Contents

Acknowledgements
A number of people have made contributions to the preparation of this report.

EMANZ would like to acknowledge Emsol who prepared the initial version of this report. In addition, Energy Solutions Ltd, Veritas Business Services, Enercon Ltd, and John Anderson Energy Consultant and Spotless Services NZ Ltd reviewed and provided comments on the report.

Disclaimer

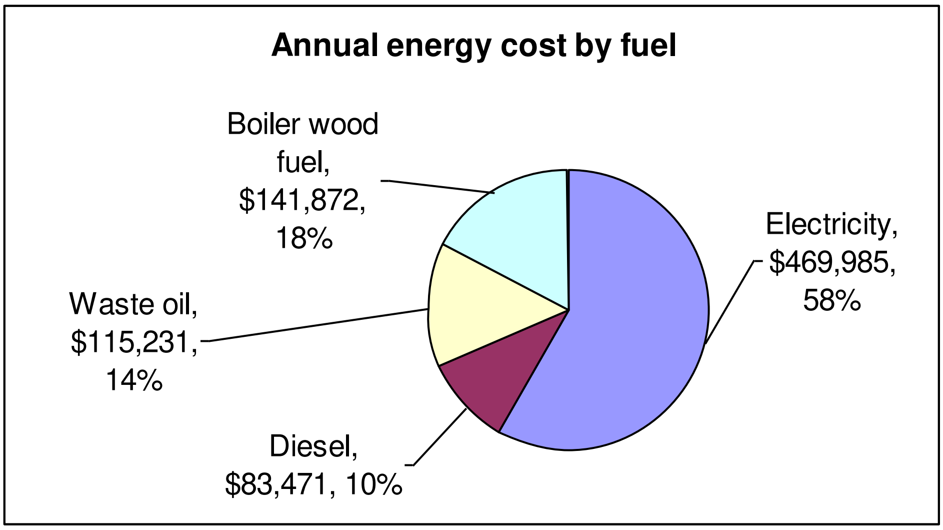
Although the data and information in this model report is representative of a real situation the values and names in the report are fictitious. **Names and data** in this report **should not be used as a reference.**

EMANZ has provided this model audit report to indicate an acceptable standard of a Level 2 energy audit and it should be used for this purpose only. EMANZ or the authors of the report will not accept any liability for how the data and information in this report is applied. The calculated savings or other values in this model can not simply be used in other audits.

1. Executive Summary

Wood Processor's mill was surveyed in August 2004.Energy costs were $810,560 in the year ending June 2004. At current energy prices**, savings between $39,000 and $158,000** a year could be achieved by adopting a number of savings initiatives, with an IRR more than 15%. These are summarised in Tables 1.2 and 1.3 on the following pages.

The proportions of energy costs and energy use are summarised below.



Energy use and costs (July 03 to June 04) excl GST

Fuel	Cost per year	Usage per year (kWh)	'Gross average cost' (c/kWh)
Electricity	$469,985	3,460,212	13.6
Wood fuel	$141,872	47,363,056	0.3
Diesel	$83,471	1,266,479	6.6
Waste Oil	$115,231	3,973,793	2.9
TOTAL	**$810,559**	**56,063,539**	**1.4**

The site used 56 GWh of energy in the 12 months ending June 2004 while it produced 44,129 m^3 of timber. This energy use is relatively high for a site involved in this type of activity and volume of output. Refer to Table 1.1 and below for a break down of energy type, quantities used and energy use index.

Although the site is very good at switching off plant that is not being used during production times or break times, a large number of savings would be achieved and maintained by adopting a formal energy management programme. This was discussed with the Engineering Manager and would include designating a person part time to coordinate the programme. It would also include installing an energy monitoring and targeting system, establishing a staff focus group with energy responsibilities, adopting a site energy policy and plan and raising awareness among staff.

Table 1.1 – Summary of Annual Energy Usage

	Production (m^3)	Annual Usage (MWh)	Energy Use Index ($kWh/m^3/year$)	Annual Cost ($)	Energy cost saved ($)
July 03–June 04 Total energy	44,129	56,064	1,270	$810,558	
If T1 met	44,129	55,655	1,261	$771,748	$38,810
If T1 and T2 met	44,129	48,869	1,107	$652,600	$157,958

The **Energy Use Index is 1270 kWh/ m^3 of mill output**, which is particularly high. It is 40% more than another mill that uses both a treatment plant and kilns audited recently in New Zealand. The high energy use at Wood Processors is a result of the unusually high use in providing heat to the kilns.

The **Electricity Use Index is 78.4 kWh/ m^3**, which is average; and less than most other mills audited recently in New Zealand.

However the electricity index has varied between 61 and 90 kWh/m^3 on a monthly basis. The variations indicate control of electricity use can be improved and potential for savings are available. New Zealand benchmarks range between 62 and 97 kWh/ m^3 and a target would be 62. Note however the proportion of timber dried, treated and planed will affect this and these processes should be monitored separately with their own target EUIs.

A summary of energy saving opportunities listed in Tables 1.2 and 1.3 below are grouped as:

T1 - energy savings opportunities achievable by proper housekeeping with present plant and processes (mostly no and low cost opportunities and little change to equipment)
T2 - energy savings opportunities achievable by cost effective investment in improved plant and processes (mostly higher cost opportunities with changes to equipment)

Capital costs are estimated. Firm quotes should be obtained from suitable suppliers before capital works are undertaken. Further investigation of some energy saving opportunities is required where indicated.

Wood Processors Ltd advised that acceptable projects will have an IRR of 15% or more. Each initiative is checked that the IRR is 15%, given its lifespan and payback period.

Table 1.2 – T1 "Housekeeping" Energy Saving Opportunities

Ref.	**Target 1: Operational or housekeeping measures**	**Estimate Cost**	**Annual Savings**	**Pay-back Yrs**	**Life Yrs**	**> 15% IRR?**
4.2.1	Upgrade power factor correction equipment on Transformers 3 and 4 to achieve 96%	$16,750	$16,056	1.0	5+	YES
5.1.1	Balance phase voltages at main motor switchboards	$250	$2,242	0.1	1+	YES

Ref.	Target 1: Operational or housekeeping measures	Estimate Cost	Annual Savings	Pay-back Yrs	Life Yrs	> 15% IRR?
5.1.2	Regularly stop compressed air leaks	$1500	$3120	0.5	1	YES
5.1.2	Use air hoses less and use blowers and brooms instead	$400	$526	0.8	5+	YES
5.2.2	Stop six steam leaks	$2460	$5065	0.5	2	YES
5.2.2	Insulate 40 exposed steam valves, flanges and 10m pipe	$7700	$3138	2.5	4+	YES
5.3	Link planer fan switch to planer operation	$450	$1865	0.2	5+	YES
5.5.1	Replace ten incandescent lamps with Compact Fluorescent lamps.	$50	$245	0.2	3	YES
5.5.2	Make an operator in each area responsible to switch off lights at times not being used.	$500	$2,475	0.2	1	YES
6.1 6.2	Adopt an energy policy and plan and establish a part time energy coordinator	$20,000	Catalyst for other savings		1	
	TOTAL		**$38,810**			

Table 1.3 – T2 "Capital Investment" Energy Saving Opportunities

Ref:	Target 2: Retrofit Measures	Estimate Cost	Annual Savings	Pay-back Yrs	Life Yrs	> 15% IRR
3.5	Measure fuel into boiler and install steam meter, keep boiler 2% more efficient	$15,300	$15,100	1.1	4+	YES
5.2.1.1	Replace sawdust dryer to boiler duct fan motor with smaller high efficiency motor	-$75 NPV	$495	0	12	YES
5.2.2	Increase boiler efficiencies from 75% to 78%: increase frequency of tuning, add heat recovery, improve fuel/ air control	$130,000	$29,000	4.5	9+	YES

Ref:	**Target 2: Retrofit Measures**	**Estimate Cost**	**Annual Savings**	**Pay-back Yrs**	**Life Yrs**	**> 15% IRR**
5.2.3	Repair kilns and then educate operators to load packs to best practice.	$15,000	$77,800	0.2	2+	YES
5.2.3	Use VSD on kiln fans to reduce fan speeds controlling to timber moisture or temperature drop across load	$20,000	$13,640	1.5	8	YES
5.5.1	Upgrade 18 self-ballasted mercury lamps to metal halide lamps	$7,200	$1,888	3.8	4	N
	Install energy monitoring and targeting system	$30,000	$16,000	1.9	4+	YES
	TOTAL (note not all mutually exclusive)		**$137,221**			

Notes

1. Peak load savings are included and are based on the tariff charges currently in place by the lines company. As derived in Section 4.1.1 these are calculated at **$110** per kVA peak per year. Where the peak load is achieved in 'summer' months only then it is calculated at $30 per kVA peak per year. **Important:** When controlling to a target peak load it needs to be continuously maintained and particularly for four month(s) during winter demand charge times.

2. Electrical energy savings are calculated at a rate of (between **10.3** and **11.1**) cents/kWh, being the marginal cost, depending on time of day; refer to *Section 4.1.2*.

