FEASIBILITY OF A PLANTATION-BASED FIREWOOD INDUSTRY IN NORTH EASTERN VICTORIA

September 2003

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AUSTRALIAN FOREST GROWERS
North East Victoria Branch

Plantation Development Services Pty Ltd

Plantations North East Incorporated

DEVELOPING A PLANTATION-BASED FIREWOOD INDUSTRY IN LOW RAINFALL AREAS OF NORTH EASTERN VICTORIA

Prepared for

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September 2003

EXECUTIVE SUMMARY

This study considers the potential for growing firewood in north east Victoria for domestic consumption in Melbourne and local regional centres based on its commercial viability under the following circumstances:

- as a replacement land use suitable for outside investment on a moderate to large scale;
- as a replacement land use suitable for direct investment by existing landowners; and
- as an integrated land use undertaken by existing landowners to complement agricultural activities.

This was based on an examination of the following factors :

- the size and location of firewood markets;
- the factors that currently influence the market or are likely to influence it in the future, and the likely trends in supply and demand that will result from this;
- the physical and social attributes of north east Victoria that determine its suitability as a potential firewood supply zone; and
- the costs and returns associated with developing and managing a firewood plantation resource capable of supplying particular markets.

Firewood Markets

Based on population-based extrapolations from past studies, substantial amounts of firewood are consumed for domestic heating in Melbourne and regional Victoria.

Past studies have also shown that approximately 43% of all firewood is collected by Melbourne householders for their own use, with the balance being supplied by commercial producers and retailers. It appears as though the size of commercial firewood markets has remained relatively stable during the past decade.

The Melbourne market offers positive financial returns to the firewood industry under some limited circumstances, however regional markets could not be supplied by financially viable plantations unless growers were offered significant subsidies to overcome the very high costs of transport and lower firewood prices.

There is some uncertainty as to the size of the Melbourne market, but an estimate of 170 – 230,000 tonnes per annum seems to be realistic. There is a further domestic market of about 60,000 tonnes per annum in north east regional centres.

Market Influences and Future Trends

The study identified the following issues as having an influence on the firewood market:

- the availability and sustainability of supplies;
- the marketability of currently non-preferred species including fast-grown plantation wood;
- environmental factors – both positive and negative, including government protection initiatives;
- cost considerations – compared with other forms of heating.

It appears that the greatest influences on the firewood market over the next 15 – 20 years will be the uncertainty of a continuing supply at reasonable prices, and the nature of government initiatives to regulate the collection and use of firewood in order to protect the environment.

As most firewood is thought to come from private land, it is difficult to make reliable predictions about the size and sustainability of current supply zones. However, it appears as though unless alternative species are used, and/or a plantation resource is developed, current supplies based primarily on red gum will decline substantially in the future.

If a sustainable source of supply can be created from a renewable plantation resource, the use of firewood for heating or for electricity generation is an environmentally-superior option to non-renewable energy sources such as conventional coal-fired electricity.

In the USA, the demand for firewood for domestic heating has dropped over the past decade as consumers have recognised the convenience and lower cost of gas heating in particular. A similar trend could be expected in Australian metropolitan areas where high firewood prices have already elevated the cost of wood heating above at least two other options. However, expected increases in the price of electricity and gas, particularly if the Kyoto Protocol is ratified, should encourage demand for firewood provided a readily available source of supply can be maintained.

Environmental concerns surrounding the use of firewood are based on the impacts of its collection on biodiversity, and of its use on air quality.

There is a tightening of regulations to restrict firewood collection on public and private land order to conserve biodiversity. This will potentially reduce the ability to collect firewood for personal use or commercial sale. At the same time, there is increasing encouragement for plantation development. However, even if substantial plantings are undertaken immediately, it will take at least 15 years before plantation-grown firewood is able to significantly off-set supplies from native forests and woodlands.

The impact of firewood collection on biodiversity could also be reduced by broadening firewood production to include waste from other timber production operations, and encouraging the use of a greater range of species to spread the effects of collection more widely.

The wood heating industry has gone to significant lengths to address air quality concerns arising from the use of firewood. Considerable effort has been invested in developing advanced technology, low emission heaters to meet the Australian Standard now agreed upon by all states. However despite this, there continues to be strong opposition to the use of wood heaters based on environmental and health concerns in some regions, including inland NSW and northern Tasmania. These areas are typified by very high wood consumption (ie. 40-50% of householders) and topographic and climatic conditions conducive to the accumulation of wood smoke for lengthy periods.

Moves in both North America and Europe towards cleaner “green” energy generation from biomass will increase demand for fuelwood in the future. In the USA, the increasing demand for wood energy for electricity generation is more than compensating for a reduction in demand for its use for domestic heating since the mid-1990’s.

The development of a sustainable firewood plantation resource is integral to the future of firewood as a source of domestic heating. It would also seem to be worthwhile in anticipation of the transition to more environmentally-friendly, renewable energy sources being encouraged by government policies in Australia and throughout the world.

Commercial Viability

The generally high land values and low potential growth rates within the region is likely to limit interest in large scale plantation development amongst potential significant investors, and only existing farmers running low profitability sheep and cattle grazing ventures will be attracted to firewood as a replacement land use on a moderate scale.

Conclusions

There is a market opportunity to supply firewood to meet the large Melbourne market. However it will take 15+ years before substantial immediate plantings are able to supply significant quantities to the market. By this time, the demand for firewood may be very different as a result of environmental controls on the collection and use of firewood, or greater consumer preference for more convenient alternatives such as natural gas. On the other hand, firewood is unlikely to disappear as a source of energy, and demand could increase over time if plantations increase the reliability of supply with lower environmental impact, and the prices of conventional energy alternatives gradually rise as is expected.

Market uncertainty, coupled with the generally high price of land and low growth rates in the lower rainfall areas of north east Victoria will limit interest amongst large scale outside investors who do not currently own land in the region. Existing landowners reliant on agriculture would be unlikely to replace their current land use with firewood on a large scale unless commodity prices fall and stabilise at consistently lower levels.

The best opportunities for firewood plantation development in the region are likely to be:

- as an integrated and complementary land use on moderate to large properties where strategically located, substantial windbreaks and shelterbelts of firewood species can eventually enhance agricultural productivity, thereby providing substantial benefits regardless of the market value of their wood; and

- as a low maintenance, aesthetic land use on small properties managed by non-traditional owners who are generally not reliant on income from their land. However, the uptake of incentives to establish trees amongst this group is likely to result in a large number of plantations of only small average size.

1 BACKGROUND

Plantations North East Inc., the Department of Sustainability and Environment, and the North East Victoria Branch of the Australian Forest Growers are promoting private forestry as a potential landuse with important socio-economic and environmental benefits to the region.

In the past, most encouragement has been provided to private growers and potential investors interested in producing logs primarily of a quality suitable for sawn timber. However, as only approximately half of the region has climatic and site qualities appropriate for the high growth rates generally required for growing sawlogs, increasing attention is being given to the potential for firewood plantations in lower rainfall areas west of the Hume Freeway. This has coincided with increasing restrictions being placed on the collection of firewood on public land and corresponding increases in product price as supplies from native forests become scarce.

Victoria's recently released Firewood Strategy Discussion Paper calls for the development of a sustainable firewood resource based largely on plantation grown wood. In order to quickly realise this goal, it will be essential to establish large areas of plantation as soon as possible. Whilst plantings by individual landholders will be an important part of this, it will rely to a large extent on investment by companies capable of undertaking large scale plantings on purchased or leased land. The potential for producing firewood on relatively short rotations suits prospectus-type plantation investment, and some companies have already expressed interest if firewood production can be proven to be viable.

In view of the above, the outputs required from this project are:

- a demonstration of the viability of investing in growing firewood in the low rainfall areas (less than 650 mm./ annum) of north eastern Victoria;

- if required, a determination of what level of supplementary funding assistance is required to make it viable; and

- a generic business plan as a major step towards attracting investment in firewood plantations.

The study is restricted to an investigation of firewood grown for domestic rather than industrial use. Most industrial firewood is comprised of wood waste generated by wood processing plants and reused on site. In the short term, the demand for industrial firewood is unlikely to increase to the point where it is sourced from native forests or plantations.

2 THE NEED FOR FIREWOOD PLANTATIONS

2.1 Current State of Firewood Markets

Firewood plantations located in the low rainfall areas of the north east could supply the Melbourne and local regional firewood markets. Based on Australian Bureau of Statistics Divisions, the potential local regional market areas are thought to be Ovens-Murray, Loddon, Goulburn, and Central Highlands. Their locations and boundaries are shown in Figure 3.1 below.

Figure 3.1 ABS Victorian Statistical Divisions

2.1.1 Melbourne firewood market

The size and geographic spread of both the Melbourne market and the potential north east supply zone is such that it is difficult to delineate a distance over which firewood would need to be transported to the Melbourne market. Assuming that Euroa represents the rough geographical centre of a north east firewood supply zone, the distance to the centre of Melbourne is about 150 km. However, in reality the distance from plantations in this area to the Melbourne market, could vary from between 100 to 250 km.

Domestic Firewood Consumption

Since 1989, there have been two studies that have included estimates of Melbourne's domestic firewood consumption. FTSUT (1989) estimated annual consumption at that time to be 400,000 tonnes, whilst Reed Sturgess and Associates (1995) estimated a usage range of 300 – 420,000 tonnes per annum.

It should be noted however that the Reed Sturgess study did not include Melbourne firewood consumer surveys, but based its Melbourne consumption estimate on extrapolations from the earlier FTSUT study on the basis of changed population estimates and consumer preference trends.

The most recent study of firewood consumption by Driscoll et al (2000), estimated current Victorian domestic firewood consumption to be 1.2 million tonnes per annum. This fits midway between the range of state consumption estimated by Economists at Large (2000) of 0.72 to 1.5 million tonnes per annum. However, as the Driscoll et al study was based on a very limited survey (ie. only 103 respondents), its total consumption finding should be treated with caution. In recognising this weakness, Driscoll et al prefers to express statewide consumption in terms of a range of from 0.96 to 1.48 million tonnes per annum, based on 95% confidence limits.

In the late 1980's, Melbourne was found to consume 40% of the state's firewood (FTSUT, 1989). However since then, Australian natural gas consumption has increased by 50% (ie. from 600 to 900 PJ), whilst slow combustion wood heater sales have declined and stabilised at a lower level, indicating that natural gas is substantially replacing firewood as a heat source (FS, 2002). Gas usage has increased throughout the state but probably most particularly in Melbourne, with only 20% of Victorians currently without access to natural gas mains (FS, 2002).

Therefore, it is likely that the proportion of the state's firewood consumed in Melbourne has fallen somewhat although it is difficult to quantify. If it is now assumed that 30% of the state's total consumption is in Melbourne, this percentage applied to Driscoll's estimated Victorian consumption (as above), estimates Melbourne's domestic firewood consumption at 280 – 440,000 tonnes per annum.

The recently released Victorian Firewood Strategy Discussion Paper prepared for the Department of Sustainability and Environment, used different criteria to estimate Melbourne's consumption at 280,000 tonnes per annum. This was based on proportional estimates of city households that burn wood at an average rate (tonnes/annum) derived by the FTSUT (1989) study, applied to 1996 ABS census data about particular categories of housing more likely to use wood heating. This method may underestimate actual consumption by unfairly discounting the proportion of households that use firewood by deducting certain dwelling categories whose non-contribution to firewood consumption would have already been accounted for in the original 1989 study telephone surveys. In addition, the use of 1996 census data would understate the current number of Melbourne households and have a corresponding impact on the consumption estimate.

Both methods of estimating Melbourne's firewood consumption have flaws that could only be overcome if a substantial new study of household consumption and firewood merchant sales were to be undertaken. In the absence of such a study, it seems fair to assume that Melburnians consume somewhere between 300-400,000 tonnes of firewood per annum.

Collection and Sale of Domestic Firewood

Driscoll et al (2000) found that 44.1% of domestic firewood consumed in Victoria had been purchased which is less than the national average of approximately 50%. The balance is collected by householders for their own use. Melbourne's consumers have less opportunity to collect their own wood and it is to be expected that the percentage of firewood purchased would be higher there than for the state as a whole.

Although 60% of Victoria's firewood is consumed in country regions (see above), Reed Sturgess and Associates (1995) found that only approximately 23% of rural users purchase firewood. Therefore, in order to meet the statewide purchase average, approximately three quarters of the firewood consumed in Melbourne must be purchased.

However this contrasts sharply with the findings of FTSUT (1989) who reported that only approximately 40% of Melbourne's firewood was purchased. Averaging these results, gives an estimate of 57% of Melbourne's firewood that is thought to be purchased which equates to a commercial firewood market of approximately 170 – 230,000 tonnes per annum.

This is considerably higher than the 145,000 tonnes commercial market estimated by the Victorian Firewood Strategy Discussion Paper (2002) which presumed that only 50% of Melbourne's firewood was purchased.

Purchase Prices

Economists at Large (2000) reported that Melbourne firewood merchants pay their suppliers $85-95 per tonne, and in turn sell the split, dry, and delivered product to consumers for $120-140 per tonne. This is based on red gum which dominates Melbourne's commercial firewood market.

Since then the Victorian Firewood Strategy Discussion Paper (2002) has defined the retail value of red gum and box at $165 per tonne for both city and country consumers.

However, anecdotal evidence suggests that consumers can pay as much as 20-50% more for Red Gum when conditions in supply zones limit its availability, as occurred during a recent very wet winter (Corangamite Farm Forestry Network, reported in Economists at Large, 2000).

Hamilton (2002) reported that firewood merchants in Melbourne are selling split, dry Sugar Gum for as much as $140 per m^3 (ie. $180 per tonne), and are paying their suppliers $120-130 per tonne.

It is likely that many consumers are able to purchase firewood for lower prices than stated above, particularly where they can deal with small independent suppliers selling low quality species, and are willing to pick up wood that has not been split.

Species and Sources of Supply

Driscoll et al (2000) found that the major species currently being used as domestic firewood in Melbourne is red gum (*Eucalyptus camaldulensis*), which makes up about a third of firewood consumed, and the majority (~80%) of what is sold.

A further third of Melbourne's firewood is comprised of mixed local eucalypts such as stringybarks, peppermints, and gum. It is assumed that only a small proportion of this is sold, with most being collected by consumers for their own use. Box and ironbark species comprise about 15% of annual firewood consumption. Box species comprise about 12% of what was sold by retailers who were surveyed by Driscoll et al (2000).

The balance of annual consumption is comprised of a variety of species including mallee stems and roots (~3%), pine waste, recycled timber, and Jarrah from Western Australia which surprisingly comprises about 1.3% of annual consumption (Driscoll et al, 2000). No data was presented on the use of Sugar Gum which may reflect the fact that this species is not readily identifiable by most wood merchants and consumers, as it is known that significant quantities are now being sold in Melbourne by at least five wood yards. (Hamilton, 2002).

Driscoll et al (2000) found that the majority of Victoria's firewood was sourced from private land, with minor but significant collection from roadsides and public land. Reed Sturgess and Associates (1995) found that firewood harvested under permit from public land in Victoria during the period from 1973/74 to 1993/94 varied from about 50 – 145,000 tonnes per annum. The most recent harvest figure is 58,000 tonnes from 1999/00 (FS,2002). These figures are likely to under estimate the true amount taken from public land as it is common for permit holders to remove more than has been paid for.

Most timber sold in city wood yards is sourced from riverine forests and woodlands on private land in northern Victoria and southern NSW (Driscoll et al, 2000). A limited survey of retailers found that firewood is transported from between 50 and 450 km. from where it was harvested, with a mean maximum distance of 330 km.. Eleven of 14 retailers surveyed obtained firewood from maximum distances exceeding 300 km., including four exceeding 400 km., and one 500 km. (Driscoll et al, 2000).

Clearly firewood grown in the low rainfall areas of the north east would be considerably less costly to transport to the Melbourne commercial firewood market than the average transport cost of wood currently being supplied to the market.

2.1.2 Victorian regional markets

The Victorian regional areas that are potential markets for plantation-grown firewood from the north east are Goulburn, Ovens-Murray, Central Highlands, and Loddon Australian Bureau of Statistics Divisions.:

Domestic Firewood Consumption

In estimating firewood usage in regional areas it is important to delineate between farm and non-farm (or town) usage. Drawing on past survey results, as well as the results of their own surveys, Reed Sturgess and Associates (1995) were able to make the following assumptions that are relevant to estimating domestic firewood consumption in regional Victoria:

- farm households generally comprise about 7% of all households within a region;
- 75% of farm households use firewood;
- 33% of non-farm or town households use firewood;
- average consumption of firewood by farm households is 4.6 tonnes per annum;
- average consumption of firewood by non-farm households is 3.3 tonnes per annum.

The recently released Victorian Firewood Strategy Discussion Paper has based its regional consumption estimates on much lower proportional use of firewood by non-farm or town households. It argues that the increased use of natural gas, particularly in large regional centres such as Ballarat and Bendigo has altered firewood consumption to a similar pattern to that exhibited in Melbourne where only 16.7% of households burn small amounts (ie. 1.6 tonnes per annum) of wood largely as a secondary heating option as per the findings of the 1989 FTSUT study.

Taking account of this, it seems reasonable to alter the percentage of non-farm household usage from 33% down to 25%, and assume that a third of these use firewood at the low rate (ie. 1.6 tonnes /annum), whilst the balance maintain the level of consumption found in the 1995 Reed Sturgess study. This represents a compromise between the findings of Reed Sturgess and the Discussion Paper, recognising that there are substantial numbers of non farm or town houses in each region that are not located in major regional centres, whose usage of firewood may not have changed markedly since 1995.

Table 2.1 Estimates of regional firewood consumption

Region	Population[1]	Farm households[2]	Non-farm Households[3]	Estimated Total Firewood Consumption (tonnes/year)	
				This study[4]	Victorian Firewood Strategy[5]
Goulburn	187,000	4660	61,600	57,000 t.	53,000 t.
O-Murray	94,900	2270	30,030	28,000 t.	21,000 t.
C.Highlands	135,000	3470	46,130	43,000 t.	25,000 t.
Loddon	158,400	4110	54,570	50,000 t.	35,000 t.
TOTALS	**575,300**	**14,510**	**192,330**	**178,000 t.**	**133,000 t.**

<u>Notes</u>: 1. Population figures derived from Australian Bureau of Statistics data – 2001 Census
2. Farm households assumed to comprise 7% of total regional households as per the 2001 ABS census.
3. Non-farm households assumed to comprise 93% of total regional households as per the 2001 ABS census.
4. Based on farm and non-farm household usage from Reed Sturgess and Associates study (as above).
5. Taken from Victorian Firewood Strategy Discussion Paper (2002).

