ENERGY IMPLICATIONS OF THE EXPANDED PLANTING PROGRAMME

G. P. HORGAN*

ABSTRACT

By the year 2006 it is expected that 17.5 million m$^3$ wood per annum — twice the current harvest — will be available for processing. Some processing routes (e.g., pulp and paper manufacture) use substantially more energy than others (e.g., sawn timber production). The industry has the ability to supply the bulk of its energy needs from its own resources, using technology that is already available. Energy, with the possible exception of liquid fuels used in harvesting, need not be a constraint on the forest industry's growth.

The future may well see the increased use of wood as a fuel source, both in its traditional role as a source of low-grade heat and possibly in the production of liquid fuels such as methanol and ethanol.

INTRODUCTION

The forest industries are large net consumers of energy; in the 1976-7 financial year they consumed some 17% of the energy (electricity, coal, oil and gas) used by industry in this country (N.Z. Dept of Statistics, 1978a).

The substantial growth expected in the wood-based industries before the end of the century could have significant implications for the nation's energy needs and policies. This paper looks briefly at the potential for growth in forest-based industries, considers some of the processing options, and examines their energy implications.

WOOD AVAILABILITY

In the past 15 years the land area devoted to exotic forestry in this country has more than doubled (N.Z. Forest Service, 1978). The effect that this increase, and increases planned for the next 10 to 15 years, will have on future wood availability is indicated in Table 1.

The availability of logs of exotic species — principally radiata pine — is projected to double within 20 years and

* Forest Research Institute, Private Bag, Rotorua.
TABLE 1: ESTIMATED SUPPLY OF EXOTIC LOGS
(Average annual yield)

<table>
<thead>
<tr>
<th>Period</th>
<th>Supply (million m³)</th>
</tr>
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<tbody>
<tr>
<td>1976-80</td>
<td>8.8</td>
</tr>
<tr>
<td>1981-5</td>
<td>9.0</td>
</tr>
<tr>
<td>1986-90</td>
<td>9.2</td>
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<tr>
<td>1991-5</td>
<td>12.5</td>
</tr>
<tr>
<td>1996-00</td>
<td>17.5</td>
</tr>
<tr>
<td>2001-5</td>
<td>24.3</td>
</tr>
<tr>
<td>2006-10</td>
<td>33.3</td>
</tr>
<tr>
<td>2011-15</td>
<td>36.1</td>
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quadruple within 30. Since most rotations are 20 to 30 years long, it follows that virtually all the forest scheduled for cutting in the next 30 years has already been planted.

ALTERNATIVES

There are three possible options for dealing with this expanding wood supply:

(1) Leave the forests unharvested as a large and growing reserve;

(2) Harvest the forests as planned and process them into "traditional" forest products — sawn timber, pulp, paper, fibre products, etc.;

(3) Harvest the forests and process them into non-traditional products, e.g., liquid fuel.

These options are not mutually exclusive and it may well be that in a little over 10 years' time, when the wood supply begins to expand rapidly, all three will be pursued to some degree.

Discussing the energy implications of a mixed strategy, in which some forest would be harvested and some left, is unlikely to be a particularly fruitful exercise. Each of the many combinations possible would have its own energy implications; moreover, those of any particular strategy depend on the type of processing carried out. An appreciation of the energy implications is more easily grasped by treating each of the above options individually and examining some of the extremes within each.

Unharvested Forests

Because the energy requirements of harvesting and processing some 9 million m³ wood/year (the current harvest) are
provided for already, it is the implications of any increment to the annual harvest that must be considered. If the wood supply fails to increase because of a policy restricting total harvest to 9 million m³/year (a most unlikely occurrence), then clearly the planting programme of the 1960s and 1970s will have minimal effect on energy use.

*Harvesting for Traditional Forest Products*

The second alternative — that forests be harvested as planned (Table 1) and processed into traditional forest products — provides the rationale for the expanded planting programme. Moreover, because forest resources are far in excess of what is necessary to meet domestic demand for traditional products, it is intended that the bulk of the wood coming on stream should be exported.

This intention is clear in all official documents published since the 1969 Forestry Development Conference. One of the recommendations of that conference was the establishment of a new planting rate of 21 000 ha/year until 1985 in order to satisfy growing domestic demands and to maintain continuity of exports after 1995. In practice, new plantings have exceeded 21 000 ha every year since 1969, and are at present of the order of 40 000 ha/year. Domestic demand for forest products has grown more slowly than was expected, with the result that processing for export must now assume an even greater importance to the industry than it did in the late 1960s.

Based on Table 1 and assuming a current harvest of 9 million m³, the increment from the expanded planting programme is given in Table 2.