3. Waste oil savings are calculated at a rate of **2.9** cents/kWh being the marginal cost of waste oil.

4. Diesel savings are calculated at a rate of **6.6** cents/kWh being the marginal cost of diesel.

5. Wood waste fuel for the boiler savings are calculated at a rate of **1.5** cents/kWh being the marginal cost of the most expensive boiler fuel (ie dry shavings) bought in.

6. Steam savings are calculated at a rate of **2.5** cents/kWh being the marginal cost of the most expensive boiler fuel and factoring in steam and boiler efficiency losses and other boiler costs such as chemicals for the boiler water.

Other energy saving ideas needing further investigation include:

- Purchase the most energy efficient kilns eg those with high insulation, low resistance air flow, quality baffles and VSDs on fan motors
- Add dust collection hopper to band saw

2. Introduction

Tom Brown, Engineering Manager at Wood Processors commissioned EMANZ Accredited Energy Auditors in July 2004 to carry out an energy audit of its site near Tapawera. Joe McDonald of Energy Auditors surveyed the site, analysed opportunities and completed this report.

Wood Processors is a mill that processes Pinus Radiata. It has a treatment plant and kiln drying facilities. Approximately one third of timber is treated and most of it is dried.

The objective of this energy audit is to provide sufficient information for a plan of action to achieve energy cost and consumption saving. It is carried out to a Level 2 standard in accordance with AS/NZS 3598:2000 Energy Audits, which specifies an accuracy of ± 20%

Wood Processors advised that acceptable projects will need to have an IRR of 15% or more.

Tariff analysis and a desk-top audit of energy use were undertaken in July 04 once electricity records from July 2003 to June 2004 were obtained. Site surveys for the energy audit were carried out in August 2004.

The following persons assisted with information for the audit:

Tom Brown	Engineering Manager
Scott Smith	Contracted Electrician
Andrew Duncan	Boiler house operator
Mary Collins	Electricity account records

2.1 Description of production

Wood Processors employs 60 staff and produce 44,000 m^3 radiata timber a year.

The site consists of five main processes:

1 Mill
2 Boiler and Kilns
3 Treatment plant
4 Planer
5 Support services

The site processes Pinus Radiata logs only. The radiata timber production is approximately 3600m^3 per month. This level of production is forecast to stay the same during the next two years.

The radiata logs are debarked, sawn, kiln dried (some is treated and dried again) and planed. Approximately half is sold rough sawn and not planed.

Production is reported in volumes of timber (m^3) when it exits each stage. Timber from the planer is reported as its nominal size. Planed timber is usually smaller than the nominal size.

Production (July 03 to June 04)

Date (month)	**Production (m^3 output at mill)**	**Production of other departments (m^3)**		
	Mill out	Site logs in	Kilns output	Planer output
Jul-03	5,100	10,748	4,950	2,346
Aug-03	3,500	7,363	3,678	1,229
Sep-03	4,102	9,134	4,122	1,739
Oct-03	3,843	7,636	4,718	1,968
Nov-03	3,514	7,200	3,799	1,683
Dec-03	3,000	5,958	3,710	1,759
Jan-04	3,081	6,130	3,700	1,912
Feb-04	3,541	7,069	3,927	1,691
Mar-04	3,290	6,495	3,923	1,844
Apr-04	3,887	7,910	4,146	1,782
May-04	3,652	7,811	3,790	1,509
Jun-04	3,618	7,589	3,984	1,516
TOTALS	**44,129**	91,043	48,448	20,977

Note approximately 31% of timber out from the mill is treated, of which 9,300 m^3 is re-dried in the kilns.

Production times are summarised in the table below. Production in the mill typically starts at 6:00 am and finishes at 4:00 pm (Fridays at 3pm). There are three breaks starting at 9:00 to 9:15am, 11:30 to 12 noon and 2:00pm to 2:15pm. The kilns and boiler are available to operate 24 hours a day seven days a week. Time is spent on cleaning up mostly during production and some cleaning and maintenance one to two hours before and after production. On weekends the Mill operates on the occasional Saturday morning when required.

Area	Weekday start	Finish	Weekend start	Weekend finish
Mill	6.00 am	4.00 pm	Few Sat morning	11:30am
Kiln/ Boiler	24 hours	24 hours	24 hours	24 hours
Sawdust drier (as required)	4am	Midnight (Thursday)	Sunday 4pm	None Saturday
Planer	8.00 am	4.30 pm	At times	Sat mornings
Treatment	6.00 am	4 -10 pm	Some	Some
Workshop	6 - 8 am	6 pm	Varies	Varies
Office	6 - 8 am	5 pm	Some	Some

The hours of kilns operation is also subject to availability of fuel for the boiler. From 4:00pm to 6:30pm there is maintenance in the mill, use of welders and waste belts running or cleaning.

The chipper operates through the 9am and 2pm breaks.

Mill

The mill has the following stages, listed below, each with significant size motors. It processes 380 cubic metres of logs in a workday and uses approximately 90 motors ranging up to 215 kW in size.

1 **Debarker** is the first operation and removes bark from the logs. Logs are carried by conveyors.

2 **Headrig** makes about the first seven sawn cuts (flitches). It includes a “slabber” for chipping the log to give it a square face. The log is held and adjusted into place with hydraulic controlled arms and winched through the slabber and saw.
It recently has the largest motor on site.

3 **Edger** is the main saw for removing rough edges.

4 **Re-saw** which makes cuts to smaller timber sizes.

5 **Chipper** is for producing wood chips from waste.

Compressed air and hydraulics are used to control conveyors and Mill equipment.

Kiln/Boiler

There are six kilns used for timber drying. The kilns are Mazder kilns and steam is circulated through radiators in the kiln to heat the air. Steam is generated by one boiler fuelled with wood residue. Fans are used inside the kilns to circulate air through timber packs. Air circulation induces dry air into, and exhaust moist air out of, the kiln through ceiling vents.

The kilns have between four and nine fans with each having various size motors and fan diameters.

Drying takes 20-40 hours, depending on the volume, thickness, and grade of timber in each pack.

Some of the wood residue fuel is sawdust, which is dried on site in a fuel drying operation; its Sawdust Dryer. Sawdust is blown into a rotating drum where air is heated to dry the sawdust by burning recycled waste oil.

Planer

There is one planer used to dress the timber, one rip saw and one bandsaw in the Planer department.

Compressed air is used to control conveyors and planing equipment controls.

Shavings from the planer and a bandsaw are blown and sucked through a shared ducting system to a storage bin to provide fuel for a boiler fuel.

2.2 Overview of needs for energy

The site uses electricity, wood fuel residues, waste oil and vehicle fuel (diesel).

Most electricity is used by motors to drive equipment for fans, air compressors, hydraulic power packs and water pumps. Electricity is also used for lighting, office equipment, and space heaters.

Wood fuel is used in the boiler to provide steam for drying timber in the kiln.

Diesel is used for forklifts and loaders.

Waste oil is used to dry sawdust as wood fuel for the boiler.

3. Historic Energy Costs and Use

3.1 Gross energy costs

As of June 2004 annual energy cost was $810,559 and its energy content 56.06 GWh. These include an electricity cost of $469,985 and electricity energy content of 3.5 GWh.

Energy use and costs (July 03 to June 04) excl GST

Fuel	Cost per year	Usage per year (kWh)	'Gross average cost' (c/kWh)
Electricity	$469,985	3,460,212	13.6
Wood fuel	$141,872	47,363,056	0.3
Diesel	$83,471	1,266,479	6.6
Waste Oil	$115,231	3,973,793	2.9
TOTAL	**$810,559**	**56,063,539**	**1.4**

The 'gross average cost' is a representative price of each fuel, which is used for comparing differences in tariff options, fuel types or prices at other sites. It includes all fixed energy charges such as electricity 'lines' and 'management fee' and other charges. Note it excludes the costs associated with storing and transporting on site any of these fuels. The marginal cost for each fuel is normally different, which is used for calculating savings, and is defined in Section 4 below on Tariffs.

Electricity cost per unit of energy provided is normally more than the other fuels because it is a higher grade form of energy. Wood fuel costs less than the other fuels because a significant amount is produced as a by product on site and does not have an opportunity value.

The recycled waste oil is Light Fuel Oil supplied by Energy Oils. It has a Gross Calorific Value of 43.6 MJ/kg. It costs 33.75 c/kg.