The difference between this study's estimates, and those outlined in the Victorian Firewood Strategy Discussion Paper, may be due to the Strategy's underestimation of actual consumption by double discounting the proportion of households that use firewood by deducting certain dwelling categories whose non-contribution to firewood consumption would have already been accounted for in the original 1989 study telephone surveys. In addition, the use of 1996 census data would understate the current number of households and have a corresponding impact on the consumption estimate.

The majority of regional firewood consumption occurs in the major regional population centres such as:

- Goulburn - Major population centres – Shepparton (40 km.), Echuca (110 km.)
- Ovens-Murray - Major population centres – Wangaratta (90 km.), Wodonga (160 km.)
- Central Highlands - Major population centre – Ballarat (250 km.)
- Loddon - Major population centre – Bendigo (130 km.)

Note: Distances in brackets are from Euroa which has been used as a nominal central point within the productive parts of the low rainfall region of the north east.

Collection and Sale of Domestic Firewood

From surveys conducted in regional Victoria, Reed Sturgess and Associates (1995) found that :

- only 15% of firewood-using farm households purchase firewood; and
- about 40% of firewood-using non-farm households purchase firewood.

Consequently, compared to the state as a whole, and particularly Melbourne, a much higher proportion of regional consumers collect firewood for their own use, rather than purchase it from merchants and suppliers.

Applying these findings to the overall estimates of regional consumption outlined above, the size of the Victorian regional commercial firewood market that could be potentially supplied from plantations growing in the north east can be estimated at approximately 60,000 tonnes per annum, spread across the regions as follows:

Goulburn	- 19,000 t./annum
Ovens-Murray	- 9,500 t./annum
Central Highlands	- 14,000 t./annum
Loddon	- 17,000 t./annum

Based on this, the balance of firewood consumed in these regions (ie. ~115,000 tonnes /annum) must be collected by consumers for their own use from private and public land, roadsides, or as industrial or domestic wood waste.

Purchase Prices

Regional consumers are able to purchase firewood for lower prices than are paid by Melbourne consumers (see p.8), particularly where they can deal with small independent suppliers selling lower quality species, and are willing to pick up wood that has not been split.

A recent market survey found that sugar gum, box, and red gum was retailing in the Ballarat – Geelong area for $110 – 135 per tonne. In smaller regional centres however, prices were lower ie. $100 per tonne for red gum, mallee, and box at Mildura, and $95 – 115 for stringybark and peppermint in the Latrobe Valley (ANU Forestry, 2001). In western Victorian centres such as Colac, Ballarat, and Geelong, sugar gum is sold for $100-110 per tonne (Hamilton, 2002). In the north east, box and red gum retails for up to $120 per tonne in Benalla (Sonogan, 2003), and local mixed species for about $80 per tonne in Bright (Borschmann, 2003).

Most of these prices relate to larger firewood merchants whose prices would be expected to be significantly higher than if wood was purchased from small itinerant and occasional sellers who are more prevalent in regional areas (ANU Forestry, 2001).

Determining the wholesale price that wood merchants pay to their suppliers is difficult as most are unwilling to provide this information (Driscoll et al, 2000). Anecdotal evidence suggests that the wholesale price paid to contractors could be as little as a half of the retail price in Benalla (Sonogan, 2003).

Species and Sources of Supply

As most firewood consumed in regional areas is collected rather than purchased, it is likely that the species used is strongly correlated to the composition of local forests. In regions such as the Loddon, Goulburn, and Ovens-Murray where red gum is present, it is likely to be a preferred species, whilst box species seem to be preferred where red gum is absent, and local stringybark used where box is scarce.

Driscoll et al (2000) found that the majority of Victoria's firewood was sourced from private land, with minor but significant collection from roadsides and public land. The proportion of firewood sourced from public land is likely to be higher in regional areas (see section 3.1.1). Firewood burnt in regional areas is likely to have been sourced from much closer than that sold to city consumers.

2.2 Market Influences

The next 15 to 20 years will be critical in determining the on-going viability of firewood as a domestic heating option. This is the time it will take for any plantation developments undertaken immediately to start supplying significant quantities of wood to the commercial firewood market. Until this occurs, the market will have to rely on native forest timber which may not be available in sufficient quantities to fully satisfy demand. Failure to meet demand could result in large numbers of people deserting the market in favour of other heating options, some of which are already more cost-effective than firewood in many situations.

The commercial firewood market during this period will be influenced by a number of factors such as:

- sustainability of supply;
- environmental factors – both positive and negative; and
- cost considerations – compared with other forms of heating.

In addition to these, other factors such as the marketability of plantation-grown firewood, and the potential to obtain carbon credits for growing firewood will be important in determining whether purpose-grown plantations are indeed able to fulfill the role required for firewood to remain as a viable home heating alternative.

2.2.1 Sustainability of firewood supplies

At the present time it is difficult to predict with any certainty the sustainability of current firewood supplies at the estimated levels of demand. This is because most firewood sold in Victoria, is thought to be sourced from private lands for which there is no knowledge of the area or state of the resource. However in view of the annual amounts of firewood being consumed and the over-reliance on distant riverine red gum forests, it seems unlikely that supplies can be maintained in their current form for too much longer (Driscoll et al, 2000).

The CSIRO Sustainable Ecosystems unit are currently working on a project designed to assess the sustainability of firewood resources in the Murray Darling basin which is thought to be meeting most of the current demand from Adelaide, Melbourne, Sydney and Canberra (Freudenburger, pers. comm. 3/2002). The results of this study, expected in early 2003 but as yet not available, should give a clearer picture of the ability of the resource to meet future demand.

The over-reliance on red gum firewood is thought to be due to wood heater manufacturers creating a preferential demand by using it as a test species, and then subsequently recommending it to consumers as a requirement for optimal appliance operation (Sonogan,1998). Wood yards have been forced to respond to this demand rather than sourcing firewood of perceived inferior quality from closer areas.

Driscoll et al (2000) reported that demand for red gum firewood in Melbourne is strong enough to drive wood yards to obtain supplies from 300 – 500 km. away. Similarly in Sydney, supplies are being obtained from distant sources, in some instances the same sources that supply the Melbourne market. In Canberra, wood merchants are sourcing firewood from the NSW wheat and cotton belt, up to 500 km. away (Environment Australia, 2001). Red gum also comprises about 50% of the firewood consumed in Adelaide with significant quantities also being obtained from the NSW riverina (Murray, pers. comm. 3/02).

An estimated 110,000 tonnes of Red Gum is currently imported to the Victorian market from southern NSW, of which approximately 40% is sustainably produced from public forests (FS,2002). The balance is sourced from private land in the Balranald, Hay, and Deniliquin areas, mostly clearing up a backlog of residues from timber production operations conducted over the past 10-15 years. This part of the annual supply is not sustainable, but it is difficult to know how long it will last (Murray, pers. comm., 3/02).
It seems likely that the ability to maintain an on-going and sustainable supply of firewood will depend on diversifying the sources of supply. Sonogan (1998) believes that consumers need to be made aware of the firewood qualities of a range of species to ensure that supply pressures are more evenly spread across a range of forest and woodland communities, as well as creating a demand for species that can be readily grown in plantations, or are by-products of other timber production activities.

Currently most red gum firewood sourced from southern NSW is from residues from sawlog operations, and there is some potential to produce firewood in the future from silvicultural thinnings from public forests (Murray pers.

comm.,3/02). Some firewood is also produced in Victoria as a by-product from sawlog harvesting in public forests, and there is potential for this to be expanded, including production from silvicultural thinnings. However resource loss to conservation reserves, other environmental constraints and the rationalisation of forest operations resulting from recent changes to government policy, are beginning to restrict supplies from traditional sources (Hamilton, 2000).

Most firewood researchers consider the development of plantations to be essential to ensure the sustainability of future supplies. Although governments have been encouraging hardwood plantation development in recent years, there should be concern at the current low rate of firewood plantings on private land. The recent extensive hardwood plantation development in western and south western Victoria has been almost exclusively blue gum (*E.globulus*) planted for export woodchips. Despite this, there is some potential for part of this resource to be utilised for firewood where export sales are unable to be negotiated. Major pulpwood plantation programs now underway in south east Asia also make it more likely that a proportion of the wood being grown in Victoria will ultimately be sold for firewood.

In north eastern Victoria, the establishment of hardwood plantations has so far been restricted to government programs (ie. FFORNE which planted 1700 ha. from 1996-98), some blue gum for export wood chips and occasional ad hoc small private plantings primarily for sawlogs.

However even if substantial areas of firewood plantation were to be established immediately, it will probably take 15-20 years before they are able to substantially supplement or replace supplies from traditional sources. If firewood becomes scarce during this period, rising prices could effectively remove any advantage that it may have had over other forms of heating.

Although the evidence suggests that firewood supplies are currently not on a sustainable footing, it appears that long term sustainable supply is possible if the industry shifts its focus to a broader range of native forest species, as well as plantations (Driscoll et al, 2000).

2.2.2 Environmental considerations

The use of firewood for domestic home heating has both positive and negative impacts on the environment. The ability to produce and use firewood in a manner that reduces environmental impacts compared to other alternatives will be an important determinant of its future demand.

Greenhouse Effect

Apart from solar energy, every fuel burnt for heating emits gases that contribute to the "Greenhouse Effect". Emissions from the burning of firewood account for less than 1% of Australia's greenhouse gas emissions, and comprises about 10% of the emissions produced from the heating or cooling of residential dwellings (PIRSA, 1999).

A comparison between annual carbon dioxide emissions (as a measure of greenhouse gas emission) for various home heating options found that firewood burnt in a slow combustion wood heater produced 1.7 tonnes of carbon dioxide per year. This compares very favourably with reverse cycle air conditioning (2.6 tonnes / year) and electric fan heaters (6.0 tonnes / year), although not quite as good as natural gas space heating which emits only 1.25 – 1.5 tonnes per year (SEA, 2000).

These comparisons were based on heating a 60 m^2 space for a certain period each year. In reality the amount of carbon dioxide emitted from any slow combustion wood heater will vary with the amount of wood burnt, the quality of the wood (ie. how dry it is), and the efficiency of the particular heater being used. Nevertheless, the comparison indicates that firewood can be a relatively good heating option in terms of "greenhouse" impacts, although it is not clear whether its emission level includes the use of fossil fuels required to harvest and transport it to consumers.

As the carbon dioxide released by burning firewood equates to the carbon dioxide captured as the wood grew, the long term the growing and burning firewood cycle is greenhouse neutral, apart from the fossil fuels required for harvest and transport.

Renewability

Although it appears as though firewood supplies are not currently being managed sustainably, wood is nevertheless a renewable resource unlike natural gas and coal-burned electricity which are its main competitors for home heating.

If firewood supplies can be made sustainable by broadening the harvest to include a wider range of species, utilising waste material from other timber production operations, and eventually sourcing substantial supplies from purpose-grown plantations, then it will have a distinct advantage over the use of other heating options that rely on finite resources.

Native Fauna

Current firewood production from remnant private forests and woodlands is having an adverse environmental impact by removing standing and fallen dead timber that provides important habitat for a range of birds, reptiles, and small ground-dwelling mammals. Continued unsustainable removal of firewood from woodlands is likely to have long term detrimental effects on biodiversity (Environment Australia, 2001).

Action statements prepared in accordance with the Flora and Fauna Guarantee Act 1988 are used to identify threats to particular species of threatened fauna and describe actions to mitigate these threats.

Air quality

In areas of high firewood consumption, community health issues related to wood smoke from slow combustion heaters are an important consideration.

In the USA, wood smoke pollution associated with the use of residential wood heaters is a major issue, particularly in mountainous inland areas that experience very cold winters typified by still nights with air inversion layers. Many states and cities have introduced restrictions on the use of wood heaters to minimise air pollution under certain climatic conditions (CAR, 2001). These include time restrictions on use (ie. no overnight burning), and financial assistance to replace old heaters with more efficient modern models that can reduce particulate emissions by more than 85% (PSCAA, 2001).

In Australia, air quality issues are not as prevalent as many consumers live in coastal locations where climatic conditions are not as conducive to smoke accumulation. Nevetheless the Environment Protection Authority reported that wood heaters and open fires contributed an estimated 70% of Melbourne's fine particle emissions during the winter of 1996 (FS,2002). Australian inland locations where severe wood smoke pollution problems occur are Launceston in northern Tasmania, Armidale in northern New South Wales, and Canberra.

At Armidale, local council data shows that wood heater usage is very high, with 47% of town households using them, and a further 8% using open fires. The Armidale Air Quality Research Group (1997) found that wood heaters were almost certainly the source of all major air pollutants in winter, which are otherwise undetectable during summer months when heaters are not in use.

Similarly in Launceston, which also has a very high proportion of wood-consuming households, health problems associated with the burning of firewood have also been reported. Wood smoke pollution at Launceston is thought to be largely due to the topography of the city which is centred within a basin of surrounding hills which can restrict air movement for periods of days at a time, allowing a build-up of air pollutants to occur.

It is thought that wood smoke problems could be substantially improved by educating the public to burn only dry wood (Minister for Environment and Heritage, 2001), or by insisting that only advanced technology wood heaters be used (NRC, 1996). The Australian Home Heating Association is also a strong advocate of the proper use of wood heaters for efficient burning to minimise polluting emissions.

It seems less likely that wood smoke pollution could cause significantly high levels of health problems in Melbourne where the proportional use of wood heaters is relatively low, and the topography and coastal influence associated with these cities permits significantly greater air movement. Nevertheless localised incidents of high air pollution are likely in more sheltered inland areas with the right combination of topography, climate, and high wood heater usage.

There are already voluntary local programs in Canberra and other parts of regional NSW that are aimed at encouraging householders to limit their burning of firewood under certain climatic conditions that would otherwise be conducive to the build up of wood smoke pollution (EPA, 2002).

Also, in recognition of air pollution problems in some parts of inland NSW and northern Tasmania, joint local and state government programs have been initiated to financially assist householders to replace old inefficient, polluting wood heaters (Environment Australia, 2001). Although these programs purport to encourage householders to shift to more efficient, advanced technology wood heaters that significantly reduce particulate emissions, differential levels of financial assistance is at this stage aimed strongly at encouraging householders to turn to gas or electricity. During the first year of the Woodheater Replacement Program in Launceston, only 2 householders applied for the $250 grant available to convert to a modern wood heater, whilst 148 applications were received for the larger $500 grant available to those converting to gas or electricity (AHHA, 2001).

In addition, the standard of modern wood heater that must be met to meet the requirements of these heater replacement programs is much higher than the Australian Standard, and in fact rules out 80% of the complying wood heaters that are currently on the market. The AHHA is currently negotiating to correct these anomalies so that modern wood heaters are given greater prominence in these programs (Mogg, 2002).

The Environment Protection Authority has prepared a draft Air Quality Improvement Plan for the Port Phillip region which aims in part to reduce emissions from domestic wood combustion. Its objectives are to ensure that only wood heaters of the required Australian Standard are sold, that they are properly installed, and that householders are educated about how best to operate them including the use of only dry wood that meets certain moisture content standards (FS,2002).

2.2.3 Marketability of plantation–grown firewood

Given the importance of developing firewood plantation resources to minimise environmental impacts and create sustainable sources of supply; the relative marketability of fast-grown, lower density plantation timber compared to the traditionally-used, slow-grown, dense native forest wood will be an important influence on the future viability of the firewood market.

Developing a firewood plantation resource has the potential to provide many environmental and socio-economic benefits including:

- providing landowners with a secondary income source;
- providing benefits for agricultural productivity if sited in a manner that enhances shelter and shade for stock and crops;
- reducing pressures on the biodiversity of native vegetation communities by removing the need to harvest fallen and standing dead timber from these areas;
- providing a means of rehabilitating degraded lands by reducing the impacts of salinity and rising water tables;
- contributing to a reduction in greenhouse gas emissions by sequestering carbon, particularly in the roots of species suitable for management under a coppicing regime;
- contributing to a reduction in greenhouse gas emissions by providing an alternative to the burning of fossil fuels;
- improving farm aesthetics and associated land values;
- boosting local economies by increasing the level of diversification of farming activities and associated support industries ie. nurseries, establishment and harvesting contractors, etc.

Whether these benefits can be marketed successfully to overcome the perceived preference of firewood consumers for dense native timbers such as red gum, mallee, or box is largely untested. However informal surveys of hundreds of firewood consumers conducted in both western and north eastern Victoria revealed that up to 94% would be likely to purchase plantation-grown firewood due to its perceived environmental benefits (Hamilton, 2000).

An additional survey of forty one Melbourne firewood consumers conducted in 2001, found that 85% were aware of the environmental benefits of burning plantation-grown firewood compared to wood from native forests or woodlands. If plantation-grown wood were available at the same or a higher price compared to native forest wood, 83% indicated that they would purchase it. The increased price that they would be willing to pay for its environmental advantages varied from 5-30%, with an average of 10% (Sonogan, 2002).

In the north east Victoria survey, respondents were made aware of the expected lower firewood quality of fast-grown, low density plantation timber. It is not known whether this was the case with the other surveys.

The density of 14 year old sugar gum was recently measured to be 0.79 tonnes/m^3 (Lang pers. comm., 3/02), which is significantly greater than radiata pine (0.51 t./m^3), and is better than some mature native timbers such as messmate, mountain ash and wattle (0.67 - 0.77 t./m^3) (Sonogan, 1998). This indicates that the burning quality of this species at least, is still quite high even at such a young age. In addition, the density of young plantation blue gum has been found to be 0.68 tonnes/m^3, which is also comparable with many mature native timbers.

In Victoria, one firewood merchant is already selling considerable quantities of mountain ash in Melbourne's eastern suburbs. This timber is collected as a by-product of sawlog harvesting operations in public forests, and is popular with consumers despite its low density and poor reputation as a firewood. The fact that a greater volume of wood is required to make up a tonne is seen by some consumers as a marketing advantage – it appears as though they are getting more for their money (Hamilton, pers. comm., 3/02).