<table>
<thead>
<tr>
<th>Period</th>
<th>Incremental Supply (million m³)</th>
</tr>
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<tbody>
<tr>
<td>1986-90</td>
<td>—</td>
</tr>
<tr>
<td>1991-5</td>
<td>5</td>
</tr>
<tr>
<td>1996-00</td>
<td>9</td>
</tr>
<tr>
<td>2001-5</td>
<td>15</td>
</tr>
<tr>
<td>2006-10</td>
<td>24</td>
</tr>
<tr>
<td>2011-5</td>
<td>27</td>
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The decision on what to produce from this increase in material will have a strong bearing on energy use. Pulp and paper production is much more energy-intensive than sawn timber production (Table 3), and so the energy implications of
a strategy that would convert this expanding wood supply into pulp exports are much greater than those associated with sawn timber production.

Assuming that all the incremental material (Table 2) is suitable for processing, and available economically, two possible processing options are now considered. The first option (low energy-use) involves exporting all the material as logs; the second one (highly energy-intensive) assumes that all material is converted to dried, bleached, kraft pulp.

### A Low Energy-use Option — Log Exports

As processing is minimal for export logs, the principal energy input would be in logging and transport. It can be seen from Table 3 that, although net energy use in this option is relatively low, virtually all energy used at present is in the form of oil. If oil or a suitable substitute were not available, then conventional logging and transport would not be possible either for the current harvest or for any increment. (It

<table>
<thead>
<tr>
<th>Process</th>
<th>Roundwood Required (m³)</th>
<th>Net Energy Used in Process (GJ)</th>
<th>Form in which Energy is Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logging and transport to mill/wharf (per m³)</td>
<td>1</td>
<td>0.12-0.29</td>
<td>Oil</td>
</tr>
<tr>
<td>Rough-sawn timber (per m³ sawn)</td>
<td>2.4</td>
<td>0.30</td>
<td>Electricity/steam</td>
</tr>
<tr>
<td>Production of refiner groundwood pulp (per tonne)</td>
<td>2.4</td>
<td>4.6</td>
<td>Electricity/steam</td>
</tr>
<tr>
<td>Production of thermo-mechanical pulp (per tonne)</td>
<td>2.3-2.6</td>
<td>4.2-8.6</td>
<td>Electricity/steam</td>
</tr>
<tr>
<td>Production of dried bleached sulphate pulp (per tonne)</td>
<td>5.0-5.2</td>
<td>11-15</td>
<td>Electricity/steam/oil</td>
</tr>
</tbody>
</table>

*Source: N.Z. Forest Service (1978).*
could be an interesting exercise to speculate on what energy sources might be used in logging, in internal transport, and in the vessels that would carry New Zealand produce to its final destination.) However, it is assumed in the rest of this paper that oil, or a very similar substitute fuel, will be available.

Logging and transport use 0.12 to 0.29 GJ/m³ (Table 3), which in terms of premium grade fuel represents somewhere between 3 and 8 litres/m³ (DSIR, 1978). Taking the upper figure and the increase in wood supply given in Table 2, the fuel requirement for this option would rise from some 24 million litres/year in the period 1991-5 to 216 million litres/year in the period 2011-5. Last year the average daily liquid petroleum fuel usage in this country was 6.2 million litres (N.Z. Dept of Statistics, 1978b); so 216 million litres/year represents just under 5 weeks' total national usage at current levels.

A High Energy-use Option — Kraft Pulp

Much of the fuel required in the previous option would also be required in kraft pulping. A small reduction could come about because of the lower volume and weight of processed material vis-a-vis unprocessed logs, and the possibility of using an energy-efficient transport system such as rail from the mill to the port. Any such reduction, however, would be more than offset by the energy required to process logs into pulp and then to dry this pulp. Some 9 PJ energy would be necessary to process the harvest in 1991, and this would rise to 78 PJ by 2015. All of this could be supplied as electricity from the national grid but if it were, there would be major implications. In the year ended December 1978, the Electricity Division of the Ministry of Energy generated a total of 76 PJ electricity (N.Z. Dept of Statistics, 1978b). Thus, to supply the 1991 figure and maintain all other electricity uses at the current level would require an 11% increase in generation; and to meet the 2015 figure a 102% increase over current levels would be necessary.

It should be recognised that these are extreme figures. They are based on the assumption that all the incremental wood supply will be turned into kraft pulp in mills whose external energy demands will be similar to those of mills built in the early 1970s. Although pulping requires a large net energy input, there is considerable scope, even with current technology, for the industry to generate its own energy on site (N.Z. Dept of Lands and Survey, 1977). If the potential for electricity generation from back-pressure steam were fully utilised, and some logging waste was recovered and used,
then the above figures could be reduced by half (*ibid.*). Oil, gas, coal or wood, as well as electricity from the national grid, could be used to supply the remaining energy requirements. There is also the possibility that technological developments in the next 20 years could reduce the pulp industry's need for external energy inputs.

