Developing a wood energy industry in Central Otago.

A report prepared for the Queenstown Lakes District Council, Central Otago District Council, Energy Efficiency Conservation Authority and the Department of Conservation.

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Contents

Executive Summary

An opportunity exists for the Queenstown Lakes and Central Otago districts to provide a significant proportion of their industries' energy requirements using locally owned and sourced wood fuels as a renewable fuel resource. There is currently 1,700 MWh (1,600m³ chip) of wood fuel being delivered into Central Otago by existing suppliers for heating processes. The opportunity to further supply wood energy from local sources was assessed, and is shown in the table below, demonstrating that there is a significant opportunity to increase the supply of wood energy from log residues in both the Central Otago and Queenstown Lakes Districts, as well as from existing woodchip and sawdust that is being produced from the region's wood processing sector.

	2013-2018	2019-2028	2029-2038	2039-2048	2049-2058	2059-2063
Queenstown log residues	4,639	4,183	29,447	15,286	3,011	15,169
Central Otago log residues	15,401	13,989	11,551	13,861	15,617	34,191
Sawmill wood chips	3,200	3,200	3,200	3,200	3,200	3,200
Sawmill sawdust	4,000	4,000	4,000	4,000	4,000	4,000
TOTAL (MWh)	**27,420**	**25,372**	**48,198**	**36,347**	**25,828**	**56,560**

Table: Summary of regionally available wood-energy resource

Though the resource described in the table above exists at the regional level, there are some key points that need consideration when assessing the development of a regional wood-energy industry:

- The most feasible way of utilising the log residue from the Queenstown Lakes District is for existing wood-energy suppliers to purchase log residue from the forest owners, to store logs at a central processing yard that is proximate to Queenstown and Cromwell, and to utilise their existing processing equipment at this central processing yard as and when required. This option would require the development of a suitable central processing yard and covered storage area. Existing wood-energy suppliers have the added advantage of being able to use the quality and availability of their existing supply to overcome any issues associated with the start-up phase of this local supply pathway.

- Due to the significant capital expenditure that is required to start up a new wood-energy processing business, the development of a Greenfields Queenstown-based wood energy cluster -

which includes all parts of the processing operation - is not currently considered viable. Though the volume of log residue that is potentially available in Queenstown Lakes is a valuable resource for the region's existing suppliers of wood energy, there is insufficient log residue available to specifically enable the development of a full wood-energy supply chain that is specific to this locality.

- The wood chip residue that is currently produced at Luggate sawmill presents an opportunity to supply a number of sites with a locally produced chip product. This wet wood chip is available here and now, and though volumes do fluctuate, it represents a consistent form of supply. However, to produce a seasoned and saleable wood chip will require significant investment in a heat drying process and again, storage facilities.

- Luggate Sawmill also produces sufficient volume of wet sawdust to make a small pellet mill viable. The volumes do vary and the sawdust will need to be dried. A pellet mill with a capacity of 750kg/h is the most viable option for the volume of sawdust available. There is potential to sell the product within Central Otago, and to generate a higher margin due to the reduced cost of transport of the locally produced pellet.

An assessment of 54 businesses in Central Otago identified further demand that could increase the required supply from 1,700 MWh, by a factor of four, to 7,200 MWh over the next 20 years. New proposed schools in Queenstown and council-owned facilities (Cromwell Pool and Lakes Leisure) are in the initial group of new demand for wood fuels. Potential new demand scenarios for wood fuels are outlined in the graph below.

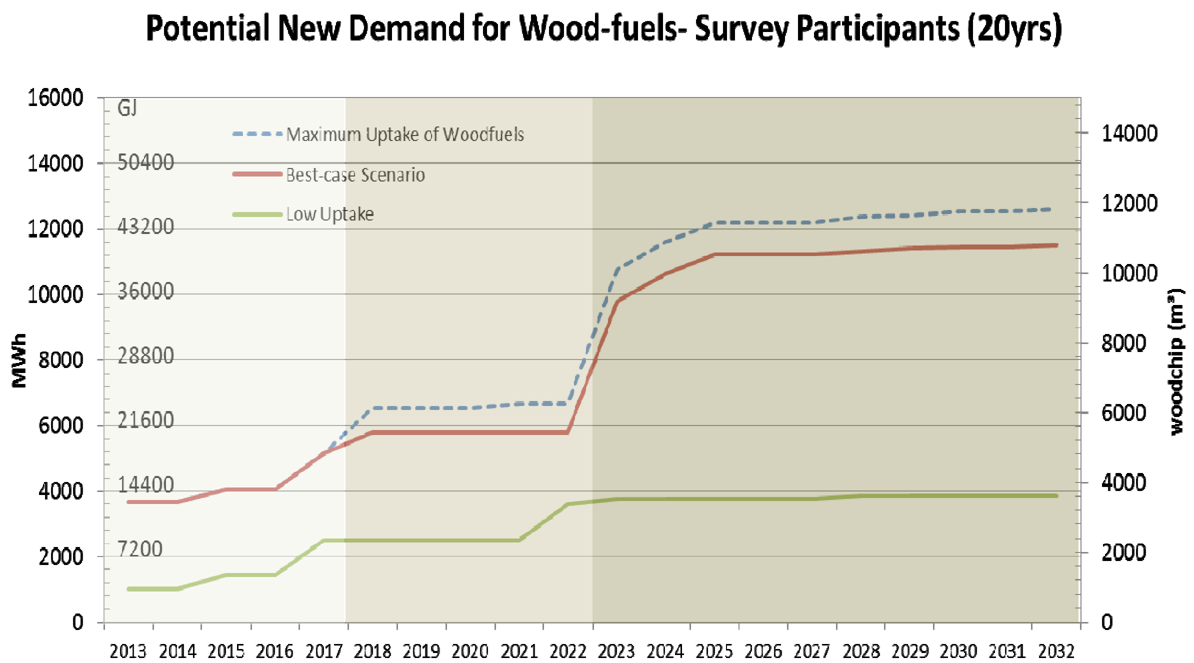


Figure 20.1: Demand scenarios for potential new wood fuel divided into three time stages

Schools, wineries and council facilities are the most convertible of sites, whilst sites like rest homes will be expensive to convert if they are using electricity exclusively. Large accommodation sites have suitable plant and pipe work (boilers and radiator heating systems) but a proportion of these sites will be difficult to convert because space is often at a premium. For these sites, just in time delivery may reduce bunker volume but additional space would still be required in the boiler room. A better option for these sites would be a centralised shared boiler and piped hot water system. Nevertheless more than 60% of boiler sites were suitable for conversion, thereby indicating good conversion options for large accommodation sites around Queenstown, and especially for those that are not centrally located in the high-density locations.

There are some encouraging new projects which are forecast for the region, mostly in Queenstown. This includes at least two new schools over the next four years and a large development at Remarkables Park (Stage Two) which includes a 1,200 unit housing development and commercial buildings. The importance of supporting these developments to utilise wood fuels needs to be reinforced as it will help build baseline demand. Council can also build baseline demand by converting sites such as the Cromwell and Lakes Leisure pools. Both of these sites are likely to show favourable return on investment.

This report found 75% of boilers were less than 10 years old. The two council pools mentioned above are among that group and management need to be made aware of the potential avoided fuel costs of switching from these relatively new boilers to wood fuels.

Figure 20.1 above shows demand broken down into three time stages. These stages have been provided as a potential path to implementing a wood-energy cluster across the region. The scenarios take into consideration low-hanging demand and matching this with the potential supply from within the region. The best estimate for potential demand (extrapolated) across the region is 22,500 MWh/annum or 21,000m^3 seasoned woodchips. As shown in the table below, there is sufficient wood energy resource available now and over the next 20 years.

	Potential energy demand (MWh)	Wood supply available (MWh)
Stage 1 (2013-2017)	3,797	20,040
Stage 2 (2018-2022)	5,484	18,172
Stage 3 (2023-2033)	10,261	40,998

Table: Summary of estimated future wood energy demand and supply balance

Recommendations

This report has highlighted opportunities to enable the development of a wood-energy cluster in the Central Otago region. To achieve this, the following recommendations should be considered.

- Given the significant volume of wilding conifer resource, and the highly fluctuating age-distribution of this resource, it is recommended that a more accurate inventory of the wilding conifer resource is completed. This inventory should better determine the age class distribution of the resource, the feasibility of harvest, as well as landowner intentions. Completing this inventory will provide greater assurance to prospective developers of a wood-energy industry.

- Upon completing the wilding conifer inventory, we recommend that council lead the planning of the development of a Queenstown Lakes District forestry estate. This forest estate will build on the base of the existing forestry resource, and seek to plan for further forestry expansion so as to develop a joint publically-privately owned forestry resource which provides consistent and reliable supply of timber and wood residue for energy. This will need to carefully match with the community's expectations regarding trees in this landscape.

- The sawdust and wood chip resource that is available at Luggate sawmill is significant, and warrants further investigation regarding its utilisation. Of particular importance is the need to better understand the cost effectiveness and viability of drying wet residues that are generated from this processing site. Given that there is a lack of New Zealand-specific information regarding the viability of heat-drying wet residues, we recommend that a project is commissioned which specifically evaluates the efficiency and cost-effectiveness of heat-drying wet sawdust residue and wet saw chip residue.

- There are approximately 9 potential businesses that will assist with Stage 1 demand as listed in Figure 20.2. These businesses/organisations need to be approached and the opportunities discussed which are specific to their requirements. These sites include:
    - Two new schools which are proposed for Queenstown, and which will have high demand for heating. It is important that these schools are heated using wood fuels. As such, the school boards and professionals involved with the design of the school need to be aware of wood fuel heating options.
    - Two council pool sites which use year round energy for pool heating. Both sites use LPG and have reasonably new boilers so they need to be made aware of the potential avoided costs of switching to wood fuels. Both sites also have high demand for hot water.

    - A Wanaka resort has also been identified in the initial group because it also has high demand for pool heating and hot water. The site is best suited to a portable boiler solution and their existing boilers are near the end of their life.

- A ‘bio fuels champion business group’ should be formed and funding should be allocated to investigate wood-energy projects in the district. For implementation projects the funding needs to be significant and similar to the former EECA wood-energy funding of up to $200,000 or 40% of project costs. The funding is likely to get businesses to seriously consider wood energy and the criteria for being part of the group will include a level of commitment to implement projects.

- Councils, industry and other stakeholders should consider submitting on the Otago Regional Air Plan to review the current rules for modern wood fuel boilers greater than 1MW.

- A wood-energy workshop and showcase that promotes the use of wood fuels should be held in Central Otago. The workshop would not be technical and would be aimed at business owners and decision-makers so they are able to get a better understanding of the technology. It could be led by owners of existing boiler plant (e.g. Mt Difficulty, Rippon and Dunstan School).

1.0 Introduction

An opportunity exists for the Queenstown Lakes and Central Otago districts to provide a significant proportion of its industry's energy requirements using locally owned and sourced wood fuels as a renewable fuel resource. So as to evaluate the opportunity, this report has assessed the potential to develop an effective regional wood-energy cluster. A viable wood-energy cluster effectively requires two key ingredients – a secure supply of feedstock and demand for a wood fuel product. This report attempts to quantify both the potential demand and potential supply within the Queenstown Lakes and Central Otago District Council boundaries.

The first part of the report addresses the requirements of the supply chain, from forest floor to point of sale. It begins by assessing the volume of usable wood biomass residue that is available within the region. It then discusses the operational considerations of a potential bioenergy business, evaluates these considerations with due applicability to the regional estate, and provides recommendations for a supply chain. The viability of a bioenergy business is explored, with the potential risks also discussed.

The second part of the report identifies the potential demand for wood energy from Central Otago's industry. Using real sites across Central Otago, this report assesses factors such as feasibility to convert, suitability of site, appropriateness of fuel, and estimation of energy requirement. This information was then evaluated at a regional level to produce an estimate of regional demand for wood energy. Opportunities for uptake of wood energy are discussed, and recommendations for next steps are made.

2.0 The Forest Resource

To date there has been little evaluation of the forest resource within the area of this study, primarily because of its relatively low significance as a commercial land use in this region. Regional data collected by the Ministry for Primary Industries is of insufficient detail to enable district-scale analysis of the commercial forestry resource, and instead analyses the resource at a combined Otago-Southland region level. In producing this report we have collected information from a variety of sources, seeking to provide as accurate a picture of the forest resource as possible. Information has been collected from regional databases, council databases, specific GIS mapping of local resources, and from targeted interviews with known forest managers. The map below shows the limited forest resource within the region.

Map 1.0. Forest types and extent across Central Otago and Queenstown Lakes Districts. Modified from the Ministry for Primary Industries "Otago wood supply" map, 2008.

2.1 Central Otago District forest resource

Covering an area of approximately 11,000km, Central Otago stretches from Raes Junction in the south to the Lindis Pass in the north. Low rainfall over most of Central Otago and cold winters limit the potential for commercial forestry. The forest species are predominantly composed of hardier and slower-growing species, Douglas fir, Corsican pine, European larch and Ponderosa pine.

1. Corporate Forests

Central Otago has only one significant plantation forest that is currently being harvested - the Naseby Forest, owned by Ernslaw One Limited. It was established in 1900 and has an area of approximately 1,950 hectares in established forest. This forest has a "lumpy" age-class distribution which means that setting a regular, sustainable harvest yield is not possible, but instead the forest is used as part of a wider "operating circle of Ernslaw One southern forests" meaning the Naseby Forest harvesting activity is planned and implemented as one part of a bigger forest operation. It has an anticipated harvested volume for the next 10 years at 20,000-24,000 tonnes/annum, and then after 2022 it averages 17,000-18,000 tonnes/annum for the following 10 years (pers.comm Phil De La Mere).

Two more large plantations were established in Central Otago in 1999/2000. The Trinity forests are spread over two areas – Pinelheugh forest (893ha) and Teviot forest (662ha), which are both located near Roxburgh at the eastern end of Central Otago, some 100km from the Otago coastline and forest sawmilling town of Milton, and 145km from Queenstown. These forests are planned for 50-year rotations, with no production thinning taking place in the interim years. The proximity to the large sawmills of coastal Otago and Tapanui, and also to the Port of Dunedin, means that the majority of logs produced from the Trinity forests will be sold to these destinations.

2. Small woodlots

As at 1 April 1997, the Ministry of Forestry estimated a Central Otago forest resource of smaller forest owners amounting to an estimated 2,000ha. These forests range in size from 1ha to 150ha. In completing this report, the inventory for this district's forest resource has been generated through the assessment of the coarse data of Land Cover Database (version 3) and through discussions with the Central Otago District Council, as well as relevant forest managers. A more current estimate of the collective Central Otago forest estate is 4,500ha, suggesting small woodlots amount to a combined 1,000ha.

2.2 Queenstown Lakes District Forest Resource

With only a handful of small commercial-sized forests in existence, and the largest forest being just 175ha, the commercial forestry sector within the Queenstown Lakes District is limited. However, unlike Central Otago, the climate of the Queenstown Lakes District is excellent for growing conifer trees. The high rainfall, warm days and cool nights of the Lake Wakatipu and Queenstown Lakes area provides very efficient carbon absorption which translates to favourable growing conditions for conifer forests, and some of the best Douglas fir growth rates in New Zealand (pers.comm D.Guild). The excellent growth of Douglas fir is characterised by the conifer-clad slopes which provide the backdrop of Queenstown. This forest has resulted from deliberate plantings of seed in the 1940s-1960s, with natural regeneration occurring since that time. It is this prolific natural regeneration which has considerably expanded the forest resource in the area, far beyond that of intentionally planted forests.

The lack of corporate forest estate in the district, combined with the dispersed and fragmented nature of the forest ownership in the district and the large proportion of wilding forest resource make it a difficult forest resource to quantify. The inventory for this district's forest resource has been generated through the GIS digitisation of individual forest stands throughout the district. Through a desktop evaluation of aerial images and ground-truthing of significant sites, the forest sites have been identified and mapped as being among the following:

1. Private commercial forests

301ha of commercial forests within the Queenstown Lakes District have been mapped and assessed as being suitable for harvesting.

2. Planted woodlots

278ha of scattered woodlots exist across the Queenstown Lakes District. Ranging in size from 0.5ha to 28ha, all sites have been assessed as being accessible for harvesting.

3. Queenstown Lakes District Council (QLDC) forests

The forest resource owned and managed by Queenstown Lakes District Council does include significant areas of wilding-spread forest that are now managed as a semi-commercial forest resource. This includes the well-known forests of Ben Lomond and Queenstown Hill, which though originally intentionally planted, have grown significantly through the spread of wilding trees.

The QLDC forest estate that is accessible for harvesting consists of 204ha of managed wilding forest at Ben Lomond, Fernhill and Queenstown Hill, and a further 175ha of plantation Douglas fir forest at Coronet. The total forest estate amounts to 379ha.

4. Wilding spread forests

The mapped area of the Queenstown Lakes District wilding forest resource that is not currently managed is 1136ha. This is forest that has a closed canopy, or is at sufficient stocking to demonstrate that a merchantable crop could be harvested in the future. These sites were then assessed for accessibility, feasibility of harvesting and likely resource consent restrictions, reducing the area by 30% to 794ha.

2.2.2 Wilding Conifers

"Wildings" is the term used for the natural regeneration or seedling spread of introduced trees, occurring in locations not managed for forest production. Within this district they are a significant environmental issue, and cause for considerable community debate. The spread of wilding trees results in a number of issues and, as discussed in the QLDC's Section 32 report (2013), can threaten the following values when the wilding spread reaches a certain density:

- Landscape – dense wilding spread disrupts views of existing open and often treeless natural landscapes.
- Conservation – dense wilding spread dominates and eventually replaces native flora/fauna and habitat.
- Production – dense wilding spread shades out grazing species.

• Recreation – dense wilding spread can affect tramping, walking, cycling and running.

• Water – dense wilding spread lowers the water yield.

• Historic – dense wilding spread can damage or hide archaeological and historic sites.

• Property – dense wilding spread increases fire intensity due to the presence of increased fuel. The risk of fire remains unchanged.

Others view wildings as a resource that should be managed for both timber and non-timber forest products, for their ability to sequester carbon, and to mitigate against other environmental concerns such as soil erosion. Their potential use as an energy source is another option, which this report considers.

Most wildings grow close to the parent seed source and are termed fringe spread. Wildings further afield are termed distant spread, and they will often grow from seed wind-blown from exposed take-off sites and usually occur as scattered outlier trees (Day and Ledgard, 2008:17). The main factors influencing wilding spread are the species present, the siting of the seed source trees, the surrounding vegetation cover and land management and its potential as a repository for the seed source, the presence of browsing animals, and the presence of the right combination of temperature and wind.

3.0 The Regional Forestry Industry

3.1 Forest Harvesting and Infrastructure

The dispersed and fragmented nature of the collective Queenstown Lakes/Central Otago forestry resource is characterised by low-quality forest infrastructure, and a small forest processing industry. Apart from Naseby forest and some of the larger commercial forests, most of the forests do not have established internal roading and are instead harvested in a piecemeal manner that incorporates forest roading as the harvesting activity progresses.

One small-scale harvesting contractor works permanently for half of the year in the Queenstown Lakes District, and other harvesting contractors work on a case-by-case basis as demand requires. Ernslaw One, as owner of Naseby forest, does not have a permanent harvest contractor at this forest due to the lack of a normal age-class distribution and the lumpy harvesting activity that occurs as a result.

3.2 Forest Harvesting Systems

The various systems used to harvest New Zealand exotic forests have a significant impact on both the environmental impact of the operation itself, as well as the ensuing profitability of the forest resource. The forests within the scope of this study can be categorised into ‘sensitive-landscape’ harvesting and ‘business-as-usual’ harvesting. The business-as-usual harvesting is relevant for all forests where no extraordinary planning or operational requirements are needed to enable a quality harvest. For the purposes of this study, the Central Otago forests are considered suitable for the business-as-usual harvesting systems, primarily because the majority of the forest in this district exists as part of large-scale corporate forest estates.