The Corangamite Farm Forestry Project (CFFP) has been successfully marketing 40-50 year old sugar gum as a plantation-grown firewood in Melbourne where it is now retailing at the same premium price as yellow and grey box. Demand in at least some Melbourne outlets is currently outstripping supply. Sugar gum is popular because it has excellent burning qualities and it is the only plantation–grown hardwood firewood available, and as such it has captured the 'green' market.

Woodstock Firewood in Canberra are selling an "Eco Loads" product, so named because it is more economical and more environmentally friendly than the standard mix of box and ironbark. Eco Loads are comprised of 75% red or yellow box and 25% of seasoned radiata pine by weight. In the first year Eco Loads formed 1% of their sales but by year three this proportion had risen to 35%, and has since stabilised at about that level. Due to the bushfires around Canberra in 2003 the supply of radiata pine was disrupted and socypress pine has now replaced it in the Eco Loads.

In northern Tasmania, a timber cooperative is marketing its produce as "Farm Wood" to alert consumers to its perceived environmental benefits compared to timber from public native forests (Hamilton, 2002). A similar strategy could be employed to assist the market acceptability of plantation-grown firewood, and to overcome any negative perceptions about its quality.

Overseas experience suggests Australian firewood consumers have been spoilt by a relative abundance of dense species with excellent burning qualities. In the western and northern areas of Canada, there is virtually no hardwood timber, so consumers make do with softwood. Apart from requiring greater volumes to produce the required level of heat, softwood is successfully used for domestic heating in some of the world's coldest climates (NRC, 1996). Based on this there seems to be no reason why consumers wouldn't use plantation-grown wood of lower quality, particularly if its environmental benefits can be highlighted, and if better quality wood (ie. red gum) becomes scarce and accordingly more highly priced.

2.2.4 Carbon credits

Carbon credits awarded for the sequestration of carbon in plantations have the potential to greatly improve the economic viability of growing some forest products. However, carbon trading is part of the Kyoto Protocol (1997) which can only come into force if it is ratified by the developed countries (including Australia and the USA) which have so far failed to recognise it.

If the Kyoto Protocol was to be ratified, forests or plantations which have been planted on formerly cleared land after 1990 would be eligible for carbon credits. However in developed countries, trees planted now will have their carbon absorption counted only during the period from 2008 –12. (Outlook, 2000). A decision is pending about the post – 2012 period. (ANU Forestry, 2000).

A grower would have to incur considerable costs in order to become eligible for carbon trading. These are associated with the requirement for independent measurement and verification of the amount of carbon present in the plantation, and its registration as a tradable commodity with an authorised market clearing house for sale and the exchange of monies. In addition, it is anticipated that a condition of carbon trading will be that plantations are insured against loss from fire, wind, snow or disease. These costs will generally be prohibitive for small independent growers, and it is expected that carbon trading will only work for small growers where they are able to form themselves into co-operatives.

Another very important implication for plantations being grown on short rotations for firewood will be that any carbon credits gained for growing the plantation will be lost once the plantation is harvested at which time it will incur a carbon debit required to be paid by the owner. The quantity of the debit will be at least equal to the quantity of carbon credits sold. (ANU Forestry, 2000).

Plantation species such as sugar gum, or blue gum which are able to be managed for firewood on a coppice regime will effectively store carbon in their root systems for long periods, and this may reduce the carbon debit compared to the carbon credits received. Whether or not this will be the case is yet to be determined.

A number of recent studies have found that carbon credit trade is unlikely to be rewarding for small-scale growers due to the high cost of technical, financial, and institutional risks and uncertainties (ANU Forestry, 2000).

2.2.5 Cost comparison with other heating options

It is very difficult to compare the costs of different home heating options for every situation due to variability within:

- heater design and use efficiency within each option;
- house design and energy saving efficiency ie. presence of roof insulation, air tight windows and doors, etc. - largely a function of house age and building style;
- costs of fuel or energy required by various heating systems - largely a function of location;
- costs of appliance installation and set-up.

Accordingly, any of the popular heating options can be cheapest depending on the situation in which it is used. Firewood has been traditionally favoured in country areas because it can be obtained relatively cheaply, whereas the cost or availability of connection to gas or electrical systems may have been prohibitive in many cases in the past.

The Victorian Sustainable Energy Authority has attempted to compare set-up and running costs of various heating alternatives for Melbourne households (SEA, 2001). Assuming a 60 m^2 space to be heated, slow combustion wood heaters were shown to have competitive running costs compared to other options. The analysis assumed that the heater would burn 1.7 tonnes of firewood per annum at a cost of $175 per tonne. Set-up and running costs for various options are shown in Table 2.2.

Over a 5 year period, the firewood option ranks fourth behind natural gas space heating, electric storage fan heating, and reverse cycle air conditioning in order from cheapest to most expensive. This assumes the costs of buying energy and firewood remain the same relative to each other during the 5 year period.

It should be noted that the firewood price used in this study is similar to what the Victorian Firewood Strategy Discussion Paper believes is currently paid for red gum in Melbourne. In country areas, where firewood is generally cheaper, the wood heater option is more competitive if it is assumed that other energy costs remain similar or are higher than city prices. Wherever firewood can be obtained for $90 per tonne or less, it is in fact the most cost-competitive heating option over a five year period.

Table 2.2 Comparison of Heating Options (taken from SEA, 2001)

Heating Option	Minimum Set-Up Cost	Running Costs ($ / pa.)	Five Year Annual Operating Cost (inc. Set Up)
Natural Gas Space Heater	$ 600	$ 150 – 275	$ 270 – 395 pa.
Electric Storage Fan Heater	$ 400	$ 200 – 300	$ 280 – 380 pa.
Reverse Cycle Air Conditioning	$ 800	$ 175 – 350	$ 335 – 510 pa.
Slow Combustion Wood Heater	$ 800	$ 300	$ 460 pa.
Electric Space Heater	$ 200	$ 475 – 575	$ 515 – 615 pa.
LPG Space Heater	$ 600	$ 475 – 675	$ 515 – 795 pa.

If the study is assumed to be a fair representation of actual running costs, than for most country and some city householders the use of firewood is currently their most cost-effective heating option. However, for householders in city or regional areas paying high retail prices for firewood, there are already probably two or three cheaper heating options.

2.3 Future Trends in Firewood Consumption

It is difficult to predict trends that may occur in firewood consumption during the next 15 – 20 years as they will in turn be based on factors that are also relatively unpredictable. These include:

- Firewood demand and price
- Conventional energy prices

An examination of overseas trends can also provide an indicative guide to the future of firewood usage.

2.3.1 Firewood demand and prices

Dickson et al (2001) reported that residential energy comprises 13% of Australia's total final energy consumption. Currently firewood is the third largest source of household energy behind electricity and natural gas, and in 1990, solid fuel and wood heating appliances provided more than 20% of the nation's domestic heating energy (Environment Australia, 2001).

However, Dickson et al (2001) forecast that demand for energy from electricity, gas, and solar power will grow at an average rate of 2.3% per annum during the 20 year period from 1998/99 to 2019/20, whilst both firewood and heating oil will lose market share. The growth in demand for firewood is expected to remain at less than 1% per annum during this period. From this it seems that provided firewood supplies can be maintained, there will continue to be a stable and slightly increasing growth in demand for it.

The Australian Home Heating Association (AHHA) has concerns about the impact of bad and often ill-informed publicity about the use of firewood on future demand. The declining sales of wood heaters over the past few years is thought to be at least partially due to the impact of such publicity (AHHA, 2001) which is generally focussed on two fronts – the effect on air quality, and the effect on biodiversity.

This concern has manifested itself in the heater replacement programs currently underway in Tasmania and NSW, where householders are in effect being offered a financial incentive to convert to gas or electrical heating, despite the fact that the wood heating industry has spent vast sums in developing more efficient, low emission heaters to meet the tight Australian Standard (AHHA, 2001). This is different to heater replacement programs in USA and Canada that effectively aim to replace old wood heaters with efficient advanced models.

The AHHA believes that one of the major determinants of the future of wood heating will be the extent to which government regulatory bodies consider and enforce industry standards and regulations (AHHA, 2001). The wood heater programs example cited above demonstrate that the nature of the standards set by government regulatory bodies will also be a determining factor in future firewood demand. Despite this concern, South Australian government bodies currently developing clean air and biodiversity protection legislation, have indicated that they are not seeking to unreasonably restrict the wood heating industry.

Although encouragement for firewood plantation development is currently strong in western Victoria and southern NSW (around Deniliquin), firewood supplies for at least the next 15 – 20 years will be reliant on reserves in traditional sources of supply. Therefore future firewood prices will largely depend on the rate of current firewood resource depletion and the ability to find alternative sources of supply during this period.

With regard to Adelaide and Melbourne, there is no way of knowing the rate at which the current resource will decline as it is thought to be largely located on private land (Driscoll et al, 2000), although steadily rising prices in recent years tend to suggest that available supplies of red gum are already scarce. Future supplies to Adelaide in particular are reliant to a large extent on NSW land management policies that may ultimately restrict the ability to collect firewood in the areas from where most of its supply is thought to be derived.

This is not necessarily an indication that overall firewood supplies are under threat as if other species are used, supply could be maintained, maybe even at lower prices. The ability to find alternative firewood supplies would appear to be lower in Adelaide than in Melbourne which is located close to extensive areas of state forest where other timber production operations are undertaken. However, there is a strong possibility that blue gum plantations in the state's south east could eventually supply significant quantities of firewood to Adelaide.

At the current high retail price being paid for firewood in Adelaide, home heating with slow combustion wood heaters ranks behind three other options in terms of cost competitiveness. If firewood prices rise in accordance with progressive resource depletion, its cost-competitiveness could be expected to drop further behind these other options.

However where landowners are able to collect their own firewood, or purchase it for less than $90 per tonne it is still the most cost-competitive heating option (see section 3.1.5). The majority of wood-using householders in regional South Australia, as well as a significant number in Adelaide are able to meet these requirements, and so firewood should remain as a very cost-competitive alternative as long as a stable supply can be maintained, and restrictions on its use do not become prohibitive.

2.3.2 Conventional energy prices

Electricity and gas prices will depend on availability of supply, and environmental and political factors such as the requirement to reduce greenhouse gas emissions.

In South Australia and Victoria, electricity is mostly generated using coal and gas resources, whilst renewables account for less than 1% of the total capacity. However the combustion of these fossil fuels produces greenhouses gases that are now thought to contribute to global warming.

The Commonwealth's 2% Mandatory Renewable Energy Target (CMRE) derived from the Renewable Energy (Electricity) Act (2000) has encouraged state governments to consider how to move from conventional electricity and gas energy systems based on the use of finite fossil fuels, to systems based largely on renewable technologies.

It is anticipated that there will be a long transition period as the economy phases in the use of renewable technologies, cleaner fossil fuel technologies, and energy efficiency measures. In the short term the main transition features are expected to be decreasing demand growth resulting from increased energy efficiency and higher uptake of embedded gas and renewable energy generation. Eventually price increases in fossil fuels and decreases in renewable energy technology costs are hoped to encourage more renewable generation (Energy SA, 2001).

However, ultimately the level of renewable and sustainable technologies employed during the transition period will be greatly affected by whether the Kyoto Protocol limiting the greenhouse gas emissions of developed countries, is ratified.

Odlum and Wilson (2001) speculated that without ratification of the Kyoto Protocol, it is likely that energy usage over the next 20 years will follow a business-as-usual path, with only minor increases in the development of renewable technologies in accordance with government target requirements, community demand, and pilot projects. Under this scenario, electricity prices are likely to rise by between 1.4 and 3.3%, as a result of compliance to the CMRE target, but a major influence on electricity retail prices will be competition between distribution companies on which it is difficult to speculate.

It is assumed that natural gas will become a more prominent energy option during the next 20 years as pressure from large consumers, including electricity generators, has caused the government to commit to a Victorian-South Australian gas pipeline project. Presumably, the greater availability of natural gas as a competitor will affect electricity pricing.

If the Kyoto Protocol is ratified, it is expected that an increase in the cost of electricity will occur as a result of a carbon dioxide emission tax designed to encourage the development of renewable alternatives such as solar, wind, or biomass power generation. Large increases in the price of electricity from conventional coal-fired generation will occur, and a significant increase in demand for the use of natural gas which it is assumed will increase its price by approximately 15 % (Odlum and Wilson, 2001).

The expected gradual or rapid increase in the price of conventional energy (depending on ratification of the Kyoto Protocol) will have an effect on the demand for firewood, but only if a reliable and sustainable supply can be maintained, and it can be collected and used with minimal environmental impact.

2.3.3 Overseas experience

Firewood was used for domestic heating in more than 90% of households in Canada and the USA prior to the twentieth century. However, by 1970, its use had fallen to very low levels (about 1% of households in the US). About this time, concerns about the future of fossil fuel supplies led to a resurgence of demand for firewood which has grown steadily since (EREN, 2001). In Canada, approximately 20% of households now use firewood as either a primary or secondary source of heating (NRC, 1996).

Wood burning for domestic heating is regarded as being an integral part of the Canadian energy scene for the foreseeable future, provided advanced wood heating technology that minimises air pollution becomes the norm (NRC,1996). An important part of the confidence in the future of firewood in Canada is the abundance of fuel wood resources, and the view that firewood is a renewable resource that can be used to reduce environmental impacts compared to fossil fuels (NRC, 1996). This abundance of resource would appear to be a major difference between the Canadian and Australian wood heating scene.

Future trends which are likely in Canada are the tightening of emission standards leading to the mandatory use of advanced wood heater technology; the increased use of pelletised biomass fuels for domestic burning as the need to dispose of wastes increases; and the rising cost of electricity that will continue to make firewood an attractive heating option (NRC, 1996).

In the USA, the use of what is termed wood energy rose by about 5.5% during the 1995-99 period (EIA, 1999). However, whilst firewood remains a major source of energy for home heating, it is increasingly being viewed as an alternative power generation fuel using boiler technologies that are being developed and refined at the present time. This has seemingly underpinned a transition in its use away from burning in residential wood heaters (which dropped by approximately a third during the 1995-99 period), to its use as a source of industrial and commercial energy (EIA, 1999).

During the 8 years from 1992 - 2000, the number of wood heaters sold in the USA increased by 11%, whilst the number of gas appliances increased by 600% indicating that gas has become a major player in the home heating market place in only a short time. In the shorter term, during 1999 and 2000 wood heater sales declined by 23%, whilst pellet burning heaters increased by 48% from a much lower base (HPBA, 2000). These burn pellets of sawdust waste with virtually no gas emissions and are very environmentally friendly.

This apparent recent US. trend away from the use of firewood for domestic heating is due to a combination of the convenience of using gas, a lower level of new home starts, and the Y2K phenomena which artificially stimulated demand prior to 1999 – 2000 (HPBA, 2000). No mention is made of environmental concern about wood smoke pollution or biodiversity conservation as factors in forcing consumers away from the use of firewood.

There is also a move towards the use of fuelwood for biomass-fuelled electricity generation in Europe (Hamilton, 1999), particularly Sweden and Germany (Raison, 2002).

2.4 *Conclusions*

The establishment of firewood plantations is a crucial element of the challenge to develop the sustainable resource essential if firewood is to remain as a viable home heating option, particularly for those households located in Melbourne or major regional centres who are largely reliant on the commercial firewood market.

However, as substantial production from a major plantation resource is expected to take at least 15 – 20 years, the greatest influences on firewood consumption during this period will be the uncertainty of supplies from traditional supply zones, the impact of this on firewood price, and the nature of government initiatives to regulate the collection and use of wood in order to protect the environment.
At the present time it is difficult to make reliable predictions about firewood supplies during the next 15 – 20 years, but a CSIRO study to be completed during 2003 should give a clearer picture of the state of the Murray-Darling red gum resource which currently supplies much of the Victorian commercial firewood market.

However, it appears as though unless alternative species are used, and/or a plantation resource is developed, firewood supplies based primarily on red gum will decline to the much lower levels that can be sustained from sawlog residues from public forests. This could potentially push prices to levels that may force consumers to turn to other forms of heating.

There is some potential to use other native forest species due to Victoria's relatively large area of public forests, although increasingly government land use policies are restricting commercial access to these forests as well as limiting opportunities for consumers to collect their own wood.

Environmental concerns surrounding the use of firewood are based largely on the impacts of its collection on biodiversity, and of its use on air quality. However, the fact that two wood heater replacement programs now operating in southern Australia have been structured to provide incentives for householders to turn to other forms of heating despite the ready availability of modern, low emission wood heaters; indicates that concern about the use of firewood is being driven more by the desire to protect biodiversity.

The impact of firewood collection on biodiversity can be reduced by broadening firewood production to include waste from other timber production operations, and encouraging the establishment of plantations to shift production away from native forests and woodlands.

Although government environmental agencies are intent on encouraging the development of a plantation firewood resource they must be mindful of the fact that plantation developments initiated now will take 15 –20 years to become significant sources of wood. Until that time the firewood market will have to be sustained largely from its traditional sources, and a balance must be struck between environmental protection and firewood production if there is to be a demand for plantation-grown firewood when it becomes available.

The greater emphasis of biodiversity conservation associated with firewood collection in Australia compared to North America is probably related to lower availability of reliable supplies here compared to Canada and the USA, where the environmental concern is centred more on air quality issues.

All Australian states have adopted standards that deal with the energy efficiency and installation of advanced technology wood heaters that operate with vastly reduced pollutant emissions. Legislative policy is currently being finalised in Victoria to ensure that these standards are met (EPA Victoria, 2002).

If a sustainable source of supply can be developed, the use of firewood for heating or for electricity generation is an environmentally-superior option to non-renewable energy sources such as conventional coal-fired electricity. The expected increases in the price of electricity and gas, particularly if the Kyoto Protocol Is ratified, should encourage demand for firewood provided a readily available source of supply can be maintained.

Plantations established in the low rainfall areas of north east Victoria could potentially supply firewood to Melbourne, and major local centres such as Benalla, Shepparton, Wangaratta, and Wodonga, as well as Ballarat and Bendigo.

Estimates of the amount of firewood consumed in these centres vary from 300-400,000 tonnes per annum in Melbourne, and from a combined total of 135 – 180,000 tonnes in the other accessible major regional centres. Of this, an estimated 50-60% of Melbourne's firewood and about a third of that consumed in regional areas is thought to be purchased from the commercial market. Not withstanding that plantations may be developed within adjacent regions, there appears to be considerable scope for establishing plantations in the north east to meet this demand as native forest firewood supplies decline.