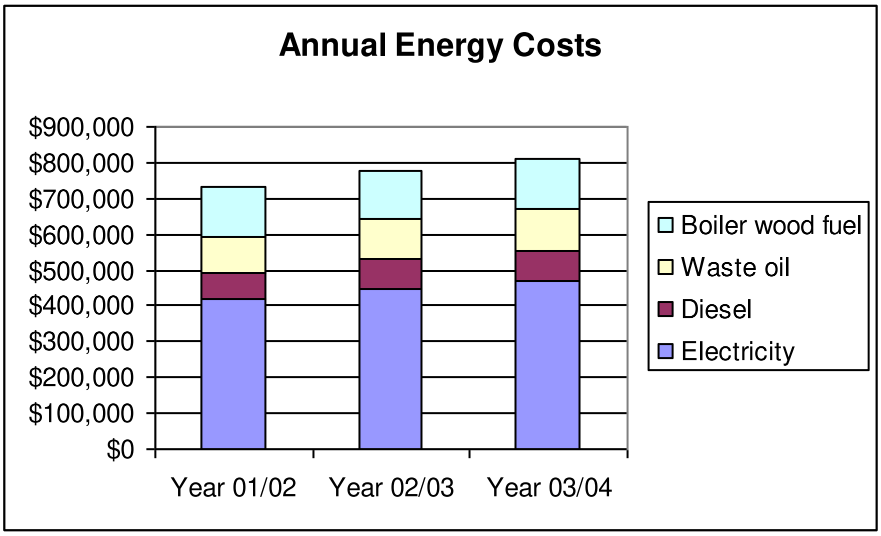
Chip is sold at $35 per tonne and bark at $5 per tonne. These are not used for fuel although could be in future.

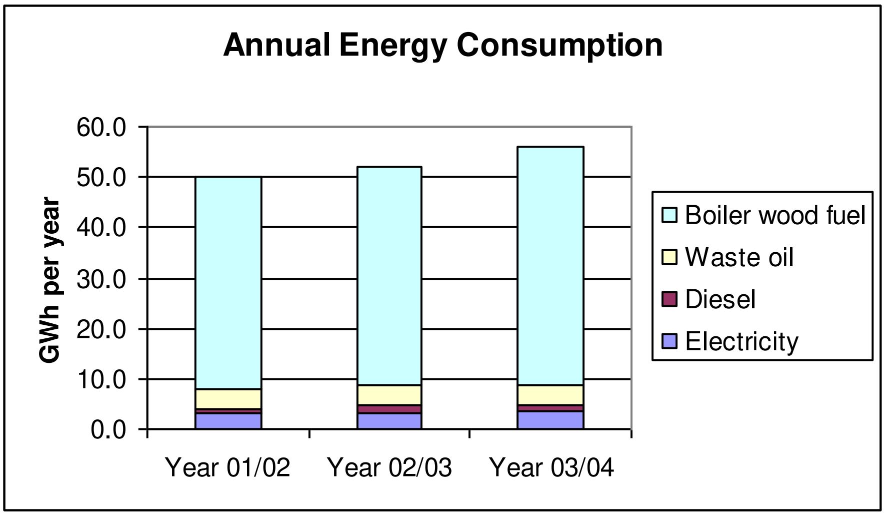
3.2 Annual energy use and costs

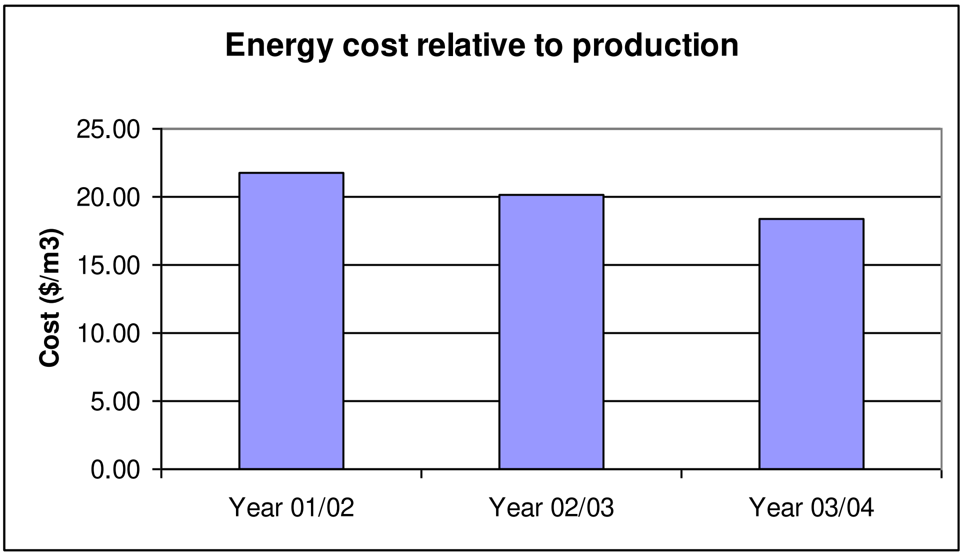
Annual energy costs have increased 11% during the past three years from $730,621 in the year ending June 2002 to $810,559 in the year ending June 2004. This has been largely due to electricity costs increasing, refer to the charts below. In addition, the use of wood residue energy has increased, which also contributed to the energy cost increase.

Note, although electricity costs increased because of price increases by 1.2% most was due to increased electricity use as a result of increased production.

However note also, energy cost per m^3 timber produced reduced 15.7% from $21.80 to $18.37 per m^3 during the two years. Refer to the third chart below. Because energy prices increased, it implies energy use relative to production decreased. As advised by staff, the only changes at site have been an increase in production and therefore there is a fixed component of energy use that is not being affected by production variations. This is likely to be the energy used for lighting and other equipment left switched on after hours.



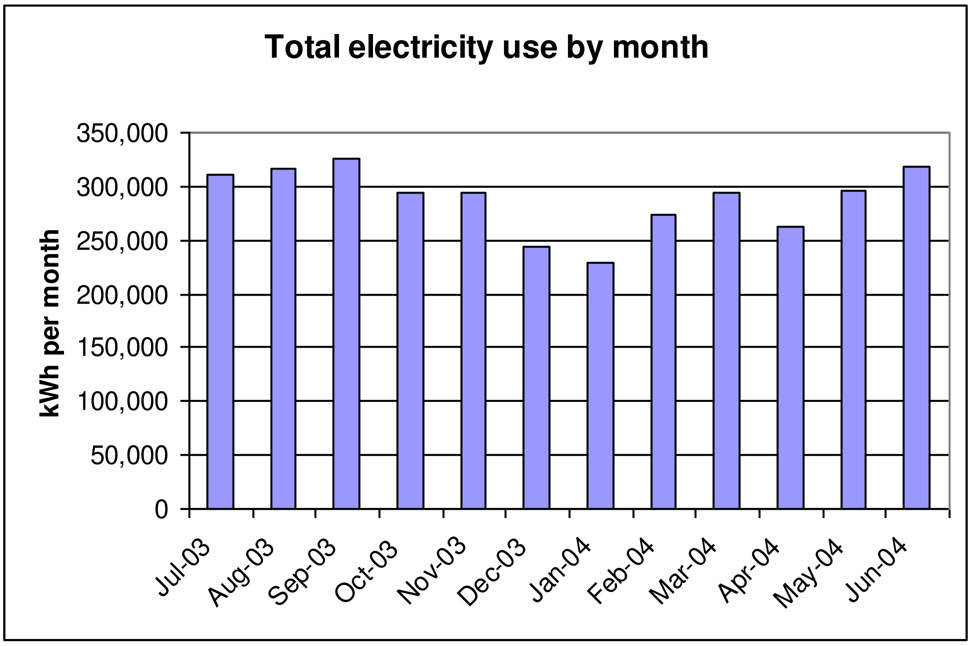




3.3 Seasonal electricity use profile

The figure below shows monthly total electricity consumption for the whole site.

Variations are largely due to production variation which typically occur during holiday periods, and some smaller seasonal variation due to wetness of timber, temperature and daylight hours. This is evaluated further in the section following.



3.4 Energy Use Index

The energy use index for energy across the whole site is 1270 kWh/m^3 for the year ended June 2004. The energy use index is a key indicator of energy efficiency and compares the total energy use (electricity, wood residue, diesel, and waste oil) relative to the volume of timber produced. It is useful to compare yearly, monthly, weekly or even on a daily basis.