In contrast, harvesting forests within the designated outstanding landscape area of Queenstown requires significant operational and resource management planning and associated community consultation. The significant land use and landscape changes that result from harvesting under traditional harvest regimes require additional methods to reduce and mitigate the negative effects associated with these operations.

On the exposed and visually prominent slopes that surround Queenstown, there is a need to lessen the normal size of harvesting coupes so as to minimise the scale of change that results from the harvesting operation. Small forest coupes of 2-3ha have become the normal scale of harvesting on these hills in recent years. In particularly sensitive environments, these coupes may be smaller, or a model of 'selective logging' can be prescribed. Under a selective logging management regime, only a portion of the standing volume of forest will be removed, leaving some trees standing after the harvesting operation is completed. The scale and type of harvesting that occurs needs to be balanced against the need to achieve sufficient harvest output to ensure profitability.

3.3 Timber processing.

The lack of an established forest resource in the region has unsurprisingly resulted in a lack of processing infrastructure in this area. The map below shows the distribution of processing facilities in Otago and Southland, with the majority of processing sites occurring around the Southland Plains and coastal Otago. The map clearly indicates the lack of processing facilities within the Central Otago region.

Luggate sawmill is the only timber processor within Central Otago, processing 5,000 tonnes of logs per annum to produce sawn timber for the domestic market. It is an important business for this region, enabling the local processing of high-quality logs into sawn timber for the local population.

In Central Otago, next to the Naseby forest, Wood Energy New Zealand (WENZ) operates a central processing yard for its wood-energy business. This central yard consists of a large yard for storing logs, a covered shed for storing wood chip, and the necessary machinery (chipper, digger, loader) to convert logs to chip wood for energy.

Map: Locations of Otago and Southland wood and paper processors and ports. Modified from the Ministry for Primary Industries "Otago wood supply" map, 2008.

3.4 Transport

Central Otago is a relatively remote region that is dependent on either road transport or air transport to shift freight and people. Freight transport, particularly to the lakes destinations of Queenstown and Wanaka, is often particularly expensive. This is due to the high-consumption attributes of these economies which, particularly in the case of Queenstown, rely on tourism and consumer-led activities to underpin their local economy. The tourism-service economy does not export products from the region, and as such, Queenstown and other towns in this locality consume large quantities of inward goods, but do not produce outgoing goods. This is of particular relevance when considering the cost of freight, as the lack of ability to 'backload' freight is often a significant and costly issue.

4.0 Forecast Log Volumes – Queenstown Lakes District

The forest forecast harvest volumes from the Queenstown Lakes District is depicted graphically below. The unplanned nature of the collective Queenstown forest resource is obvious, with very high fluctuations occurring across the next fifty years. The current annual harvest volume of 4,000-8,000 tonnes (40,000-80,000 tonnes per 10-year age class) continues until 2028. A dramatic increase in resource occurs from 2029 through to 2048, due to a combination of commercial forests maturing and large tracts of the wilding forest resource maturing into a harvestable size. Harvestable volumes then drop dramatically in 2049, back to the pre-2029 volumes.

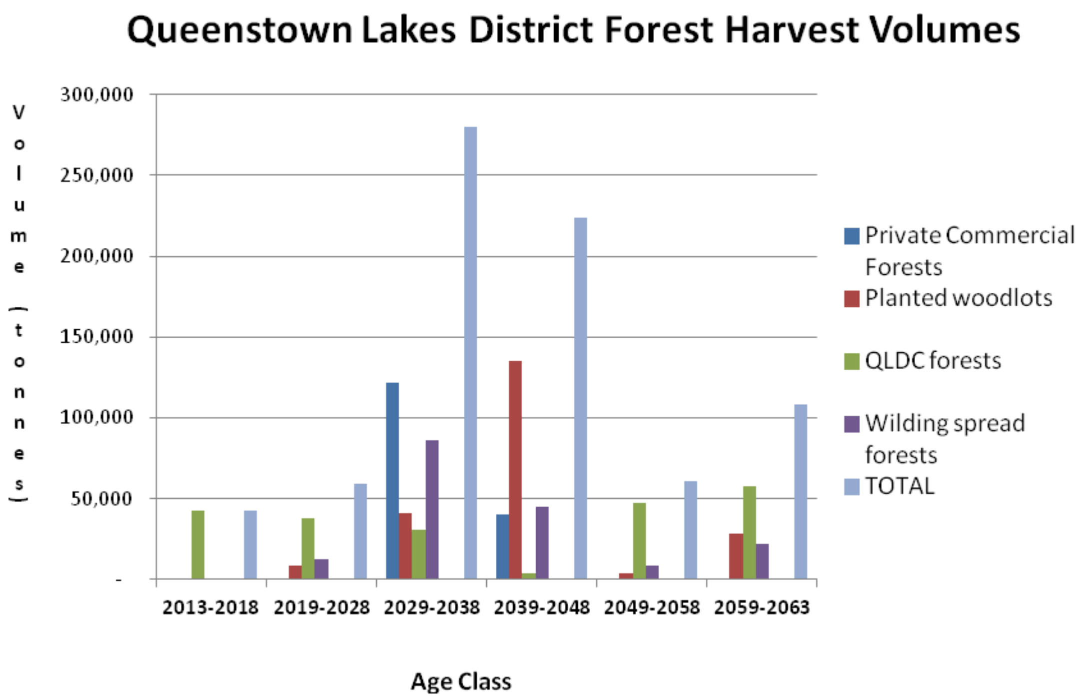


Figure 4 Expected harvest volumes for Queenstown Lakes District

Market conditions, logistical constraints, environmental and social conditions may impact upon the ability to match these expected harvest volumes. However, the most significant factor contributing to the uneven flow of future harvest volumes is the variability within the forest resource itself.

The coarseness of the data that has been used to collate these estimates needs discussing. The age of the wildings resource has been estimated based upon a desktop evaluation of the forest canopy of each site, and through selective ground-truthing. The very nature of wilding forests means that there is a large variation of ages and sizes of trees within each forest, sometimes with an age distribution of 30-40 years between the oldest and youngest trees. As such, it has been difficult to accurately categorise the age class distribution of these forest stands. The volumes in the graph below have been based on the wilding forests reaching a mean age of 40, at which point the forest composition favours mature trees and as such resembles a mature forest that is profitable to harvest. However, it is likely that some of this wilding forest resource is maturing earlier than estimated in this analysis, but without completing a more detailed forest inventory of the wildings forest resource this cannot be known.

The significant fluctuations in available volume require wood-energy participants to carefully consider the reliability of long-term supply. This is considered later in this report.

4.1 Forecast Log Volumes – Central Otago District

The presence of a corporate forest estate within Central Otago provides a much more regular harvest volume, as shown in the graph below. Though the data that has been used to produce this graph is fairly coarse, it provides a good estimation of expected harvest volumes from this district. The reliability of this resource, represented by the steady and gradually increasing volume, is a valuable attribute when considering the development of a wood-energy industry. It is important to note that the Trinity forests, located in the east of Central Otago, are accounted for in the graph below (from 2049). However, their proximity to coastal Otago may mean the log products are more suited to being transported eastward.

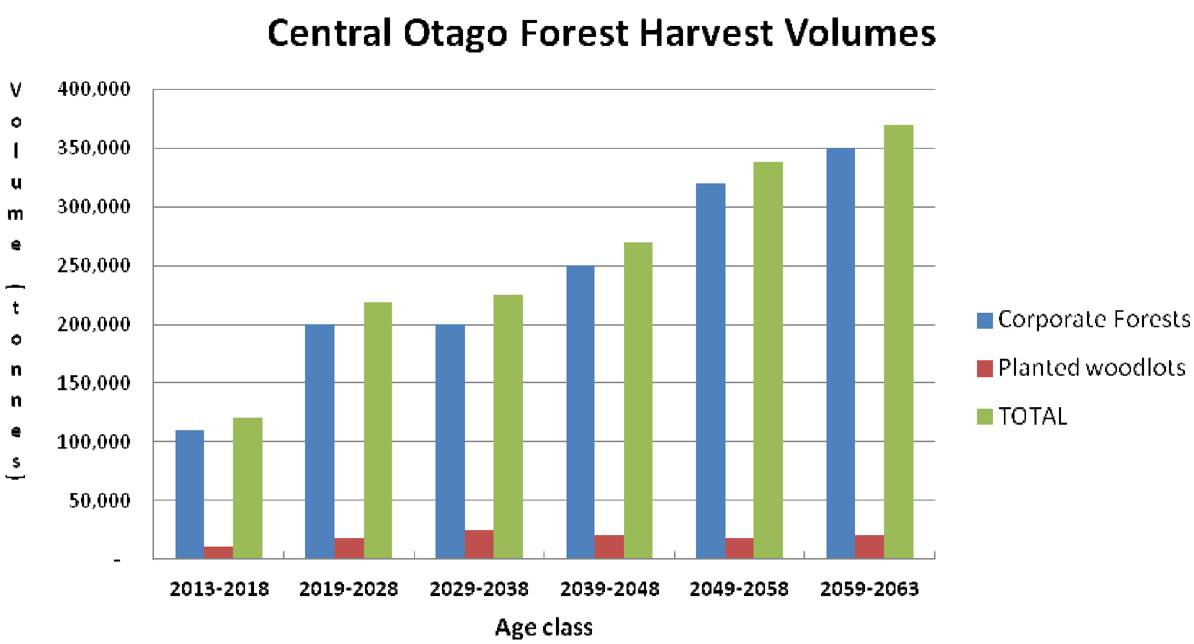


Figure 4.1 **Expected harvest volumes for Central Otago District**

5.0 Availability of forest biomass resource for energy

Understanding what resource is available as a viable and consistent supply of raw resource to enable the production of wood energy is a key objective of this project. The raw resource could arise from five main sources, namely:

1. Use of existing local low-value log products that are currently marketed and sold into alternative markets;
2. Importing low-value log products into the region;
3. Capturing wood residue that is not currently sold from the forest site;
4. Use of the wilding conifer resource ;
5. Use of other local biomass products that are currently produced and sold into alternative markets.

5.1 Use of existing local low-value log products that are currently marketed and sold into alternative markets

Chip logs are the lowest value of the marketed logs that arise from normal forest harvesting operations. Usually chip logs are either sold to local chipping processors who process the raw log and then sell into export chip markets; or they are sold as unprocessed chip logs for export; or lastly, they are sold to processing plants for the production of products such as paper or medium density fibreboard.

The distance from Central Otago and the Queenstown Lakes District to industry chipping facilities, ports, and the Mataura-based medium density fibreboard (MDF) plant make supplying these traditional chip-log markets with lower-value log products a difficult proposition that has limited viability. Instead, local firewood markets are the traditional markets for these low-grade logs. Demand for firewood logs is high, demonstrated by the existence of an estimated 40 firewood merchants across the two districts, supplying an estimated 30,000-40,000m^3 of loose firewood per annum (pers.comm Fran Bourke). As a result, the historical sale of low-value stems from these forests is to the firewood market. Though much of the new housing that is being developed in the Queenstown Lakes District is using alternative resource for heating, there will inevitably be an increasing demand for firewood as the district's housing stock expands. Therefore, there is competitive demand for this fuel wood product.

The billet wood market, selling woody residue of lengths between 1.0 and 3.0 metres, is not an option in Central Otago. In coastal Otago and Southland communities the billet wood log is typically sold to the Mataura-based Dongwha Patinna Medium Density Fibreboard (MDF) plant for a sale price that effectively provides the harvesting contractor with some cost-recovery value, and the forest owner with a negligible financial return. The primary benefit to the forest owners of selling billet wood is the 'clean' forest landings that result, requiring less post-harvest management to rehabilitate these sites. The ability to pay the harvest contractors a fee for their handling of this product is also of importance.

The profitability of various log grades sold from the Central Otago and Queenstown Lakes District forests were evaluated in order to understand the potential profitability of shifting additional log production into lower-grade fuel wood, thereby increasing the availability of logs for use in the wood-energy sector, and improving the potential viability of a new wood-energy industry. A summary of the log products and the returns to forest owners, after costs, is shown in the tables below.

The costs associated with harvesting these forests has been based on whether the harvesting activity is taking place in a sensitive landscape, or whether it is occurring in a normal forest setting that is less restricted by environmental and community requirements. Within the Queenstown Lakes District harvesting costs are higher than the typical industry rates, largely due to the restricted harvest coupe sizes and the lack of established internal forest roading infrastructure. This is contrary to harvesting operations that occur within corporate forest estates, for example, where the forest infrastructure is normally established well in advance of the harvesting.

5.1.1 Assessment of the recoverable value of Douglas fir forests within the Queenstown Lakes District.

The Douglas fir forests in Queenstown provide high yields of high-quality logs. The following prices and yields have been based on mean 5-year historical prices, and both real (completed) yield recovery data and forecast inventories. Recoverable volume is set at 915 tonnes per hectare. Shifting the emphasis towards recovering fuel wood (chip wood/firewood) provides very similar returns to the forest owner. The recoverable harvest volume is sufficient in each scenario to ensure that this provides sufficient revenue to the harvesting contractor. This is primarily because of the high recoverable volume per hectare, and the limited proportion of S3 sawlogs.

REVENUES				
LOG GRADE	S1	S2	S3	Firewood
SALE POINT	Mill	Mill	Wharf	On truck
SALE UNIT	t	t	t	t
GROSS SALE VALUE	$135.00	$110.00	$95.00	$35.00
LESS OPERATIONAL, MANAGEMENT and MARKETING COSTS				
LOGGING & LOADING	$40.00	$40.00	$40.00	$20.00
CARTAGE	$21.00	$21.00	$40.00	

OTHER	$1.20	$1.20	$1.20	$1.20
ESTIMATED NET RETURN TO WOOD OWNER	$72.80	$47.80	$13.80	$13.80

Table 5.1 Log grade values for Queenstown Lakes Douglas fir forests

Douglas fir Sawlog Regime		**Douglas fir - fuel wood**	
Grade	%	**Grade**	%
S1	55	**S1**	55
S2	28	**S2**	28
S3	7	**Fuel wood**	17
Fuel wood	10		
Net return to grower	$55.86/tonne	**Net return to grower**	$56.28/tonne
Return/Ha	$51,112	**Return/Ha**	$51,496

Table 5.2 Estimated stumpage return for Douglas fir forests

Conclusions:

Forest harvesting in Queenstown Douglas fir forests will favour the recovery of fuel wood over lower-grade sawlogs. As such, for this report we have estimated the district's available volume based on limited sawlog production and increased fuel wood production.

5.1.2 Assessment of the recoverable value of Corsican/mixed species forests within the Queenstown Lakes District.

The expected yield recovery in the mixed species/Corsican species forests is much lower than that in the Douglas fir forests. A yield of 500 tonnes/hectare has been used in these calculations. This has been based upon historic log sales data and also forecast volume modelling so as to achieve a mature forest. Recoverable volume is lower per hectare, therefore requiring a higher contract rate for the harvesting contractor. Sawlog prices are also lower for Corsican and Radiata pine.

LOG GRADE	Sawlog	Posts	Firewood	Billet
Sale point	Delivered	Delivered	On truck	Delivered
Sale unit	t	t	t	t
Gross sale value	$90.00	$85.00	$38.00	$35.00
LESS OPERATIONAL, MANAGEMENT and MARKETING COSTS				
Logging and loading	$45.00	$40.00	$20.00	$10.00
Cartage	$21.00	$30.00		$10.00
Other	$1.20	$1.20	$1.20	$1.20
Estimated net return to wood owner	$22.80	$13.80	$16.80	$13.80

Table 5.3 Log grade values for Queenstown Lakes Corsican/mixed species forests

Using the expected grade recovery below provides very different returns to the forest owner. Though fuel wood provides the forest owner with a better return per tonne than post wood, logging rate paid to the harvesting contractor for fuel wood is significantly less. With the low harvesting productivity in these forests, it is not viable for a harvesting contractor to operate at these rates. To ensure viability of the harvest contractor's operations, the logging rate was increased to $45/tonne for sawlogs and $30/tonne for fuel wood. At these contract rates, the operation becomes viable for the contractor, but the return for the grower is significantly less and therefore not considered to be an option.

Corsican sawlog		Corsican fuel wood	
Grade	**%**	**Grade**	**%**
Sawlog	35	**Sawlog**	35
Posts	29	**Fuel**	65
Firewood	36		
Net return to the	$18.03/	**Net return to the**	$12.40/

Grower	tonne	**Grower**	tonne
Return/Ha	$9,015	**Return/Ha**	$6,200

Table 5.4 Estimated stumpage return for Corsican forests

Conclusions:

Forest harvesting in Queenstown Corsican/ Radiata forests do not favour emphasising the recovery of fuel wood over lower-grade sawlogs. As such, for this report we have estimated the district's available volume based on normal sawlog production and fuel wood production based upon usual firewood/chip wood production.

5.1.3 Assessment of the recoverable value of Corsican/Radiata pine forests within the Central Otago District.

The expected yield recovery in the Central Otago Radiata/Corsican pine forests has been based upon the MAF Regional Yield Tables, and plot data collected as part of the valuation process of the Central Otago District Council forests. An average yield of 450 tonnes/hectare has been used. Sawlog prices are based upon five-year historical averages for each of these log grades. Cartage and logging costs are based on current market rates for this district.

LOG GRADE	S1 and S2	L1 and L2	S3	Industrial	Firewood
Sale point	Delivered	Delivered	Delivered	Delivered	Delivered
Sale unit	t	t	t	t	t
Gross sale unit	$83.00	$60.00	$65.00	$50.00	$35.00
LESS OPERATIONAL, MANAGEMENT and MARKETING COSTS					
Logging and loading	$26.00	$26.00	$26.00	$20.00	$18.00
Cartage	$15.00	$15.00	$15.00	$15.00	
Other	$1.20	$1.20	$1.20	$1.20	$1.20
Estimated net return to wood owner	$40.80	$17.80	$22.80	$13.80	$15.80

Table 5.5 Log grade values for Central Otago radiata pine forests

Assessing the two log-grade scenarios below provides different returns to the forest owner. Shifting the production focus from a straight sawlog regime into a regime placing more emphasis on converting lower-grade wood into fuel wood provides the forest owner with a smaller return per hectare. Contractor rates for the fuel wood regime have been increased to compensate the harvesting contractor for reduced earnings that arise as a result of the shift in emphasis to recovering fuel wood. Shifting production away from cutting L1 and L2 logs into cutting fuel wood was also considered, but the return to the grower was too low for this to be considered a viable option.

	Central Otago sawlog	Central Otago fuel wood
Grade	%	%
S1 and S2	14	14
L1 and L2	21	21
S3	30	30
Industrial	11	0
Chip	24	35
Net return to the grower	$21.60/ tonne	$18.83/ tonne
Return/Ha	$9,720	$8,473

Table 5.2 Estimated stumpage return for Central Otago radiata forests

Conclusions:

Though some forest harvesting in Central Otago could absorb a shift in the distribution of log grades that are recovered from industrial grade logs to lower-grade firewood/chipwood/fuel-grade logs, it is a less profitable option and as such has not been accounted for here.

5.2 Importing low-value log products into the District.

The potential to use some of the expanding regional chip log supply has been considered as one way of providing sufficient volume of fuel wood to enable a viable wood-energy industry in this region. As an example of a forest resource that is not within the physical boundary of this project, but which could supply the Queenstown area, Ernslaw One owns and manages Aparima Forest, which is located in

Mossburn, Northern Southland. Approximately 135 kilometres from Queenstown, production thinning in this 6000ha forest is scheduled to commence in 2014. At a forest age of 20, it is expected that 20,000 tonnes of chip log will be harvested annually, for a period of five years (pers.comm Phil De La Mere). The potential destinations for this product are either the MDF plant in Mataura, Port Bluff, or local firewood markets.