In view of this, the development of a sustainable firewood plantation resource would seem to be worthwhile in anticipation of the transition to more environmentally-friendly, renewable energy sources being encouraged by government policies in Australia and throughout the world.

3 DEVELOPING A SUSTAINABLE PLANTATION-BASED FIREWOOD RESOURCE

If plantation-grown firewood is to largely replace supplies obtained from native forests, dead trees on farms and woodlands during the next 15 – 20 years, a substantial plantation resource would need to be developed during this period.

The ability of a particular regional area to support a sustainable firewood plantation resource will depend on the size of the markets that are to be supplied, as well as the willingness of landowners and investors to participate in the development of the resource. This in turn will rely on the financial attractiveness of firewood plantations, as well as lifestyle and community considerations.

3.1 Plantation Area Required for a Sustainable Level of Firewood Production

The land area required to produce a sustainable level of firewood production will be dependent on the size of the markets targeted by growers, and the growth rates of plantations established to supply those markets. In reality plantations established across any large and diverse region (such as north east Victoria), will exhibit wide variations in growth rate, making it difficult to estimate the area required to supply a particular market. However, for a range of average growth rates, Table 3.1 provides an indication of the area of plantation required to meet the commercial markets of the size outlined in Chapter 2.

Table 3.1 Areas of plantation (ha) required to provide sustainable levels of supply to various firewood markets

Commercial Firewood Markets			Average plantation growth rate (m^3/ha/annum)				
Location	**Dry tonnes**	**Green m^3**	**6**	**8**	**10**	**12**	**14**
Melbourne	200,000	266,667	40,400	30,300	24,200	20,200	17,300
Goulburn	19,000	25,333	3,800	2,900	2,300	1,900	1,600
Ovens-Murray	28,000	37,333	1,900	1,400	1,200	1,000	800
Central Highlands	14,000	18,667	2,800	2,100	1,700	1,400	1,200
Loddon	17,000	22,667	3,400	2,600	2,100	1,700	1,500
Total	**278,000**	**370,667**	**52,300**	**39,100**	**31,500**	**26,200**	**22,400**

Notes:
Conversion factors : 1 green m3 = 1.1 green tonnes, 1 green tonne = 0.75 dry tonnes of young plantation-grown timber.

Assuming the most likely commercially viable scenario to be a plantation estate based on average growth rates of 10-12 m^3/ha/annum, it seems reasonable to assume that a plantation area of 20-24,000 hectares would be sufficient to sustainably supply the Melbourne commercial firewood market. Whilst an area of 26-32000 hectares would meet current firewood markets in Melbourne, Goulburn, Ovens-Murray, Central Highlands and Loddon regions.

3.2 Number of Participants Required For Various Levels of Supply

The most efficient means of developing a substantial firewood plantation resource will be through large scale industrial investment similar to what has occurred in western Victoria with blue gum plantations established for the export woodchip market. However to date the firewood market has attracted little industrial scale investment, and any plantings undertaken specifically to produce firewood have so far been almost all of a small scale by individual landowners.

If a substantial firewood plantation resource established during the next 15-20 years is to be dependent on small scale farm forestry plantings, an estate of for example, 10,000 ha comprised of small blocks averaging 10 ha. in size, would require 1,000 landowners to establish plantations during this period. If average plantation size increased to 30 ha., the number of participants would reduce to 333 (Table 4.2). Many more participants would be required if bigger markets were to be targeted.

In order to establish a sustainable plantation resource during the next 15 - 20 years, the annual planting program should at least equal the target area divided by the rotation length. For example, for a 10,000 hectare plantation estate to be managed on a 15 year rotation, 666 hectares would need to be established annually during the next 15 years. Higher annual planting rates would enable the target area to be met sooner.

Table 3.2 Numbers of landowners needed to meet various plantation area targets.

Area of Resource	Average size of plantation						
	5 ha	10 ha	20 ha	30 ha	40 ha	50 ha	100 ha
10,000 ha.	2000	1000	500	333	250	200	100
20,000 ha.	4000	2000	1000	667	500	400	200
30,000 ha.	6000	3000	1500	1000	750	600	300
40,000 ha.	8000	4000	2000	1333	1000	800	400
50,000 ha.	10000	5000	2500	1667	1250	1000	500

The number of participants required to be recruited annually in order to establish a plantation resource during the next 15 years will vary in accordance with the proposed size of the estate, and the average size of plantation. Table 4.3 shows the variation in required annual participant recruitment based on different sized plantation estates and average plantation size.

Table 3.3 Annual recruitment of landowners required to meet plantation area targets in next 15 years.

Plantation Area	Average size of plantation						
	5 ha	10 ha	20 ha	30 ha	40 ha	50 ha	100 ha
10,000 ha.	133	67	33	22	17	13	7
20,000 ha.	267	133	67	44	33	27	13
30,000 ha.	400	200	100	67	50	40	20
40,000 ha.	533	267	133	89	67	53	27
50,000 ha.	667	333	167	111	83	67	33

4 FIREWOOD PLANTATION RESOURCE MANAGEMENT

4.1 Selection of Suitable Species

The key factors to be considered when determining the suitability of a species for firewood production are:

- Growth rate - the ultimate measure of their ability to produce merchantable quantities of firewood from a range of sites in a reasonable timeframe;
- Calorific value - the amount of heat obtained per unit volume of wood.
- Other burning properties such as ease of ignition, presence of sparks, production of coals and ease of splitting.

If plantations are to produce a combination of firewood and sawlogs, sawing and drying ability, and timber qualities must also be considered in species selection. A summary of firewood properties is provided in Table 4.1.

4.1.1 Firewood properties

Table 4.1 Properties of potential firewood species (DCNR 1994).

Species	Relative calorific value	Density, air dry (kg/m^3)	Splitting	Ignition	Sparks (spitting)	Coaling	Coppice ability*
Mallee roots *Eucalyptus spp*	100	NA	Difficult	Poor	Few	Excellent	NA
Belah, Buloke *Casuarina spp*	100	1121	Good	Poor	Few	Excellent	No
Grey Box *E. microcarpa*	100	1121	Difficult	Poor	Few	Excellent	Yes
Red Ironbark *E. sideroxylon*	97	1090	Difficult	Poor	Few	Excellent	Yes
Age 8	74	831***					
Yellow Box *E. melliodora*	95	1090	Difficult	Poor	Few	Excellent	Yes
Sugar Gum **E. cladocalyx**	95	1070	Difficult	Poor	Few	Excellent	Yes
Age 14	70	790**					
Red Box *E. polyanthemos*	94	1060	Difficult	Poor	Few	Excellent	Yes
Yellow Gum *E. leucoxylon*	90	1010	Difficult	Poor	Few	Excellent	Yes
Long-leaved Box *E. goniocalyx*	89	1010	Difficult	Poor	Few	Good	Yes
Blue Gum *E. globulus*	83	927	Fair	Fair	Few	Good	Yes
Age 14	61	686***					
River Red Gum **E. camaldulensis**	81	915	Difficult	Poor	Moderate	Excellent	Yes
Red Stringybark **E. macrorhyncha**	80	890	Good	Good	Few	Good	Yes(?)
Manna Gum *E. viminalis*	76	855	Good	Good	Few	Good	Yes
Wattle **Acacia spp**	63	705	Excellent	Excellent	Few	Fair	No
Radiata Pine *Pinus radiata*	45	512	Fair	Excellent	Many	Poor	No

* Bird et al (1996) ** Hamilton (2002) *** Sonogan (2000)

It is interesting to note that mature blue gum and sugar gum both have higher densities and calorific values than river red gum. Young (age 14 yr) blue gum has a density 75.0% of mature red gum, while young sugar gum has a density of 86.3% of mature red gum. At the lowest end of the scale radiata pine has only 56% of the density of red gum.

The most common firewood used in Victoria is red gum (Driscoll et al, 2000a). Other durable species such as red box, yellow box and mallee roots are also preferred. Where these species are less available, the easier to obtain local species such as messmate, manna gum, brown stringybark (*E. baxteri*) and red ironbark are commonly used (Driscoll et al, 2000b).

4.1.2 Growth rates

At present consumers express strong market preference for red gum and box species. However as they are generally slow growing, they are unlikely to form the basis of a plantation firewood industry. Clearly for a plantation-based firewood industry to develop, consumer preference will need to be altered by marketing the positives of the faster-grown plantation-preferred species.

There is evidence to show some consumers have a preference for plantation grown firewood [Hamilton (2002), Waring (2000)]. This preference could be expected to increase as the community become more conscious of where their firewood comes from, but realising this preference in the market may not be automatic (see 2.2.3). Thus, while the firewood properties of a species cannot be ignored, there may be opportunities to market fast growing plantation species that are at this stage not preferred for firewood.

In lower rainfall areas less than 650 mm./annum where blue gum growth and survival is uncertain, sugar gum is likely to be the preferred plantation species as it is clearly superior in both growth and firewood properties to other species capable of survival under these conditions. Red gum hybrids have been planted in many areas around Australia on an experimental basis with those between red gum and blue gum, and red gum and flooded gum (*E. grandis*) usually outperforming the growth of both of their parent species. However the trials are still only several years old.

It is difficult to accurately predict growth rates in lower rainfall areas as few plantations have been grown and measured over a long period in such areas. Also, the species able to survive in such areas have traditionally not been grown and managed for productive purposes to anywhere near the extent as species such as radiata pine, and blue gum. However, Table 4.2 shows predicted growth rates for potential firewood plantation species based on limited experience with low rainfall plantations from around the state.

Table 4.2 Indicative growth rates for potential firewood species (m^3/ha/yr).

Species	Rainfall Zones (mm./year)		
	400 - 500	500 - 600	600 - 700
Sugar Gum	5 - 7	7 - 9	9 - 12
Spotted Gum	unsuitable	unsuitable	9 - 12
Red Ironbark	3 - 5	5 - 7	7 - 9
Swamp Yate	2 - 3	3 - 5	5 - 7
Blue Gum **	unsuitable	unsuitable	10 – 15
Red Gum	2 - 3	3 - 5	5 - 7
Red Gum hybrids	4 - 6	6 - 9	9 - 12

** Blue Gum should not be commercially planted in locations receiving annual rainfalls less than 650mm. Preferably it should only be grown where over 700 mm. of rainfall is received.

4.2 Site Selection and Establishment

The key factors in selecting a site for commercial eucalypt plantations are:

- Slope: Slopes less than 15° are preferred - management and harvesting costs increase significantly on steeper slopes.
- Access: Easy access is preferable for establishment, management and harvesting purposes. If bridges or extensive roading is required, investment costs increase significantly. Even the need to gravel a landing and several hundred metres of road can add $100-200 per hectare for roading.
- Soil depth: Plantation growth and the ability to survive drought improves with soil depth. Blue gum and other high rainfall species require soils at least 2 metres deep, whilst sugar gum requires at least 1.3 m. Within this depth there must be no water or root impeding layer.
- Soil texture: The most favoured soils are loams and light or medium clays. Sandy soils with good water holding capacity are suitable. Heavy clays are generally unsuitable.

- Rainfall: Rainfall is a key factor for plantation growth. Generally the higher the rainfall the better is the growth (see Table 4.2).

- Frosts: Most eucalypt and acacia species can be established where frosts are common. Spotted gum and to a lesser extent sugar gum, are sensitive to frosts. The frost sensitivity will limit the areas where plantations can be established. Other species such as blue gum have frost sensitivity, but are less affected.

- Water logging: Areas subject to extended water logging should be avoided. Mounding will help to overcome effects of short term surface water. Red gum will tolerate seasonal flooding for many weeks.

- Obstacles: Obstacles such as boulders and sheet rock make operations less efficient and reduce the effective planting area. Areas with fewer obstacles are preferred.

The key steps in plantation establishment are:

- Removal of unwanted competing vegetation: This could include trees, shrubs, woody weeds or pasture. Methods of removal vary with the type of vegetation and could include grazing, slashing, herbicide application, or burning.

- Soil preparation: Eucalypt seedling growth usually responds to deep ripping and mounding. Ripping with a winged ripper to 650 mm is usually prescribed, but there is little scientific evidence to support ripping deeper than 400 mm in most soil types. Mounding is usually completed in the same operation as ripping. Mounds should be about 1.4 m wide and 30 cm high. Rip lines are usually 3-4 m apart. The wider 4 m. spacing is slightly less costly and allows machine access between the rows.

- Pre plant weed control: At least four weeks prior to planting, herbicide should be applied to knock down any weed regrowth and to provide a residual control over germinating weeds. The type of herbicide and application rates vary depending on the weed spectrum. Weed control may be limited to a 1.5 – 2.0 m strip along the planting line, or it may consist of a broadacre coverage over the whole area.

- Planting of seedlings is usually completed during winter, but may be delayed until later if frost sensitive species are being planted. Seedling and planting quality should satisfy forestry standards.

- Stocking: Plantation stocking may vary depending on site quality, species and rotation length. Generally about 1000 trees/ha are planted, but this may be varied to achieve a targeted tree size or tree diameter. An average tree size of 0.20 – 0.25 m^3 would suit firewood production. Diameters over 30 cm may not suit firewood cross cutting equipment. On lower quality sites stocking at 800 trees/ha would be appropriate.

- Fertiliser: A starter fertiliser containing nitrogen and phosphorus is usually applied within four weeks of planting as a spot application near each seedling. Boron is commonly deficient, especially on granite based soils, and should be applied with the starter fertiliser where it is known or likely to be deficient.

- Follow up weed control: If weeds regrow during the spring after planting, additional weed control may be necessary. If site preparation and pre-plant weed control are thorough, follow up weed control should not be necessary until at least the following year.

- Second year weed control: Weed control in the second year of growth usually benefits tree growth. If the trees have already reached a height of two metres within a year of planting, the benefits of second year weed control may be marginal.
- Follow up fertiliser: Additional fertiliser should be applied on the basis of foliar analysis. Foliar analysis is the best way of determining which nutrients to apply and in what quantities. The correct procedure and timing of foliage collection must be followed.

- Replanting: If survival is poor after 10 months, replanting failed sections and gaps is recommended. The trigger point for replanting is usually an overall survival of less than 80%, or sections of more than 0.2 hectares with less than 50% stocking. Some growers may use a 70-75% stocking level standard.

- Browsing control: Seedlings need to be protected from browsing animals such as hares, rabbits, white cockatoos and wallabies. Individual guarding of trees for large scale planting is expensive and not recommended. Other means of control will vary with the browsing agent but could involve shooting or poisoning if permitted.

4.2.1 Plantation establishment costs

Costs of establishment will vary with topography, size of plantations, roading requirements, browsing and weed control requirements, and availability of and competition between contractors. Indicative costs are detailed below.

Table 4.3. Indicative costs for plantation establishment.

Operation	Indicative cost ($/hectare)
Ripping/mounding	200
Weed control	140
Browsing control	30
Planting stock	300
Planting	150
Fertiliser	80
Fertiliser application	60
Sub Total	**$960**
Roading	100
Cooperative fee	300
Total	**$ 1360**

Notes:

- Assumes the plantation owner is a member of a growers cooperative who provide forestry planning and plantation design advice and assist with operational supervision and monitoring. Fire protection – does not include cost of any firebreak construction that may be deemed necessary.
- Land rates and charges - not included.
- Costs are based on an initial stocking of 1000 trees per hectare on a 4 x 2.5m. grid.
- Costs relate only to the first year of plantation rotation. Additional costs for weed control and replanting may be required in the second year.

4.3 Firewood-only Plantation Management

A firewood-only plantation is essentially grown on successive short rotations, being clear felled at the end of each, and then regenerated from managed coppice to produce a new crop. For this report a rotation of 15 years was assumed. At this age many plantations are at peak volume production, with trees of a size suitable for commercial handling, and merchantable per hectare volumes available. In addition wood in these plantations is denser than that available from younger plantations. However rotation length may be varied depending on growth rates, species, markets and grower needs.

Plantation management mainly involves maintaining adequate soil nutrition, and protection from fire, disease and insects. No thinning or pruning is required, although a limited form pruning at an early age to remove multiple leaders may assist with later harvesting where tree processors are employed, but is not essential.

After harvesting, coppice regrowth from the stumps becomes the basis of the next crop. Once established the coppice must be thinned to one or two shoots per stump, depending on the number of coppicing stumps. If coppice regrowth is not required, stumps would need to be poisoned at harvest to prevent sprouting, and new seedlings could then be replanted between the stumps along the original planting rows. However the lower cost of managing coppice generally makes it a more desirable option than replanting.

4.3.1 Management Costs

Management costs of firewood-only plantations will depend on how the landowner's business is structured. Early age fertiliser may be necessary to correct nutrient deficiencies. Pruning will not be required, except possibly early form pruning. Roading costs would vary between properties and may not be necessary in low rainfall areas that can be harvested in dry conditions.

The cooperative fee is based on a large program (about 1000 ha/yr planted) managed through a self funded growers' cooperative. Individuals could choose not to join a cooperative, but they would miss out on the advantages of organised marketing, technical advice, harvesting equipment and systems, and other services. Insurance has not been included in the costing but many growers may opt to insure. Further detail about firewood cooperatives is contained within section 4.6

Table 4.4. Indicative costs for plantation management over two 15 year rotations.

Year	Activity	Indicative Cost ($/hectare)
1-14	Cooperative fee	35
2	Early age fertiliser	300
14	Roading	200
15	Cooperative fee	300
16	Coppice Management	400
16-29	Cooperative fee	35
29	Roading	100
30	Cooperative Fee	300

Notes:
- Insurance not included.
- Fire protection - assumed livestock will keep fuel loads down once trees are established.
- Land rates and charges - not included.
- Forestry advice - available from Co-operative.
- Initial establishment and harvesting costs are not included as plantation management costs.

4.4 Harvesting and Processing

The systems employed for harvesting firewood will vary according to the scale of production. For example, the delivery of only small loads of wood may only require an operator with a chainsaw and trailer which may be adequate for production of several hundred tonnes of firewood per year. However, at the other end of the scale where a large grower or cooperative is supplying a significant proportion of the Melbourne market, the level of production may need to be 1500-2000 green tonnes per week. Such an operation would require tree processors and forwarders capable of producing 100-150 tonnes per day.

The key steps in firewood harvesting are:
- Falling the tree.
- Removal of bark.
- Forwarding the wood to the plantation edge.
- Crosscutting into firewood billets, usually about 30 cm.
- Drying the wood.
- Delivery of the wood to a storage or sale area.

