FORESTENERGY

Harvesting and processing forest biomass for energy production in Ireland

PROJECT TEAM

Tom Kent, Waterford Institute of Technology*
Pieter Kofman, Danish Forestry Extension
Dr Eleanor Owens, Waterford Institute of Technology
Dr Dmitri Botvich, Waterford Institute of Technology
Enda Coates, Waterford Institute of Technology
Sarah Cooley, Waterford Institute of Technology
Sean Kelly, Waterford Institute of Technology
Meabh Kenneally, Waterford Institute of Technology
Cathy Walsh, Waterford Institute of Technology
Dan O'Mahony, Waterford Institute of Technology
Nicholas Mockler, Waterford Institute of Technology
Damien O'Donovan, Waterford Institute of Technology
Tom O'Dwyer, Waterford Institute of Technology
Alastair Dunnett, Waterford Institute of Technology
Seamus Forde, Waterford Institute of Technology

* Email: tkent@wit.ie

COMPLETION DATE: February 2009

BACKGROUND

Concerns over climate change, security of energy supplies and sustainable forest management have directed international policy supporting the development of renewable energy from wood fuel. The EU plans to produce 20% of energy requirements from renewable sources. It is expected that almost 65% of that goal is to come from biomass and most of that biomass would be in the form of wood.

The Irish Energy White Paper and Bioenergy Action Plan for Ireland set out the framework for meeting these targets in Ireland. Sustainable Energy Ireland has mounted a successful campaign to encourage private individuals and commercial firms to install wood fuel boilers, thus creating a demand for wood fuel in the form of wood pellets and dry wood chip. Three peat-fired power stations are gearing up to fulfill their obligation to co-fire 30% biomass with peat by the year 2015. The Forest Service has had two calls for grants for companies to buy relevant wood chipping equipment. These initiatives have created a supply and demand situation.

Wood for energy is a relatively new assortment in Irish forestry and much knowledge remains to be gained. Ireland has a ready-made wood fuel resource in the large areas of farm forests planted over the last 25 years, which now require thinning to achieve production potential. Forest ownership is fragmented and knowledge of harvesting and storing wood for energy limited. The ForestEnergy project, commenced in 2006, and renewed annually, aims to develop cost-effective supply chains by adapting commercially used methods from Europe to Irish conditions.

OBJECTIVES

The main project objective was to secure marketable wood fuel of acceptable moisture content for sale from Irish first thinnings of softwoods and hardwoods.

Specific objectives were to:

- Demonstrate harvesting, extraction and wood fuel processing equipment on softwood and hardwood sites, representative of regional and site variation in Ireland;
- Produce and assess the quality of both wood chip and firewood products;
- Assess optimum storage systems to promote maximum seasoning at lowest cost;
- Investigate moisture content/climate relationships with the view to developing a moisture content reduction model based on simple climatic indicators;
- Analyse chemical composition of wood samples collected during the harvesting trials across the country, and subsequently analyse the change in chemical composition of wood fuel assortments during storage;
- Organise dissemination activities including public demonstrations, articles, workshops, presentation of results and display of wood fuel sample materials.

PROGRESS

Forest harvesting and wood fuel processing trials

Between 2006 and 2008, nine softwood sites, totalling 130 ha, received first thinning treatments. A further 35 ha of first thinning was carried out over five hardwood sites. Harvesting and chipping trials were also carried out on forest plots on Bord na Móna cut-over peat. Figure 1 presents the location of all trial sites. A range of methods was used for harvesting, extraction and chipping. All machinery and methods were studied to develop productive time per unit output for the range of site types and tree sizes encountered.

The whole tree method was the lowest cost method of

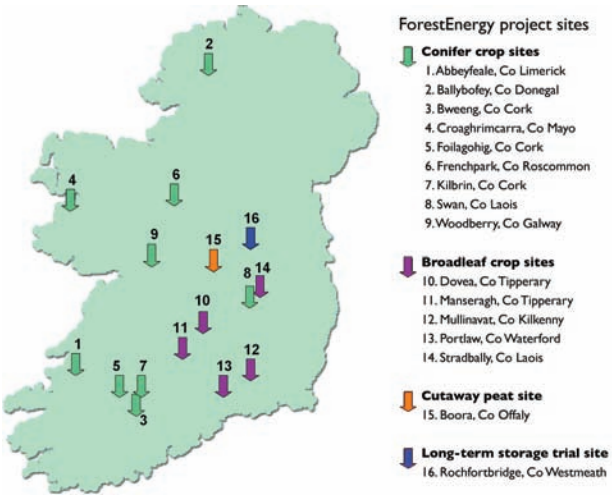

Figure 1: Location of ForestEnergy trials.

producing woodchip from first thinnings in softwoods: the trees were felled by chainsaw in a line thinning, seasoned in the extraction rack and chipped by a Silvatec terrain chipper and extracted to roadside by a chips forwarder. Figure 2 shows the Silvatec terrain chipper used on eight softwood sites, three hardwood sites and one cut-over peat site during the ForestEnergy project. On eight sites over three years, the average production cost by this method was in the range of €2.03 to €4.28/GJ. The next cheapest method, at €2.80/GJ, was also a whole tree method where a feller-buncher carried out a selective thinning and bunched the trees in the rack, for post-seasoning terrain chipping. Disadvantages of the whole tree terrain chipping system were no distinct brash mat and no machine infrastructure available in Ireland to efficiently transfer chips from the chip forwarder to a road transportation system.