As discussed earlier in this document, the transport costs associated with importing products into the Queenstown and Central Otago districts reduces the viability of this proposition. The inability to back-load log product out of Queenstown adds significant extra cost to cartage and immediately raises the total cost of the log product to be used for production of wood energy.

Using the Remarkables site as the end destination for processing (as discussed later in this document), the following chip wood prices have been generated:

Source	Log price at forest	Cartage price	Total cost
Queenstown	$35/tonne	$5/tonne	$40/tonne
Alexandra	$30/tonne	$15/tonne	$45/tonne
Aparima, Mossburn	$27/tonne	$30/tonne	$57/tonne

Table 5.2 Cost of importing low-value logs into the district

The wood-fuel business model operates under tight margins, and adding significant cost at the input end of the value chain has an immediate effect on its feasibility. In the scenarios above, the local Queenstown supply is the only viable option.

5.3 Capturing wood residue that is not currently sold from the forest site.

In this study, forest residues are defined as the unused portions of plantation trees that have been felled by logging, but remain in the forest unused. It is these forest residues that have the best potential to be used as an energy product, due to the ability to add economic value to a product that is currently valueless.

Forest biomass supply for energy is typically generated from logging residues. This material is a mixture of wood, bark and needles. When this material is “green” - immediately after harvesting - the moisture content (MC) is typically 55% MC wet basis (wb), rising to a maximum of 60% MC wb. This material occurs at two key locations within the forest; at landings (roadside skid sites) and at the stump (cutover).

Currently, the standard operating practice within most commercial forests throughout New Zealand is to push the 'waste' residue back into the forest, or to leave it in a pile on the edge of the landing. In both circumstances, the residues are left to decay.

5.3.1 Forest residues generated on the cutover

The amount and type of residue left on the cutover site will differ from site to site, depending on the type of extraction system used and the quality of the trees being harvested. Ground-based harvesting systems will typically mechanically de-limb the branches on the cutover site, thereby leaving significant woody residue behind. The branch residue that is generated as part of the log-making process is smaller in size and as such quicker to dry than that of the stem residues. However, they are also more costly to handle due to their small piece size and low density, and are typically 'contaminated' with needles and soil. These needles need to be left on the forest floor whenever possible, as they contain high levels of macro-nutrients such as nitrogen, which provide an essential contribution to the nutrient status of the forest soil. Therefore, for the purposes of this study, the branch-sized residue has not been incorporated as part of the recoverable woody residue volume.

The Wood Energy Knowledge Centre's calculator for residue recovery was used to calculate the likely volume of stem residue that remains on the cutover site. The results are tabulated below.

	Poor-Quality Stand	Average-Quality Stand	Good-Quality stand
Ground-based samples (m^3/ha)	41.82	27.68	17.83

Table 5.3: Typical stem residue recovery from New Zealand forest cutover

(From the Residue Recovery Calculator, at www.eecabusiness.govt.nz/renewable-energy/wood-energy-knowledge-centre. A default value of 615 cubic metres/Ha was used) .

Whether recovering these residues is cost effective or not will be determined by two factors - the quality of the forest itself, and the presence of a market that demands stem-residue product. The later will come in the form of a vibrant billet wood, chip wood, firewood or wood-energy market. Without such markets, recovering these cutover residues will not be cost effective due to the small piece size of stem wood being recovered, the relatively low volumes of remaining residue, and the relatively large travel distance between stem pieces. A decision to recover more of the cutover residue will instead be driven by forest managers placing greater emphasis on recovery as part of the core harvest operation. Forest managers, in turn, will be driven by a more reliable and profitable end-user market for this log product.

5.3.2 Forest residues generated at forest skid sites.

The forest landing, or skid site, is the main point of woody residue accumulation in the forest. Such woody residue is largely tree tops, branches, and log offcuts that have not been able to be utilised by the harvesting crews in meeting their log-grade supply requirements. Normally, this is because of defects within the log at that point.

The amount of residue that accumulates at the forest landing is influenced by two key factors:

1. The harvesting system used.
2. The quality of the forest crop.

The residue that accumulates at landings is of a higher priority than the residues accumulating on the forest cutover because of the following reasons:

1. There is a condensed, cumulative volume.
2. The volume of residue is located within a processing site that is best positioned to make use of forest harvesting and processing equipment.
3. The harvest contractors have already expended cost and energy harvesting the logs, and need to recover value from it.

As a result of the above, there is a much higher potential for cost-effective recovery of a potential energy by-product.

5.3.2.1 Management of stem residues at the skid site.

In the Queenstown Lakes District, harvesting crews have traditionally spent an average of between six and eight weeks at each harvest compartment, harvesting a forest area of between 2-3ha. Because of the low harvest production rates, the rate of accumulation of woody residue is not high. In Central Otago forest management conditions do not typically require low-impact forest management practices, but are limited by the relatively low yield forests and the low harvest productivity that results.

Within these low-productivity forests it is normal practice to process between 1000m³ and 2000m³ of harvestable log product at each compartment, though there can be significant deviations either side of this figure. This level of volume will typically be spread over two-three separate skid sites. Given that the majority of the harvesting systems are ground-based, they will typically de-limb on the cutover and therefore reduce the biomass build-up on the skid sites.

In normal current-day harvesting systems woody residue that does not meet log specifications is discarded, often thrown far from the landing with the use of grapple loaders. Maintaining a clean landing is considered to be a key component of efficient harvest practice, and harvesting contractors will keep all non-saleable log product distant from the forest landing.

Topographical limitations, especially in the steeper forests within the Queenstown Lakes District estate, create restrictions in the size of the forest landings that can be constructed. Typically the forest skid sites in these forests are only 40 metres by 30 metres long, creating a footprint of 1200 square metres. Creating larger log storage areas is unfeasible on these sites due to the topographical limitations. The environmental implication of creating skid sites in these sensitive sites requires careful consideration from forest managers, generally requiring minimisation of earthworks to ensure minimal negative effects.

Photo: Stem residue accumulation at a typical forest landing.

5.3.2.2 Types of skid site residue

Residue that accumulates on the forest landings can be classified into three types:

A) Billet wood. 1.0m – 3.0m length, SED 10cm.

B) Blocks. Larger than slovens, but smaller than billet wood.

C) Slovens. The offcuts from the butt logs, typically short, but of large diameter.

For the purpose of this study, woody residue that can be potentially used for wood chip is no smaller than the billet wood grade as specified above. Numerous studies provide evidence as to the inefficiency of handling very small pieces of residue. The lack of established and quality infrastructure in the majority of the forests in this study area make handling of the very small pieces of woody residue even more unfeasible. A number of the sites that were visited have steep and difficult access, and would not easily accommodate the large chippers that are required to process the more difficult offcuts. Likewise, accessing these sites with a bin wood (crate) truck, so as to cart the raw material away to a central processing yard, is also difficult.

Understanding this, and that many wood chippers will not process log residue of less than 1.0 metre in length, has been the basis for the utilisation cut-off point for wood chip production. Discussions with the two existing wood-energy suppliers in the region have reiterated this requirement for a wood-residue supply that is a minimum of 1.0m, with a preference for 3.0+ metre lengths.

Previous site assessments of forest skid sites in a suite of Dunedin forests provided the following information regarding the levels of wood residue that accumulate on skid sites.

	Poor-Quality Site	Average-Quality Site	High-Quality Site
Total woody residue as proportion of total recoverable volume	20%	12%	4%
Usable woody residue as proportion of total recoverable volume	12%	7%	2%

Figure 5.3: Recoverable wood residue, as proportions of total recoverable volume.

The table above summarises the expected average log stem residue volumes as a proportion of total harvestable volume, which can be expected to be harvested from different quality sites within a Dunedin corporate forest estate. The usable proportion (billet wood grade, or non-saleable chip log grade) is quantified as the 'usable proportion' of woody residue.

No skid sites were being used when this study was being completed, so the ability to visually assess the accumulated wood residue volumes was limited. However, discussions with both the QLDC district forester and logging contractor confirm that the extent of woody residue recovery is aligned with the information above.

Using the Douglas fir calculator to model the total recoverable volume across three forest management regimes has indicated that 11-15% of the total volume is waste. This is in keeping with the results above, and affirms that the recoverable component of the waste residue is likely to be 4-5% of the total volume.

5.4 Use of the wilding conifer resource

As part of this study, the potential to harvest immature Corsican/mixed species wilding forests solely for wood fuels was considered.

It became apparent that it is not commercially viable to harvest these forest sites solely for wood energy. The costs of harvesting - particularly of small trees that produce a low recoverable volume – are disproportionate to the amount of income generated from the sale of the logs for energy. Forest owners will receive in the vicinity of $2-3/tonne net return if their trees are removed solely for wood energy, compared to the $18/tonne outlined in the sawlog scenario discussed earlier. Of course, this could be a viable option for many forest owners if the priority outcome was to obtain a site deforested of wilding pines and in a ready state for an alternative use such as native afforestation or grassland. However, once a heavy infestation of wilding pines is removed, as it is in a forested situation, the change that occurs in its wake is to immediately start regrowing into a conifer forest again. It is possible for the landowner to convert the wilding forest site into native forest, or grassland, but only at a significant monetary cost, and with tremendous amounts of effort.

The highly fluctuating age-class distribution of the wilding forest resource requires prospective wood-energy industry participants to carefully consider the long-term reliability of the resource. Though there is significant available volume for the two decades 2029-2048, the dramatic decrease following this period requires careful planning to ensure an ongoing and consistent supply.

However, the variability within the age-class distribution of the wildings forest resource does provide flexibility to extend the expected rotation of these wilding forests beyond that estimated in this analysis. Additional flexibility in their management also arises from the fact that the wilding forests have not been purposefully established to provide the landowners with a return on investment, and as such there is greater potential to harvest the forest stand to provide a lesser return on investment than that which would normally be targeted by plantation owners. Lastly, as previously stated, the age classes of the wilding forest resource has only been assessed at a desktop level with a limited amount of ground-truthing. As such there may be significant deviations in the actual age classes of these forests, which could provide a more 'normal' forest structure that is less punctuated by spikes. Better understanding the age class of the wilding forest resource is an important next stage in the development of a wood-energy industry in Central Otago.

5.5 Estimated available annual log volume for wood energy from Queenstown Lakes.

The graph below shows the estimated availability of total log volume and woody biomass for energy generation for the Queenstown Lakes District. The assessments have been based on the following factors:

- Within Douglas fir forests, the sale of logs for wood energy is favoured over the sale of the lowest-grade sawlogs. As such, extra available volume for wood energy is realised from these forests, amounting to an estimated 17% of total harvested volume.
- Within wilding forests, the proportion of low-grade log product is estimated at 30% of volume. This is due to the largely unmanaged nature of these forests. As a result, the volume of available wood fuel as a proportion of total volume harvested changes over time depending on the proportional significance of the wilding forests.
- The bullet wood grade is recovered from all forests, and amounts to an estimated 4% of extra volume, over and above normal saleable harvestable volume.
- It is not viable to import logs from out of the district and as such it is not accounted for here.

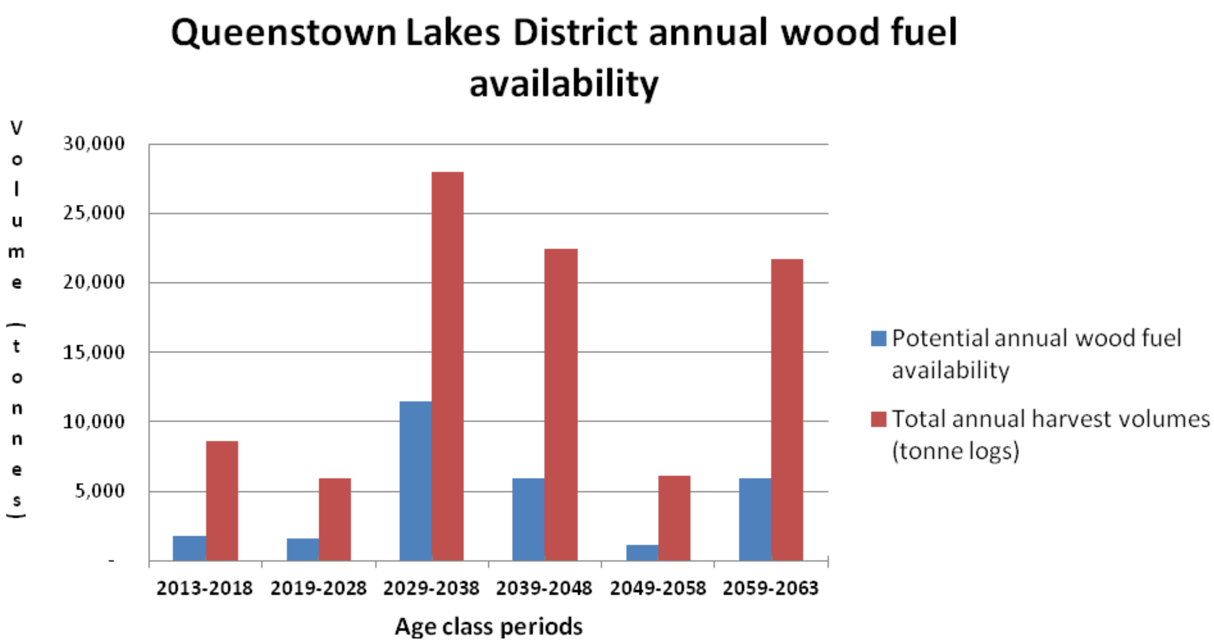


Figure 5.5 **Queenstown Lakes District annual fuel availability.**

5.6 Estimated available annual log volume for wood energy from Central Otago District

The graph below shows the estimated availability of total log volume and woody biomass for energy generation for Central Otago. The assessments have been based on the following factors:

- Given that there is no financial incentive to shift production toward favouring fuel wood production, there have been no changes to the typical log grade mix that is usually cut from managed forests in Central Otago.

- The proportion of chip wood/fuel-grade wood that is cut from these managed forests has been set at 25% of volume until 2038. This is higher than normal for managed forests in New Zealand, but is representative of the low-quality trees that have historically been grown at Naseby forest due to poor species selection. From 2039 this proportion drops steadily through to 15% by 2059, reflecting the progressive improvement in forest quality at Naseby.

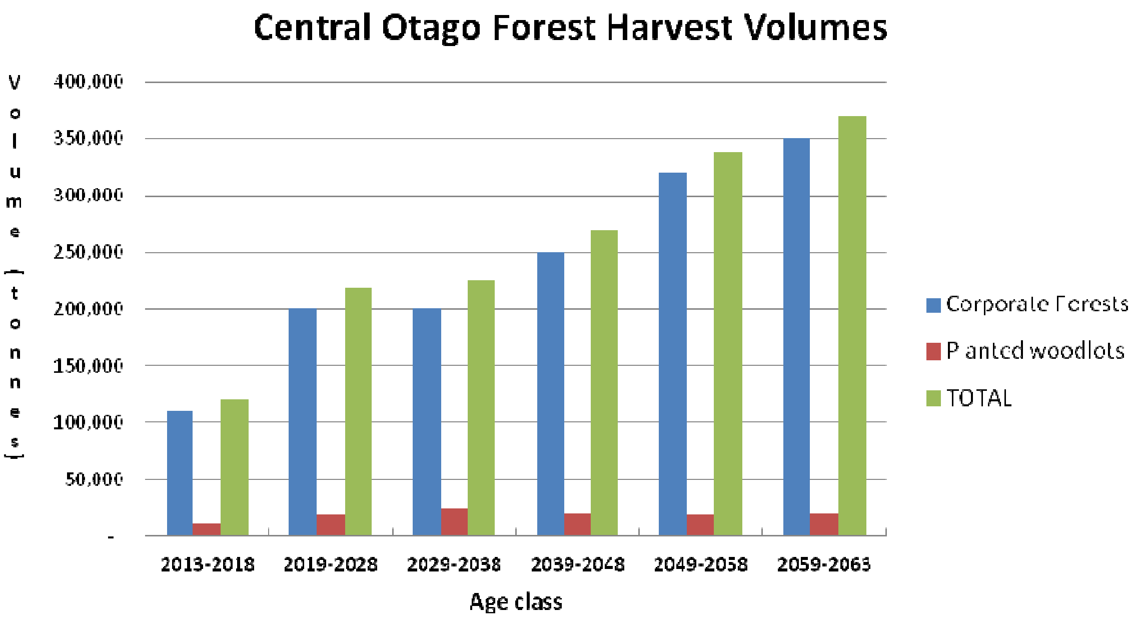


Figure 5.6 **Central Otago District annual fuel availability.**

5.7 Estimated total available annual log volume for wood energy from Central Otago and Queenstown Lakes.

The graph below outlines the total estimated log volume that is available for wood-energy production across the region. The consistent supply that is available from the Central Otago forests dilutes the significance of the fluctuations of the Queenstown Lakes resource.

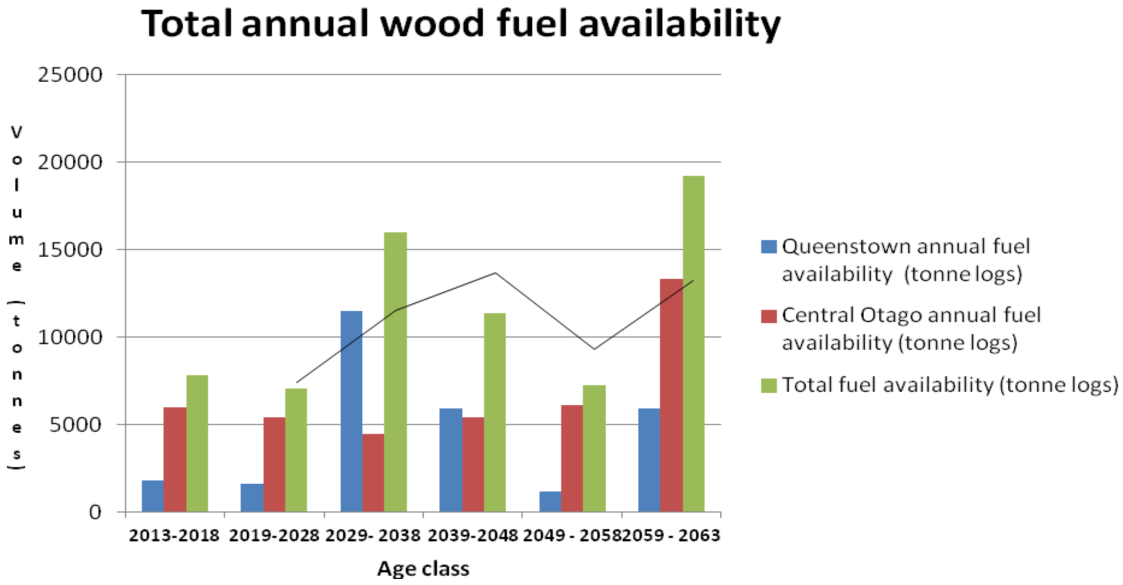


Figure 5.7 **Annual fuel availability from Central Otago and Queenstown Lakes.**

Naseby forest is already providing a sustainable resource that produces a quality wood-fuel product. This forest is able to supply all existing demand for wood fuels, as well as considerable future demand. However, the cartage associated with supplying this product from the northern point of Central Otago into Queenstown (a distance of approximately 170 kilometres) adds more cost to the delivered price of the wood fuel for customers in this part of the region.

The limited forest harvesting activity occurring within the Queenstown Lakes District does not currently provide a viable wood-energy resource for the district. However, this current lack of viability is partially driven by the lack of demand for wood energy, and as such the impetus to generate a sustainable and reliable managed resource. Harvesting activity is very low and as such there is no surplus of logs to be used for the production of wood energy. Currently, the low-value log products are readily consumed by the firewood market, and though this market will remain, it will decrease in proportional importance as the availability of log supply grows.