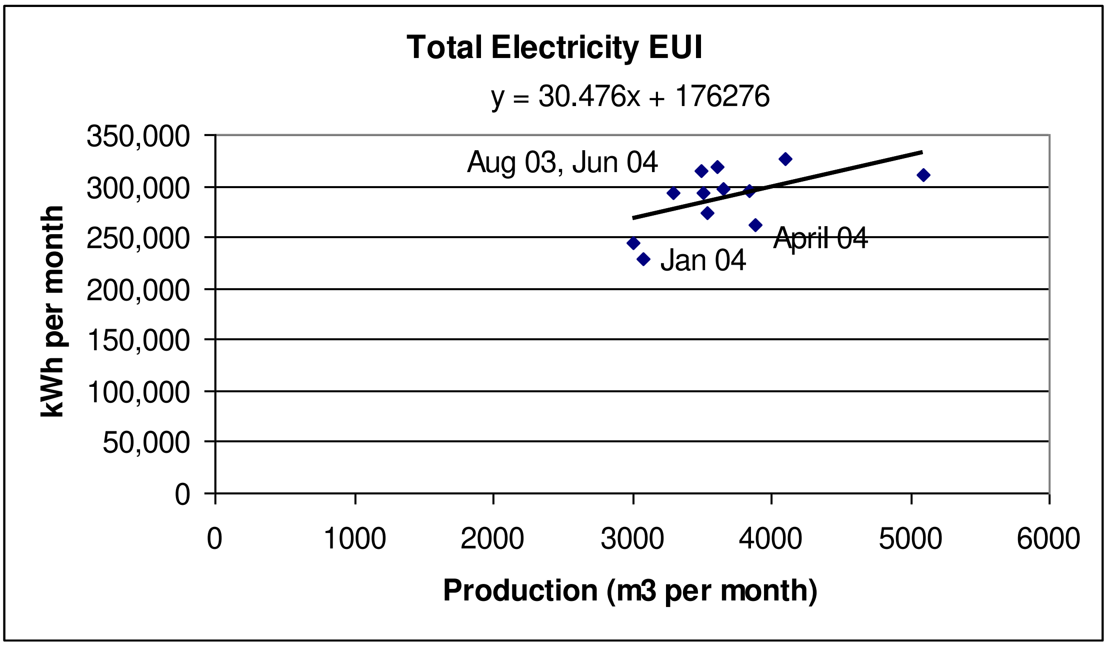
Benchmarks of other mills range from 420 to 750 kWh/m^3 (Ref: NZ Wood Processors Energy Research Centre; 2003) and an audit completed recently by the auditor of a similar mill to Wood Processors, with both treatment plants and high proportion of drying, had a total energy use index of 935 kWh/ m^3. These indicate 1270 kWh/m^3 is high. The indicatively high EUI at Wood Processors is mostly due to a high proportion of timber dried and poor efficiency in timber drying, refer to Section 5.2.

The Electricity Use Index is an efficiency indicator for electricity across the whole site in terms of kWh versus production volume. For the 12 months July 2003 – June 2004 it is 78.4 kWh/m^3 and the chart below illustrates this for each month.

The points for January 04 and April 04 correspond to months of low electricity use compared with production; while the points for Aug 03 and June 04 show a worse than average index corresponding to an increase in electricity use without any increase in production.

These would normally be affected by the relative amount of kiln production however drying was not unusually low or high in these months. Refer to the Production Table, Section 2.1.

This relationship should be monitored closely in future to determine why electricity relative to production for some months is higher than other months.



The large variation from month to month, or scatter, is an indicator in this case that control of electricity usage could be improved. This plot should be continued each month as part of an ongoing monitoring programme. Any variations should be investigated.

Electricity Use Benchmarks

The average electricity EUI at Wood Processors 78.4 kWh/ m^3 is within the range of most published benchmarks or other sites audited (see table below) indicating reasonable overall efficiency. Benchmarks range from 62 to 97 kWh/m^3 and is typically 68 kWh/m^3, which was published by NZ Wood Processors Energy Research Centre (NZWPERC) from a 2003 survey of NZ mills. A recent audit by the author of a similar mill to Wood Processors had an electricity use index of 88 kWh/ m^3.

Reference	**Year data**	**Comments**	**kWh/m^3**
NZWPERC 2003	2003	Survey of members	68
One similar mill	2003		88
Wood Processors	**2003/04**		**78.4**

The table below shows the electricity costs for each of the main departments and energy use intensities for the year ending June 2004. These have been derived from the site's four main metering points Transformers 1, 2, 3 and 4 and have been cross checked by calculating separately using daily profile electricity loads and individual motor loads. In addition, department daily electricity consumptions were checked with an electricity data logger during the site energy audit.

Table 3.2 Electricity Consumption Year Ended June 2004

		kWh		*kWh/m^3*	*kWh/m^3*
				Wood Processors	***Similar sites***
	Electricity (total)	**3,460,212**		**76.8**	**88**
1	Mill	711,997		16.1 M	24 – 32 M
2	Planer dept.	157,996		7.5 P	6 – 24 P
3	Boiler/Kilns	2,481,267		51.2 K	47 – 83 K
	Other support services	108,952			

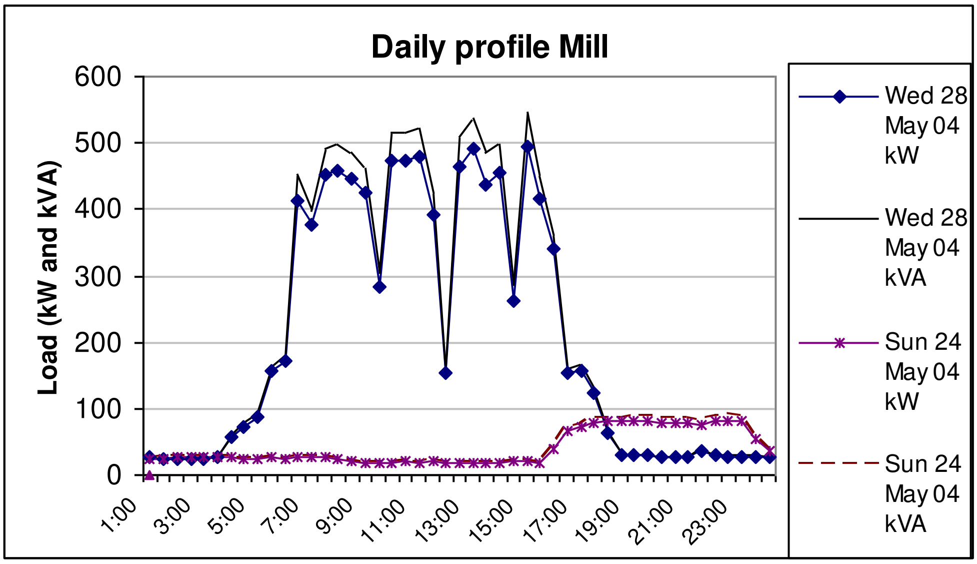
M = kWh/m^3 Mill production; P = kWh/m^3 Planer production; K = kWh/m^3 Kiln production. Refer to Sec 2.1 above.

Wood Processors is relatively efficient with electricity use compared to other mills. The milling department in particular uses less electricity relative to the volume of timber milled, indicating less opportunity for improvement. Note although Wood Processors has a fuel dryer using electricity, when other mills often do not, Wood Processors has steam boilers, which use less electricity than hot water systems commonly used at other mills.

The kiln, boiler and planer operations are at the lower end of the range of indices from other mills. Wood Processors is not the lowest in these areas, which does indicate some potential for savings.

3.5 Daily electricity load profile

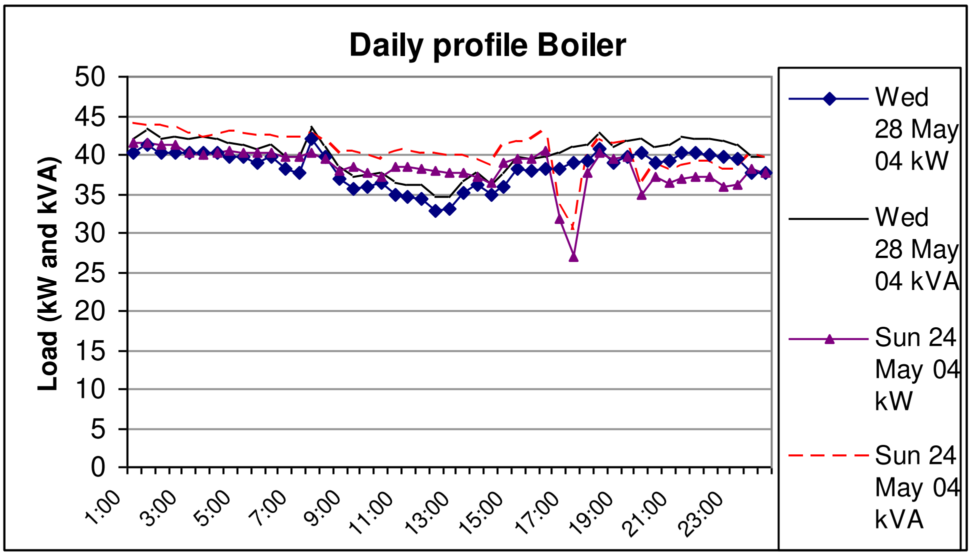
Typical daily load profiles for each main transformer are represented by the charts below. These were established from half hourly electricity use data supplied by Zantec Energy.