Clearly there are a number of other processing options much less extreme in their energy use than a kraft pulp mill. A well-designed sawmill can, by efficiently burning residues other than pulp-quality chips, be energy-independent (Forestry Council, 1979; Fraser *et al.*, 1979). The more sawn timber produced *vis-a-vis* pulp, the lower will be the net external energy input required by forestry. The examples, particularly the pulp one, do show that the energy implications of proposals for the utilisation of the new forest resource should be given some consideration.

**Non-traditional Products**

The third alternative for using the increased wood supply is in non-traditional products. These products may be produced for either the domestic or the export market, or possibly for both.

Since this paper is about energy, it is worth considering wood as a fuel in this section. Even though wood has been the principal world fuel until comparatively recent times (even today more than 1200 million tonnes/year are used — Sutton, 1978), the growing of trees for energy is not practised commercially in this country. Hence, energy forestry warrants a "non-traditional" label.

As a fuel, wood can be used directly to supply low-grade heat (cooking, space heating, water heating); it can be used as the feedstock for thermal electricity stations; or it can be used for the production of gaseous or liquid fuels such as methanol or ethanol. All of these possible uses are receiving attention from a number of researchers both here and overseas.

Of the various options for using wood as a fuel, perhaps the most interesting are those involving its direct use to supply low-grade heat, and those that convert it to a liquid fuel. The liquid fuel option possibly has the greater glamour, particularly as this nation faces the prospect of having to restrict its use of imported petroleum products.

Both methanol and ethanol are seen as possible substitutes for petroleum fuels. Indications are that, to produce sufficient methanol to substitute for 15% of current road transport fuels, some 4 million m³ woody biomass would be required
per year; slightly more material would be necessary if ethanol were the substitute fuel (W. B. Earl, pers. comm.). The figures produced earlier in this paper (Table 2) indicate that forestry could make a significant contribution to liquid fuels supply.

A review of the potential for energy farming in this country (NZERDC, in prep.) concludes that:

1. It would be technically possible to provide all New Zealand's road transport fuels from energy farming;
2. Energy farming can show a high net energy gain;
3. Biomass fuels would be more expensive than gasoline is at present (1979);
4. If oil prices continue to rise, biomass-based fuels will become competitive with oil.

The study showed that net energy input:output ratios for radiata pine range from 1:7 to 1:15 depending upon the management system and on the fuel produced. It also suggested that fuel from large, efficient processing plants would probably cost some 19 to 26 cents/litre compared with the present (April 1979) ex-refinery but before-tax price of gasoline of 16.2 cents/litre (G. S. Harris, pers. comm.). Because the study was theoretical, the production costs must be treated with some caution. However, they are low enough to suggest that continuation of research in this field is warranted.

Although lacking the glamour of liquid fuels, the direct use of wood to provide low-grade heat may prove to be of great long-term importance. Wood is a very suitable fuel for supplying household water- and space-heating requirements, and such use would release oil, gas and electricity for other purposes.

An average household in the northern part of the North Island uses some 23.4 GJ/year in water- and space-heating; the average household in Southland uses about 68.4 GJ for the same functions (Peet et al., 1978). With the new, efficient wood-burning appliances now coming on the market, an Auckland householder would need at most 3 tonnes of air-dried wood/year to supply all water- and space-heating requirements, and the Southland householder would need 11 tonnes to do the same job. If the real price of other fuels continues to rise it is likely that wood will have an increasing role as a domestic and industrial fuel, particularly in areas where it is readily available. (The recently announced decision of the Hikurangi Dairy Company to use wood as a fuel is worth noting in this context.)
OTHER CONSIDERATIONS

This paper has concentrated only on the energy implications of the planting programme. Depending on how the resource that has been created is used, the forestry sector has the potential to be, in energy terms, a "paragon" or an "ogre". Clearly, if energy is a constraint on development, consideration will have to be given to the energy implications of the likely processing options. Energy, however, is only one of a number of possible constraints. Can profitable markets be found for our forest products? Are there sufficient water resources available for all of the processing options? What environmental constraints will be placed on the industry? Can the industry find the capital for all the development options? This last could well prove to be the most binding. For example, for the bleached kraft pulp option considered earlier in this paper, one mill (capacity 200 000 tonnes/year) would have to be built every year from 1990 until 2014. At present a mill of this size would cost between $200 million and $300 million (N.Z. Dept of Lands and Survey, 1977). Thus this option would require some $5000—7500 million (today's prices) of capital over a 25-year period. How much of this could the industry generate internally? How much would it have to borrow, and from what sources?

Many of these questions, which will have to be considered by the industry in the next three decades, may prove much greater constraints on growth than energy. The industry has the ability to generate most of its energy needs from its wood resource. Ensuring an adequate supply of liquid fuels is perhaps the greatest energy problem facing the industry and the nation as a whole. The forests of New Zealand may even provide a solution to this problem.

ACKNOWLEDGEMENT

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REFERENCES