However, the local Queenstown forest resource does have the potential to supply a small customer base of wood-energy users in Queenstown. The 'forest estate' is currently being under-cut and is not being harvested to its potential. This current lack of harvesting activity in the Queenstown Lakes District is not wholly due to a lack of a mature forest resource, but is also due to harvest accessibility issues and regulatory issues associated with gaining the necessary consents and approvals to extract trees from the sensitive landscapes of Queenstown. If the mature resource was immediately available for harvesting under a sustained yield approach, then the volume of logs available for wood energy from that harvesting activity alone would be sufficient to make a start-up wood-energy industry viable. Within fifteen years forest harvesting activity is expected to significantly increase and as a consequence will create sufficiently large volumes of log residue to support a strong base of demand for this resource.

The early users of wood chip in the district can be serviced from the existing supply at Naseby Forest, or from other chip that is imported into the region. As the expected forest harvesting increases in the Queenstown Lakes District, there will be an opportunity to harvest, cart and store logs for local drying and subsequent chipping. Given that the demand for wood chip as an energy source is initially likely to be slow, the ability to slowly stockpile and dry logs is high.

5.8 Estimated available wood energy in the region from log residues

The two tables below show the estimated energy that can be provided from the available wood residue that has been identified in the discussions above.

	2013-2018	2019-2028	2029-2038	2039-2048	2049-2058	2059-2063
Queenstown	16698	15058	106000	55026	10838	54606
Central Otago	55440	50358	41580	49896	56216	123077
TOTAL (GJ)	72138	65416	147580	104922	67054	177683

Table 5.8 Available wood energy from log residues (Gigajoules).

	2013-2018	2019-2028	2029-2038	2039-2048	2049-2058	2059-2063
Queenstown	4639	4183	29447	15286	3011	15169
Central Otago	15401	13989	11551	13861	15617	34191
TOTAL (MWH)	20040	18172	40998	29147	18628	49360

Table 5.8b Available wood energy from log residues (Megawatt hours)

6.0 Operational considerations for producing wood chip

6.1 Producing a quality wood chip product

The key principle underpinning the production of a quality wood chip is that minimising moisture content is the most significant factor (Nurmi 2000), as moisture content determines the net calorific value of the fuel. To produce a wood chip of high-energy content requires woody residue of low moisture content.

To achieve a dry wood chip product, with a targeted moisture content of 30%, the raw log residue can either be:

1. Chipped green, drying the green wood chip, and then storing.
2. Chipped dry and stored immediately.

6.1.1 Chipping green logs, then drying and storing

It is important to note that chipping green logs and then storing the resultant chip without subjecting the chip to a heat process is not an option. Storing comminuted (broken up) material of moisture contents between 25% and 50% wet basis, in large piles and for long periods, will increase the risk of it being subject to microbial activity. This will increase the risk of degradation, and also increased heat generation and thus the risk of combustion.

There is little ability to passively dry the residue once it is comminuted, as stated in two reports (Nurmi, 1999 and Hall, 2009). As such, any supply chain that aims to chip green logs and then dry the green chip to low moisture content (25–30%) will require a level of process heat. This type of heating process is the same process that is required when considering the drying of the wood chips that are produced at Luggate sawmill.

6.1.2 Chipping dry logs and storing

This process requires logs to be dry before they are chipped. It has the advantage of requiring less total energy to produce the wood chips. The chipping machinery, however, generally requires more energy to chip dry logs than green logs, with an associated higher level of repairs and maintenance.

The climate of Central Otago is excellent for air-drying logs, as demonstrated by the existing wood-energy operation at Naseby Forest where logs are consistently and quickly brought down to 20-30% moisture content. The Queenstown climate, with a higher rainfall and damper winter, is less of an exemplar site for air-drying logs, but it is still considered viable if the correct site is chosen.

6.2 Residue recovery options – during or after harvest?

Residue from a landing can be recovered either during the harvest operation, or after the harvesting operation is complete. Both options have their advantages and disadvantages.

6.2.1 During the harvest operation:

Handling the wood residue as a component of the wider harvesting operation has a number of advantages, including the ability to use the harvest crew's on-site machinery to handle the residue. The advantage to a harvesting crew of clearing log residue from the processing site in an efficient manner has obvious economic and safety benefits. The potential cost savings with such a system arise from the reduced handling of the residue product, as the product does not need to be re-handled. The continual clearing of the skid site will provide a clearer work site, and thus a safer and more efficient work environment. Such a system would require additional planning and adaptation from the existing harvest system, and depending on its configuration, will require additional space on the processing site.

6.2.2 Post-harvest recovery operations:

Evaluating the potential for residue recovery from a typical abandoned landing provides the advantage that the residue recovery programme is divorced from harvest operations, so harvesting efficiencies can continue unimpeded. However, there are three obvious disadvantages in recovering the waste residue from an abandoned skid site:

- Typically the residue is pushed by bulldozers or skidders into 'birds nests' with significant amounts of soil contaminant mixed in. This contamination provides difficulties when wanting to chip the product, ultimately lowering the quality of the product.
- To store the log residue product effectively will require extra storage space, or will compete heavily for the existing space on the landing.
- Additional handling equipment is needed to handle the woody residue in a separate operation, after the harvesting operation is complete. This additional handling adds significant cost, estimated at $4/tonne of product handled.

6.3 Transport

Woody residues can be carried from the forest to the end user, or to an interim storage area, in two main ways - in their original unprocessed form, or in a reduced particle size. Carrying residues in their raw form involves loading a product of low uniformity and low bulk density. Typically, the loads have large air voids. The density of a load of residue is defined as the proportion of the load volume which is airspace, and what is solid material. Bin wood – stem sections of length of less than 3.7m with no branches, have an estimated residue density of 40-45%. This compares to logs at 60-70% and chip (comminuted) at 30-

35%, or 35-40% compacted (Hall, 2009). There is a limited ability to compact raw woody residues beyond careful stacking techniques.

Typically, cartage operators are paid on the weight of material they carry from the forest to the utilisation facility. This highlights the challenge facing all cartage operators of placing enough material in a box of fixed maximum dimensions to reach the maximum legal weight for each trip they undertake. To carry anything less than the maximum is to under-utilise the truck's capacity. Unfortunately, unlike many other materials commonly transported in bulk, woody biomass in its various forms has a relatively low bulk density.

If the log residue is dried on the landing for a lengthy period, then the moisture content will typically drop from 55-58% to 30-40% after a period of 3-6 months. Though providing a higher-energy product, it is lighter and as such, less attractive for the cartage company to cart.

6.4 Comminution

There are three main options when considering where to process the stem residue. These are, either:

1. Chip at a central processing yard, external to the forests.
2. Chip in-forest, after the harvest operation.
3. Chip in-forest, during the forest operation.

6.4.1. Chipping at a central processing yard, external to the forest

To retain a profitable margin from the sale of any low-value woody residue, the supply system must ensure that the logs are handled as little as possible. Any extra handling of the log residue will add unnecessary cost to the operation.

Chipping the product at a central process yard has the advantages of keeping chipping equipment in one site and minimising the potential for under-utilisation of the equipment. All other things being equal, if the log residue supply is maintained at sufficient levels to allow for constant throughput through the chipper, then there will be minimal down time.

Alternatively, chippers can be transported to the central process yard as and when required. This is a viable option when limited volume of chip is being produced at any one site, and the capital cost of a chipper is not justifiable for the limited volume being produced.

The other major advantage of chipping at a central point is that the resultant chip product can be immediately stored under cover, thus reducing the possibility of the wood chip reabsorbing moisture.

6.4.2. Chipping in-forest, after the harvest operation

This option also has its advantages, but is considered unfeasible given the very scattered nature of the forest estates across both the Queenstown Lakes District and Central Otago.

Such a system requires the on-site storage of logs until the logs are sufficiently dry to chip. If consistency of demand of the wood chip product is generated then there is potentially no requirement for two-stage transport, with the product being delivered immediately to the end customer. As such, there is no need for costly capital investment in storage systems, and the need to cart raw residues of high-moisture content/low-energy content is eliminated.

However, there are some major limitations to this strategy of chipping in-forest:

1. There needs to be a storage system within the forest that allows the woody residue to be stored in a manner that allows for drying of the logs and provides for minimisation of contamination. The raw log residue will need to be sufficiently dry to enable the in-forest production of a wood chip of 30% moisture content. This will require either an extension to the existing skid site that is being used, or for the logs to be transferred to a historic skid site that is no longer needed.

Extending skid sites is considered to be costly to the forest owner, due to both the construction costs, and also due to the degraded quality of land that results and the resultant loss of productive land. As importantly, this option will often be impractical within the Queenstown sites due to the terrain and steepness encountered.

2. Transferring the log residue to a disused skid site or landing is also an option that has been considered. In established, large-scale forests, the ability to transfer log residues over a short distance is best achieved by using large (40m³) hook bins. As the harvesting crew processes the logs, the log residue is thrown into the hook bin directly. This provides a clean residue product, and helps to ensure that skid sites are kept clean without impacting significantly on the harvest operation.

Again, the lack of permanent forest infrastructure and the fragmented forest estate would make this system too difficult to effectively manage, too expensive and unviable. Also, there is insufficient volume from each harvesting operation to justify dedicated hook-bin trucks, and the potential to share equipment amongst crews is very low, due to the low harvesting activity and the wide distances between the various forests. At each storage site, there would be a need for the log heaps to be rebuilt to allow maximum drying. This would demand extra handling equipment, which could be rotated around each forest.

3. Managing a just-in-time chip delivery system is considered too difficult to implement. The delivery system that provides wood chip to the Queenstown-based end user requires utilisation of smaller trucks with a carrying capacity of 30-40m³. Chipping direct to truck will only be viable with fewer, larger trucks. Chip liners (80-90m³ capacity) are more suitable. An efficient just-in-time delivery system would need to

be developed to enable full utilisation of both the carriers and the chipper. Chip liners servicing the forest will need to be filled quickly and efficiently to allow quick turnaround. Likewise, the chipper will need to be fully occupied to be utilised. The low standard of internal forest roading in at least some of the forests makes them inaccessible to large road-transporter trucks such as chip liners.

Alternatively, the logs are chipped on the skid site, discharging the chips onto the ground. Again, this is not preferred, as some chips become unrecoverable from the ground and additional equipment is required to load from the ground into the trailer.

Due to the reasons listed above, the option of chipping in-forest is not considered viable.

6.4.3 Chipping in-forest, during the forest operation

The potential to chip logs within the forest as a side-process of the core harvesting operations has been dismissed because of two main reasons. Firstly, green logs with high moisture contents would be being chipped. As discussed earlier, this is not an option due to the immediate degradation of wood chip that would occur.

Secondly, the potential for the chipping operation to adversely affect the main harvest processing operation is high. Given the limited space available on the forest landings, managing concurrent operations would be difficult.

6.5 Summary table of the Potential Supply Chains

The table below summarises the key advantages and disadvantages of each of the options that have been discussed.

Production of chip within the forest	Advantages	Disadvantages	Assessment
Option A: Mobile chipper, during harvest operation	1. Handling equipment present on site	1. Will be chipped green. 2. Will need process heat to dry the chip 3. Is likely to impact upon harvest operation	Not viable
Option B. Shift logs to CPY within forest, dry logs, then chip	1. Easy to shift from the skid site 2. More efficient cartage (carting dry chip)	1. Need additional equipment within each forest area. 2. Additional capital investment in hook bins and trucks	Low. Only viable for the large and well-developed Naseby Forest.

		3. An additional handling step required. Costly. 4. Requires good-quality infrastructure to accommodate trucks. 5. Some landings will not be suitable for drying logs	
Option C. Store logs at landing. Chip at landing, after harvest operation is complete	1. Transporting dry chip from forests is more efficient than transporting high-moisture-content logs	1. Problematic to ensure chip liners are co-ordinated with the chipping operation. 2. Requires good-quality infrastructure to accommodate trucks. 3. Many landings will not be suitable for storing and drying logs. 4. Additional handling – chip liners will not be able to deliver to end user, but to central yard instead.	Not viable.
Option D. Shift wet log residue from forest to external CPY during harvest operation. Chip when logs are dry, at CPY.	1. Easy to manage as part of the daily harvesting operation. 2. Good ability for total quality control; including chipping in centralized location. 3. Chipping direct to storage, retaining a quality product. No contamination. 4. Less product handling	1. Transporting a low-energy, high-moisture product from forest to CPY	high
Option E. Dry logs in the forest. Shift the dry logs from forest to the external CPY for chipping.	1. Transporting a higher-energy product. 2. Chipping directly to storage, with greater ability to retain a quality product.	1. Won't meet the payload with cartage. Low utilisation 2. Need sufficient storage space in-forest for drying. 3. Additional machinery and handling, adds cost. 4. Less ability for total quality control.	Potential. Some detrimental limitations.

Table 6.5: Summary table of potential supply chain options

6.6 Optimising the wood chip supply chain

For the following reasons, Option D above is the most effective and feasible method for producing a quality wood chip product from the scattered forest areas:

1. This wood chip supply pathway is consistent with current harvesting systems, with little deviation from current practice for harvesting crews.

2. The advantage of the traditional log-and-load system is that it exists now, and as such it will not involve any additional capital expenditure from forest owners, harvesting contractors or cartage contractors.

3. Incorporating the recovery of the woody residue as part of the harvesting operation reduces the site requirements for storage, and also reduces the likelihood of contamination of the logs.

Other points to note when considering this supply chain are:

1. To ensure the operation is as efficient as possible and to maintain the productive output of the harvesting contractors, it is important that minimal time is attached to handling of the residue and that the on-site accumulation of recoverable volume is minimised.

2. Though no additional capital outlay will be required to service the forest operations, it is noted that a greater consistency of specialized bin truck will be required. If a regular market for the billet wood is developed, such as wood energy, then a more consistent supply of bin wood trucks would be viable for cartage contractors.

3. The fuel wood (current firewood and bin wood) should be stacked as per other log products, and loaded out as per other log products, with removal on a regular basis.

4. It is recommended that in the early stages of the market development, forest owners prioritise the recovery of the larger-volume, longer-length pieces of billet wood. These are easier to handle throughout the supply chain and as such are more cost-effective.

5. The low harvest production levels and the low existing demand for wood energy mean that logs will need to be stockpiled and then chipped as a sufficiently viable size of log volume becomes dry. The higher moisture content of logs in the winter months requires chipping to be avoided in this period. It is anticipated that the chipping operation is best undertaken after the wet and cold weather of winter and before the heavy rains of late spring. October through to March would traditionally be considered suitable months, though this will change from year to year.

6. Frequent moisture-content monitoring will enable a decision to be made as to when logs are chipped. A rotational 'first-in, first-out' system is preferable so as to reduce the potential dry matter loss of the log residue.

7.0 Locating and developing a central processing yard for wood chip production

In considering the processing of wood chip, it has become clear that the scattered forest estate is not sufficiently concentrated to provide for just one processing site. Long-distance cartage of low-value wood residue is not economically feasible, and as a consequence, processing must occur within close proximity of the forests producing the logs. There are two obvious concentrations of forest estate – one being at Naseby Forest, and the other being the assortment of forests that are present within a 50km radius of Queenstown.

The central processing yard adjacent to Naseby Forest is a functioning and effective operation that possesses the qualities necessary for a profitable operation. These qualities include – being close to the forest itself, being in a dry climate and having covered storage and large areas of flat space. The site's main limitation is that it is a considerable distance from any significant population centre and as such, is distant from energy users and users of wood energy. If demand for wood energy grows in places such as Alexandra, then the most feasible option for delivering wood energy to these sites is by chip liner to a central hub in Alexandra, and then using a smaller truck to deliver to the specific end-user sites. Such a scenario would require investment in additional storage, or the site chosen as the delivery hub.

No such infrastructure exists in Queenstown or the immediate environs. As part of this study, several sites were assessed for their potential as processing sites. Two candidate sites were identified as being suitable. One site is the council-owned Victoria Flat landfill, some 33km from Queenstown and 27km from Cromwell. The advantages and disadvantages of this site are:

- ✓ It is a dry site and, being in a gorge, attracts significant wind which would further assist the air drying of logs.
- ✓ There is plenty of flat land, a weigh bridge and under-utilised equipment such as a wheel loader.
- ✓ The council ownership of the site should provide some certainty regarding long-term lease rates.
- ✓ Its central location makes it ideal as a repository for raw logs and as a distribution for sites around Cromwell, Queenstown and Wanaka.
- ✓ There are no resource consent difficulties, as it is consented for landfill operations.
- Perhaps its only limitation is that it is a distance from both the forests and the demand which is centred on Queenstown. As such, there are some inefficiencies with cartage.

The second site that was identified as being a candidate site was at the Remarkables, some 10km from the centre of Queenstown. The advantages of this site are:

- ✓ Relatively cost-effective rental price.
- ✓ There are no resource consent difficulties as it is consented for firewood operations.
- ✓ It is very close to both the forests and the energy users of Queenstown, so cartage throughout the whole supply chain will be minimal.
- ✓ It is close to State Highway 6, leading to Southland. This is an excellent site to receive any logs that may need to come from Southland.
- There is no existing storage shed or equipment that could be utilised.
- Flat land could be limited as there are a number of competing uses for it.
- The rental price is always subject to change.
- It is not such a dry or windy site as the site at Victoria Flats.

Both of these sites have attributes that are positive for a central processing yard (CPY), and demonstrate the type of infrastructure and locality that is required. Determining the best location for a CPY will be led by the need to most effectively service early cornerstone customers, as well as by securing the most commercially viable site.

The seasonal demand for wood chip will mean storage capacity is a key issue. It will be important to ensure sufficient wood chip is available during periods of high demand, and to have sufficient storage cover to ensure the quality of the stored wood chip is maintained during the summer periods of low demand, which also coincides with the periods of peak production of the chip.

Any storage facility would need to provide for first in – first out rotational handling, minimising the possibility of inadvertent long-term storage through inability to access the older material. It would also be prudent to monitor the temperatures of the piles. The best cover for the chip product is a non-contact roof that allows for breeze flow through the site and for any moisture and heat build-up to escape. The ideal storage unit would entail three sides and a roof, with concrete floors and a rear concrete wall. This structure would allow for shifting and loading of the wood chip. There will need to be sufficient space within the storage shed to allow for free movement of machinery, especially when filling the hopper.

8.0 Other biomass supply options

8.1 Luggate sawmill wood chips

The Luggate sawmill currently produces 150m³ of chip per week, but this can rise to 250m³ when the demand for sawn timber is high. Currently used for animal bedding, this product is consistent and of a uniform size and shape that would be suitable for use in wood boilers. The limitations of this wood chip product are that its high moisture content requires some form of drying before it can be used in boilers. Additionally, though by default, the logs are typically quite clean of bark, but there is a small amount of bark wood chip that results from the milling and chipping process. This inferior product is difficult to grade out, but with annual costs for operating a debarker at $60,000-70,000, it is not economically viable to include debarking at the start of the process.

To enable the saleability of this product it would need to be dried. Within New Zealand and overseas, there is very little available information regarding the costs of drying wood chip using heat. Information on small-to-medium-scale drying is limited, particularly with regard to energy costs. Some research in the UK has largely found active wood chip drying not to be economically viable, particularly in relation to the low unit cost value of the base product (Forest Research 2011). However, one study on drying trials found that active wood chip drying can be efficient enough to dry wood chip at an operational cost less than the value of the chip (Emma, 2012). However, the method of drying is constrained by the low $/kWh value of wood chip, meaning very efficient drying methods and technology are essential.