The order of these steps may vary according to the harvesting system used.

4.4.1 Large scale production

Large scale firewood production would require access to a large area of productive plantation estate capable of supporting annual production of up to 100,000 green tonnes (79,000 dry tonnes).

Harvesting.
The most appropriate method of large scale harvesting would involve tree falling, debarking and delimbing, cutting to length at the stump (possibly tree length), and forwarding to the plantation edge. The trees could then be cut into firewood billets and dried on site, or transported to a central depot for processing.

A large area is needed for storage. For a 20 hectare harvest producing 240 tonnes/ha., the loose stack would contain 6000 m^3 of firewood. This could be 10 m wide, 4 m high and 150 m long. A central storage depot containing 25,000 tonnes, would need a firewood stack 5 m high, 80 m long and 80 m wide. For the purposes of this study, it has been assumed that firewood will be stored at the point of production until dry, and then transported to a wholesale firewood yard.

Operations would be similar to blue gum plantation harvesting for pulpwood, where machines harvest, debark and bunch young eucalypt trees prior to forwarding (National Forests and Timber, Oct 2001). Harvesting rates vary from 20-35 green tonne per hour per machine depending on tree size. Tree sizes are generally 0.10 to 0.25 tonne per tree. Wood down to 50 mm. small end diameter is processed.

Harvesting costs in 2002 for Timbercorp's operations in Western Australia were estimated to be $17.70 per tonne including on-site chipping and loading into a truck-mounted container. This was based on a piece size of 0.2 tonne per tree, which could be achievable in a 15 year old firewood plantation by manipulating stocking rates.

This rate is lower than some Tasmanian operations where harvesting, not including chipping is $17-$22 per tonne (Naughton pers. comm.). The lower rates apply to plantations on flat ground yielding 300 tonne per hectare, whilst the higher rates are for moderate slopes yielding 150-200 t/ha.

Rates in West Australia average about $19/t (Wettenhall pers.com.) for piece sizes of 0.15 - 0.25 tonne. If harvesting volumes are small (less than 1250 tonne) and relocating distances are up to 50 km the additional cost could be $1:00/t (McCormack et al, 2000). For firewood production from good plantations on moderate rainfall sites, it is assumed that harvesting volumes are likely to 180-240 tonne/ha. where growth rates are 12-16 m^3/ha/yr on a 15 year rotation, and topography gentle to moderate. A rate of $19 per tonne was adopted for analysis.

<u>Cross cutting and Delivery.</u>
A large proportion of firewood is currently produced from mature native forest or woodland trees with large (over 30 cm) diameters. Cross cutting into billets is commonly done with chainsaws, swing saws, and saw benches with circular blades. For smaller diameter wood from firewood plantations (mainly under 25 cm) different ways of cross cutting will be required.

Scandanavian firewood mills which can cross cut to selected lengths, split and pile up to five m^3/hr are already available in Australia (Alarautalahti, pers. com.). Depending on cutting capacity and additional equipment, these machines can be purchased for $10-16,000. They can run independently or from a power take off. A small tractor with 40-50 HP is sufficient to power them, and tractors are also needed to shift the machines. Although several machines are currently in use there are no detailed studies to describe their production capacity under Australian conditions with variations in billet length and wood diameter (Sonogan, pers. com.). Such trials are in the planning phase, but are yet to be funded.

Based on limited operational experience, actual production rates currently being achieved in Australia are considerably less than the manufacturer's rating of 7-8 m^3/hr for 33 cm billets of 10-15 cm diameter (Alarautalahti, pers. com.). Over a two week period one operator achieved 30 m^3/day, or 4-5m^3/hr of dry wood. The limiting factor is the speed which logs can be fed through the machine and therefore production rates could increase significantly with consistently higher diameter wood.

For this analysis a production rate of five m^3/hr was assumed. It was estimated it would cost of $50/hr to run a 45 HP tractor and firewood machine, with an operator. That gave a cost for cross cutting and splitting of $10 per m^3. Delivery was estimated to be $11 / dry tonne based on a 50 km cartage distance. The costs included $3.50 / dry tonne to load, and $0.15 /dry tonne / km. haulage.

Budgeting on 750 tonnes per harvesting machine per week, similar to that expected by Albany Plantation Logging Services (National Forest & Timber, Oct 2001), and 50 weeks operation per year, the production per year would be 37,500 tonnes. To achieve 100,000 tonnes of firewood per year, three full time harvesting machines and three forwarders would need to be employed.

4.4.2 Medium scale production

Medium scale firewood production requires access to a moderate area of plantation of variable productivity or a small number of scattered small plantations capable of supplying up to 10,000 green tonnes (ie. 7,900 dry tonnes) per year.

Harvesting

Mechanical harvesting machines would be unsuitable for a medium scale operation as their production rate requirements are too high.

Tree falling would be carried out by a chainsaw operator who would directionally fall trees to facilitate later extraction. Branches would be manually trimmed and the tree docked at the merchantable length. Assuming a cost of $30/hour for a faller equipped with a chainsaw and an average tree size of 0.18 tonne, costs will vary from $6-14 per tonne as time per tree increases (Figure 5.2). Sonogan (pers. com.) estimated a time of 4.7 minutes per tree to fall, delimb, cut to length and rough stack. Thus a time of about 3.5 minutes to fall, delimb and cut to merchantable length (without stacking) at a cost of $10 /tonne seems a reasonable estimate.

In the absence a mechanical harvesting system, bark removal could be a time consuming and costly exercise. The easiest and most cost-effective method would be to fall the trees several months in advance of cross cutting. As the wood and bark dry they separate without the need of mechanical assistance. This system is commonly employed successfully by firewood cutters (Sonogan, pers. com.).

Attachments for farm tractors are available that can enable them to extract felled trees to the plantation edge for cross cutting. One example is the Hydraulic Forestry Tong produced by Fransgård. These grapple tongs, fitted to a 70 HP tractor, can enable it to skid trees from the plantation. Care would need to be taken during skidding to ensure that the wood was not soiled to the extent where cross cutting was slowed due to saw damage.

Production rates for skidding tree lengths from firewood plantations are not available. However, assuming a hire rate of $55 /hr, including operator, and an average tree size of 0.18 tonne, and eight trees per load; the skidding cost varies from $6-19 per tonne as the number of loads per hour varies from 6 to 2. In easy terrain with short skidding distances (<200 metres) it was assumed 4 loads/hour were achievable at a cost of $10 /tonne.

The total cost assumed for medium scale harvesting was $20 /tonne, which was only $1 higher than for large scale production. However a higher degree of uncertainty applies to this estimate.

Cross cutting and Delivery.

Cross cutting would be carried out by firewood mills described for high scale production. Costs of production are likely to be marginally higher as wood may not be presented as well as that produced by a mechanical harvesting system. There may be more bark and uncut limbs. A cost for cross cutting and splitting of $11 per m^3 was assumed.

Delivery costs are likely to higher than for large scale production as the degree of mechanisation is likely to be lower. An additional $3 per dry tonne was added to make the delivery cost $14 / dry tonne.

Figure 4.1 Cost of manually falling, delimbing and docking

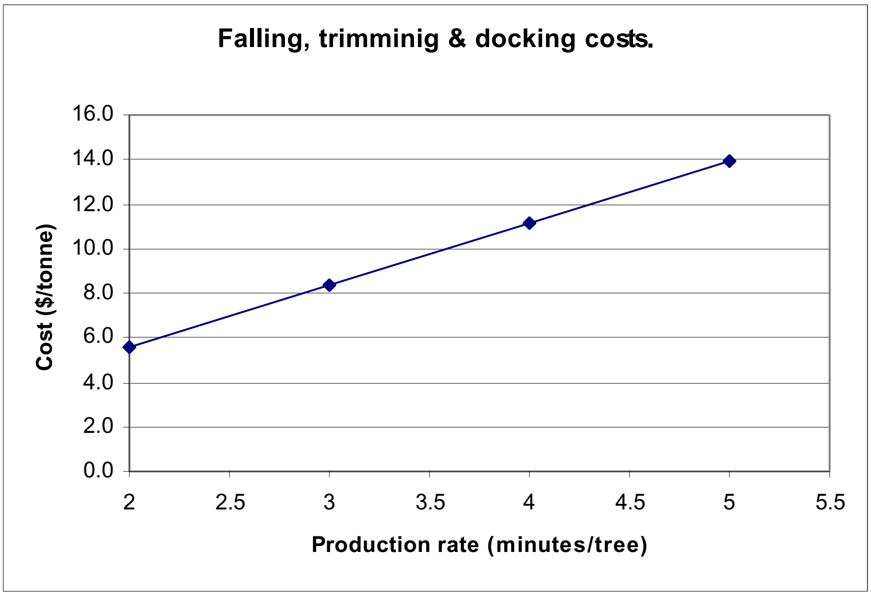
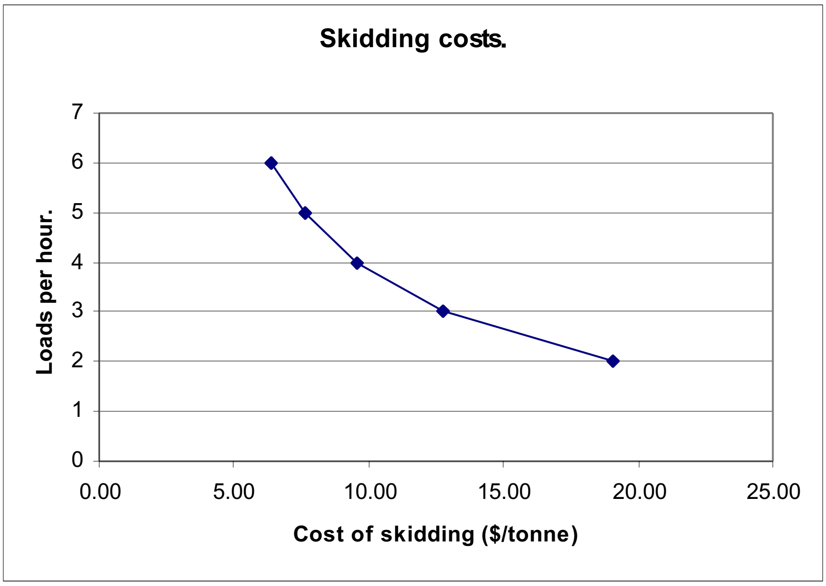


Figure 4.2. Costs of skidding with farm machinery.



4.4.3 Small scale production

Small scale production would be appropriate to harvesting many small scattered woodlots of variable productivity such as is common with small farm forestry plantings. It would involve firewood being produced at the stump and loaded directly into a trailer or truck. Cross cutting would be carried out with a chainsaw and the removal of bark would be a key consideration for a small scale operator. As for the medium scale operation it would be best to fall trees several months prior to cross cutting to allow bark to separate from the wood naturally as the trees dry.

In a harvesting trial at Dookie College in north central Victoria, one man using a chainsaw and a front end loader produced 300 mm. firewood blocks, loaded onto a truck for $26.54 per green tonne (Sonogan, pers. com.). Using a conversion factor of 0.79 this equates to $34 /dry tonne. Trees used in this trial averaged over 30 cm. in diameter. However if diameters were 15-20 cm. the cost of production would increase substantially, and possibly double. Also although labour and chainsaw use was costed at $20/hr for this trial on the basis of a tendered quotation, the operator felt that future similar work should be worth $30/hr.

During 2002 a Geelong firewood contractor advertised a rate of $45 /m³ to produce heaped firewood from standing mature trees (over 30 years). This would equate to $57 /dry tonne. For younger and smaller trees the rate is likely to be significantly higher. On this basis, a production cost of $65-$75 /dry tonne is assumed for small scale harvesting.

A small scale producer is more likely to home deliver rather than sell to a wholesaler. Handling costs would be high due to manual loading and small delivery volumes, and a delivery cost of $25/ dry tonne was assumed.

4.4.4 Harvesting and Processing Costs

As there are no documented Australian studies of the production of plantation grown firewood, cost estimates must be based on experience from other similar operations and anecdotal evidence. A summary of expected costs associated with different scales of firewood production are contained in Table 4.5.

Table 4.5 Summary of production costs for varying scales of firewood production.

Production Costs	Scale of Firewood Production		
	Large	Medium	Small
Annual volume (m^3 green).	100,000 (79,000)	10,000 (7900)	1,000 (790)
Daily production (m^3 green).	400 (316)	40 (32)	4 (3)
Cost of harvest ($/ green tonne).	$19 (26)	$20 (28)	$65-75 (82-95)
Cost of crosscutting and splitting ($ /green tonne).	$10 (13)	$11 (14)	
Cost of delivery ($/dry tonne).	$11	$14	$25
Total cost ($/dry tonne)	$50 / dry tonne	$56 / dry tonne	$107 - 120 / dry t.

Notes: Figures in brackets are based on dry tonnes, assuming a density of 0.79 tonnes/m³ (ie. the density of 14 year old sugar gum)

4.5 Firewood Plantation Returns

Returns to firewood growers will vary with the species grown, growth rates, wholesale or retail prices, distance to market, any credits or incentives received for tree growing, the method of sale, and the costs incurred in production.

4.5.1 Wholesale and Retail Prices

The wholesale price is the price that a grower could be paid by selling firewood to a retailer rather than directly to a consumer. The retail price is the price paid by consumers.

Small growers or suppliers may be able to sell their product direct to consumers, thereby becoming retailers themselves and avoiding the lower wholesale price that they would get by supplying a wood yard. Whereas, for larger growers or suppliers without the time or desire to sell to large numbers of small consumers, it is more convenient to sell to only one entity i.e. a wood yard, for the wholesale price.

The wholesale price may vary for different species of firewood, but it should always be sufficient to cover all the costs of establishment, growing, harvesting and processing, and transport. Due to the higher costs of transport, the wholesale price is generally significantly higher for wood sold in city woodyards, compared with rural areas. The wholesale price of wood in the Melbourne markets is estimated to be $120 - 130 per dry tonne for sugar gum. In north east Victoria it varies in accordance with the local availability of suitable species, possibly in the range of $60 – 100 per dry tonne.

4.5.2 Methods of Sale

Firewood can be sold by two key methods:

On the stump
The plantation owner negotiates a price of sale for the standing trees, and has no involvement with the harvesting, drying or sale to wholesalers or retailers. There are advantages for growers who are too busy to organise harvesting and marketing, or for those who do not feel capable of undertaking these tasks.

Cut, dried and delivered to a woodyard.
Trees are harvested, cut to length and dried before being sold to a woodyard or retailed. Depending on the scale of operation, this may be undertaken by contractors or by the plantation owner (see 4.4, Harvesting and Processing).

The value adding to the standing trees of this option should make it more profitable for the plantation owner, depending on conditions negotiated with the harvesting contractors.

4.6 Firewood Growers' Cooperative

In the absence of industrial scale investment by one or two large corporate entities, a plantation development designed to provide a large proportion of Melbourne's firewood is likely to involve many landowners (see Table 3.2).

High prices for wood products are usually achieved by being able to meet demand with a consistent supply of quality product. Selling on the basis of an intermittent supply exposes growers to spot market prices which are usually lower than a longer term contract price (although, in times of very high demand, the spot price may exceed the longer term contract price). Consequently the marketing of the wood would be a major component of such a project and a growers' cooperative would enable it to be undertaken in an efficient and more rewarding manner.

Cooperatives already dominate the dairy, rice, fishing, grain, wool, cotton and sugar industries, with many having grown into multi-million dollar businesses exporting a diverse range of products (Gill 1997). A firewood cooperative could set quality standards for harvesting and production, and assist individual growers throughout the establishment and growing phases.

Gill (1997) describes a cooperative as an incorporated enterprise that is owned and controlled by its members. Membership is voluntary and can include individuals and/or corporate bodies. In forming a cooperative, members agree to make use of its services and contribute capital to fund the enterprise, usually by purchasing shares. Funds are contributed not for capital gain but for service or trading benefits. Dividends may be paid but they are secondary to trading benefits derived. Members exercise their control of the cooperative by electing a board of directors charged with its management, by approval of the rules by which a cooperative operates, and by the passing of resolutions at general meetings. Every member has one vote irrespective of the capital contributed or the volume of business transacted.

Hughes (1997) outlined the following functions that a tree growers' cooperative could manage:

- *Marketing*: The primary function of a tree growers' cooperative is securing sales and negotiating contracts.
- *Market development*: The cooperative can explore alternative markets and various techniques of marketing.
- *Forest Management Plans*: Market development will be integrated with the preparation of forest management plans which cover all aspects of growing. An inventory and valuation may also be maintained.
- *Arrangements with contractors*: The cooperative may enter legal arrangements with contractors and hired labour, assuming responsibility for legal, insurance, workers' compensation and related matters on behalf of its members.
- *Harvesting and transport*: Harvesting and transport may be coordinated and supervised by the cooperative.
- *Financial transactions*: Financial transactions may be centralised.
- *Equipment purchases*: The cooperative may purchase forestry equipment, technology and office requirements on behalf its members. Bulk purchases may attract discounts.

- *Advice and information*: In the early stages of development of the private forest industry, government agencies have undertaken to provide extensive management advice and marketing information. As the industry develops this provision is likely to be withdrawn, leaving the industry to function in a more self-reliant manner. The advisory and information providing role of tree growers' cooperatives will acquire greater significance as this process of government withdrawal occurs.

- *A voice for its members in control of their business*: Members of a tree growers' cooperative exercise control over the policy of their enterprise, and possess a voice in its operation. Tree growers who deal independently with major companies or government agencies are not so enfranchised.

Gill lists the essentials for a successful tree growers' cooperative as, *inter alia*:

- A committed group of enthusiastic tree growers to facilitate the new cooperative.
- A well researched and constructed business plan.
- An inventory of members' forest resources to enable to enable planning and to understand the potential marketing opportunities.
- Adequate communication to growers, processors and contractors of the cooperatives policies and procedures.
- Having administrative procedures that ensure both timber and cash are properly accounted for.
- Having an informed and dedicated board of directors.
- Having sufficient funds and working capital to finance the cooperative.
- Having suitably qualified staff, including industrial forest, marketing and administrative skills.
- Having skilled and motivated contract harvesters.