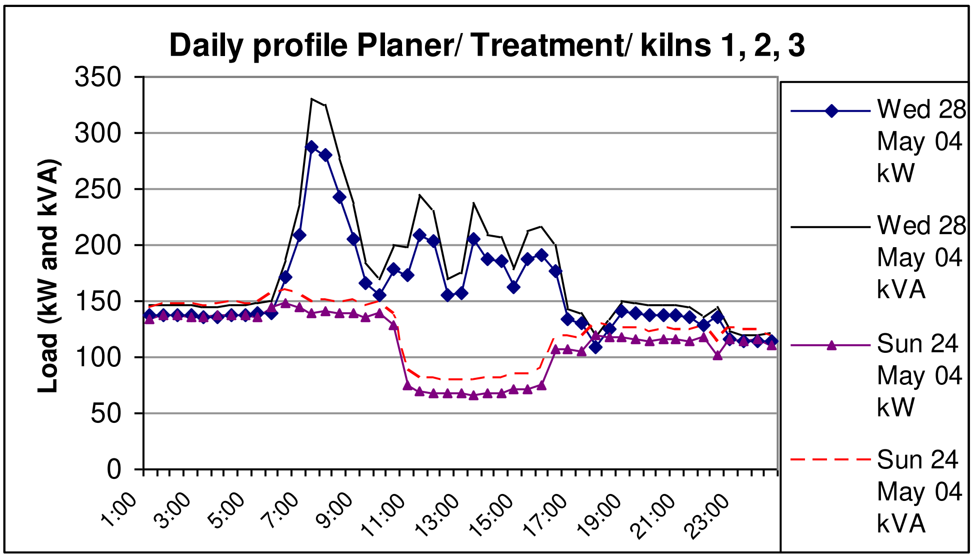
In the mill, represented by the chart above, a significant increase in load up to 410 kW occurs from 6:00am when the operations start; this subsides again at 4:00pm when these operations stop. The loads reduce at 9:30am, 11:30am and 2.00pm when the plant stops for breaks and lunch.

The 80kW load between 4am and 5am, and on Sunday in the evening, is mostly the fuel drying operation. Half of the 160 kW load between 4am and 6am and after 4:00 pm until 6pm is typically the compressor and conveyors running during cleaning times.

There is a 10 – 20kW load during the night when all equipment is switched off and some lights left on.

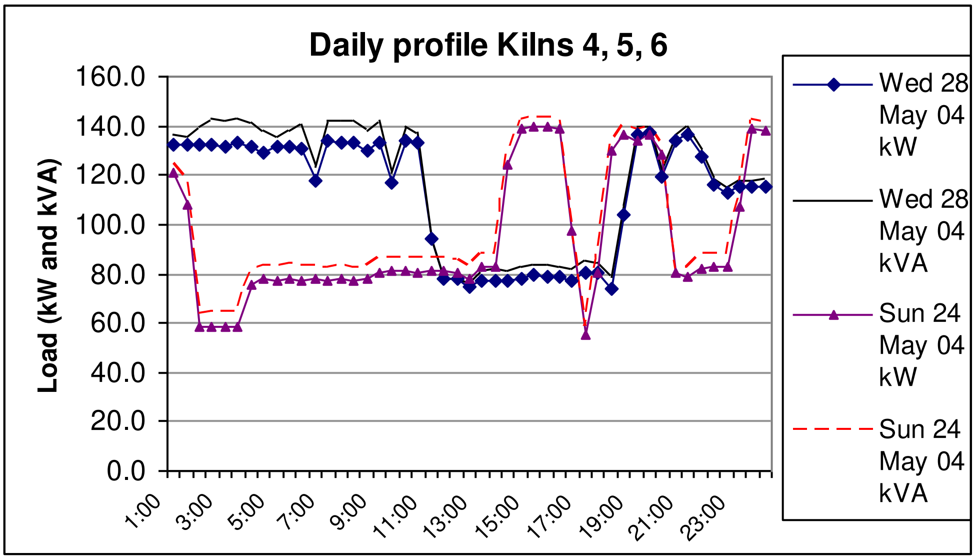


In the boiler house and fuel handler there is an approximate 40 kW constant load.



In the planer, treatment plant and kilns 1 – 3, represented by the chart above, a significant increase in load up to 300 kW occurs after 6:00am when the planer operations start; this is less in the afternoon and subsides again at 4:00pm when these operations stop. The loads reduce at 9:30am, 11:30am and 2.00pm when the plant stops for breaks and lunch.

The 150 kW constant load, and before 6am on the Wednesday, are the kilns fans operating 24 hours a day. On the Sunday at 10am there is a clear reduction to 60 kW when two sets of fans have stopped and one started again at 4:00 pm



The 80 and 130 kW constant loads are the kiln fans operating almost 24 hours a day. The step ups and downs are when kilns are stopping, being reloaded and starting again.

Electricity loads at Transformers 1 and 2 are significantly less than the capacity of that transformer. Refer to the table below. This means that these could possibly be combined and some fixed fees avoided because there is no proposed expansion in the near future.

	Load (kVA)		
	Transformer size	**Winter maximum**	**Anytime maximum**
T1 Kilns 4 - 6	300	145	170
T2 Boiler	300	62	66
T3 Planer kilns	500	350	370
T4 Mill	750	600	600
TOTAL	**1850**	**1157**	**1206**

3.6 Wood fuel

Wood residue is used to fuel a steam boiler, which is an Anton 6.5 MW supplied in 1987 by Syke Engineering.

Both sawdust and wood shavings residues are used in the boilers. The shavings are provided dry enough to use in the boiler while the sawdust is dried on site before it is suitable to use as a fuel.

Sawdust is obtained as a by-product from the mill operation while a small amount is bought. Shavings are obtained from the planer operation and a significant amount bought. The cost of the bought wood residue is to cover transport costs.

The cost and energy equivalent of each wood residue are summarised in the table below. Derivation of the energy equivalent is explained below and included in the Fuel Balance Table at the end of this Section 3.6.

	Wood waste total	Sawdust (incl drying cost)	Shavings made on site	Shavings bought
Cost	**$288,700**	$145,763	$0	$137,537
kWh/yr	47,363,056	27,987,240	6,963,724	12,412,092
c/kWh	**0.61**	0.52	0	1.11

The marginal cost of wood fuel is the most expensive option used, which is the shavings purchased from Kintan Millers at $67.50 a tonne, which equates to **1.5 c/kWh**. Other shavings bought are purchased at an equivalent 0.64 c/kWh and the average is 1.11 c/kWh.

The volume of wood residue used in the boiler is not measured. Although a guide given by staff is 250 kg per hour per MW of boiler capacity.

Approximately 47.4 GWh ± 15% of wood residue is used each year. The non-electricity fuel use index is 1073 kWh per m^3 mill production.

The fuel energy was calculated using mass and volumes of timber and moisture content from production and waste volumes produced. In addition, energy available from sawdust and wood shavings was compared with the demand for heat, which was calculated using advice from the kiln supplier on the demand for energy from each kiln.

A summary of fuel balance for the heat supply system is included in the table below.

Wood residue supply

Approximately 5,858 tonne of sawdust at 10% moisture content (MC) oven-dry basis and 4360 tonne wood shavings per year is used in the boiler. The kiln dried timber, radiata is 12-15% MC, which has a net calorific value 16 MJ/ kg.

The dried sawdust at 10% MC is 17.2 MJ/kg. It moisture content was measured recently from samples of dried sawdust at 9% wet basis.

Boiler efficiency and energy required

WOOD FUEL ENERGY BALANCE				
A) Annual energy available from fuel				
Total wet sawdust 150% MC (oven-dry basis)			13,313	tonne
Dried sawdust 10% MC			**5,858**	**tonne**
Dried sawdust energy 10% MC	17.2	GJ/t	**100,752**	**GJ**
			27,986,789	**kWh**
Purchased shavings			2,793	tonne
Dry shavings Energy 12% MC	16	GJ/t	**44,684**	**GJ**
			12,412,089	**kWh**
Dry shavings made on site			1,567	tonne
Dry shavings Energy	16	GJ/t	**25,069**	**GJ**
			6,963,724	**kWh**
TOTAL Energy			**170,505**	**GJ**
			47,362,602	**kWh**
B) Energy demand				
Kiln drying timber volume			48,448	m3
Heat energy needed for kilns	2.25	GJ/m3	109,008	GJ
			30,280,000	kWh
At boiler efficiency	75%		40,373,333	
At steam distribution efficiency	85%		**47,498,039**	**kWh**
Boiler and distribution efficiency	64%		**47,498,039**	**kWh**

The kiln supplier advises, that each Kiln requires approximately 1 MW each of boiler capacity, or including flash steam losses of 10% 1.1MW, per 10,000 m^3 timber dried.

Benchmarks of NZ mills (Ref: NZ Industrial Energy Benchmarks; 2003) indicate that 1.9 to 2.6 GJ/m^3 of heat is required to dry timber. Using 2.25 GJ/m^3 equates to approximately 47.5 GWh of fuel needed for 48,448m^3 dried timber. This assumes a combined boiler, pipe and condensate return efficiency of 64%; a possible separate efficiency would be the boiler at 75% and the steam distribution at 85%. Refer to Fuel Balance chart preceding.

This is similar to the energy available from fuel supplied, calculated above. Note however a boiler and steam system efficiency of 64% is low and indicates significant potential for improvement.

The amount of wood fuel and moisture contents should be measured to calculate and confirm the potential energy used and available. In addition a steam meter should be used to measure steam generated from the two boilers. This will provide the necessary information to check and track the efficiency of the boiler and steam system and potential for producing valuable forms of energy.