A potential drying process at Luggate would utilise the dry wood chip from this process to dry further green wood chip for on-sale. The energy used to dry green wood chip is typically 950-1400 kWh/tonne (FCPR045, 2011), requiring the utilisation of approximately 1m³ of chip to provide the energy to dry 1m³ of chip for sale. Taking into account the estimated loss of volume during the heating process (20% of total volume), a rule of thumb would be that 2.4m³ of green chip will produce 1m³ of saleable seasoned chip. This does significantly reduce the amount of saleable seasoned chip, but leverages off the on-site and low-cost energy resource that is available. The available volume of seasoned dry wood chip would be between 3,200MWh and 4,200MWh, depending on the sawmill productivity.

Available raw volume	7,500 – 10,000m³ of wet chip / annum	
Available saleable volume	3,000–4,000m³ of seasoned chip / annum	3,200MWh–4,200MWh annual availability

Table 8.1 Availability of wood chip from Luggate sawmill

8.2 Sawdust from Luggate sawmill and other portable sawmills

The sawmill at Luggate is currently producing in the vicinity of 30m³ of sawdust per week (pers. comm. Gerard Haggart). Combined with the various portable sawmills that operate in the region, this amounts to an estimated 50m³ of sawdust that is produced on a weekly basis. Currently most of this sawdust is used for cattle bedding, composting, mulch or left in situ.

The sawdust represents a significant resource that could potentially be used to generate wood pellets. The main issues requiring further consideration are:

1. How to retrieve the sawdust from a variety of sites in a cost-effective way.
2. How to ensure consistent and high-quality sawdust that is free of bark and dirt. This is a particularly relevant issue for the sawdust that arises from portable sawmills, where it is normal practice to cut through the bark.
3. How to cost-effectively dry the sawdust prior to completing the pelletising process.

None of these issues are insurmountable, but would require careful consideration before investing in a pellet production business. This is discussed later in the document.

Available raw volume	1,500m³ of wet sawdust/annum	
Available saleable volume	750m³ of pellets/annum	3,500-4,500MWh/annum

Table 8.1 Availability of sawdust from Luggate sawmill

8.3 Vineyard prunings

Conversations occurred with representatives of the Central Otago Wine Growers Association regarding the potential use of vineyard prunings as a potential source of wood energy. However, most vineyards mulch the prunings in situ, using it as an important organic material within the vineyards (pers.comm James Dicey). As such, there is no volume that can be attributable to supplying the wood fuel market.

8.4 Mulch from green waste and urban trees

Council staff from the CODC and QLDC, as well as their key contractors for parks and reserves management, were interviewed in order to understand the potential volume of green waste that could be used for energy. All the green waste in Wanaka is composted and sold on site by the operator. All mulched green waste from the townships of Kingston, Glenorchy, Luggate, Hawea and Makarora is left on site to be used by those communities. Within Queenstown and the immediate surrounding suburbs, there is currently 400 tonnes per annum of green waste mulched at Frankton transfer station.

Approximately one third of this is taken for use by the Parks and Reserves Department for garden mulch, and the rest is currently being stored at the landfill for future composting with the region's wood waste (pers.comm. Stefan Borowy). During the course of completing this report, it became obvious that the private sector is showing growing interest in this resource for commercial composting and mulching on low-organic soils.

Having assessed some of the mulch that is being produced, it is considered that the quality of the product is too variable for it to be of immediate use as a resource for energy generation. The significant proportion of leafy material and the shredded nature of the product (rather than it being a chipped product) make its use as a consistent quality and high-energy-content product limited.

Within Central Otago, a similar situation exists, with an estimated annual volume of 200 tonnes (pers.comm. Alan Marshall). Again, much of this product is used for mulching and landscaping by the commercial sector.

9.0 Summary of the potential available wood energy resource in the region

The table below summarises the estimated wood-energy resource that is available across the region. The figures in the table reflect the outcomes of the assessments that have been completed as part of this project, described above, and based on best available data and estimates.

	2013-2018	2019-2028	2029-2038	2039-2048	2049-2058	2059-2063
Queenstown log residues	4,639	4,183	29,447	15,286	3,011	15,169
Central Otago log residues	15,401	13,989	11,551	13,861	15,617	34,191
Sawmill wood chips	3,200	3,200	3,200	3,200	3,200	3,200
Sawmill sawdust	4,000	4,000	4,000	4,000	4,000	4,000
TOTAL (MWH)	27,420	25,372	48,198	36,347	25,828	56,560

Table 9.0: Summary of regionally available wood-energy resource

The estimated resource is of the gross availability, and does not take account of existing use of the resource. For example, the sawdust and wood chips that are produced as a by-product at Luggate sawmill are currently used for animal bedding and represent a resource that is being used by the farming community. However, in the table above, it is the gross resource that is produced which is described.

10.0 Developing a Wood Energy cluster in Central Otago

There is already a strong wood-energy industry in Central Otago, represented by the existence of two of New Zealand's key participants in the industry. The existing wood-energy supply chain that Wood Energy New Zealand (WENZ) operates from Naseby is an efficient and profitable system that is operating well, and is particularly well positioned to supply towns in Central Otago such as Alexandra, as well as larger cities such as Dunedin. Spark Energy, based out of Queenstown, also operates a successful enterprise that services clients throughout New Zealand, but with a predominant focus on the lower South Island. Though both of these enterprises are based out of the Central Otago region, the core of their customer-bases are located further afield in Dunedin.

For both of these businesses, and for any other entities contemplating entering the wood-energy industry, it is important to consider the most feasible method for supplying wood energy into Queenstown, Wanaka and Cromwell. The distance from existing key sources of biomass supply, both at Naseby forest and also from Dunedin-based forests, requires the careful consideration of other pathways when considering supply into these more western localities.

There are four supply pathways that require consideration when assessing the viability of a wood-energy business in Central Otago/Queenstown Lakes:

1. Developing a greenfields entity that utilises log residue from forestry operations;
2. Selling log residues from forestry operations to existing wood fuel providers;
3. Utilising existing sawmill wood chip from Luggate sawmill;
4. Utilising existing sawdust to produce wood pellets.

These four pathways are each considered below.

10.1 Developing a Greenfields entity that utilises log residue from forestry operations

One option for supplying wood energy into the Queenstown Lakes District is to establish a new entity that specifically uses the log residue from forestry operations in this area. The development of a new stand-alone wood-energy business would require specialist equipment, heavy machine, chipper, land and buildings, requiring an investment of \$650,000-\$850,000. To provide a return on the investment, a slightly better than break-even scenario would require the annual production of 6,000m^3 of logs.

However, this is not a viable option due to the fluctuating and at times insufficient supply of log residue in the Queenstown Lakes District. The average available volume over the next fifteen years is in the vicinity of 1700m^3/annum, and though there would be sufficient volume for the two decades beginning from 2029, it would again fall to low volumes after 2048.

Alternatively, a Greenfield business could be developed that had a lower capital investment which covered the development of a covered storage area and sought to hire the main equipment necessary to produce wood chip. This would allow smaller volumes of logs to be processed, with less overhead and capital cost. Though such a model would provide for ongoing cashflow, it would not provide for an increase in capital asset value and it makes the wood chip producer very reliant on the utilisation of an external party's equipment.

10.2 Selling log residues from forestry operations to existing wood fuel providers

A second option for further developing a wood-energy industry in the Queenstown Lakes District is to build upon the industry that has been developed by existing suppliers of wood energy. This would make use of the forecast growth of log residue volume that is arising from this district, whilst making use of the infrastructure, machinery and systems that the two established providers of wood energy – Wood Energy New Zealand (WENZ) and Spark Energy – already possess.

A likely supply chain is described below:

Key Stages	Requirements
Logs delivered to site	Logs purchased 'at forest' by wood-energy supplier Logs delivered by independent cartage company Rental site, with covered shed and large flat area Wheeler loader present on site
Preparation of logs for chipping	Logs stacked for optimum drying Managing log piles to ensure logs are chipped in order of priority
Chipper relocated to site from Dunedin or Naseby	Minimum of 500m³ chip produced per trip Dry hire excavator, unless part of chipper configuration Chipped directly into covered storage area
Distribution to end users	Using small delivery truck if located close to the end user Chip liner if longer trips are required On-site wheel loader used for loading

Table 10.2 Outline of supply chain that utilises existing wood-energy suppliers infrastructure

Capital investment would still be required, but significantly less than if a greenfields business was to be established. A suitable storage site and processing area would be required, including a covered building for storing dry wood chips.

It has been estimated that under such a regime, these two existing providers could deliver energy into Queenstown for 4.5-5.5c/kWh. This is based upon paying the market rate for chip logs ($35/ tonne), bringing the necessary equipment to site as and when needed, investing capital into storage and yards, but keeping general additional overheads low. Wood chip energy is currently being delivered into Queenstown for between 4.5c/kWh and 6.5c/kWh from Naseby forest.

10.3 Using the Luggate sawmill residue

The resource at Luggate provides an opportunity to supply locally produced wood chip using an existing waste residue product. However, any prospective entity wishing to use this resource to supply users in the region would need to carefully evaluate the cost of drying this product, and further evaluate the impact that the presence of low volumes of bark will have on the saleable product.

The capital investment required to convert the wet chip into a seasoned and saleable wood chip product, though not insignificant, could be justified given the volume of wood chip that is being produced at this site. A drying process and covered storage area would be required, as well as the usual loading and handling equipment. The most viable option would be to utilise the sawmill's existing loading and handling equipment, and to bring a portable drying unit on site as and when required. A covered storage area would need to be built, either at this site or at a locality that allowed a more efficient distribution to local users.

Using the Luggate sawmill wood chip resource would ideally form just one part of a wood-energy business' residue supply. Diversity in supply is required as there is significant risk attached to developing a business which is dependent on a single source produced by an external entity.

Item	Estimated cost
Raw cost	2 c/kWh
Estimated drying cost	2c – 3c/kWh
Total estimated cost to produce and transport	4.5c – 5.5c/kWh
Estimated capital costs – drying plant	$150,000 - $300,000
Estimated capital costs – storage	$50,000

Table 10.3 Overview of the cost and capital investment required to process the Luggate wood chip.

10.4 Utilising existing sawdust to produce wood pellets

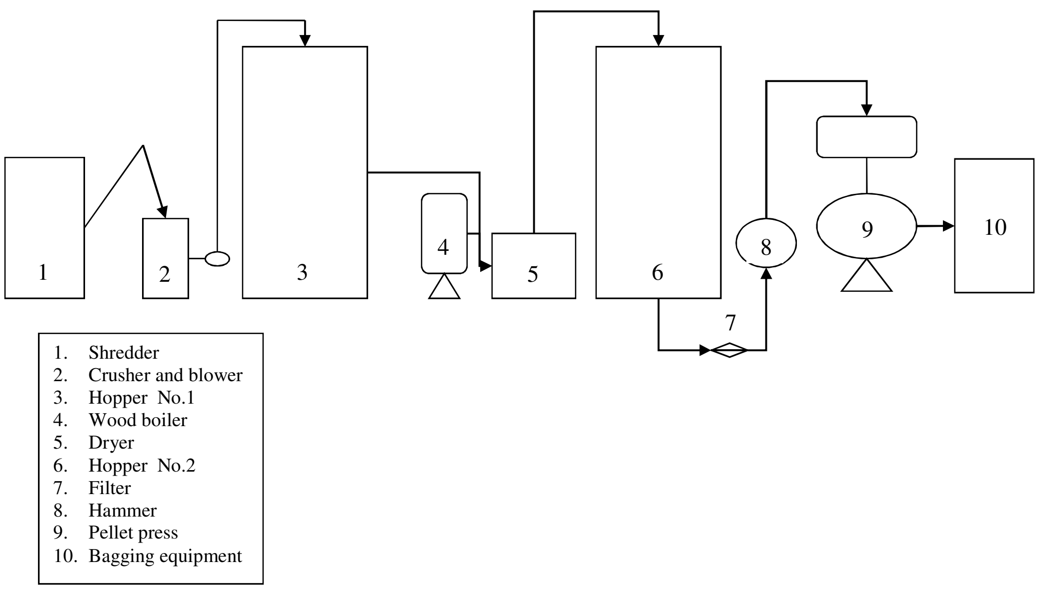
The availability of sawdust from operations at Luggate Sawmill and other portable sawmilling operations provides an opportunity to develop a small-scale pellet operation that would enable competitive supply to local markets.

What has become clear during the development of this report is that a reasonable component of the current retail price of pellets sold in Queenstown is related to the cost of cartage. It is possible to bulk-purchase pellets ex-gate from Rotorua (Natures Flame) for $250-300/t, but with the addition of cost of freight to Queenstown and margin, the price has increased at least two-fold to $600-750/t[1]. This cost is based on feedback from mostly domestic and low-volume users. It is estimated that for larger and consistent volumes it should be possible to deliver to Central Otago for $450-490/t[2].

There appears to be a business case for a local pellet manufacturing plant based on:

- The fuel component costs associated with purchasing pellets from outside the region. It is estimated that approximately 2.2-5.3c/kWh can be attributed to transport costs. This variance in transport cost is largely based on the volumes. A local pellet plant will not have to incur this cost.
- The domestic and commercial rates are much higher in Queenstown than in other towns so margins for a local pellet plant may be attractive.
- Luggate sawmill has a small volume of wet sawdust that could be dried and used for pelletising.

Pellets do require significantly more processing than wood chip, as outlined in the pellet process below:



[1] This pricing is based on small volume and domestic users
[2] Based on pricing from Nature's Flame for bulk purchase to Dunedin without margin

As a consequence the capital investment is significantly higher, as shown in the table below. This cost of investment in plant has been based on an EECA monitoring report of small pellet factories.[3]

Site	Capacity (t/h)	Output (t/year)	Capital Expenditure ($)
Site 1	0.3t per hour	750t per year	$350,000
Site 2	2t per hour	2000t per year	$800,000

Budgets for manufacturing pellets have been developed, as shown in the table below based on real values from the two sites.

	Site 1	Site 2
Capacity (t/h)	0.3	2
Output (t/year)	750	2000
Capital Expenditure ($)	$350,000	$800,000
Sales (@$470/t)	$352,500	$940,000
Cost of manufacturing	$203,750	$405,000
Gross Profit	$148,750	$535,000
Cost of Admin/finance	$89,250	$127,400
Net Profit	$59,500	$407,600
ROI Investment	5.9	2.0
Assumptions	Loader available	Land and building not req
	$45/t paid for logs	delivered
	Secure source of	wood

Table 10.4 Costs and returns from pelletising operations

[3] EECA Monitoring Reports www.eecabusiness.govt.nz

Based on a 2:1 conversion factor of sawdust to pellets, the Luggate resource is reasonably small. That is, for every 10m³ of sawdust produced daily at Luggate, 5m³ of pellets can be produced. From the scenarios created in this report, the Luggate sawmill resource would be sufficient to supply two sites. Based on this scenario, Site 1 plant (750t/year) would be the best match for the Luggate resource with an expected ROI of 6 years.

10.5 Wood-energy supply pathway conclusions

A number of opportunities are present for stakeholders wanting to develop a wood-energy industry in the Queenstown Lakes District and to expand upon the existing wood-energy industry that is in existence. Key points are:

1. There is insufficient log residue available in Queenstown Lakes to enable the development of a Greenfields wood-energy business specific to this locality. However, the volume of log residue that is potentially available in Queenstown Lakes is a valuable resource for suppliers of wood energy and its utilisation will provide a more cost-effective wood chip product (at 4.4c–5.5c/kWh) than competing wood chip products which need to be imported into the district.

2. The most feasible way of utilising the Queenstown Lakes log residue is for existing wood-energy suppliers to purchase log residue from the forest owners, to store logs at a central processing yard that is proximate to Queenstown and Cromwell, and to utilise their existing processing equipment at this central processing yard as and when required. This option would require the development of a suitable processing yard and covered storage area. Existing wood-energy suppliers have the added advantage of being able to use the quality and availability of their existing supply to overcome any issues associated with the start-up phase of this local supply pathway.

3. The wood chip residue that is currently produced at Luggate sawmill presents an opportunity to supply a number of sites with a locally produced chip product. This wet wood chip is available here and now, and though volumes do fluctuate, it represents a consistent form of supply. However, to produce a seasoned and saleable wood chip will require significant investment in a forced-heat drying process and again, storage facilities. It has been estimated that this wood chip could be produced and transported for 5.0-5.5c/kWh. The return on investment for this supply pathway requires specific evaluation.

4. Locally producing wood pellets provides an opportunity to utilise sawdust from sawmilling processes, and in doing so to provide a competitive wood pellet product that is not subject to the same high transport costs that imported pellets are subject to. The low volumes of sawdust that are produced locally would make this a small-scale operation, but one that produces sufficient volume to be able to consistently supply the three sites that have been identified in this report.

To scale up this operation would mean using residues that are not as refined as sawdust, and as such there would need to be further capital investment for additional processing of the raw residues.

B. Understanding the Demand for Wood Energy in Central Otago

11.0 Overview - Wood fuel plant and equipment

Wood energy for heating has been around since the beginning of time and most New Zealanders will be familiar with drying and storing wood for winter, preparing and starting the fire, adding logs to keep the space warm and having to empty the ash bin.

These same steps apply to modern wood boilers except they are now fully automated and highly efficient. Seasoned wood fuel is delivered and mechanically transferred into an onsite bunker, a heat gun initiates combustion and fuel from the bunker is transferred to the boiler using a series of augers. The boiler can turn on and shut off automatically and is able to relight itself as and when required. A modern wood boiler can also de-ash and conveniently empty into an ash bin. So the only real intervention with a new modern boiler is to empty the ash bin and perform regular maintenance.

The boilers and associated equipment demand additional space when compared to conventional LPG or diesel boilers. To put this into context, a conventional 100 kW LPG boiler[4] has a volume of approximately 0.89m^3 and is similar in size to a diesel boiler. A comparative wood boiler[5] measures 4.05m^3 not including any additional components such as emissions control and fuel bunker. Coal boilers are very similar to wood boilers in volume and associated equipment and plant layout.

Like wood boilers, coal boilers store the fuel on site and use augers to transfer the fuel into the boiler for combustion. LPG and diesel boilers use small pipework to transfer the fuel into the boiler. For diesel boilers, the fuel is usually stored on site and is transferred to the burner using gravity. LPG can be stored on site in bottles or reticulated. Some typical configurations for a wood boiler, bunker and fuel transfer system are illustrated over page.

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[4] Aquatherm 100kW specifications (760*900*1300) in mm.
[5] Heizomat RHK-AK 100 (1085*1700*2200) in mm.

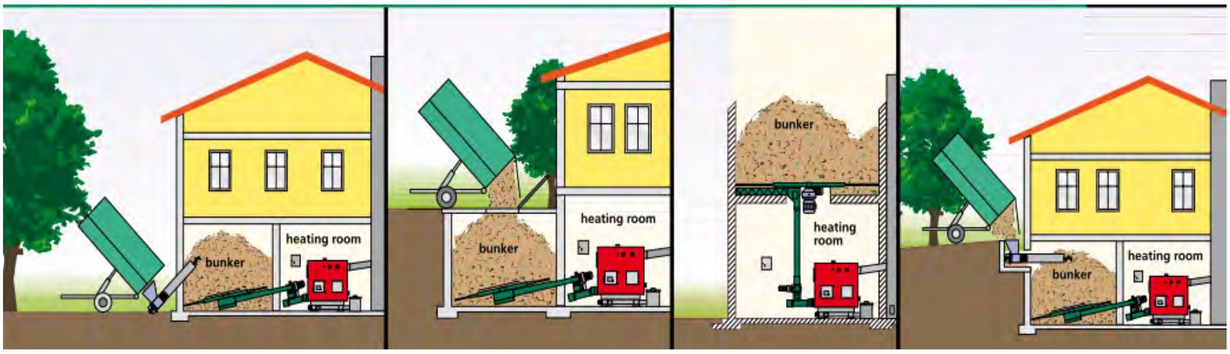

Figure 11.0 **Wood fuel storage and bunker configurations**

12.0 District heating

Wood fuel boilers can be used to heat individual buildings but can also be used to provide heat for multiple buildings that are in close proximity. This is known as district heating. District heating is a system consisting of a centralised boiler and an underground pipework of heating pipes. The system provides heat to users for processes such as heating or hot water. This technology is utilised extensively in Europe on a town scale.