To ensure a firewood cooperative is well financed and serviced with appropriate management, forestry, marketing and administrative skills; members would pay on a per hectare basis at establishment, a continuing lower fee during plantation growth, and a small proportion of sales. For a project, based on establishing about 1000 hectares of plantation per year, the cooperative fee at establishment is assumed to be $300/ha, with an annual fee of $18/ha/yr while the plantation grows, and $250/ha for harvesting and marketing.

The fee establishment fee is based on employing a project manager, an office manager, two foresters, legal fees, accounting fees, auditing fees, office accommodation and services, vehicles, equipment and contingencies to a total of $300,000 per annum. During the growing phase an additional forester and office staff would be needed to service the continually expanding plantation area and grower base at a cost of around $100,000 per annum. The harvesting phase would see the need for a marketing manager, a field supervisor, additional accounting and other services, as well as an extensive wood holding/drying yard at a cost of around $250,000 per annum.

If the annual planting was lower than 1000 hectares the resources to manage the project would also be lower. However, it is doubtful if the cooperative cost per hectare would be significantly different as the benefits of scale would be reduced.

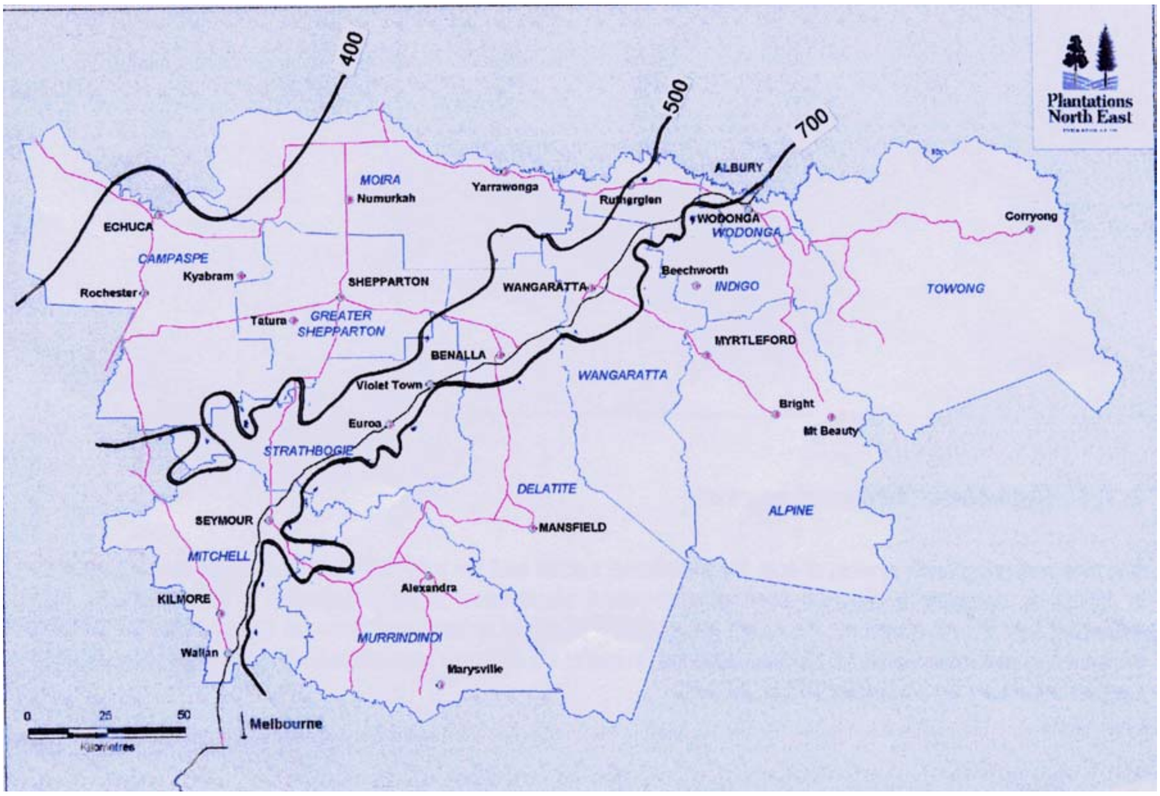
5 POTENTIAL FOR DEVELOPING A PLANTATION-BASED FIREWOOD INDUSTRY IN NORTH EAST VICTORIA

5.1. Potential Land Availability

In accordance with the project brief, firewood plantation development is considered to be most suited to the lower rainfall section of Victoria's north east, as higher rainfall areas are preferred for higher value plantation development.

Although the project brief refers to low rainfall areas as receiving less than 650 mm./annum, it is difficult to delineate the location of this rainfall isohyet. By contrast, the 700 mm. isohyet has been mapped in a number of past reports and correlates fairly closely with the location of the Hume Freeway. Therefore for the sake of simplicity, the section of the north east being considered for the development of a plantation-based firewood industry is those areas generally west of the Hume Freeway. Figure 5.1 shows the extent of the north east region, the low rainfall areas generally west of the Hume Freeway, and the local government municipalities included in this region.

Figure 5.1 Low Rainfall Areas and Local Government Municipalities



The 500 and 700 mm. rainfall isohyets have been taken from a map available from the Department of Sustainability and Environment website, based on the DNRE Geospatial Data Library Layer ROAD500. The 400 mm. isohyet was taken from the Land Conservation Council, Murray Valley Study Area Report (1983).

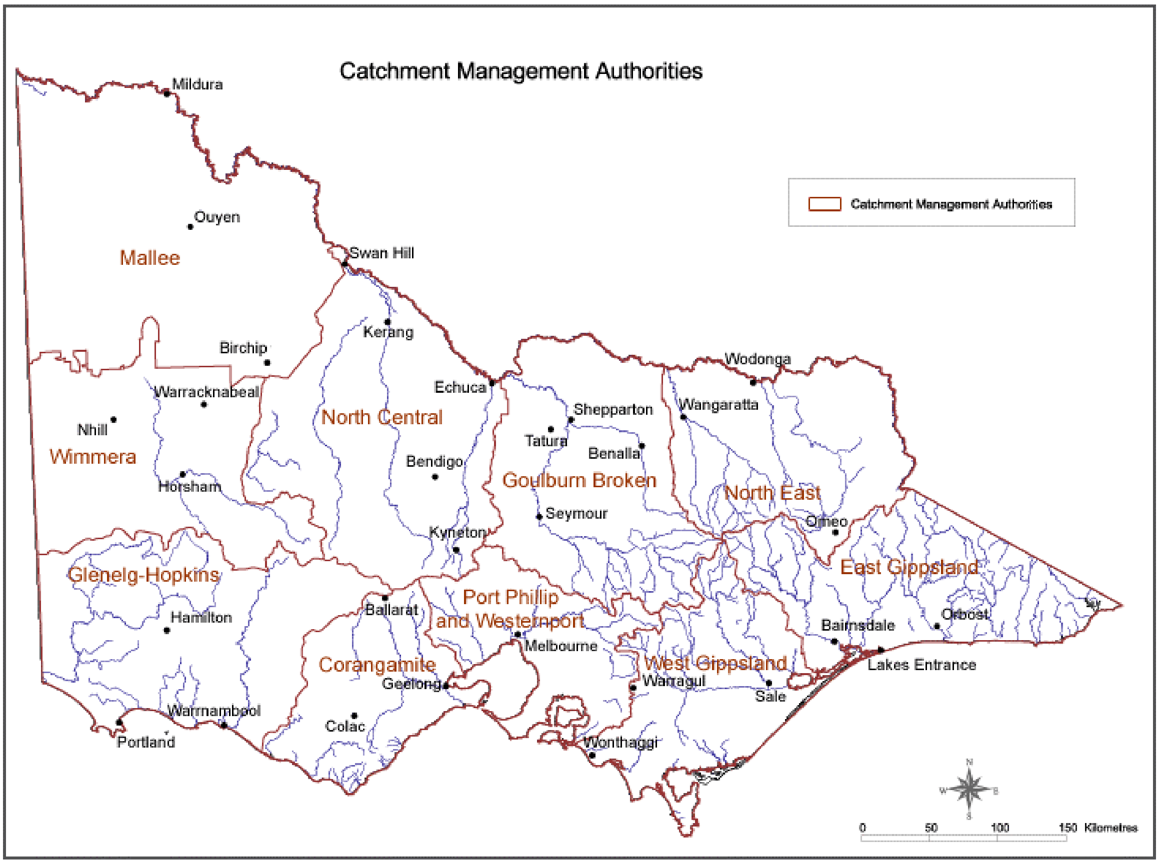
The lower rainfall regions of north eastern Victoria that are most suitable for firewood plantation development lie across three Catchment Management Areas – Goulburn-Broken, North East, and Port Phillip.
Within the Goulburn-Broken Catchment Management Area there is about 510,000 hectares of land which meets the following criteria (Robb, 2003):

- Cleared agricultural land.
- Has a rainfall of 400 – 700 mm/year.
- Has a slope of 18º or less.
- Is not within 10 metres of a roadway, fenceline or waterway, or in a township.

Much of this land is likely to be suitable for growing firewood plantations, although the area that would be available for this use is not known.

Additional suitable land would also be located within the North East and Port Phillip Catchment Management Areas, but the area is unknown. However, land in the North East CMA is likely to be too far from the Melbourne firewood market to support commercially viable firewood plantations.

Figure 5.2. Boundaries of Victorian Catchment Management Areas.



5.2 Land Capability for Plantation Development

Land capability for plantation development is based on a combination of climatic, topographic and soil factors. Topography can limit the ability to establish productive plantations, whilst rainfall and soil depth are the most critical determinants of tree growth. Soil structure and fertility can also limit growth, but to some extent can be overcome by standard plantation establishment operations such as soil cultivation and fertilisation.

The topography of the cleared arable land in the western, low rainfall part of the north east region is generally flat to gently undulating creating few limitations for plantation establishment.

Annual rainfall declines generally from east to west across the study area from about 700 mm. near the Hume Freeway to less than 400 mm. in the north western corner close to Echuca. Most of the study area is contained in the 400 – 500 mm. rainfall zone, with only a narrow belt of land receiving between 500 – 700 mm. per annum. Rainfall is winter-biased, with warm and very dry conditions generally prevailing through an extended summer – autumn period.

Whilst firewood plantations could be grown throughout the low rainfall study area, they are more likely to grow at rates that make them commercially viable in the 500 - 700 mm. zone compared to the less than 500 mm zone.

Table 5.1 Annual rainfall of major centres in the study area

Location	Annual Rainfall (mm.)	Location	Annual Rainfall (mm.)
Benalla	672 mm.	**Rochester**	451 mm.
Dookie	554 mm.	**Rutherglen**	596 mm.
Echuca	437 mm.	**Seymour**	602 mm.
Euroa	655 mm.	**Tatura**	492 mm.
Kilmore	650 mm.	**Violet Town**	645 mm.
Lemnos	563 mm.	**Wangaratta**	642 mm.
Numurkah	449 mm.	**Yarrawonga**	515 mm.

Notes: Rainfall data was obtained from the Bureau of Meteorology Climate Averages (www.bom.gov.au), Land Conservation Council Study Area Reports for Murray Valley (1983) and North Central (1978), and Rainfall Statistics Australia (1977), Department of Science, Bureau of Meteorology.

Another important climatic parameter is frost which can be prohibitive limitation to some tree species such as spotted gum (*C. maculata*), and to a lesser extent sugar gum (*E. cladocalyx*). Table 2.2 below shows the number of light (ie. less than 2^0C.) and heavy (ie. less than 0^0C.) frosts per year for a number of locations throughout the study area.

Table 5.2 Frost frequency for major centres in the study area

Location	Light frost	Heavy frost	Location	Light frost	Heavy frost
Benalla	49	20	**Rochester**	38	10
Dookie	25	5	**Rutherglen**	82	44
Echuca	34	11	**Seymour**	47	19
Euroa	34	10	**Tatura**	48	18
Lemnos	40	15	**Wangaratta**	59	29
Numurkah	32	9	**Yarrawonga**	28	8

Notes: Frost data was obtained from the Bureau of Meteorology Climate Averages (www.bom.gov.au)

The cleared arable land of the study area mostly lies on riverine plain land systems which are generally comprised of sodic duplex soils formed on alluvial material. The most common soil type is a red duplex with a well drained surface horizon, but sub-soil horizons of generally low permeability commonly with layers of buckshot gravel. Much of the area of this soil type is irrigated, despite its pre-disposition to waterlogging (LCC, 1983).

Yellow sodic duplex soils are common in drainage depressions on the riverine plains, whilst brown sodic duplex soils occur on slightly elevated areas. These yellow soils have dispersible sub-soils which are prone to salting and gully erosion. On that part of the alluvial riverine plain in the Euroa, Numurkah and Lockwood districts, uniformly textured, heavy, grey-brown calcareous sodic clays predominate (LCC, 1983).

The flood plains of all major rivers in the study area are comprised of silty, gradational soils featuring a generally structureless top soil that when dry, forms an extremely hard layer that plant roots find difficult to penetrate (LCC, 1983).

Rising above the riverine plains in the south western part of the study area are gentle ridges of Palaeozoic sediments. The major proportion of this country is public land, but sections of cleared arable land still comprise a significant area. Sodic duplex soils derived from slates and sandstones occur in most places, except for steeper slopes which are generally comprised of shallow, stony, gradational soil types with low water-holding capacity. The soils of the gentle hills and ridges are prone to salting and gully erosion (LCC, 1978).

There is little information available about soil depth to bedrock or impermeable clay layers, although it could be expected to be highly variable and in need of assessment on a site by site basis. Similarly, soil fertility is likely to be variable, although undoubtedly fertilisation will be an integral requirement for plantation success.

Past studies of potential plantation growth rates in the north east have concentrated on those areas of the region to the east of the Hume Freeway, where annual rainfall totals of more than 700 mm. are capable of supporting moderate to highly productive plantations of conventional species such as radiata pine (*Pinus radiata*), and blue gum (*E.globulus*).

Borschmann (1998) did not attempt to define growth rate categories within the lower rainfall areas west of the Hume Freeway, preferring to simply consider the whole area as capable only of growth rates less than 16 m^3/ha./year. However based on growth experiences from throughout the state, Table 4.2 outlines indicative growth rates for a range of plantation species that would be suited for growth in the low rainfall areas of north east Victoria.

5.3 Land and Population Demographics

Based purely on property size, the low rainfall section of north east Victoria appears to be attractive for large scale plantation investment as it contains a high proportion of large properties. Approximately 35% of all properties of greater than 250 ha. in the North East region are located in the Campaspe, Greater Shepparton, and Moira Local Government Areas (LGA) which comprise about two thirds of the low rainfall zone west of the Hume Freeway (PNE, 2000).

In addition, it is suspected that a high proportion of the large properties in the Strathbogie LGA are thought to be located in the substantial section of it that is west of the Hume Freeway.

Another way of considering the suitability of the study area for plantation development, is that 57% of all rural properties in the Moira LGA are greater than 100 ha., as are 55% of properties in the Campaspe LGA, 43% in the Greater Shepparton LGA, and 86% in the Strathbogie LGA (PNE, 2000).

The north east region has continued to grow since the early 1960's. As of 2000, it had a population of approximately 280,000 people, which had grown 0.6% since 1995 (PNE, 2002). The major population centres are those cities and towns located on or close to the Hume Highway, such as Wodonga (30,000 people), Wangaratta (15,500), Benalla (8,300), Seymour (6,600), and Euroa (3,000); as well as Shepparton – Mooroopna (32,000) (PNE, 2000).

If the adjacent Albury City and Hume Shire in NSW. are included, a further 50,000 people could be considered to be at least partially impacting on the social and economic character of the region.

Primary production and manufacturing industries employ up to 40% of the workforce, whilst retailing, community services, and hospitality are important industries in the urbanised centers. Industry growth in the region has been generally steady and equitable in most sectors since at least the early 1990's.

The major agricultural land uses in the low rainfall areas west of the Hume Highway are sheep and beef grazing on dryland properties, and dairy, fruit and vegetables on irrigated land in the Shepparton Irrigation Zone.

5.4 Community Attitudes

The financial viability of traditional agricultural ventures such as dryland grazing has gradually deteriorated largely as a result of on-going low commodity prices, drought, and increasing land management costs resulting from emerging environmental issues such as salinity and soil acidity. In addition, the farming community in grazing areas is ageing as there is little to encourage recruitment of younger people into such ventures. Consequently there is growing awareness amongst farmers that changes are required to improve profitability and a need to better manage the physical requirements of farm work. Farm forestry plantings on a portion of the property are being increasingly viewed as having attractive environmental and agricultural productivity benefits with a reduced requirement for management inputs once they have been established.

Despite this generally favourable attitude amongst farming communities, anecdotal observations of regional farm forestry uptake around the state indicate that few full-time farmers have the financial capacity to plant significant areas on their property without assistance from government subsidies. As government programs are limited, the annual areas of farm forestry planting are correspondingly small. A further observation is that full-time farmers are generally unwilling to forego income from significant areas of their land for the period required by farm forestry plantings. Consequently amongst landowners taking advantage of government subsidies there is an over-representation of hobby farmers who have disposal incomes and no real need to manage their land productively. Most landowners in this group generally own small holdings thereby limiting annual plantings to small scattered blocks lacking any economy of scale for either plantation establishment or future harvesting.

Whilst small scale farm forestry has many supporters, larger scale industrial plantation development resulting from corporate investment is required if plantation areas are to dramatically increase in the short term. Extensive consultation with the north east Victorian community was undertaken in recent years to assess attitudes towards the concept of large scale forestry developments on farmland in the region (Crossfield 1998). Although many issues were raised by the community relating to technical, economic, environmental and social aspects of such projects, the majority of these could be resolved through consultation between the proponents of a forestry development and the community to provide an explanation of what a specific forestry development entailed. However despite all efforts to consult there are likely to be sections of the community that are unlikely to accept forestry development in some local areas. In considering the feasibility of any large scale plantation development it would be prudent to identify these local communities and avoid forestry activities in close proximity to them.

5.5 Conclusions

North east Victoria has suitable physical attributes for the development of a plantation-based firewood industry with a potentially large available land base in the lower rainfall area west of the Hume Freeway.

If a 10 – 15,000 hectare firewood plantation estate was targeted for establishment during the next 15 years, it would only require the equivalent of 2-3 % of the land thought to be suitable for plantations in the Goulburn-Broken CMA, although it would constitute a larger proportion of the better quality land if limited to areas in the 550 – 700 mm. rainfall zone.

