Preliminary results on the physical & chemical properties of *Eucalyptus* in Ireland

The SHORTFOR research project aims to:

- Study the potential of short rotation forestry to supply fibre and fuel markets in Ireland
- Assess suitability of *Eucalyptus* species as a short rotation forestry species
- Estimate total above ground biomass and merchantable stem volume from a range of stands
- Determine physical and chemical properties of *Eucalyptus*.

This research note summarises the results of determination of physical and chemical properties of *Eucalyptus* species, carried out by WIT in co-operation with Coillte, whereby samples were collected in the field (species and locations described in Table 1 below) and the following parameters were determined by WIT:

- Green density, expressed in kg m^{-3}
- Moisture content, expressed as a % of total weight
- Basic density, expressed in kg m^{-3}
- Bark content, expressed as a % of total weight
- Bark content, expressed as a % of total volume
- Ash content, expressed as a % of dry weight
- Gross Calorific Value, dry basis expressed in MJ kg^{-1}
- Net Calorific Value, as received expressed in MJ kg^{-1}

These parameters were described for wood, bark and leaf partitions and roundwood and logging residue assortments, though only mean values for roundwood and logging residues are presented in this research note. In addition, the concentration of carbon, hydrogen, nitrogen and chlorine was determined for *E. nitens* at Coolgreaney.

Figure 1. *E. delegantensis*, Ferns, Co. Wexford

Figure 2. *E. nitens* at Cappoquin: Largest tree dbh of 76 cm

Figure 3. Ground wood, leaf, bark, roundwood and lop & top samples for ash content and calorific value testing

Table 1. Sample species and site details. (Ref. 1)

Species	Location	Planting Year	Harvesting Year	Age	Survival @ 8-9 years	Top Height (m) @ 13-14 years	Mean DBH (cm) @ 13-14 years
E. nitens	Coolgreaney Forest, Co. Wexford	1993	2009	15	60%	21.5	26
E. nitens	Hollyford, Co. Tipperary	1993	2010	16	90%	22.5	26
E. delegatensis	Bree, Co. Wexford	1992	2014	22	80%	17.5	23

Table 2. Mean physical and energy parameter values for sampled *Eucalyptus*.

		E. nitens (Coolgreaney)		*E. nitens* (Hollyford)		*E. delegatensis* (Bree)	
Parameter	Unit	Roundwood	Logging Residues	Roundwood	Logging residues	Roundwood	Logging residues
Green Density	kg m^{-3}	1075		990		939	
Moisture Content	% total wt.	59.3	52.2	56.2	51.5	53.4	44.5
Basic Density	kg m^{-3}	446		435		436	
Bark (% Weight)	% total wt.	15		11		10	
Bark (% Volume)	%	14		13		15	
Gross Calorific Value	MJ kg^{-1}	19.05	20.03	18.76	20.41	19.6	20.0
Ash Content	% dry wt.	1.45	2.4	1.55	2.84	0.38	1.77
Net Calorific Value	MJ kg^{-1}	5.7	7.6	6.2	7.9	7.2	9.2

Table 3. Chemical composition and energy parameters of *E. nitens* (Coolgreaney) compared to literature values.

	WIT Measured		Literature		
Major Element	*E. nitens* Logging residues % total dry weight	*E. nitens* Roundwood % total dry weight	Eucalyptus spp. (Ref. 2)	Wood, Eucalyptus (Ref. 3)	Stemwood, Eucalyptus (Ref. 4)
Carbon, % dry wt.	47.18	45.89	48.20 - 49.50	49.50	47.20
Hydrogen, % dry wt.	5.60	5.56	5.87 - 5.92	5.75	6.50
Chlorine, % dry wt.	0.18	0.19	0.08 - 0.13	0.055	n/a
Nitrogen, % dry wt.	0.55	0.07	0.15 - 0.39	0.14	0.50
Ash, % dry wt.	2.40	1.45	0.50 - 1.10	0.50	1.40
Gross Calorific Value, MJ kg^{-1}	20.03	19.05	19.23 - 19.42	19.22	19.00

Conclusions:

- Despite fast growth rate, sampled eucalyptus has relatively high basic density wood. *E. nitens* and *E. delegatensis* is c. 440 kg m^{-3} compared to Sitka spruce at c. 370 kg m^{-3}.
- Bark content is very high compared to other species, at over c. 15% by volume. Debarking for panel board or sawlog production may be problematic due to the tough fibrous nature of the bark. Bark removal can be difficult, so is often carried out during harvesting.
- Moisture content, and the impact of moisture content on net calorific value, indicates that eucalyptus must be seasoned in order to be used for energy.
- Ash content and calorific values are higher for logging residues compared to roundwood due to the presence of greater concentrations of non-combustible mineral elements and extractive oils respectively.
- Chlorine concentration is high at c. 0.2% dry weight, though these values are the average of a very small sample size from one site. At this chlorine level, eucalyptus would be deemed unsuitable as woodchip for supply into Bord Na Mona for example as the maximum allowable concentration is <0.1%. Further analysis is required to understand better the variance in chlorine and other chemical elements in *Eucalyptus*.
- Sample values determined by WIT are in line with values for the same parameters quoted in the literature.

References:

Ref. 1 Neilan J. & D. Thompson. Eucalyptus as a potential biomass species in Ireland. COFORD Connect Note. Reproductive Material No. 15. www.coford.ie.

Ref. 2 Kitani, O. and C.W. Hall (1989). Biomass Handbook. Gordon & Breach Science Publishers, New York.

Ref. 3 http://rredc.nrel.gov:80/biomass/doe/nrel/comp/alki/appendix.html. Cited in: www.ecn.nl/phyllis

Ref. 4 Hallgren A.L.; Engvall K. And B.J. Skrifvars (1997). Ash-induced operational difficulties in fluidised bed firing of biofuels and waste. Proc. 4th Biomass Conference of the Americas, p.1365-1370.