TECHNICAL NOTE

TN - 55

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# Effect of in-forest drying on cost of transporting forest arisings as bio-energy

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*Figure 1 - The content, form and storage of residues can affect transport costs.*

## Introduction

When considering use of in-forest arisings as a bio-energy fuel, where and when to convert the residue from its raw form to fuel (Figure 1), is a critical decision and there are a number of factors to consider.

Chipped or hogged residues are easier to handle and transport as they tip and flow well and have higher bulk density (30% to 33%) compared to unhogged materials (25% to 30%). However, once the residues are chipped they need to be used quickly as dry matter losses, mould and fungi growth and pile heating can occur in just a few weeks. Piles of chipped residues have little capacity to dry without forced ventilation and may absorb more moisture if they are exposed to rainfall.

If the residues are left unchipped, they are bulky to store and transport (Figure 2). They are also comparatively difficult to handle during loading and unloading. However, they also tend to dry out over time. The drying of the residues raises the net calorific value of the fuel. There are less dry matter losses and fewer pile heating problems and mould and fungi growth is minimal in piles of unchipped residues.

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# Results

In a recent residues drying trial (Hall, 2000[1]) raw piled residues were found to dry from a moisture content of 60% to 40% in four months (Figure 3). The cost of storage was minimal as the residues were piled on disused landings created during logging. The storage cost would be the interest on the cost of handling the material and would be in the order of $0.05 per tonne.

Traditionally, the harvesting and transport costs for forest products are calculated and paid for on a per cubic metre or per tonne basis. However, these approaches are not appropriate for wood fuels, as the delivered product is energy not tonnage or volume.

As the moisture content of wood drops, the net calorific value (energy content) rises (Figure 4, Baines, 1993).

***Figure 2*** *- Raw residues stored for in-forest drying*

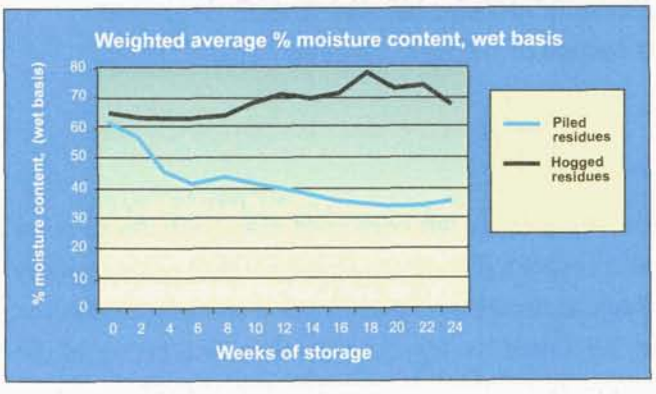


***Figure 3*** *- Moisture loss in stored residues*

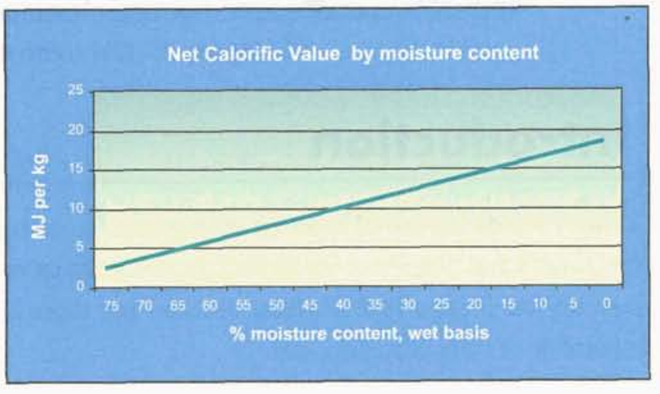


***Figure 4*** *- Energy content of wood versus moisture content*

Given these factors, it is possible to calculate that for air-dried residues, although the delivered tonnage is lower, the delivered energy is higher as moisture content drops (Figure 5). These calculations assume; transport distance of 35 km, load volumes for a truck and trailer as 85m$^3$ and that a load bulk density of 30% (0.3 tonnes per m$^3$ of load space) is achieved.

[1] This trial involved assessment of 200 m$^3$ piles of hogged and unhogged material stored in Kinleith forest from September 1999 to January 2000. This study is part of ongoing work to emphasis the use of forest residues for biofuels.