Such an estate growing in this zone on land primarily receiving above 600 mm. would be capable of sustainably supplying up to half of Melbourne's commercial firewood requirements

If no large scale corporate investment can be attracted to the region, and assuming an average plantation size established by existing property owners of 20 hectares, such an estate would require the participation of 500 - 750 landowners at an annual recruitment rate of 33 - 50 over the next 15 years. This may be a difficult goal, but it would be significantly more attainable if a proportion of the area was comprised of larger plantations of over 100 hectares.

6 COMMERCIAL VIABILITY OF PRODUCING PLANTATION-GROWN FIREWOOD IN NORTH EAST VICTORIA

The commercial viability of establishing a plantation firewood resource in the low rainfall areas of north east Victoria needs to be considered in three ways. These are :

- the commercial viability of growing firewood as land use suitable for outside investment on a moderate to large scale by corporate investors;
- the value of growing firewood as a land use suitable for direct investment by existing landowners; and
- the economic, environmental, and social value of growing firewood as an integrated land use which complements existing agricultural activities.

6.1 As a Land Use Suitable for Outside Investment

This refers to the suitability of the region for large, industrial scale investment by companies or individuals seeking to purchase or lease land to develop a substantial firewood plantation resource. Corporate investment decisions are likely to be strongly influenced by a comparison of the economic value of growing firewood and the value of land under current uses which will affect land purchase and rental prices.

Land suitability analysis is a method of showing variations to the commercial viability of plantations across a broad geographic region. It assumes recent past land sale prices are indicative of the current value of land for particular uses, and compares these to the Net Present Value of growing firewood on land of similar quality. It therefore integrates land capability with plantation costs and returns in order to measure economic suitability (Baker et al, 1999). It was most recently was used to determine the regional potential for plantations in all Australian regions thought to have potential for large scale forestry development. This included a consideration of the viability of growing radiata pine in a part of the project area in the Murray Valley region. (ABARE, 1999).

Like all measures of commercial viability, land suitability is reliant on a wide range of plantation growth, marketing, and financial climate assumptions incorporated into the Net Present Value calculations, as well as averaging of land capability across broad areas when in reality it will most likely vary from hectare to hectare.

6.1.1 Land values

There is excellent information available about the current value of cleared agricultural land (independent of farm infrastructure) throughout Victoria based on past land sales. The Valuer General's office of the Department of Sustainability and Environment has recently determined average land values on a Parish basis to comply with the Auditor General's requirements in accordance with the Financial Management Act, 1994. However as the project study area is comprised of 184 Parishes and the cost of obtaining land values for all of these was prohibitive, indicative land values were sought from a scattered representative sample of 15 Parishes as per Map 6.1.

As the average Parish cleared land values have been determined exclusive of the influence of farm assets and infrastructure (such as houses, sheds, yards or fences), they are essentially representative of the particular combination of land productivity and location applicable to each hectare. Due to practical limitations we have used rainfall zone as the sole indicator of plantation productivity. Other factors that are difficult to consider on a regional basis such as topography, soil depth, type, or fertility can also adversely affect or enhance productivity. These factors, together with others such as waterway frontage are the reasons for the variability of land values within each rainfall zone, and can explain why the average land value in the 500 – 550 mm. zone can be lower than those in the supposedly less productive 400-450 mm. zone.

Presumably discrepancies such as this would not be as apparent if data from all of the area's 184 Parishes had been able to be used to determine the average land value within each rainfall zone.

Table 6.1 Parish average cleared land values

Rainfall Zone (mm. / year)	Parish	Shire	Average cleared land value ($ / ha.)	
			By Parish	By rainfall zone
400 – 450 mm.	Bamawn Picola Undera	Campaspe Moira G. Shepparton	$1800 $1100 $1500	$1466 / ha.
500 – 550 mm.	Moora Tharanbegga Murchison Nth. Pranjip Devenish	Campaspe Moira G.Shepparton Strathbogie Delatite	$1100 $ 950 $1600 $1400 $1200	$1250 / ha.
550 – 600 mm.	Mokoan Norong Killawarra Miepoll	Delatite Indigo Wangaratta Strathbogie	$2000 $1400 $2200 $1200	$1700 / ha.
600 – 650 mm.	Avenel Panyule Bylands	Strathbogie Mitchell Mitchell	$3000 $1200 $2000	$2066 / ha.

6.1.2 Land suitability analysis

In analysing the suitability of cleared agricultural land for industrial-scale firewood plantation development, the Net Present Value (NPV) of firewood plantations in various rainfall zones was compared with that land's average market value as determined from the recent Valuer-General assessments as outlined in Table 6.1.

Whilst the NPV figures will represent the theoretical maximum plantation productivities for each rainfall zone based on the best soil and topographic conditions, the average land value figure against which the comparison is made will not take account of the fact that there may be cheaper, yet equally productive land available in each zone whose value has been reduced by distance from towns and highways.

The determination of an NPV for large scale firewood plantation development in a range of rainfall zones in north east Victoria was based on two 15 year rotations (ie. 31 years) using the following assumptions:

- that a company invests in growing, harvesting, retailing firewood to consumers from their own woodyards;
- the use of sugar gum (*Eucalyptus cladocalyx*), based on the belief that this species is best suited to survival and fast growth in the less than 650 mm./annum rainfall zone;
- expected sugar gum growth rates over a 15 year rotation in various rainfall zones are as follows:
  10 m^3/ha/annum in the 600 – 650 mm. annual rainfall zone;
  9 m^3/ha/annum in the 550 – 600 mm. annual rainfall zone.

- the plantation is established on flat or gently undulating ground that minimises the costs of plantation establishment and harvesting;
- that plantation establishment in year 0 costs $1275 per hectare, including $400 planning and supervision cost; and $150 in year 1 including a $75 planning and supervision cost.
- Roading costs were assumed to be incurred immediately prior to harvesting in year 14 @ $200 /ha., and in year 29 @ $100 /ha.
- that the company leases land from farmers at the rates of 5% of the land's value per annum (as per Bulman 2002D);
- that industrial scale developments will involve fully mechanised harvesting systems ie. the use of feller/bunchers and forwarders, to harvest trees and deliver them to processing points for mechanised cross-cutting and splitting;

- that the following costs will apply for plantations that yield at least around 150 m^3/ha. (ie. growth rate of at least 10 m^3/ha/annum):
  harvesting and delivery to processing point: $20.90 per green m^3
  processing (cut into blocks): $10 per green m^3

  In less productive plantations, these costs would increase dramatically due to smaller average piece sizes and the need to use alternative non-mechanical harvesting and delivery methods.

- that the following conversion factor applies for young sugar gum: 0.79 dry tonnes = 1.0 green m^3
- after harvesting and processing, the firewood is left to dry for a year on site before being loaded and transported to the company's wood yard;
- that cut firewood is transported 50 km. to a storage and sale depot at a cost of $0.12 per dry tonne per km., and that this plus the cost of loading and unloading amounts to $11 per dry tonne;
- that the retailer nets $140 per dry tonne for sugar gum firewood, excluding the costs of operating the woodyard. The retail price of $140 per dry tonne based on the high price of red gum @ $180 per dry tonne, discounted by the difference in density between red gum and young sugar gum, and further discounted in order to attract consumers away from the traditionally preferred red gum or mallee;
- a minimum plantation size of 20 hectares is assumed;
- that plantations are not insured against damage by natural agencies such as fire;
- that no salinity, carbon, or biodiversity credits are paid to landowners;
- that the NPV analysis does not consider the tax implications that apply to either or both costs and returns;
- the discount rates used were 5, 8 and 10%; and
- the plantation regenerates after harvesting by coppicing, with a cost of $400 per hectare to thin the coppice after one year.

Table 6.2 Results of land suitability analysis of large scale Sugar Gum firewood plantation development in the low rainfall region of north east Victoria.

Rainfall Zone (mm.)	Land value ($/ha)	Land Rental ($/ha/yr)	Average Plantation Growth Rate (m^3/ha/yr)	Discount Rate (%)	Net Present Value ($ / ha)	Land Use Suitability Rating
550 - 600	Low $1200	$60	9	5	$ 3666	Strongly Suitable
				8	$ 1230	Suitable
				10	$ 312	Unsuitable
	Ave. $1700	$85	9	5	$ 3251	Strongly Suitable
				8	$ 921	Unsuitable
				10	$ 50	Unsuitable
	High $2200	$110	9	5	$ 2836	Suitable
				8	$ 612	Unsuitable
				10	- $ 212	Unsuitable
600 - 650	Low $1200	$60	10	5	$ 4212	Strongly Suitable
				8	$ 1532	Suitable
				10	$ 522	Unsuitable
	Ave. $2100	$105	10	5	$ 3465	Strongly Suitable
				8	$ 977	Unsuitable
				10	$ 50	Unsuitable
	High $3000	$150	10	5	$ 2719	Unsuitable
				8	$ 421	Unsuitable
				10	- $ 420	Unsuitable

Notes:

- Annual Land rental is assumed to be 5% of the value of the land
- Suitability rating is determined by comparing the NPV for each scenario against the land value. Plantation development based on all the assumptions used to determine NPV (as above) can only be a suitable land use if the NPV is greater than the current land value.

6.1.3 Conclusions from the land suitability analysis

Land suitability analysis measures the commercial viability of large scale firewood plantation development by corporate investors leasing land from landowners. As these investors must maximise returns, it is assumed they will only be interested in growing plantations in areas capable of productive growth of sufficient magnitude to support cost-efficient mechanised harvesting operations at 15 year rotation lengths. In the low rainfall areas of the north east, this was assumed to be possible only by growing sugar gum in areas of greater than 550 mm. rainfall.

Due to a lack of land value data in the 650-700 mm. rainfall zone, the analysis considered only those areas of the north east that fall within the 550 – 650 mm. rainfall zone.

The results show that where plantation productivity of at least 9-10 m^3/ha./annum can be obtained on land valued at less than $2000 per hectare able to be leased for less than $100 /ha./year, firewood plantation development, including harvesting and retail marketing is a commercially viable land use at generally low or sometimes moderate discount rates.

At present, these conditions are to be found in some parts of the Mitchell Shire in the Tooborac / Puckapunyal area, and in the Strathbogie Shire north west of Euroa. Similar conditions also exist north of Wangaratta, but this area is so distant from Melbourne where the highest firewood returns are available that its ability to be viable is likely to be affected. There may well be other areas that meet this criteria that have not been identified by this study due to the prohibitive costs of accessing more than the limited land value data presented for the region in Table 6.1.

As the results presented above are based on landowners receiving no subsidies or grants for environmental services, the mooted introduction of credits for salinity, carbon, and biodiversity benefits associated with plantation development has some potential to increase the extent of areas within the region where corporate investment in plantation development can be commercially viable.

However, the results in Table 6.2 suggest that the value of these credits would need to be substantial (ie. $500 – 700 per hectare) in order to have significant impact in converting Unsuitable to Suitable areas amongst the rainfall zones tested above.

It should be noted that the viability of corporate firewood plantation developments as shown above relies on a continuing favorable economic climate of generally low to moderate discount rates, and therefore carries a degree of risk.

6.2 As a Land Use Suited to Direct Investment by Existing Landowners

The commercial viability of firewood plantations established by individual landowners is enhanced by the fact that they do not have to incur land purchase or lease costs, which is a major expenditure that must be borne by large-scale corporate investors.

If landowners undertaking direct investment are numerous enough they may warrant the formation of a growers' cooperative (see 4.6) which will incur a cost, but will also ensure cost-efficient harvesting, marketing and consistent supply of the substantial quantities of firewood required to maximise grower returns. It is unlikely that small individual farm growers could have any significant impact on meeting the Melbourne or regional demands for firewood if there are insufficient numbers to warrant the formation of a growers' cooperative.

The base case economic performance of firewood-only plantations grown by existing landowners in the 550–700 mm. rainfall zone of north eastern Victoria relies on the following assumptions:

- Growth rates - 10 m^3/ha./annum (sugar gum); 15 m^3/ha./annum (blue gum –only in parts of the 650-700 mm. zone)
- No government subsidies, incentives or credits
- No consideration of taxation implications or inflation.
- Grower cooperative fees included
- Establishment costs of $960 per hectare in year 0
- Wood density of plantation sugar gum – 0.79 kg./m^3; blue gum – 0.69 kg./m^3

Of the potential firewood markets discussed in section 2, the most attractive returns would result from supplying the Melbourne market with higher quality species such as sugar gum. Growing and supplying lower quality, low value species such as blue gum would be unlikely to be viable without some form of environmental benefit or incentive payment.(see Table 6.3 below)

Table 6.3. Economic performance of landowner grower firewood plantations growing in the 550 – 700 mm. rainfall zone supplying various markets.

	Melbourne		North East Victoria	
	100 km haul	**200 km haul**	**40 km haul**	**80 km haul**
Commercial market	170,000 – 230,000 dry t./year		60,000 dry t./year	
Plantation area required[1]	20 – 30,000 ha.		6000 – 9000 ha	
Wholesale price for sugar gum	$125 / dry tonne		$ 80 / dry tonne	
Return to grower for base case with sugar gum[2] (IRR %)	8.6 %	6.9 %	negative	negative
Return to grower for base case plus $500/ha credit	10.7 %	8.8 %	negative	negative

Return to grower for base case with blue gum[3] (IRR %)	5.0 %	1.0 %	negative	negative
Return to grower for base case plus \$500/ha credit – blue gum	6.7 %	2.1 %	negative	negative
Return to grower for base case with no co-operative fees - blue gum	7.2 %	3.4 %	negative	negative

Notes:

1 Plantation area required is based on an average plantation growth rate of 10 m^3/ha/yr (green).

2 The base case IRR figures calculated for Sugar Gum assume a growth rate of 10 m^3/ha/yr, a rotation of 15 years, wood density of 0.79 m^3/tonne, no carbon credits, no other credits, a cooperative or management fee of \$300 /ha in year 0, \$18 /yr in years 1-14 and 16-29 and \$250 /ha in years 15 and 30 and with inflation or tax not included.

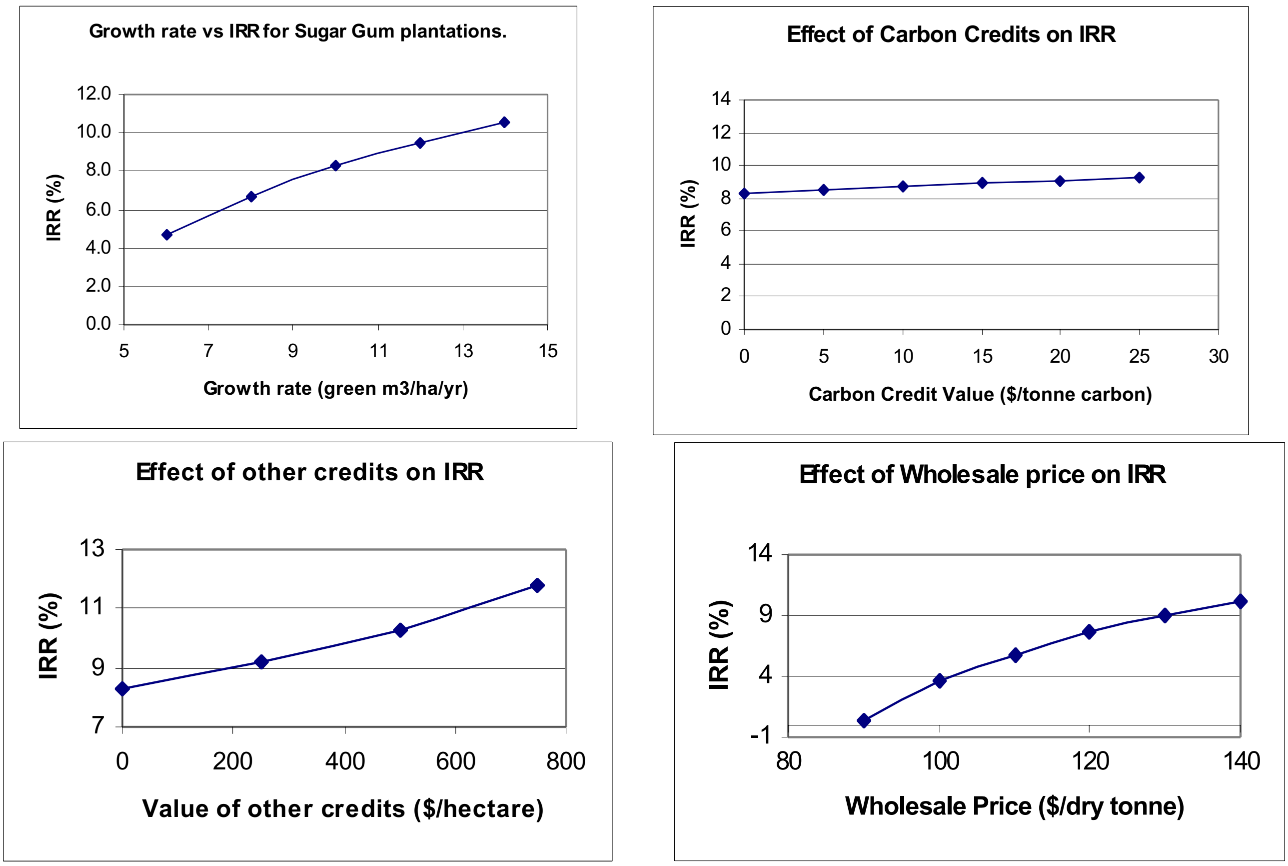
3 The base case IRR figures calculated for Blue Gum assume a growth rate of 15 m^3/ha/yr, a rotation of 15 years, wood density of 0.69 m^3/tonne, no carbon credits, no other credits, a cooperative or management fee of \$300 /ha in year 0, \$18 /yr in years 1-14 and 16-29 and \$250 /ha in years 15 and 30 and with inflation or tax not included. Firewood prices are discounted 15% compared to Sugar Gum.

6.2.1 *Sugar gum firewood*

Table 6.3 shows that plantation-grown sugar gum firewood from the 550-700 mm. rainfall zone has the potential to produce an internal rate of return (IRR) of 8.6% within a cooperative grower arrangement to supply the Melbourne markets (see Table 6.3). The IRR could increase significantly without cooperative fees, with higher growth rates, or with the benefits of other credits or incentives paid for tree growing. However independent growers who are not part of a growers cooperative may incur additional costs for marketing, harvesting and technical advice.