In comparison, the production cost of wood chip using standard harvester and forwarder roundwood line and selective thinning, with logs stacked in the forest to season and chipped at roadside, was in the range of €6.53 to €7.59/GJ. A variation of this standard thinning system was to replace the pulp assortment with an energy wood assortment, with no minimum top diameter and branches only loosely delimbed leaving stubs, cut to a variable length up to 4.5 m.

Figure 2: The Silvatec terrain chipper.

The production cost of chip with this energy wood system was between €5.82 and €6.81/GJ.

The substantial difference in production costs can be attributed to three main factors: harvesting whole trees yielded on average 50% more biomass and the energy wood assortment yielded 15% additional biomass per hectare in comparison to the round wood methods. Also, the whole tree harvesting operation is faster and cheaper as there is no delimbing and cross-cutting to length. Finally whole trees dried more in the stand compared to logs stacked at roadside in first thinnings.

In hardwoods, time studies were carried out on marking stands prior to thinning, in addition to studying various systems for thinning to produce wood chip and firewood assortments. Marking the crop, in accordance to the Forest Service/Teagasc guidelines, averaged 1 ha per man day. There was little variation between personnel studied or between sites.

As in the softwood trials, the lowest cost method of producing woodfuel was terrain chipping whole trees. Production costs ranged from €2.82/GJ for a line thinning only by chainsaw, to €7.09/GJ when the thinning included selection between lines. Using the feller buncher for line and selection thinning in hardwoods gave a production cost of €3.37 - €4.07/GJ.

Wood fuel storage trials

Softwood storage trials were carried out in the forests and were carried out at an open, exposed depot site for comparison. Hardwood trials were carried out in the forest and storage trials of 3 m length logs and firewood products stored under a variety of conditions were also carried out. All material was harvesting between March and June and all chipping was carried out in August – September to benefit from summer seasoning. Sites harvested in 2006 were chipped after one summer only. Sites harvested in 2007 were partially chipped after one summer and the remainder chipped after two summers seasoning. In the forest, whole trees were seasoned in the extraction rack; roundwood and energy wood assortments were stacked at roadside. Some stacks were covered and some left uncovered. Moisture content was

Figure 3: Whole ash trees, stored under plastic cover at roadside over summer 2006, chipped with a Jenz 700 towed chipper into walking floor lorry.

sampled at time of harvest and again post seasoning as the material was chipped.

Freshly felled Sitka spruce at first thinning varied in moisture content between sites and assortments but averaged 60% moisture content. There was a large variation between years, between sites and between assortments in the rate of drying. The hardwood results were interesting, in that ash had a mean initial moisture content of 40%. On the other hand, the ash assortments stored in the forest did not dry to any great extent. Table 1 details the change in moisture content between harvesting and after storage in the forest.

General conclusions from the in-forest storage trials were that the forest environment at first thinning stage is not conducive to rapid, even, predictable drying of stored wood. Whole tree assortments generally performed better than roundwood and energy wood assortments. Covered stacks dried better than uncovered stacks, however the covers used degraded substantially in the second year and were not effective. Wood fuel stored in the forest did not dry sufficiently for use in commercial boilers requiring fuel of less than 35% moisture content. In-forest storage may be used to dry wood fuel to 45-50% moisture content.

A storage trial was constructed near Rochfortbridge on an open, exposed Bord na Mona site to assess drying potential of logs moved from the forest to a depot. Eight steel bins were constructed, placed on load cells and c. 25 tonnes of logs were placed in each to assess the loss of weight over time. The assumption was made that any loss of weight would represent a loss of moisture. Moisture content and other parameters were sampled intensively at the beginning and end of the trial. Bins were filled with freshly felled material in April, June, September and December 2007 to assess the variation in drying seasonally. All bins were emptied in August 2008.

All log stacks achieved an end moisture content in the range of 18-22%. The mean time length to achieve a 30% moisture content required for commercial wood fuel boilers was 19 weeks, for material stored in April this was 16 weeks, whereas material stored in December required 26 weeks. On average, the stacks lost 47% of the initial total weight, and 63% of initial total moisture. The energy content of the wood fuel increased on average by 17% over the storage period. Figure 4 shows a summary of the variation in seasonal moisture content reduction over the storage period.

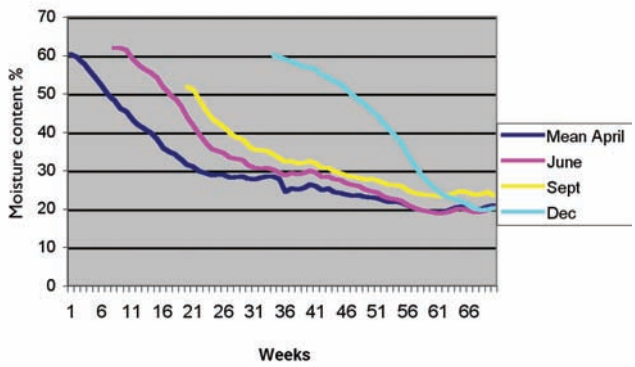

Figure 4: Seasonal variation in moisture content reduction of logs stored at the Rochfortbridge trial.