Smaller district heating systems are more common in New Zealand and an example of this is the Dunedin Energy Centre which provides steam to Cadbury's, Dunedin Hospital, Otago University, Alsco and several other smaller users[6]. For a district heating scheme to be viable in Central Otago there needs to be a reasonable scale of demand for heat and electricity in close proximity.

It is common in Europe to combine district heating with power generation. This is known as combined heat and power (CHP). CHP uses a fuel source to generate electricity and the waste heat from generation is captured and utilised for district heating.

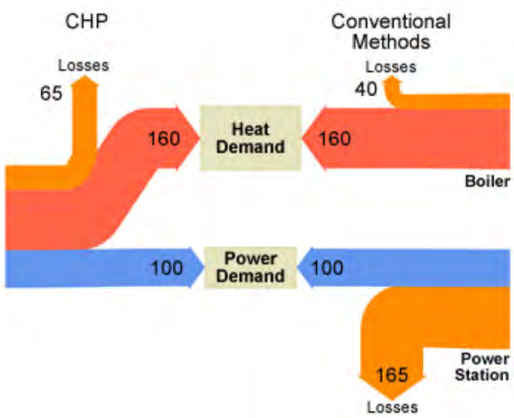

Fig 12.1 Efficiency of CHP versus conventional heating using boilers (DEFRA)

[6] http://energyforindustry.co.nz/experience/dunedin-energy-centre/

In 2010, Queenstown Lakes District Council commissioned *The Frankton Flats District Heating Feasibility Study* (Aircomm 2010). This study investigated a district heating system in Frankton with demand assessed for:

- Queenstown Airport
- Lakes District Hospital
- Alpine Aqualand and
- The Events Centre

This study was based on a wood chip centralised boiler providing low-temperature hot water and came to the conclusion that the actual cost to supply heat from the DH system would be higher than the current cost of fuel to the individual sites.

During the recent Shaping Our Futures Energy Forum held at the Queenstown Council Chambers (25th Feb 2013), The Porter Group CEO Alistair Porter suggested a biomass CHP unit for the Stage Two Remarkables Park Development could be considered. This project has the potential to create significant demand for wood fuels and would certainly guarantee a Central Otago wood cluster if it proceeded.

There is merit in reassessing the Frankton Study based on a CHP arrangement including heating demand from The Remarkables Park Stage Two development and generating electricity for use on site. In addition to the demand from the Frankton Study would be a 1,200-unit housing development, The Hilton and Kawarau Hotels, The new Remarkables School (1500 pupils), Glenda Drive Industrial Zone and Remarkables Park Stage One commercial buildings. Estimated demand could be in the region of 6,000 – 10,000MWh/year of heat demand (6,000 – 10,000m^3 chip).

The Energy Efficiency and Conservation Authority (EECA) has indicated interest in supporting an initial assessment and local councils should also consider supporting one.

13.0 Otago Regional Council Air Plan

Because this project falls within the ORC Air Plan, the impact of emissions from boilers needs to be considered. The ORC Air Plan has been summarised below based on conversations with ORC staff[7] and interpretation of the plan in respect of Central Otago. Central Otago is divided into three air zones:

- Alexandra, Arrowtown, Clyde and Cromwell
- Ranfurly, Roxburgh, Queenstown and Wanaka
- All other areas not within Air Zone 1 or 2

[7] Matthew Bell (Alexandra Office) and Debra Mills (Dunedin Office) 19 March 2013

The main rules that may have an impact on biomass boilers are:

Rule 16.3.4.1- The discharge into air of products of combustion arising from fuel-burning equipment from single activities or a combination of activities located on one site (excluding domestic heating appliances subject to Rules 16.3.1.1 to 16.3.1.6) in Air Zone 1 or 2 which:

- Does not exceed a heat generation capacity of 1MW; or
- Does not exceed a heat generation capacity of 5MW and burns only gas, oil or bio-oils (excluding waste oil) with a sulphur content of less than 1%;

is a permitted activity providing

- In the case of equipment installed after 28 February 1998, any chimney complies with Schedule 6 (“Determination of Chimney Heights”); and
- No material specified in Rule 16.3.3.1 is burnt; and
- Any discharge of smoke, odour, particulate matter or gases is not noxious, dangerous, offensive or objectionable at or beyond the boundary of the property.

Chimney heights can be challenging especially within built-up commercial areas but ORC’s Matthew Bell[8] suggested that clean-burning appliances are looked at favourably if outside the height requirements and are still likely to be permitted. If the activity is not able to meet these criteria it becomes a discretionary activity requiring resource consent so must comply with emissions standards for particulates (PM10) which are:

- For new activities **(25µg/m³)** and
- For existing activities **(50µg/m³)**

This adds additional cost to a project:

- Bag house filtering can add $200,000[9] to a 1MW boiler project regardless of the fuel being coal or woodchip. The College of Education, Otago Polytechnic and University of Otago boiler projects all required some type of emissions filtering.
- Resource consenting.
- Emissions monitoring.

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8 Pers Comms 19 March 2013
9 Per Comms, Vortex Engineering 02 May 2013

14.0 Wood fuel specifications

There are several fuel options available including hog fuel, low-grade chip, high-grade chip and wood pellets. Hog fuel and low-grade chip are normally used for industrial applications and considered inferior products due to their physical properties. Consequently, the cost of the product is cheaper.

The two main types of fuel being considered in this study are A-grade wood chips and pellets. This type of fuel is more suitable to Central Otago businesses and is still low-cost. Furthermore, the Dunedin wood cluster was developed using these types of fuels and has shown that it is important to gain business confidence in wood energy, which is more likely with quality fuels. Each has its merits and disadvantages with regards to the region, plant and equipment, fuel properties, cost and bunker storage.

	Advantage	Disadvantage
Wood chip	Low- cost fuel Can add value to existing supply chains without large investment in plant Proven technology in NZ Central Otago climate is suitable for log drying Significant energy savings possible if using LPG or diesel	Low energy density Requires large on-site storage bunker Fuel deliveries can be difficult High investment cost for new boilers
Wood pellet	High energy density Storage bunker can be much smaller Low MC% and may be ideal in sub-zero conditions Proven technology in NZ	High-cost fuel compared to woodchip High associated transport cost because of distance from suppliers

Table 14.0 Advantages of different fuel types

The Bioenergy Association[10] outlines fuel quality parameters for these fuels on its bioenergy website.

Specification	Measurement	Comment
Diameter	6mm	Smallest diameter
Length	<6 x dia mm	
Ash	<1%	Note – all EU stds list <1% ash
Additives	<1%	Starch binding agent only
Moisture	<10% (<8%)	By weight (Note - <8% limit used for test fuels when testing appliances)
Bulk density	>650kg/m3	
Energy content	>17MJ/kg	As received basis
Mechanical Durability	97.7 % (proposed)[7]	Tumbler 2000 test or equivalent test suggested;
Particle size	<3.0mm	
Fines	<1.0%	By weight, ex gate
Chlorine	<20ppm	
Sulphur	<0.05%	

Table 14.1 Wood pellet Category A specifications

Size[3]		**S30**	**S50**	**S100**
Coarse Fraction ≥ 20% of total by weight	Cross sectional area max, (cm^2)	3	5	10
	Length max (cm) (Max of 1% of the total mass)	8.5	12	25
	Nominal mesh size – coarse screen (mm)	16	31.5	63
Main Fraction ≥ 60-100% by weight	Nominal mesh size – medium screen (mm)	2.8	5.6	11.2
Fine Fraction ≤ 5% by weight	Nominal mesh size – fine screen (mm)	1	1	1
Moisture % by weight (moist basis)				
M20 M30 M35 M40 M55 M65	≤ 20% ≤ 30% ≤ 35% ≤ 40% ≤ 55% ≤ 65%			
Ash % by weight (dry basis)				
A.5 A1 A3 A6 A6+	≤ .5% ≤ 1% ≤ 3% ≤ 6% > 6% - Actual Value Stated			
Bulk Density				
Kg/m^3	Actual value stated			
Energy Density				
MJ/Kg	Actual Value Stated – If sold by weight			

Table 14.2 Wood chip specifications

[10] BANZ Wood Fuel Classification Guidelines- http://www.bioenergy.org.nz/resources.asp#tech_docs

15.0 Existing and future demand for wood-fuels

There are two main suppliers of wood fuels already operating in the region, namely Wood Energy NZ and Spark Energy. Both suppliers provide A-grade quality wood chip. The main sites utilising wood fuels are:

- Mt Difficulty Wines (Bannockburn)
- Rippon Winery
- Dunstan High School
- Dunstan Boardinghouse
- Lakes Leisure Wanaka Pool

From conversations with these suppliers it is estimated that currently 6,000 GJ (1,600m³ chip) is being supplied into the area for biomass boilers, mostly in the form of A-grade wood chip. Both suppliers are able to provide a seasoned quality fuel in large quantities for future demand.

There are several large developments currently proposed/approved in the region that may be ideally suited for using wood fuel. These include:

- Remarkables Park Commercial Zone Stage 2 (Combined Heat and Power (CHP))
- Lakes Hayes Estate 700-unit subdivision (District heating)
- New schools proposed for Frankton and Jacks Point (heating and hot water)
- Ngai Tahu Convention Centre (heating and hot water)
- TSS Earnslaw (steam)

Where possible these developments will be taken into account when estimating future demand for wood fuels.

16.0 Energy demand survey

An online survey was developed and sent out via various networks to potential heat users in Central Otago. The survey captured information relating to heat demand, type of process, cost of energy and feedback relating to site constraints. A copy of the survey questions are contained in Appendix 1.

In addition to the survey, other sources of energy demand have also been included. This includes information from Ahika's own database from sources such as energy audits and reports such as Frankton Flats District Heating Feasibility Study[11]. A total of 54 responses were received across the range of sectors. Agriculture is totally represented by wineries and wine processing. The school sector also includes higher education providers such as the Otago Polytechnic. The commercial sector is a diverse group including offices, buildings and other commercial businesses such as banking, small laundry services and legal professionals.

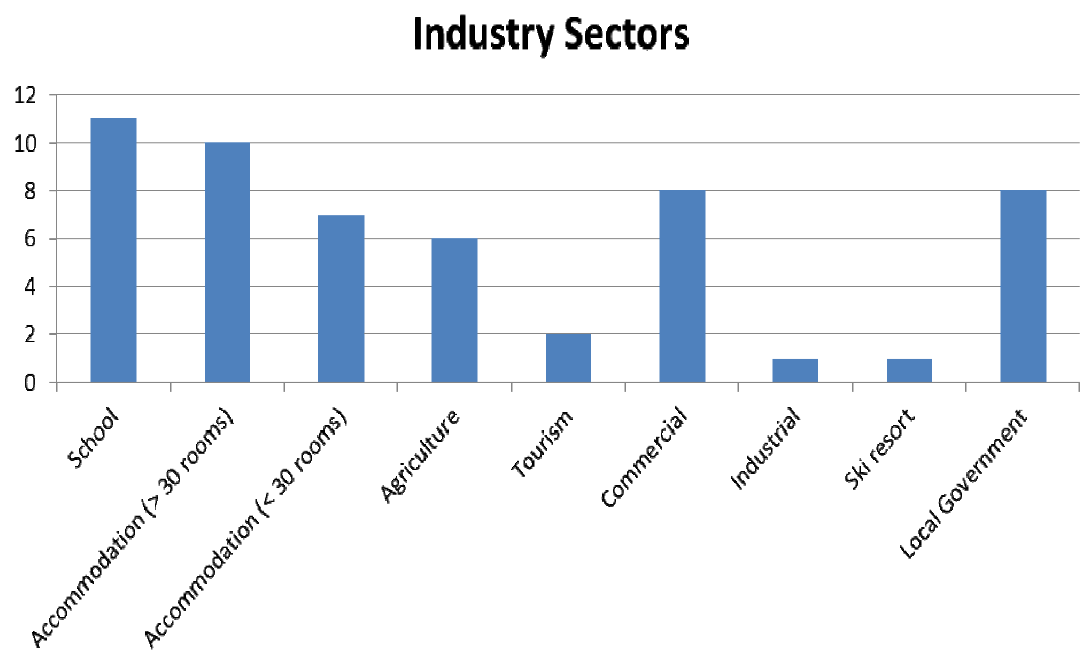

Figure 16: Number of participants per sector group

The groups were located in various Central Otago locations with the greatest response from the main centres of Queenstown/Frankton, Cromwell, Wanaka and Alexandra. These centres represent 84% of total responses.

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[11] Aircomm Building Services, The Frankton Flats District Heating Feasibility Study, 2010

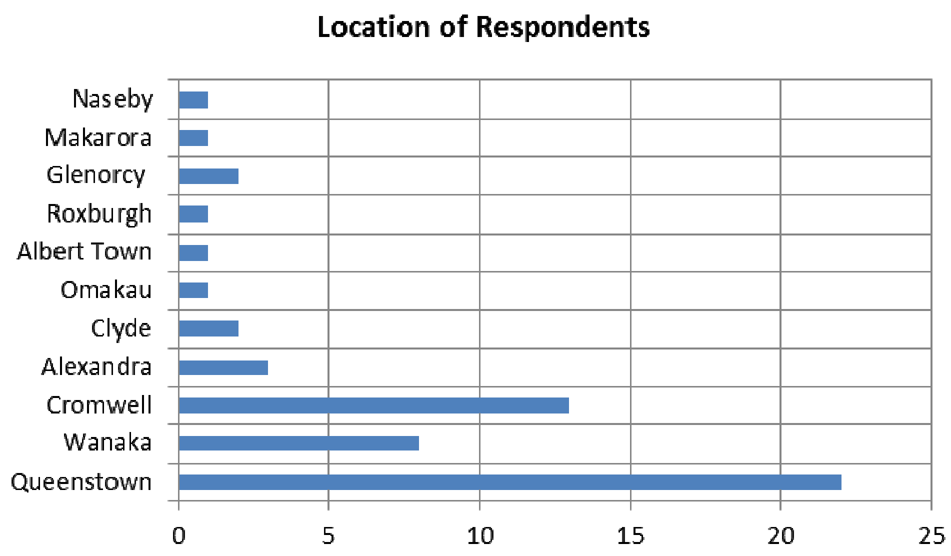


Figure 16.2 Number of participants per location

The business case for converting to wood fuels is mostly based on financial performance. That is, the cost of the project, the expected energy savings and the return on investment (ROI) ratio. To identify businesses that are likely to perform financially, several key indicators have been developed. These key indicators are described below.

Existing heating infrastructure – businesses with existing infrastructure such as boilers and hot-water pipework make it much simpler and less expensive to convert than for a business using electric heaters or individual heat pumps. Almost 60% of participants have existing boiler and hot-water pipework infrastructure indicating a retrofit for wood fuels is possible because of their existing infrastructure.

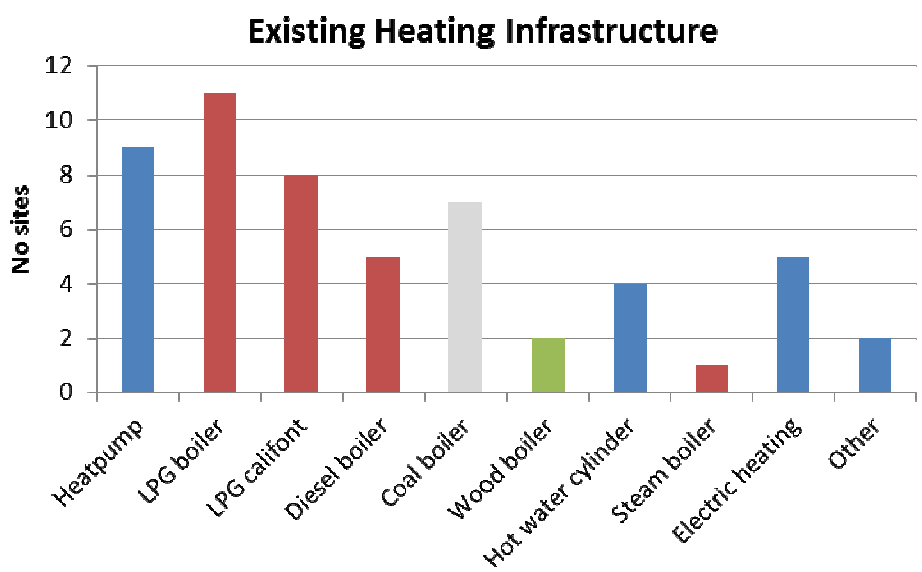
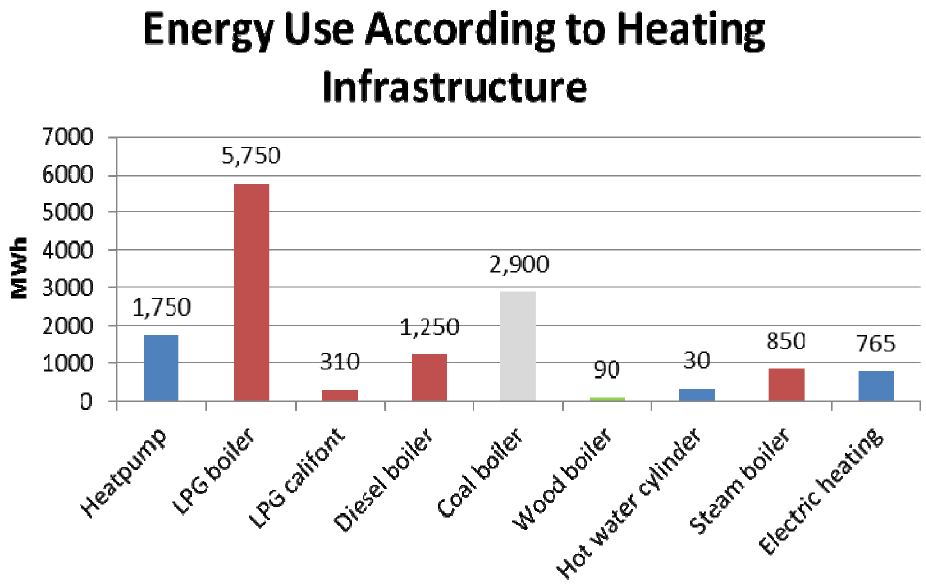


Figure 16.3 Heating infrastructure fuel types in blue (electric), red (LPG/diesel), grey (coal) and green (wood).



Graph 16.4 Heating infrastructure energy use in blue (electric), red (LPG/diesel), grey (coal) and green (wood).

In Figure 16.4, LPG and diesel account for 60% of the total energy use followed by coal (21%), electricity (20%) and wood (1%).

Figure 16.4 indicates fuel type per sector and shows a diverse mix of fuels across all sectors. Interestingly, rest-homes are all electric system which would make it more challenging to convert despite being a large and consistent user of hot water and heating. Large accommodation and campgrounds use a high share of LPG or diesel. Government and schools use a diverse mix of fuel types.