NZERA advise in its guide on monitoring and targeting (M&T) energy use that an M&T system alone results in energy cost savings of 2-5% for the typical industrial business. Assuming that M&T contributes to 2% of this saving then $648 will be saved in electricity use and $14,387 in boiler fuel costs.

T2 Recommendation
Establish a method for measuring and monitoring the volume of wood planer shavings and sawdust supplied and its moisture content. Install a steam meter at the main supply line. A 2% improvement in boiler system efficiency would save $648 per year in electricity costs and $14,387 in boiler fuel costs.

This may include weighing a sample of truck loads for the tonnes of shavings and sawdust bought and corresponding moisture content. In addition it could include recording and calculating the volume of shavings produced from the planers and blown to the boiler storage bins. Alternatively install a revolution counter on the feed auger to the boiler and calibrate it to establish the mass of shavings supplied per auger rev. This will cost approximately $1500.

Steam Meter Suppliers advise a steam meter installed in a 150mm diameter line would cost in the order of $12,000 for a pipeline unit or wafer unit $8000. A total of $16,000 is allowed for, which includes staff time costs at $60 per hour.

3.7 Energy use and cost by end use

An Energy Balance is used to determine the amount of energy used by each end use technology type. It is established, refer to Appendix 3 table, by comparing electricity and other fuels used (and invoiced for) with end use equipment loads and times they operate.

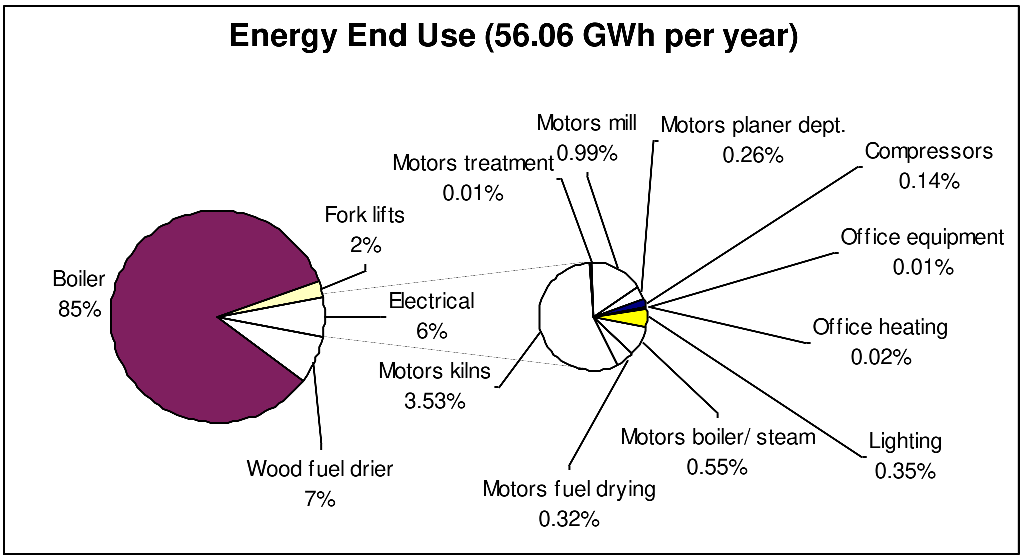
For electricity, four TOU meters supplying separate departments and a range of daily load profiles were used to cross check load and time assumptions.

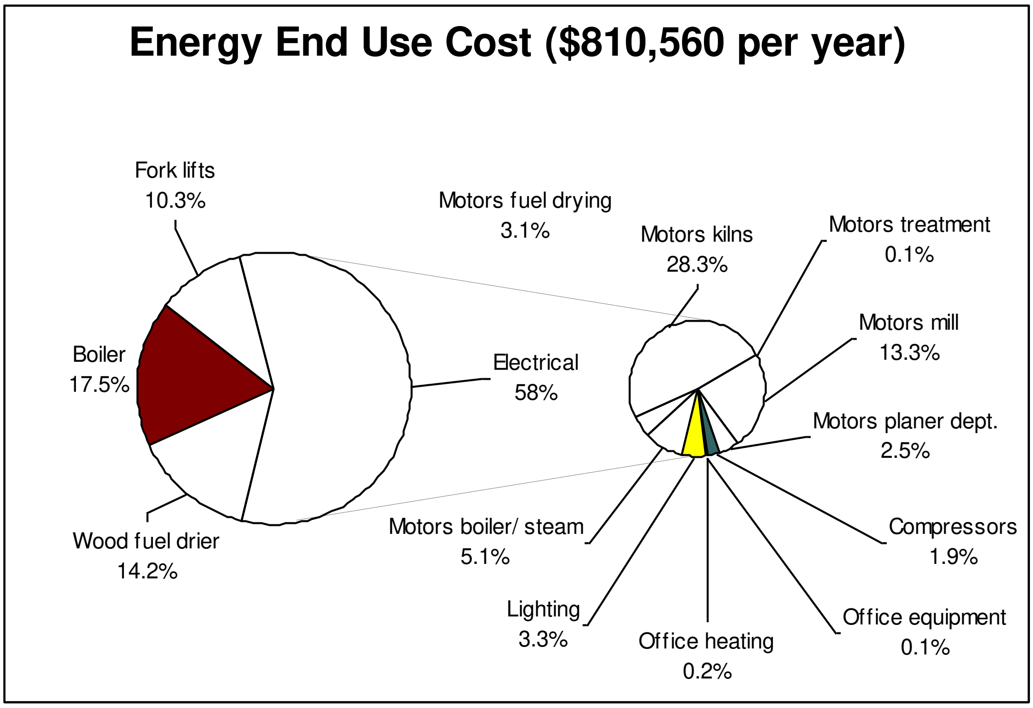
The pie charts below illustrate energy consumption and costs of electricity for each main system and end use.

The electrical loads use 6%, costing 58%; whereas

The boiler uses 85% of the total energy, costing 17.5%;

Although the boiler is the biggest user of energy the electrical motors incur the biggest cost. This is due to the mill using energy, which is a higher grade and more costly energy form than thermal fuels.





4. Tariff Review

Wood Processors is supplied electricity from Zantec Energy. Electricity Network services is provided by Regional Lines. Currently the site is metered at five entry points; it has four Time of Use (TOU) accounts for the main areas of the site supplied by Zantec Energy and one fixed commercial anytime non-TOU electricity account for its main office.

Wood Processors has a three year electricity supply contract with Zantec Energy, which is due to expire this year in December 2005.

ELECTRICITY USE BY LOCATION

The five entry points are:

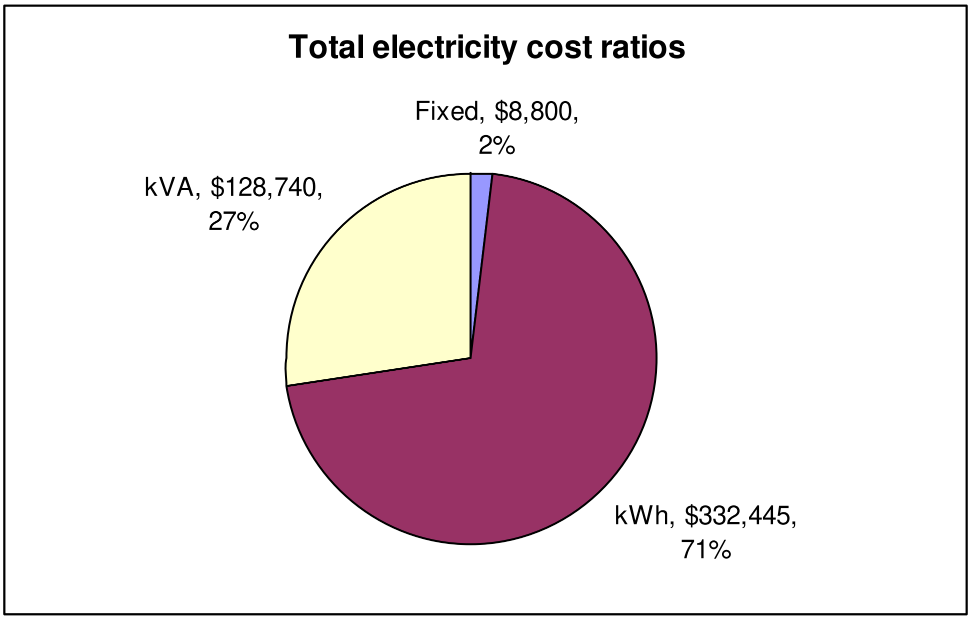
ICP 008805215XL48C (Account 204-485-515)-“Transformer 1” Mill/workshop/sawdust dryer
ICP 008805500XL87F (Account 204-422-207)-“Transformer 2” Boiler
ICP 008805214XLF47 (Account 204-422-228)-“Transformer 3” Planer/Kilns
ICP 008805600XLB7C (Account 204-422-225)-“Transformer 4” Kilns
ICP 0008805248XL282 (Account 204-046-010)-“Transformer 5” Office