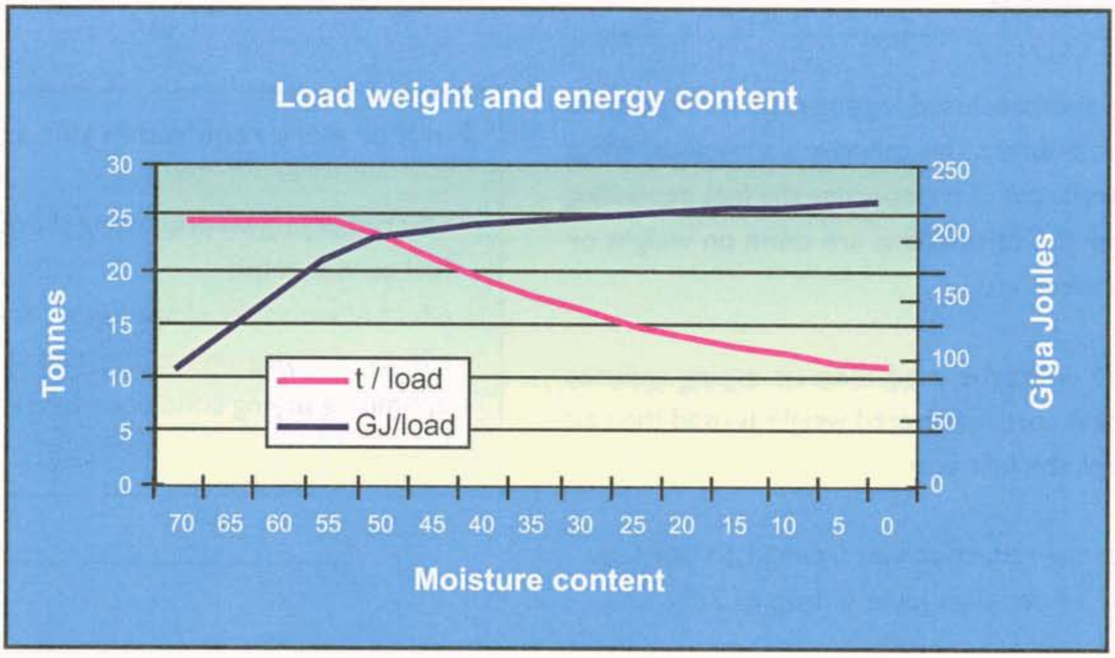


***Figure 5*** *- Load weights and energy values by moisture content*

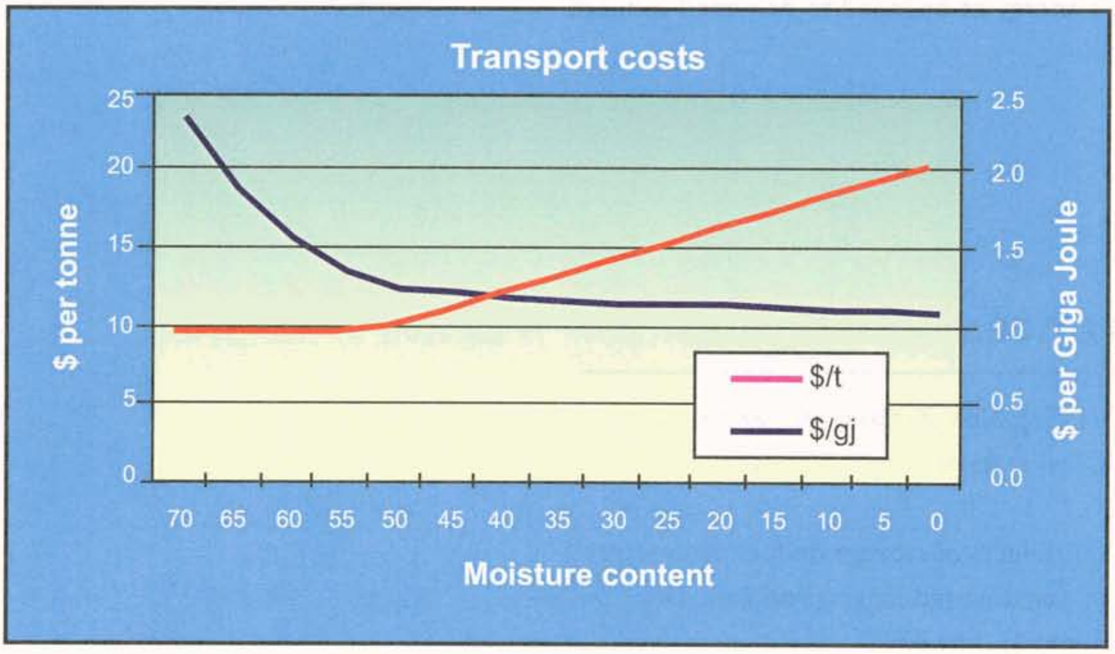


***Figure 6*** *- Transport cost for tonnes and energy*

If a transport cost is then calculated (Riddle, 1993) for the trucks over a given transport distance, then it is possible to calculate the cost per tonne and cost per Giga Joule of the load (Figure 6).

It can be seen in Figure 6, that although the transport cost per tonne has risen, the transport cost of per Giga Joule of energy has dropped. The storage cost of 5 cents per tonne (less than one cent per Giga Joule) is more than offset by the reduction in transport cost per Giga Joule if the residue is stored for three to four months.

These costs relate only to the transport component of the fuel delivery system. The effects of the drying on other parts of the system, such as processing and handling have not been calculated. This area requires further work as processing of the dry material may reduce the productivity of the chipper or hog.

## Summary

Air drying of unprocessed logging residues is possible at low cost, in-forest. This can have a substantial effect on the overall cost of transporting the fuel, depending on whether the calculations are done on weight or energy content.

If delivered energy is used then air drying reduces delivered unit cost, if delivered weight is used then air drying raises the unit cost.

In this case the reduction was from $1.55 per Giga Joule to $1.13 per Giga Joule, a drop of 27%.

When considering the use of in-forest residues as bio-energy fuels it is important to consider the cost of delivered energy as opposed to delivered tonnage or volume.


**Further work required in this area is on:**

- effect of drying on processing production and fuel consumption
- effect of wood shrinkage during drying
- effects of drying on handling and storage
- optimising drying conditions (pile design and location)

## References


Baines J.T. (1993): New Zealand Energy Information Handbook. Taylor Baines and Associates.

Hall P. (2000): Effects of storage on fuel parameters of piled and comminuted logging residues. Liro Report. Volume 25. No. 5.

Riddle A. C . (1994): Business management logging. Liro Handbook.


*The costs stated in this Report were derived using the procedures shown in the Liro Handbook, Business management for logging. They are indicative only and do not necessarily represent the actual cost of the operation.*