General conclusions from the storage trials were that logs and trees stored in the forest will not achieve a moisture content of less than 30% over either one or two summer seasons, due to the shelter effect and humid micro climate found. Covered stacks will dry 10% in one summer and an additional 5% in two summers. Uncovered stacks are not recommended. Seasoning roundwood to less than 30% moisture content is possible in ambient Irish climate in an open exposed depot. Logs that begin seasoning in spring will dry fastest, while logs beginning seasoning in winter will dry slowest. Covering stacks in an open depot will both aid faster drying and ensure more uniform moisture content in the stack.

ACTIVITIES PLANNED

The final project report is in preparation. Twenty-one COFORD Connects Notes covering all harvesting, storage, fuel quality and tree moisture content outputs are being written at present. Dissemination of project outputs is continuing through the woodenergy.ie website. A number of research papers are in preparation.

OUTPUTS

Presentations

Kent, T. *Wood Energy – From Forest to Market.* Presentation made at National Forestry Conference: New forestry initiatives - opportunities for the sector. 7 March 2008, Enfield, Co Meath.

Table 1: Mean moisture content changes pre- and post-seasoning for assortments stored in the forest. All moisture contents are after one summer season only unless stated.

Species	Assortment	Mean Moisture Content%			
		At harvest	Post-seasoning		
			2006	2007	2008
Sitka spruce	Pulpwood uncovered	61	63	54	47 (2 summers)
Sitka spruce	Pulpwood covered	62	55	48	45 (2 summers)
Sitka spruce	Energywood uncovered	62	62		
Sitka spruce	Energywood covered	60	57	53	48 (2 summers)
Sitka spruce	Whole trees	57	50	50	47 (2 summers)
Sitka spruce	Whole trees (chemical thinning)	58	52	39	
Sitka spruce	Whole trees (felled standing)	54		44	
Ash	Whole trees	42	36		37
Ash	Roundwood	37			31

Kofman, P. *Fuelling your Boiler the Right Way – Feedstock Quality for Commercial Boilers.* Presentation made at Bioenergy 2008 Conference: A Growing Opportunity for Energy and the Environment. 19 June 2008, Teagasc Mellows Centre, Athenry, Co Galway.

Kent, T. *Wood Fuel Quality Parameter Testing – Summary of Current Activities*. Presentation to NSAI CEN Solid Biofuel Mirror Group Meeting, 25 June 2008, Waterford Institute of Technology.

Kofman, P. *Developing Quality Wood Fuel from Irish Forests, Avoiding the Pitfalls.* Presentation made at SEI Wood Energy Conference: Fuelling Your Future. 10 September 2008, Westport, Co Mayo.

Kent, T. *COFORD Forest Energy Programme Overview.* Presentation to Inter-Departmental Bioenergy Working Group, hosted by Sustainable Energy Ireland, 11 September 2008, Dublin.

Kent, T. *Development of Wood Energy Supply Chains*. Presentation made at Forest Service Seminar - Wood Fuel: The Energy Solution for Kerry. 19 September 2008, Killarney, Co Kerry.

Kent, T. *Producing Wood Chip for Energy – Experiences from the COFORD Forest Energy Programme*. Presentation to the Wicklow Uplands Private Forest Owners Group Seminar. 12 November 2008, Co Wicklow.

Kent, T. and Kofman, P. *Moisture Content Management - The key to wood fuel quality. A result of COFORD Forest Energy Programme.* Irish Bioenergy Association Wood Energy Information Day. 19 November 2008, Enniskillen Co Fermanagh.

Field days

Kent, T. and S. Kelly. Forest Energy Project: results and conclusions of the COFORD funded research programme. Society of Irish Foresters/Irish Timber Growers Association/Irish Farmers Association Field Day 23 May 2008, Ballybofey, Co Donegal.

Coates, E., Cooley, S., Kelly, S., Kent, T. Mockler, N. and Owens, E. Woodfuel Quality Testing Demonstrations and Talks and Wood Energy Assortment and Machinery Demonstrations and Talks. COFORD/SEI/Teagasc Bioenergy 2008, Teagasc, Athenry, Co Galway.

Coates, E., Kent, T., Kelly, S. and Kofman, P. Wood fuel supply chain and quality assessment on softwood first thinning site, Croaghrimcarra, Co Mayo. Public demonstration arranged for at SEI Wood Energy Conference: Fuelling Your Future. 10 September 2008, Westport, Co Mayo.

Coates, E. and Kent, T. Wood chipping methods and costs and wood chip quality demonstration and talk. Teagasc Out-wintering Pad Public Demonstration Day, 19 November, Moorepark Research Centre, Co Cork.