standing charge (per flat p.a.)</u>		
	£0	£100	£200
£30.00	-	-	£154,000
£32.00	-	-	£145,000
£34.00	-	-	£136,000
£36.00	-	£186,000	£128,000
£38.00	-	£177,000	£119,000
£40.00	-	£168,000	£110,000
£42.00	-	£159,000	£102,000
£44.00	-	£150,000	£93,000
£46.00	-	£142,000	£84,000
£48.00	-	£133,000	£75,000
£50.00	£182,000	£124,000	£66,000
£52.00	£173,000	£115,000	£57,000
£54.00	£164,000	£106,000	£48,000
£56.00	£156,000	£97,000	£39,000
£58.00	£147,000	£88,000	£30,000
£60.00	£138,000	£79,000	£21,000
£62.00	£129,000	£70,000	£12,000
£64.00	£120,000	£61,000	£3,000
£66.00	£111,000	£52,000	-
£68.00	£102,000	£44,000	-
£70.00	£93,000	£35,000	-