204-485-515	204-422-207	204-422-228	204-422-225	204-046-010
Mill-Workshop Fire station Sawdust dryer Cafeteria	Boiler house Shavings distribution	Planer Dry Chain Kilns 1,2,3 Treatment plant	Kilns 4,5,6	Office

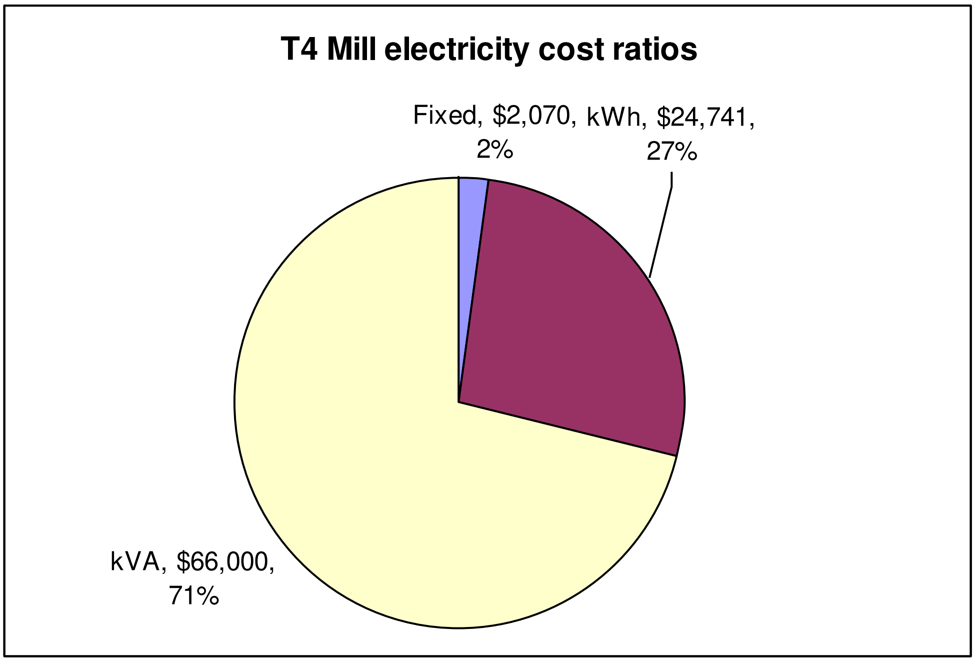
Discussed below are opportunities for reducing both Energy and Network rates.

4.1 Electricity costs

Electricity costs are the summation of Network charges and Supplier energy usage charges, and each includes a fixed charge component. The total cost was $469,985 excl GST for the year to June 2004.



Most (71 %) of the electricity cost is a direct result of electricity used in terms of kWh. A significant proportion is based on maximum demand per half hour in terms of kVA (27%) and fixed charges are small (2%). Maximum demand charges are particularly high for the Transformer 4 account at the Mill department at $66,000 (71% of total at this department) a year.



4.1.1 Network Charges

Network charges were $158,980 and have accounted for 33.8% of total electricity cost. Network charges are variable and are a function two factors:

1 Winter and anytime peak loads in terms of peak demand in kVA resulting in a cost of $128,740 a year; and
2 Electricity consumed, kWhs, resulting in a cost of $26,720 a year.

An Anytime maximum demand is charged monthly at an equivalent $30 per kVA per year and Winter maximum demand charged May to August at an equivalent $80 per kVA per year. These are calculated on the basis of the highest half hour metered kVA load occurring in the previous year (starting April and ending March). In most cases an annual peak load change results in a combined change of $110 per kVA per year. The Winter charge is calculated on the highest half hour metered kVA load occurring between 6:30am and 10:30pm and between April and August.

4.1.2 Energy supplier charges

There is an existing three year contract (1 Jan 2003 to 31 Dec 2005) with Zantec Energy for the main areas of site, which is a fixed-price-variable-volume contract ie the "energy" component of prices are fixed for three years and the volume of electricity use can vary from month to month at these same prices. These energy prices although fixed are different each month and time of day.

Prior to Jan 2003 electricity was purchased at Spot Market rates.

On average the "energy" component price was 8.1 c/kWh from July 2003 to June 2004.

In future prices contracted with Zantec Energy continue to vary according to the time of day, day of the week, and seasonally. Therefore the average price for 24 hour 7 day operations is different, although not significantly, to 8 hour 5 day operations. Three price groups are used in savings evaluations depending on when the load typically occurs:
(a) continuously all year,
(b) during working hours and five days per week, or
(c) overnight and weekends.

Table 3.4 Average Marginal Electricity Costs to Dec 2005

Marginal cost (c/kWh)	**TOU "energy" c/kWh**	**Total marginal c/kWh cost (includes loss factors and network c/kWh charges)**
Every day, 24 hours	8.98	**10.6**
Weekdays 6.00 am to 5.00 pm	9.37	**11.1**
Weekend and Night	8.84	**10.3**

On average the "energy" component price will be 9.1 c/kWh until Dec 2005. Note however these prices vary between 6.9 c/kWh during Jan-Feb at 4 to 8am in the weekend and 11.6 c/kWh during June-Aug at 4 to 8pm on a week day.

Office
The office is on fixed commercial rates at 14.99 c/kWh. This could be connected to one of the TOU supplies at a cheaper rate 11.1 c/kWh and save approximately $1090. However this would add to the day peak load and result in an additional cost of approximately $1500.

4.2 Peak load control

4.2.1 Power Factor Correction

Based on June 2004 data, power factor at peak loads varied between 75% and 95% at the four Transformer meters. Normally it is cost effective to install power factor correction equipment to increase power factor to 95-97%.

Mill

Power factor correction equipment is used at each transformer. The equipment at Transformers 3 and 4 is not sufficient to manage the large and frequent fluctuating loads induced by the small number of large motors, such as the185 kW headrig motor. This results in power factor as low as 82% and 75% respectively at peak load times.

EMANZ Energy Auditors measured and logged kW, kVA and power factor during production and compared this with the billed data. Results were consistent with inadequate power factor correction.

$20,140 per year would be saved by improving power factor to 96%. At Transformer 3 this would result in 370 kVA reducing to 316 kVA, which costs $30 per kVA per year Anytime and for the Winter charge 350 kVA reducing to 299 kVA, which costs $16 per kVA per month April to August.

At Transformer 4 this would result in 600 kVA reducing to 469 kVA, which costs $110 per kVA per year for the Anytime and Winter charges combined.

Power factor correction equipment would cost up to $16,750 for this site to upgrade as advised by Power Factor Correction Suppliers.

T1 Recommendation
Upgrade power factor at Transformers 3 and 4 so it is maintained at 96% or better; Save $20,140 a year at a cost of $16,750.

5. Study of End Uses

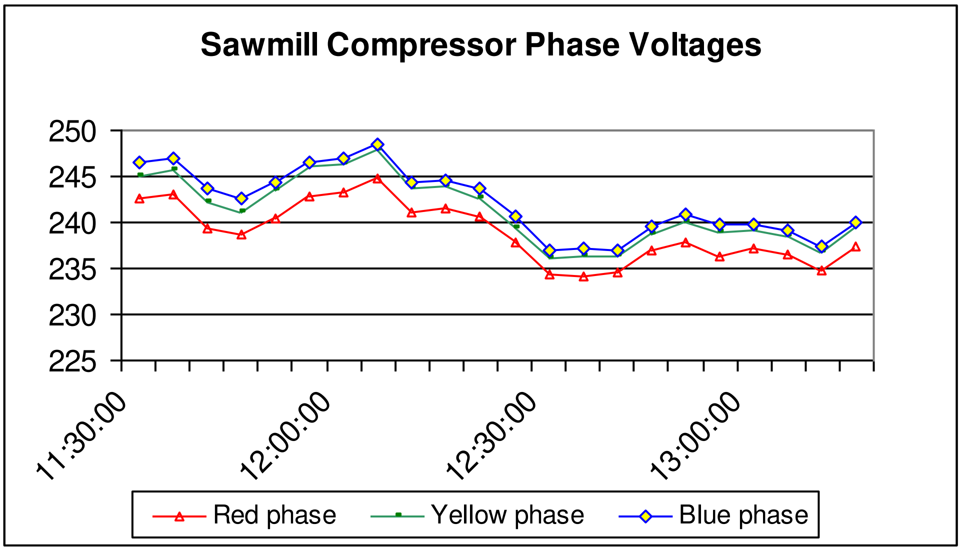
5.1 Mill

5.1.1 Motors

To operate efficiently motors need to be sized correctly to match the normal continuous load and to handle peaks without overloading. While tripping out on overload protection is unacceptable for production, motors that are oversized for normal operation will run at a poorer power factor and lower efficiency than when sized to match the loads. This situation can often be significantly improved with varying loads by using variable speed drives to automatically correct for load variations. A range of different variable speed drives are available for different load applications including torque control and remote automatic computer based control and datalogging.