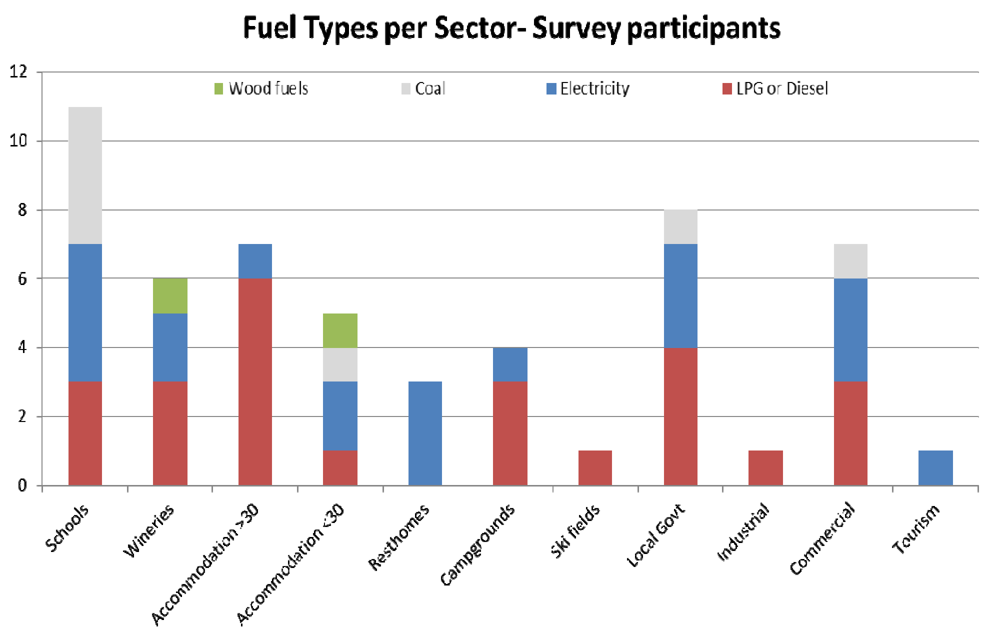


Figure 16.5 **Fuel type per sector**

Seasonal energy demand – Energy savings that result from converting to wood fuels are directly related to energy consumed. As such, a business with year-round demand will achieve greater savings than a business with only seasonal demand, therefore improving the ROI ratio. This doesn't necessarily mean a business will not convert to wood fuels if its demand is seasonal but it certainly favours businesses with consistent demand. From a fuel-supply perspective, year-round demand is important for cash-flow too. The 15 sites identified as consistent year-round energy users were mostly local government facilities (pools and hospital) and accommodation. These sites would be considered the low-hanging fruit for developing a wood-supply market.

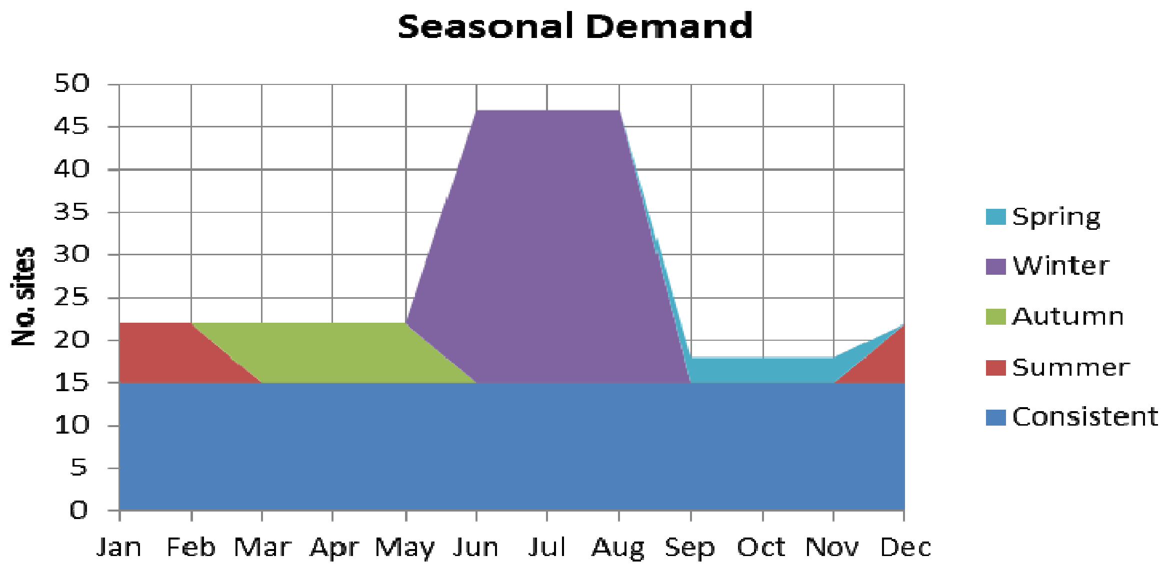


Figure 16.6. Current energy demand from the various businesses with the obvious winter peak

Current price of energy – High-cost fuels such as diesel and LPG provide a greater margin of savings when converting to wood fuels. Electricity can also be considered a high-cost fuel but heating infrastructure (lack of) is the issue. Fuels such as coal are very low-cost so other drivers, such as environmental issues, need to be considered. The unit price of coal in this survey is very low.

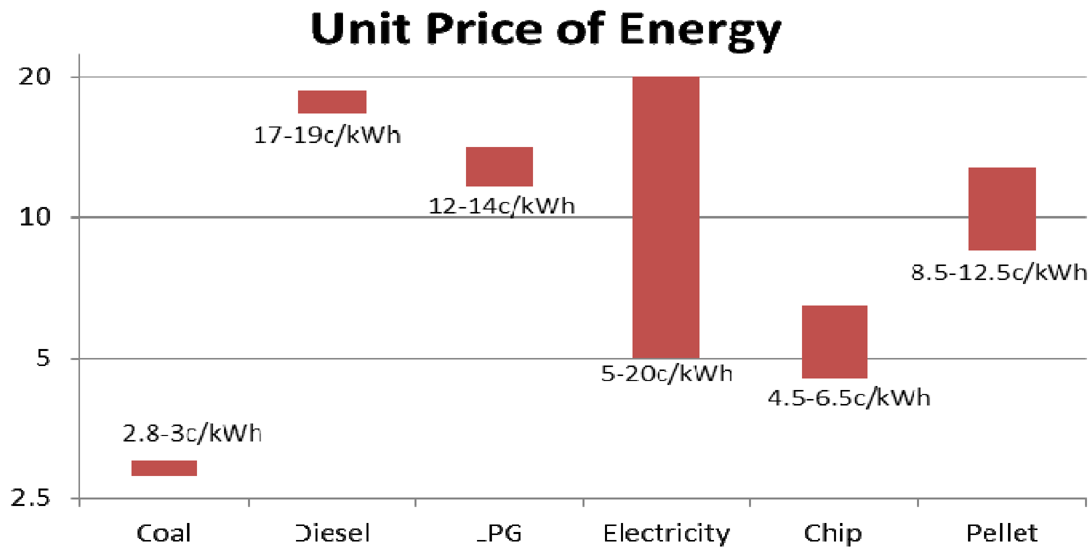


Figure 16.7 **Unit price of coal, diesel, LPG, electricity and wood fuels in Central Otago businesses and organisations**

16.1 Comments regarding the survey

The challenge of any survey is getting accurate and complete information. The survey contacted approximately 149 businesses with a response rate of 36%. While a survey is an economic means of reaching and getting feedback from businesses, Ahika Consulting Ltd would hesitate to use this method again as a lot of time was invested in the process of getting businesses to respond.

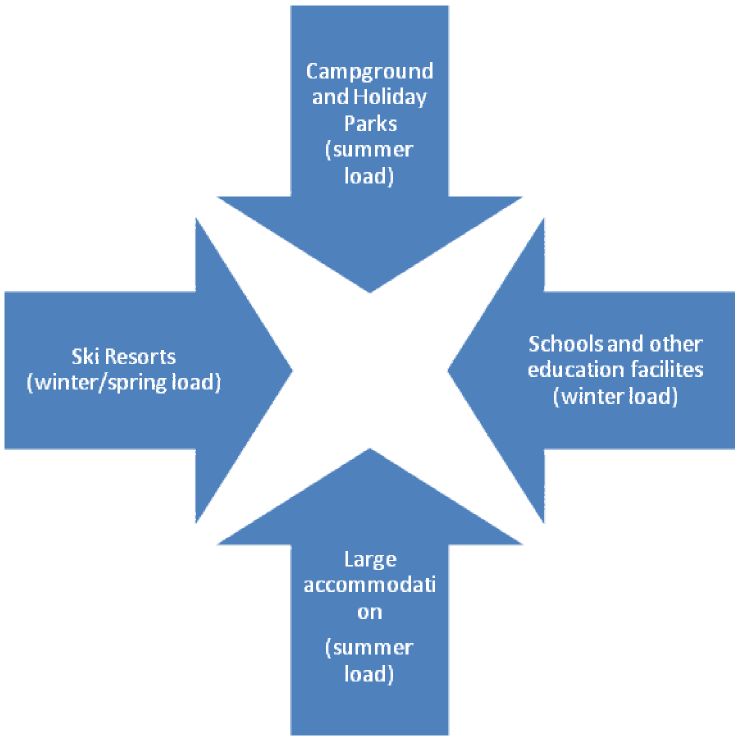
The timing for the survey was slightly unfortunate as it coincided with a busy time for many businesses. One particular sector (campgrounds and holiday parks) was almost entirely unrepresented due to the timing of their busy season and should be revisited to get a better understanding of their energy demand.

The survey was not specifically about the wilding pines but it became obvious from phone conversations with business staff and owners that the issue is important. This observation could be utilised for marketing purposes and increasing uptake of wood fuels in the region.

17.0 Portable boiler systems

Portable boiler systems are available from suppliers for purchase or rent. The boilers are containerised and can be moved accordingly. The Wanaka Pool selected a containerised option because the boiler was likely to be relocated in the future to a new location.

Looking at the seasonal demand profile from the survey (Fig 15.6), there may be an opportunity for seasonal business sectors to share a portable boiler system. Investment in wood boiler plant is expensive which can be a barrier as seasonal demand increases ROI. A portable system will enable businesses to share a boiler which will halve investment costs and maintenance and provide a better business case for investment. The next step would be matching load and seasonal demand. Some potential matches within the sectors are shown in the figure below.



18.0 Outcomes from site visits

Businesses from the survey group were visited to get a better understanding of site location, constraints and the feasibility to convert to wood fuels. The sites are considered a fair representation across the sectors and evenly spread around Cromwell, Wanaka and Queenstown. One site was located in Alexandra.

Sites were assessed based on key criteria such as:

- **Fuel delivery and access -** It is important that fuel can be delivered quickly and easily into bunkers.

- **Plant room space -** Biomass boilers and associated infrastructure are significantly larger than traditional LPG, diesel or electric boilers.
- **Location of bunker -** Fuel bunkers should be in close proximity to the boiler and of sufficient capacity for at least 5 days' supply depending on the fuel type.
- **Fuel type -** some sites may be better suited to pellets and others wood chip.

	No	Fuel delivery/access			Location of bunker			Plant room space			Fuel type	
	sites	Easy	Possible	Difficult	Easy	Possible	Difficult	Good	OK	Poor	Chip	Pellet
Winery	3	3			2	1		2	1		3	
Schools	3	3			3			3			3	
Commercial	1	1			1				1			1
Accommodation >30	7	3	2	2	2	3	2	2	2	3	3	4
Industrial	1		1			1			1		1	
Ski Field	2	1	1			2			2		1	1
Pools	2	2			2			2			2	
Accommodation <30	2	1	1		1	1			2			2
Total	**21**	**14**	**5**	**2**	**11**	**8**	**2**	**9**	**9**	**3**	**13**	**8**

Table 18.0 Results of site assessments

Figure 18.1 Accommodation site with difficult topography and access for boilers and bunker storage

Figure 18.2 Pool site- LPG boiler (300kW- less than 10 years old) located in ex-coal boiler house with easy access and bunker storage

Of the 21 site visits more than 60% were able to utilise wood chip. The remaining sites had storage space or fuel delivery constraints making pellets a more viable, but still not necessarily easier, option.

In summary, the following conclusions have been drawn:

- **Wineries, Schools, Pools** - Good space for plant and fuel deliveries.
- **Ski fields** - Sufficient space for fuel deliveries but constrained plant room space.
- **Commercial** - Reasonably good space for plant and fuel deliveries.
- **Accommodation -** Accommodation sites need to be assessed on a case-by-case basis but larger sites in close proximity to other buildings or the town centres (Queenstown) appear difficult to convert to wood fuels.

18.1 Key drivers and concerns

Almost 85% of businesses surveyed identified the on-going operating costs of their heating process as being very important. This is also linked to financial performance as 68% identified return on investment as being equally important. Of the businesses which featured in these two statistics, more than half were using diesel or LPG, which is favourable for wood chip as both these factors are key benefits of converting.

The greatest concern to businesses considering switching to wood fuels is security of local supply. This is not surprising since the industry is still relatively under-utilised in Central Otago and business confidence is not there yet. The recent sale of Wood Energy NZ - the majority supplier of wood fuels in Otago - to

Pioneer Generation (ex-Otago Central Electric Power Board) may provide more certainty to businesses over time.

Capital expenditure is another very important consideration for businesses and this may be seen as a barrier since biomass boiler projects are expensive. At least one potential biomass boiler project in Queenstown (large accommodation) has been on hold for the last few years for this reason.

Air quality also featured as being very important to businesses and could be considered both a driver and concern. Concerns from larger accommodation providers related to the perceived nuisance of smoke (visual and odours) to clients and the impression this may have on them. While the combustion efficiency (emissions and smoke) of new biomass boilers is proven, the concern is a valid one for businesses that are firstly, unfamiliar with this type of technology and secondly, competing for clients in a difficult economic market.

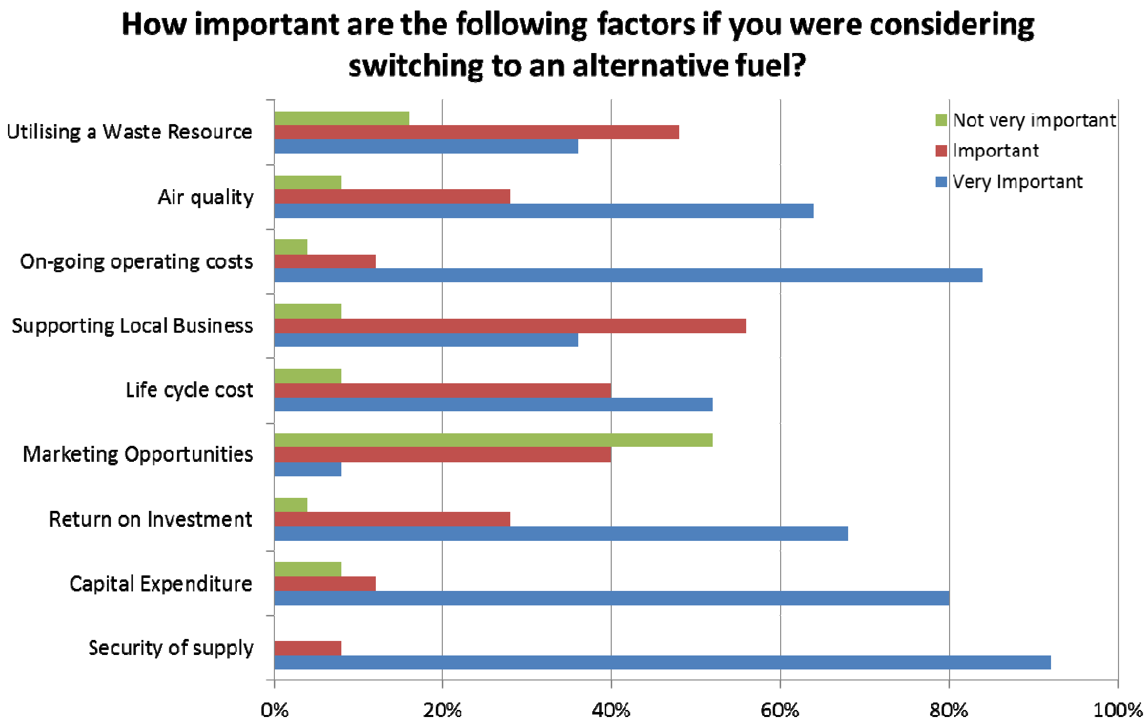
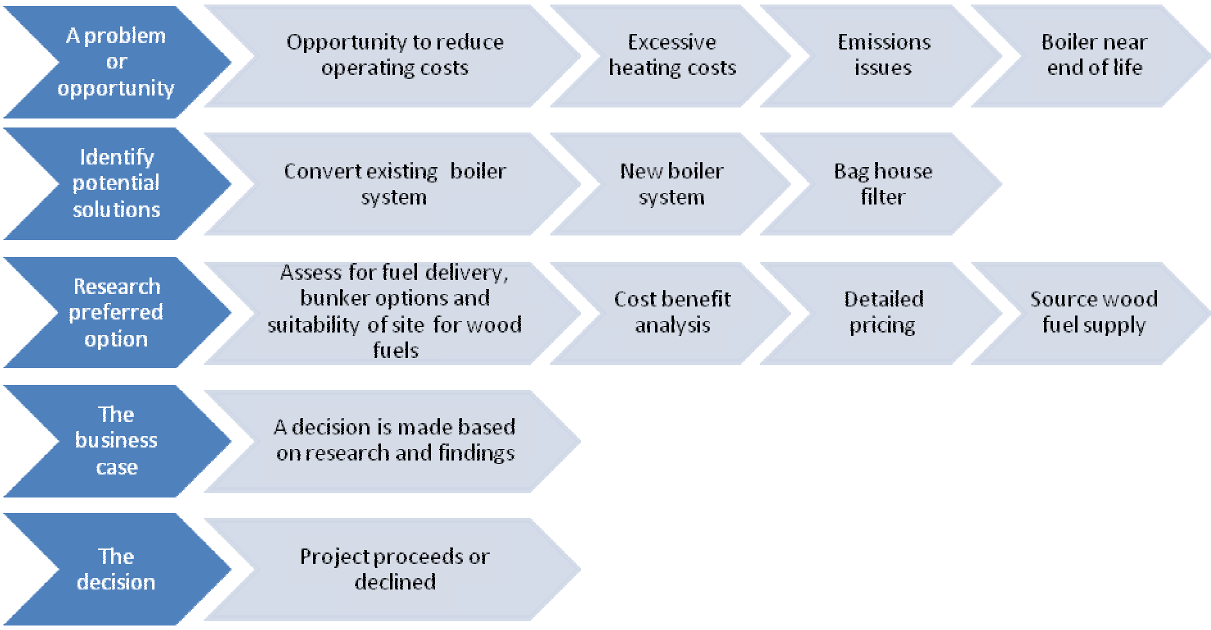


Figure 18.3 **Feedback from survey**

19.0 Business case for converting to wood-fuels

As with all business-related investment projects a due process is usually followed. To look at the process simply it would look something like this:



In most cases, a successful outcome (converting to wood fuel) is based on financial performance but there are some sectors with other equally important criteria. For example, the wine industry has seasonal and low demand for energy which would indicate longer ROIs. Regardless of this, at least two wineries in Central Otago (Mt Difficulty and Rippon) have installed wood boilers. Other factors (such as environmental responsibility, point of difference, market leadership and marketing) have helped these projects to proceed. The fact that these wineries are also exporting to Europe and are likely to have an awareness of consumer expectations may also be a factor.

EECA's Renewable Heating in Schools Programme[12] provides funding support grants and interest-free loans to improve the business case for schools (Dunstan College) to convert but there were other factors which played on the final decision too, namely consenting issues and perceived environmental responsibility (to use a fuel with the least impact on the environment).

Another example is a large accommodation site in Queenstown which was assessed for wood fuel. The financial performance of the project was very positive but the project never proceeded because of space issues. So this is a case where financial performance was not sufficient for the project to proceed.

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[12] EECA pilot programme which ran from 2007 to 2010 with support from MinEdu and MAF

This demonstrates that the business case for wood fuels is reasonably dynamic, based on a mix of financial performance (potential energy savings and ROI), environmental responsibility, funding support, capital available, consenting requirements and technology gains.

Table 19.1 was developed to get an understanding of potential 'first off the block' sites. Sectors were assessed economically and technically based on site visits and survey information. Table 19.1 indicates rest-homes, council pools and large accommodation sites as favourable sites, which is not surprising since these sectors have year-round energy use. Nevertheless, schools and small accommodation are other opportunities worth pursuing.