Internal rate of return is sensitive to key input variables such as plantation growth rates, price and incentives are important variables in determining IRR, but carbon credits do not have a significant impact (Figure 6.1).

Figure 6.1. Sensitivity of IRR to growth rate, carbon credits, firewood price and other credits.



The value of a $500/ha incentive or credit paid at establishment increases IRR from 8.3 to 11.8%.

Wholesale price is a key input. As price increases from$90 to 140 per dry tonne, IRR increases from 0.3 to 10.1%.

6.2.2 Blue gum firewood

Blue gum has a faster growth rate than sugar gum, but it requires a higher rainfall and should be limited to areas receiving at least 650 mm rainfall and deep soil. In addition its basic density is lower and it is not expected to achieve as high a price as firewood. Allowing for a 15% discount in wholesale price compared to sugar gum, the financial returns for blue gum firewood are negative for rural markets but positive for Melbourne markets (Table 6.3).

6.3 As an Integrated and Complimentary Land Use

There is now a large body of research information espousing the value of even small areas of strategically located tree plantations as an integrated, complementary land use that can significantly enhance the productivity of an existing agricultural primary land use. The accepted general rule is that establishing trees on only 10% of a property's area in windbreaks and shelterbelts can increase agricultural productivity from the property as a whole by 10%. Consequently, landowners considering the merits of establishing firewood plantations in this manner do not necessarily have to consider them in terms of a direct replacement of their existing landuse, in the way that a plantation investment company does.

The commercial viability of plantations established as an integrated and complementary land use can only be assessed in conjunction with the agricultural land use on a whole-of-property basis. However, the reality is that establishing windbreaks and shelterbelts on a substantial area of a property will usually reduce its overall commercial productivity for at least 5 – 10 years before benefits become apparent. This is because tree planting will tie up land that previously produced an annual income, it requires a significant initial expenditure, and it takes this time for trees to reach a size sufficient to provide the sheltering benefits that can increase crop or pasture production in their lee.

6.4 Conclusion

Assessing the commercial viability of firewood plantations does not necessarily provide an accurate insight into the full extent of firewood plantation development that may occur in the future. This is because many landowners will consider lifestyle and aesthetic issues as well as economic viability when deciding whether or not to plant trees. Also those (either individual landowners or investors) who do consider economic viability to be most important, may take a very optimistic view of productivity and prices when making their decision.

However, the study indicated that the generally high land values in the region will limit interest in large scale plantation development amongst potential significant investors, and only existing farmers running low profitability sheep and cattle grazing ventures will be attracted to firewood as a replacement land use on a moderate to large scale.

It is now generally accepted that small areas of strategically located, lineal tree plantations as an integrated, complementary land use can significantly enhance the productivity of an existing agricultural primary land use by sheltering crops, pasture or stock in their lee. The accepted general rule is that establishing trees on only 10% of a property's area in windbreaks and shelterbelts can increase agricultural productivity from the property as a whole by 10%. Consequently, landowners considering the merits of establishing firewood plantations in this manner do not necessarily have to consider them in terms of a direct replacement of their existing landuse, in the manner of a plantation investment company.

The commercial viability of plantations established as an integrated and complementary land use can only be assessed in conjunction with the agricultural land use on a whole-of-property basis. However, the reality is that establishing windbreaks and shelterbelts on a substantial area of a property will usually reduce its overall commercial productivity for several years before benefits become apparent.

However, eventually plantations established in this manner should increase the overall commercial viability of a property, particularly if firewood can be produced and sold periodically from the windbreaks.

7 HYPOTHETICAL BUSINESS PLAN FOR FIREWOOD PLANTATION DEVELOPMENT

The urgent requirement to quickly establish a large firewood plantation resource to replace rapidly dwindling supplies of available red gum could only be met by a corporate investment business model whereby land is leased or purchased by a company engaged in growing, harvesting and eventually retailing firewood.

Although firewood can be a viable landuse for individual farm growers, extensive farm forestry extension work over the past decade has proven that most landowners will only plant trees if substantial subsidies are offered, and even then the uptake is so slow that it would take decades to create a significant area of resource.

At the moment there appears to be limited opportunities for commercially viable corporate investment in firewood plantations in north east Victoria where they:

- are grown within 150 km of the Melbourne market on productive land valued at less than $2000 per hectare;
- are comprised of species with higher calorific value such as sugar gum (*E.cladocalyx*);
- can be partially financed from other means such as salinity, carbon, shelter or biodiversity credits, or have tangible agricultural benefits in addition to the value of the firewood;
- are established on sites which allow for growth rates of at least 9 – 10 m^3/ha./annum;
- have low overheads; and
- are grown under an on-going financial climate of moderate to low discount rates.

The land suitability analysis conducted earlier in the accompanying report identified areas north west of Euroa and in the Tooborac / Puckapunyal area has having potential to meet these requirements at present. However the high cost of purchasing land value data from the Valuer-General's Office limited the ability to comprehensively survey all parts of the study area, so there could well be other areas that meet the above criteria.

7.1 Primary Objective

Due to strong competition for the corporate investment dollar, it is likely that a minimum project size required to attract investors would require 15,000 ha. of plantation to be established over a 15 year period at 1,000 hectares per year. However whether this is realistically achievable in view of the limitations detected by the land suitability analysis (section 6.1) is highly debatable.

Assuming that it was thought to be achievable, the plantations would be established specifically to supply the Melbourne market and would be located within 150 km. of it. Finance for the project would be raised by attracting funds from investors through a firewood prospectus.

7.2 Business Plan Summary

The concept.
To lease cleared farmland in low rainfall areas within 150 km of the fringe of Melbourne to grow eucalypt plantations for the production of firewood. Contracts would be made with landowners for lease of their land for at least 15 years with an option for additional terms. Plantations of sugar gum would be established and managed using industry best practice. After growing for at least 15 years, or less if growth is favourable, the plantation would be harvested, the wood cut into firewood billets, dried and then retailed from wood yards in Melbourne. The plantation would then be re-established from coppice regrowth from the stumps of the harvested trees.

The product
Plantation-grown firewood can be a sustainable and environmentally friendly source of renewable energy. If dried to optimise its calorific quality, and burnt intelligently in efficient, advanced technology wood heaters, the potential environmental impacts from wood smoke can be dramatically minimised.

The calorific value or burning quality of mature sugar gum is slightly better than red gum which is widely accepted as a very high quality firewood. Young (age 14 years) sugar gum has 87% of the calorific value of mature red gum, and has already been successfully marketed in Melbourne using its environmentally friendly/plantation-grown status and its burning attributes as major selling points.

Market analysis
The Melbourne commercial firewood market is estimated to be 170,000 – 230,000 dry tonnes per year. The main species supplying the market is currently red gum for which there are significant doubts about its long term supply. The Melbourne market could support a plantation area of 20-30,000 hectares. A project of 15,000 hectares therefore aims at supplying about one half of the Melbourne firewood market.

Marketing strategy
Plantation-grown firewood could be sold through a network of Melbourne-based wood yards. It would be marketed on the basis of the environmental benefits achieved from growing firewood plantations, its high calorific value and the ambience of a natural wood fire. To assist in raising investment funds from the financial market the project could be promoted as ethical and green.

Financial data.
The cash flow for a 1000 hectares/year plantation resource established over 15 years is presented in Table 7.1. The flow is negative in years 1-14, rising from $0.92 m in year 1 to $2.327m in year 14. From year 15 there is a positive flow of $4.8m. The figures represent the optimistic scenario and are graphically- presented in Graph 7.1.

Graph 7.1 Cash flow for 15,000 ha. firewood plantation, established @ 1000 ha./yr. ($ 000's)

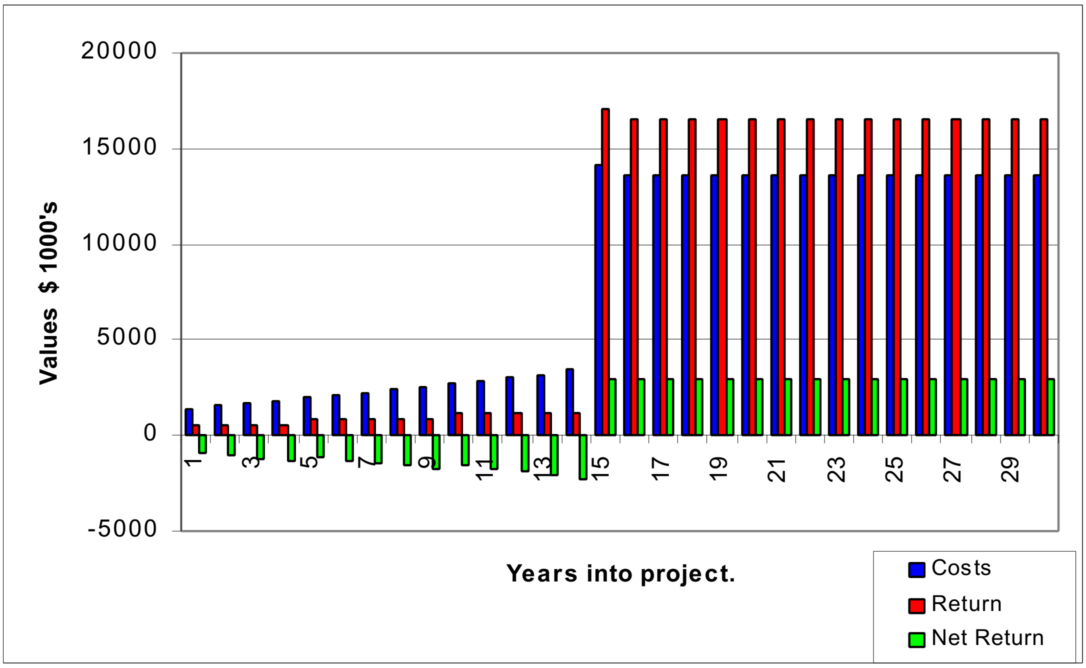


Table 7.1. Optimistic scenario cash flow for 15,000 hectare firewood plantation resource, established @ 1000 ha./ yr ($ 1000's). Assumes credits for salinity and carbon sequestration area available to plantation growers.

Year	Establish trees	Overheads	Land lease	Insurance	Roading	Harvest	Process	Transport and dry	Salinity Credits	Carbon credits	Sales	Net Return
1	960	300	100	10	50	0	0	0	500	0	0	-920
2	960	318	200	23	50	0	0	0	500	0	0	-1051
3	960	336	300	39	50	0	0	0	500	0	0	-1185
4	960	354	400	58	50	0	0	0	500	0	0	-1322
5	960	372	500	80	50	0	0	0	500	315	0	-1147
6	960	390	600	105	50	0	0	0	500	315	0	-1290
7	960	408	700	133	50	0	0	0	500	315	0	-1436
8	960	426	800	164	50	0	0	0	500	315	0	-1585
9	960	444	900	198	50	0	0	0	500	315	0	-1737
10	960	462	1000	235	50	0	0	0	500	630	0	-1577
11	960	480	1100	275	50	0	0	0	500	630	0	-1735
12	960	498	1200	318	50	0	0	0	500	630	0	-1896
13	960	516	1300	364	50	0	0	0	500	630	0	-2060
14	960	534	1400	413	150	0	0	0	500	630	0	-2327
15	960	802	1500	413	150	4950	2700	2711	500	0	16590	2904
16	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
17	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
18	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
19	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
20	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
21	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
22	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
23	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
24	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
25	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
26	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
27	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
28	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
29	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964
30	400	802	1500	413	150	4950	2700	2711	0	0	16590	2964

The three scenarios for sugar gum plantations to give a range of financial outcomes (Table 7.2):

- A base case where the most likely costs were included.
- A pessimistic case where the lower expectations were included.
- An optimistic case where the upper expectations were included.

The internal rate of return (IRR) varies from 2.5% for the pessimistic case, through 6.2% for the base case to 11.7% for the optimistic case. These scenarios do not include inflation or taxation benefits in the IRR estimates, Only the optimistic scenario includes an assumption that salinity and carbon credits will be available to growers

Table 7.2. IRR for three Sugar Gum firewood plantation scenarios

INPUTS	Base case	Pessimistic	Optimistic
IRR (%)	6.2	2.5	11.7
Growth rate (m^3/ha/yr)	10	8	12
Establishment cost ($/ha)	960	960	960
Roading – Year 0 ($/ha) - Year 14 - Year 29	100 200 100	100 200 100	50 100 50
Overheads - Year 0 ($/ha) - Years 1-14, 16-29 - Year 30	300 18 250	300 18 250	300 18 250
Firewood price ($/dry tonne)	140	130	150
Carbon credits ($/tonne carbon)	0	0	15
Other credits e.g. salinity, biodiversity ($/ha)	0	0	500
Delivery distance of dry wood (km)	150	170	120
Land lease ($/ha/yr)	100	100	100
Harvest + Transport ($/$m^3$ green)	25	25	25
Cut into blocks ($/$m^3$ green)	15	15	15
Dry + store ($/$m^3$)	4	4	4
Rotation (years)	15	15	15
Green to dry conversion	0.79	0.79	0.79
Green m^3 to green tonnes	1.1	1.1	1.1
Coppice management ($/ha)	400	400	400
Insurance	Yes	Yes	Yes
Inflation	0	0	0

7.3 SWOT Analysis: Strengths, Weaknesses, Opportunities and Threats

Strengths.

Global consumption: Firewood is a widely used product. The estimated worldwide consumption of fuel wood during 2000 was 1,765 million m^3 (FAO, 2002) including charcoal. Fuel wood consumption exceeded industrial roundwood (used for sawlog, veneer, paper, paperboard, and wood based panel products) by 11%. Total industrial roundwood consumption was 1,589 million m^3, of which 422 million m^3 was sawn wood. Consumption of fuel wood in developing countries was 1,558 million m^3, or 88.3% of total worldwide consumption.

Domestic markets: The current market for firewood potentially grown in north east Victoria is estimated to be 170,000 – 230,000 dry tonnes per year in Melbourne, with an additional 60,000 tonnes per year sold in local regional areas. These domestic markets could sustain a firewood plantation area of 20,000 – 40,000 hectares.

Future markets: The red gum resource which supplies the current market has an uncertain future. As its supply from private forests declines and if supply from public native forests is further restricted, there is a good opportunity for plantation firewood to greatly increase its market share. Plantation wood is not currently widely used for firewood, but indications are that is has great potential for consumer preference.

Environmental benefits: Wood is a potentially sustainable and renewable source of heating. It can be grown to ameliorate salinity and erosion, it is greenhouse gas neutral and trees can increase the biodiversity associated with agricultural land. Firewood plantations should therefore be viewed as environmentally friendly.

Financial returns: Fast growing firewood plantations of good quality species should yield a positive financial return when they are located within about 150 km of the Melbourne market. Returns could be enhanced where credits for other environmental benefits such as carbon, salinity and biodiversity can be used to off-set the costs of growing firewood. Returns may be further enhanced if inflation and tax benefits are included in a potential grower's financial analysis.

Social benefits: The opportunity to lease land for firewood plantations should be welcomed by many farmers who are seeking diversity for their farm, and a means of stabilising farm income.

Weaknesses

Environmental benefits: Environmental credits such as salinity, carbon and biodiversity are currently not readily realised, even though the concept is widely promoted.

Current firewood supply: There is no solid data to show that the current supply of red gum will reduce over the next 10-20 years although it is strongly suggested by anecdotal evidence. A report from CSIRO on longer term supply is expected this year.

Financial returns: The predicted financial returns may not be high enough to attract sufficient investors.

Opportunities

Rail transport: The financial analysis has assumed that road transport will be used to haul dry wood to the wholesale market. If rail transport could be organised there is a potential for significant saving.

Regional markets: If prices for firewood in regional centres increase as supplies from traditional sources decline, market opportunities may correspondingly increase.

Growth rates: With a successful breeding program for selected species the growth rates of plantations could be increased.

Threats

Heating substitutes: Where prices of firewood exceed about $100 per tonne there are cheaper heating alternatives such as various forms of gas and electrical heating.

Air quality: In some localities air quality due to smoke from firewood burning is an issue. However it is thought that wood smoke problems could be substantially improved by educating the public to burn only dry wood and insisting that only advanced technology wood heaters be used. Heater replacement subsidies are currently being offered in some of the worst affected interstate localities to facilitate this.

Plantation competitors: As investors become aware of the size of the firewood market and the potential returns there may be additional companies competing for the finite market.

7.4 Organisational Management

Having completed the project planning there would be three distinct phases to establish and manage a major firewood plantation. The phases would include the establishment phase, the growing phase, and the marketing phase.

Establishment phase

This phase would involve the procurement of land and establishment of trees. The major tasks would include:

- Finding landowners who are interested in leasing land.
- Determining the suitability of the offered sites for firewood plantations based on factors such as climate, soils, topography, access and size of allotments.
- Securing lease agreements with appropriate landowners.

- Preparing the site for planting, including any vegetation and fence removals, weed control, soil preparation, vermin control, and provision of access roads or tracks.
- Securing suitable seedlings and planting at the appropriate time, followed by any fertiliser which is required.

To secure 1000 hectares per year an allowance of $300,000 was budgeted, i.e. $300 per hectare. This included a Project Manager, two Field Foresters, legal assistance, accounting assistance, auditing, office management, office rent, vehicles and field equipment.

Growing phase

The growing phase involves the management of the plantations after planting until they are ready for harvest. In the second year the area to manage is 1000 hectares, but this increases steadily to 15,000 hectares by the fifteenth year. The main tasks include:

- Maintaining fire protection, including the liaison with fire control organisations.
- Monitoring for disease and insects and implementing any necessary control.
- Protection of young trees from browsing animals, including domestic animals.
- Monitoring the nutrition of the trees and applying appropriate fertilisers to maintain nutritional levels.
- Managing any grazing of firebreaks or other areas within the plantations.

An allowance of $100,000 per year was made for this phase which includes a Forester, office staff, a vehicle and contingencies for protection and nutrition activities.

Harvesting phase

The harvesting phase involves the harvesting of the plantations and the delivery of dry wood to wholesale firewood merchants. It may involve the purchase of harvesting and haulage equipment or it may mean establishing contracts with companies who specialise in harvesting and haulage. For the harvest of 1000 hectares of plantation per year with a growth rate 10 m3/ha/yr, the amount of dry firewood is 130,000 tonnes.

An allowance of $250,000 per year was made for this phase including a Marketing Manager, a Field Supervisor, legal assistance, accountancy, vehicle, woodyard and office rent.

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