Sector	Is it technically feasible?	Is it economically feasible?	Likely return on investment (ROI)	Comments
Schools	Yes	Yes- diesel and LPG	< 8 years	Coal boilers can be converted to wood fuels safely
Wineries	Yes	Marginal	> 10 years	Other factors may be just as important
Large accommodation	Not all sites	Yes	2.5- 5 years	District heating may be an option for some sites in Qtwn
Small accommodation	Not all sites	Yes	4- 8 years	More suited to wood pellets
Rest-homes	Yes	Yes	3- 6 years	Year-round energy use
Holiday parks/ campgrounds	Yes	Not all sites	5- 10+ years	Works best for year-round sites
Council pools	Yes	Yes	4- 6 years	Year-round energy use

Table 19.1 **Technical and economic assessment of sector groups for conversion**

20.0 Quantification of potential demand

Potential demand over time has been quantified based on responses from the survey. Approximately 17 surveys did not fully complete this part of the survey. For these sites, assumptions have been made based on values provided from other sites (within the same sector) or our own experience from working with these types of sites.

Potential demand is based on:

- Life expectancy of existing boilers being 20 years
- Conversions of existing coal boilers to wood chip
- Converting boilers which are likely to be economic based on avoided fuel costs (newer LPG and diesel boilers)
- New schools proposed for Shotover Country School (2015), Jacks Point (2015) and Remarkables Park (2017)[13]
- Annual energy demand from businesses remains consistent over time
- Boiler efficiency has not been considered
- The demand does not include existing wood chip being delivered to Central Otago or the conversion of Dunstan Hospital
- 25%MC wood chip (15.4MJ/kg)

Three trends have been plotted over a 20-year period starting in 2013.

- **Maximum Uptake -** This is the maximum uptake of wood fuels that is possible within the survey group
- **Best-case Scenario -** This scenario is considered the best case and is a reasonable but challenging target
- **Low uptake -** This scenario is conservative and should be the minimum achievable target

These potential scenarios do not take into account existing wood fuels being supplied into Central Otago. While Dunstan Hospital has not yet been converted, it is expected to be finished before spring 2013 and the wood-supply contract has already been awarded to Wood Energy NZ. So Dunstan Hospital is not included in these demand trends. So to interpret Fig 8.1, the various trends show potential new demand for wood fuels. To achieve this, three time stages are proposed that will achieve the best case scenario profile.

[13] Otago Daily Times, Jack Point preferred site for new school, 01 May 2013

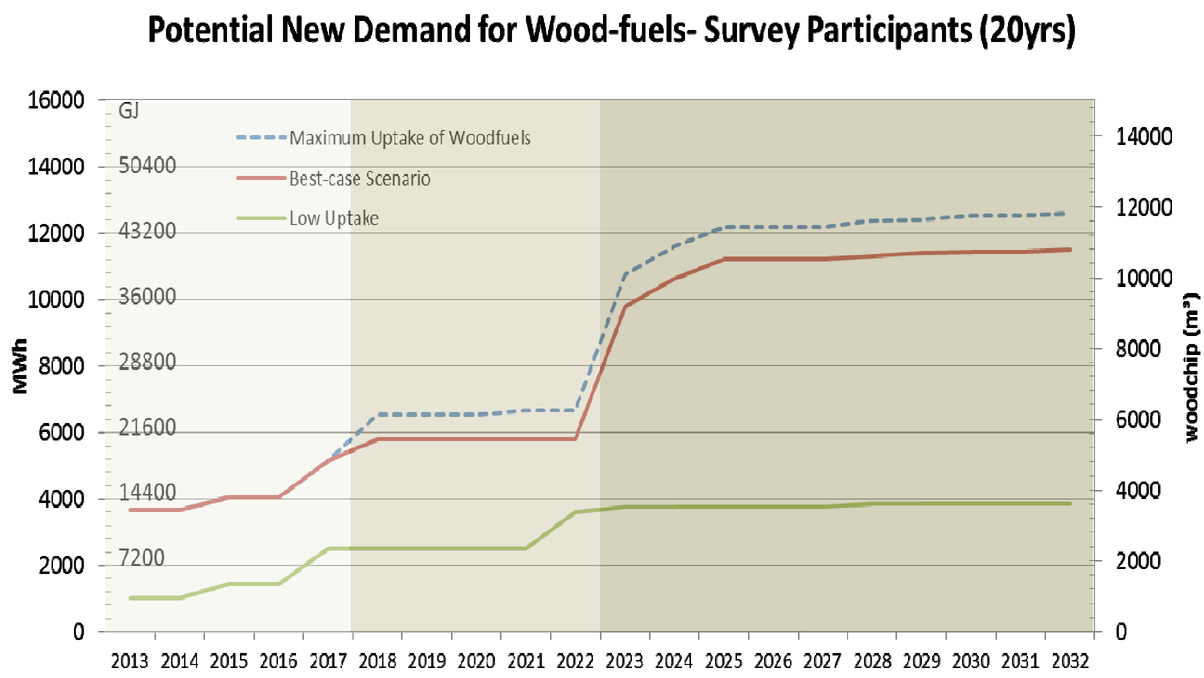


Figure 20.1 **Demand scenarios for potential new wood fuel divided into three time stages**

Best-case	Sites	Reason to convert system	Best fuel
Stage 1	Mt Aspiring College	Near end of life	Chip
2013 - 2017	Cromwell Pool	Avoided fuel cost	Chip
	Coronet Peak	Avoided fuel cost	Chip
	Jacks Point School (new)	Greenfield project	Chip
	Shotover Country School (new)	Greenfield project	Chip
	Central Otago Health Services	Near end of life	Chip
	Cromwell College	Near end of life	Chip
	Lakes Leisure Ltd	Avoided fuel cost	Chip
	Oakridge Resort	Avoided fuel cost	Chip
Stage 2	Queenstown School	Avoided fuel costs	Chip
2018 – 2022	Cromwell Primary School	Near end of life	Chip
	Queenstown Airport	Avoided fuel costs	Chip
	Remarkables Park School (new)	Greenfield project	Chip
Stage 3	Southern Lakes Laundries	Near end of life	Chip
2023 – 2032	Hilton Queenstown	Near end of life	Pellet
	Heritage Hotel	Near end of life	Pellet
	Lakes District Hospital	Near end of life	Chip
	Edgewater Resort	Near end of life	Chip

Figure 20.2 Timetable of sites for conversion to wood fuels – best case scenario

20.1 Extrapolating demand in Central Otago

Extrapolating demand across the sector groups in Central Otago has been based on survey results. Our best estimate for potential demand in Central Otago is 22,500 MWh or 21,000m³ seasoned chip. The following assumptions have been applied:

- Several new schools are planned in the near future and 27% of existing schools (with a roll greater than 155 pupils) are currently using diesel or LPG for heating
- At least 2 wineries to convert to wood fuels
- 15 small accommodation sites will be suitable to convert
- 3 campgrounds are suitable for conversion to wood fuels
- 1 ski field is suitable for conversion
- 15% of rest-homes convert to wood fuels
- 3 large accommodation sites can convert to wood fuels
- Two potential new commercial developments

21.0 Demand and supply scenarios

Three scenarios have been provided as a potential path to implementing a wood-energy cluster in Central Otago. The scenarios take into consideration low-hanging demand and matching this with existing supply within the district. Wood fuel volumes expressed in energy content (MWh) are outlined:

Annual wood fuel available	2013-2018	2019-2028	2029- 2038
Queenstown (MWh)	4,639	4,183	29,447
Central Otago District (MWh)	15,401	13,989	11,551
Total fuel availability (MWh)	*20,040*	*18,172*	*40,998*
Other waste resources			
Luggate Sawdust (MWh)	3500-4500		
Luggate Chip (MWh)	3200-4200		

Table 21.1 Annual wood fuel volumes represented in energy content (MWh)

The following figures for demand have been developed based on Table 20.2.

Annual energy demand (cumulative)	Woodchip	Pellet	Total (cumulative)
Stage 1 (2013-17) MWh	3,796	-	3,796
Stage 2 (2018-22) MWh	5,484	-	5,484
Stage 3 (2023-2032) MWh	7,235	3,026	10,261

21.2 Annual energy demand for demand scenario 2013- 2032

From Tables 21.1 and 21.2, available supply and demand have been matched respectively. There are more than sufficient volumes of wood fuel available in the district.

Conclusions:

Stage 1 (2013-17) has annual demand of 3,800 MWh which could be met by Luggate, Queenstown or Central Otago.

Stage 2 (2018-22) increases volume to 5,500 MWh and a combination of supply options are available to meet this demand.

Stage 3 (2023- 2032) increases demand to 10,261 MWh as a combination of woodchip (7,235 MWh) and Pellet (3,026 MWh). This demand is easily matched with Central Otago or Queenstown supply. There is also sufficient supply of sawdust from Luggate to meet the demand for pellets if it was still available in 2023-2032.

22.0 External factors which could affect demand for wood energy

Several factors have been identified and discussed below:

Ministry of Education (MinEdu) Funding - Of the dozen schools that completed the survey, only 25% were using high-cost fuels (diesel and LPG). The balance was using electricity or coal heating plant. MinEdu funding is structured in a way that makes it reasonably easy to implement a boiler upgrade (capital works funding) but difficult to get an increase in the Operations grant (OPS) which covers the on-going costs of the boiler. According to MinEdu's Brian Tegg[14] the OPS grant is generally fixed at 2009 levels (plus adjustments for CPI) and it is difficult to get increases unless there are outstanding circumstances. So any over-spending in the heat, light and water funding allocation must come from somewhere else in the OPS budget. Conversely any under-spending becomes a surplus in the budget.

This structure can have positive and negative effects on demand as **schools using high-cost fuels** are likely to create surpluses in their energy budget by switching to wood chip fuels. However, it may be difficult to switch **schools using low-cost fuels** (coal) despite these schools having existing infrastructure suitable for converting as it will impact on their OPS budget.

Otago Regional Council Air Plan - Under the existing Air Plan rules an LPG or diesel boiler is a permitted activity up to 5MW while a wood boiler has a maximum heat capacity of 1MW. Currently the air plan makes it a discretionary activity if a large diesel or LPG boiler (greater than 1MW combined capacity) was to convert to wood fuel. This means a resource consent is

[14] Brian Tegg Pers comms 19 March 2013

required and potentially some type of emissions filtering which increases the cost of the project and may impact on uptake. Only three sites surveyed had a load greater than 1MW. Two of the sites were larger accommodation sites and it is likely that there are several other accommodation sites that may be affected by this. The ORC requests submissions to the Annual Plan during May, which sets up the work plan for the following year. Reviews of current rules would need to be flagged up through this process and a case put forward for an amendment.

Energy resilience - Central Otago is a region heavily reliant on supply from major towns and ports in Dunedin and Invercargill. Energy resilience would be a main concern if these routes were cut off for extended periods of time. While this is a factor that is unlikely to impact on demand directly, it certainly provides a case for having a local source of wood fuel manufacturing and energy generation (heat or electricity).

Price changes for LPG and diesel - LPG and diesel prices are influenced by the US$ exchange rate and the international price of the commodity. Both of these factors can change at any time. Price increases favour a change to wood fuels.

23.0 Barriers and enablers

Though demand is currently low, Central Otago benefits from the existence of a wood-energy industry. However, the challenge is to stimulate demand to a tipping point where wood fuels are considered another option alongside traditional fuels. The following factors identify potential barriers to achieving this tipping point.

- **Installation cost for SMEs -** It is difficult to get the numbers to stack up for most small businesses because of the high capital expenditure. For these small and seasonal enterprises, a shared boiler option may be a solution so it would be a matter of finding suitable other businesses with demand during alternative seasons.

- **Unwillingness of owners/organisations to replace new heating infrastructure -** The age of the boiler stock is reasonably new and almost 75% of all boilers in the survey were 10 years old or less. While it is economic to replace boilers when they are near the end of life, it can also be economic to replace newer boilers as a method of avoiding fuel costs. Business owners and organisations may not be willing, initially, to remove a recently installed boiler system. However, this can be overcome by providing detailed cost-benefit analysis.

- **Rest-homes using electric heating –** Rest-homes are considered a low-hanging fruit for converting to wood fuels because of their consistent energy demand. However, all the rest-homes surveyed are exclusively heated with electricity. The cost of converting to a wood fuels system is much higher as the infrastructure is not in place. This may be perceived as a significant barrier to convert. One potential solution is to use a build own operate transfer (BOOT) model which companies like Energy for Industry (Owned by Pioneer Generation) normally use for larger-scale projects. EFI finances the project and sells the energy back to the client and eventually the ownership is transferred to the client.

- **Alternative heating options -** There are other alternative heating options for low temperature heating applications like under-floor and pool heating that may compete with wood fuels. Geothermal heating using heat pumps is well proven and becoming more widely used in commercial applications. Alexandra and Wanaka have reasonably low water tables where water-source heat pumps could operate efficiently year round.

Some factors which may promote demand include:

- **Wood fuel demand from new schools** - At least three new schools are planned over the next four years in Queenstown. The projects are part of new developments and can be customised for wood fuels. It is vital that these schools are encouraged to use wood fuels and the architects and engineers involved must be approached and supported to ensure wood fuels are considered. There are also likely to be budget surpluses available in the OPS grant by fuel switching from pellets to chip as an incentive.

- **School's Operation Grants funding-** Another way of encouraging schools to convert to wood fuels is to assist with topping up their Operations Grant heating budget. Schools are able to get Ministry support for capital expenditure but shifting fuels from coal to wood fuels will result in a budget increase within the ops grant.

- **Biofuel champion business group -** There are several potential medium-to-large-scale projects in Queenstown that could be developed further into a biofuel champion business group. Businesses invited to be part of the group should be provided with exclusive funding to investigate and implement wood-energy projects.

- **Coal conversion opportunities -** There are several large schools operating on coal boilers which will need replacement within the next few years. Coal boilers are ideally configured with bunkers and the necessary infrastructure for converting to new wood boilers.

- **Increase wood-energy knowledge of business owners/managers -** Feedback from the survey suggests a number of businesses want to know more about wood energy or have indicated they do not know enough to be able to comment on wood fuels. Businesses are keen to visit working sites, see how they operate and to speak with the owners and staff first-hand. A site visit/information day could be arranged to cater for business owners' requirements.

- **Commitment from local Councils -** There are numerous examples of councils in the United Kingdom that have converted assets such as council flats, offices and schools to wood fuel as a way of creating initial demand to develop a viable industry. In Barnsley Council, Yorkshire this resulted in the creation of a new wood supply company[15]. Both CODC and QLDC have assets that require consistent demand and high-energy use, making them ideal as sites to establish baseline demand and also to show Council leadership and support for the development of this industry.

- **Council incentives and enabling policy -** There doesn't appear to be any policies/strategies which support renewable energy within the CODC or the QLDC. Supportive and enabling Council policy will help to encourage demand for wood energy. Likewise, incentives for early adaptors may encourage further demand. Such incentives could be in the form of rates relief, project funding or a low-interest loan scheme.

[15] Barnsley MBC, UK 2006, The Ashden Awards Case Study

Appendix 1- Energy Survey

Information about your business

- Name of business/organisation
- Business address
- Contact details
- Sector

Information about your heat process

- Type of heat process(es)
- Type of fuel
- Type of heat source

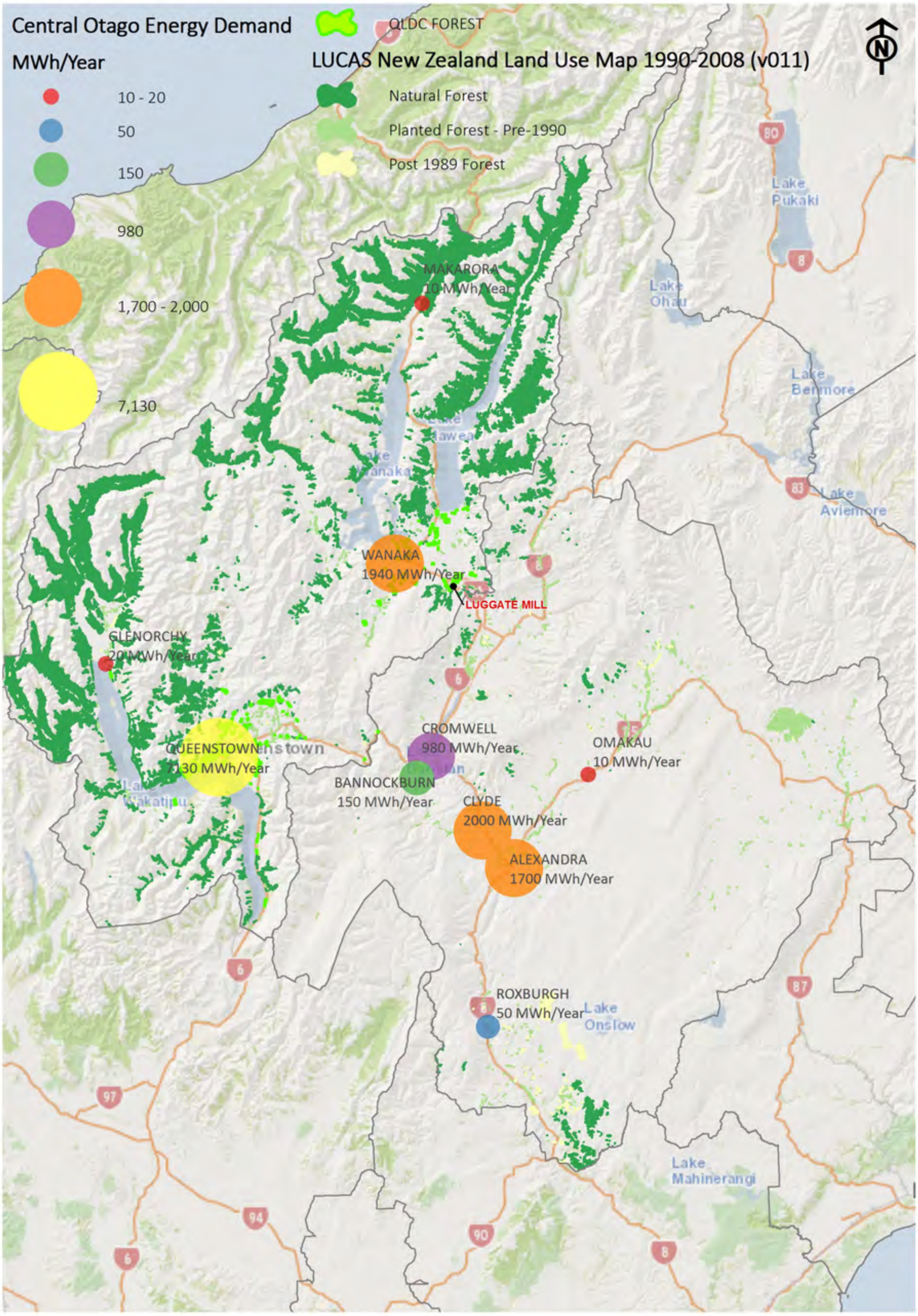
Information about energy use (in relation to the main heat source)

- Many organisations have more than one source of energy use. Please write down the name of your main heat source to which this information relates:
- Age and condition of heat source
- Condition
- What is the rated capacity of the heat source
- Average monthly energy cost
- How much do you pay for a single unit price?
- Average monthly energy use
- Which one of the following categories best describes your energy profile (check whichever one(s) apply.

Drivers, barriers and your perception of alternative wood fuels

- Would an alternative fuel source such as wood chip or pellets be of interest to your organisation?
- Would space be an issue at your site?
- How important are the following points to your organisation if you were considering switching to an alternative wood fuel source (rate not very important to very important):
- Economic return criteria
- District heating and any final comments
- Are you familiar with the concept of district heating?
- Would district heating be of interest to your organisation if a system was available in your area?

Appendix 2: Demand and Supply Map



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