Good supply voltage regulation is generally achieved by adequately sizing cables to minimise supply voltage drops and unnecessary energy losses. However it is also important to maintain supply voltage balance to three phase motors. Recent studies by the Energy Research Board show that three phase voltage imbalance as low as 1% will produce increased vibration, mechanical stress and heating leading to a shorter motor life. Typically improving voltage unbalance (the greatest difference between phase voltages divided by the average voltage) by 1.5% will improve motor efficiency by 1%.

In the graph below, which was measured by EMANZ Energy Auditors, the voltage unbalance on the loaded main mill compressor is 1.3%. The same unbalance applies to all 3 phase motors fed from this switchboard. Rebalancing here means shifting some single phase loads off red phase and onto blue and possibly yellow phase.



Over the total site there is on average over 800 kVA of motors running. If rebalancing voltages achieves an overall average improvement of say 0.5% this will reduce the peak kVA charge by 4kVA, saving $440. Total site motor energy for a year is 3,248,300 kWh.

Saving 0.5% or 16,242 kWh saves a further $1802 per year at 11.1 c/kWh, giving a total saving of $2,242 per year.

Cost is two hours per switchboard of maintenance electricians time, about $250. Payback time is under 2 months. Balance should then be checked whenever a new load is added.

T1 Recommendation
Check voltage balance at the main motors switchboards and rebalance voltages as indicated by reconnecting available single phase loads at that switchboard.
Save $2,242. Cost $250, giving payback under 2 months.

Modern electric motors manufactured to AS/NZS 1359.5:2000 are MEPS compliant and generally more energy efficient than older motors. However premium high efficiency motors to IEC 34-1 will run about 2% more efficiently, with a higher power factor and at lower temperature which results in extended motor life. These benefits are offset by an additional capital cost of some 20%. The payback period required will depend on running hours per year, and whether the motor operation coincides with any peak kVA charge or power factor penalty in the supply tariff. A payback of 2 to 3 years is not unusual for a motor with a life of 15 to 20 years. Generally a high efficiency motor will be cost effective for a continuous load running during peak production, but may not be if the load is on occasional or variable duty cycle or available for peak load shedding.

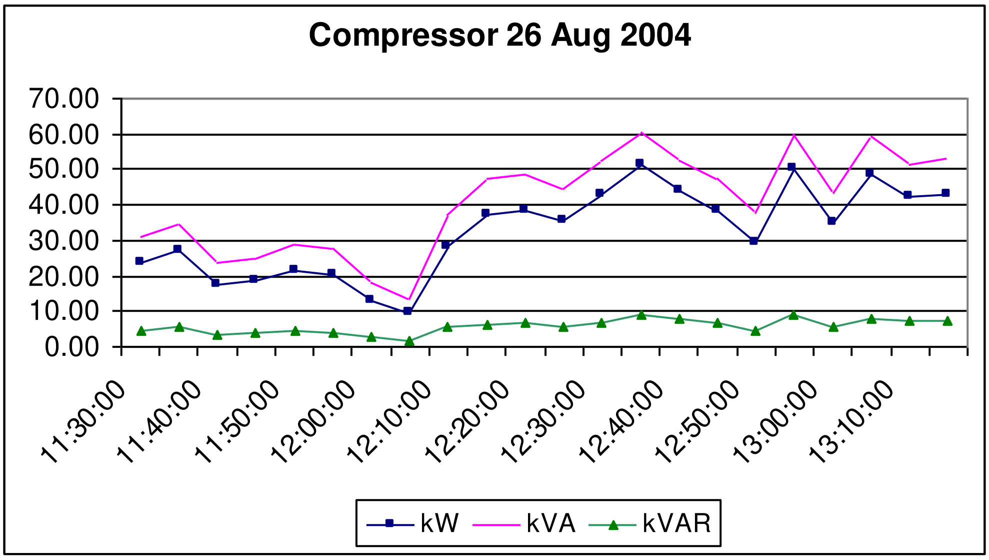
Motor rewinds will generally result in reduced efficiency by up to 5% compared to a new standard motor. Rewinds should only be used as a stopgap measure for urgent production imperatives, then retired and replaced by a more reliable and efficient modern motor.

5.1.2 Compressor

The mill has one air compressor and receiver. It is a 1996 Greggor 90VSD – 4–12 bar, which is set at 7.0 bar. It is a 90 kW rotary screw lubricated compressor with variable speed motor, operates at 7.5 bar and can supply 270 l/sec. There is no heat recovery on the unit. It is used often for powering the controls on Mill equipment and Saw Doctor equipment and for cleaning equipment during breaks, and at the beginning and end of each day.

The mill compressor uses approximately 78,200 kWh and $15,300 a year or 2.3% of all electricity used by the mill. This is low compared with other mills audited recently, and would be due to being a VSD compressor.

The chart below is the load used by the compressor measured with a data logger. Some air is used during lunch time for cleaning. A noticeable increase occurs at 12 noon when production starts again.



Equipment is cleaned with compressed air hoses. Cleaning is done sometimes during breaks and normally sometimes in the early evening at about 6pm.

Equipment should be cleaned with an air blower and brushes in some places. Compressed air is expensive form of energy for cleaning because approximately 20% only of the energy is used to compress the air, 80% is transformed into heat.

Cleaning equipment during breaks and after hours uses 25% of the compressed air loads, which was measured with the data logger and is consistent with the daily electricity profile loads. This costs approximately $3830 a year. After discussions with the cleaners, air hoses for cleaning could be reduced by 30% of the time and blowers and brooms used instead with out affecting the speed of cleaning. This would save 5865 kWh a year and the two blowers rated at 1500 W used 1.5 hours and 250 days would use 1125 kWh a year. This results in a net saving of $525 a year.

Two electric blowers and two brooms were priced at $400.

T2 Recommendation

Use two blowers and brooms to clean Mill equipment during breaks. This will save approximately $525 a year. The blowers and brooms would cost approximately $400 to purchase.

During the site visits a number of air leaks were identified such as downstream from the Headrig, one cleaning hose gun was leaking and in the Planer shed. The hose gun tap was not cocked off correctly. Maintenance personnel advise they fix about 20 leaks once a year during the summer shut down period.

Air Suppliers has an energy saving fact sheet on air leaks (Appendix 5) that specifies an air leak from a 2mm diameter hole in a 7 bar system will use 1.5 kWh electricity per hour if not fixed.

On average, ten leaks of this size left unattended for a year will cost approximately $4160 for this system, which is operating 2500 hours a year. An active programme to find and stop leaks once every three months would reduce this by 75%, saving $3120 a year. This would cost $1500 for a person working an additional three days a year (one day per quarter for three additional quarters) during some weekends to find the leaks. Materials and leak detection devices would be needed already when leaks are normally found during the summer shut down period.

T1 Recommendation
Adopt a programme to regularly identify and stop compressed air leaks every three months. Install improved control taps on air hoses so that they can not be left on accidentally when bumped. Save $4160 a year.

There is little opportunity for reducing delivery air pressure or heat recovery. Although there is a heat recover unit available there is not a need for hot water or warm air nearby.

5.1.3 Chipper

The chipper is driven by a 112kW motor which is rated at 189 Amps. The current measured while it was working was 70 to 90 Amps indicating that it was very lightly loaded at that time. Later it was observed to be still running with a very small load. Assuming that the machine's inertia ensures it will not stall on the material it chips, the motor should only have to be sized for the highest steady load that it regularly meets.

If the continuous rated current does not exceed 133Amps it could be driven by a 75kW high efficiency motor, giving a 3.2% efficiency improvement. For its estimated annual usage of 75,640kWh this will save 2,420kWh and $246 per year. Improvement in power factor gives a further saving of 6.7kVA valued at $110/kVA, saving $740/year.

This gives a total saving of $986/year. The cost of a VSD of this rating would be greater than $16,000 giving a payback period around 15 years. The cost of a high efficiency 75kW motor is $8,722, giving a payback of 8.8 years.

While neither of these options give a good return, when the chipper motor is due for replacement a smaller rated high efficiency motor will cost 20% more than a standard motor, about $1,455 more, giving a saving of $986 per year, and a payback of 1.5 years.

5.2 Timber Drying

5.2.1 Sawdust dryer

The sawdust dryer reduces the moisture content of the sawdust from 150% moisture content oven-dry basis (MC) to 10% MC before it is fed into the boilers. The mass of sawdust when dried reduces from 13,313 tonne to 5,858 tonne a year. This increases its net caloric values from 5.8 GJ/tonne to 17.2 GJ/tonne.

Dryer to Boiler Duct Fan
The fan motor on the sawdust dryer ducting sawdust to the boiler fuel storage bin is rated at 75kW and full load current at 125 Amps. The actual load current was measured at 40 Amps, which indicates that it is running inefficiently and at a poor power factor. This current increases only slightly when the duct is fully loaded, since a large proportion of the total energy is required at all times to maintain sufficient air speed. This load is a steady all day operation using 104,100kWh a year. Downsizing the motor to 22 kW would improve the efficiency by 0.5%. This will save 500 kWh a year ($50 per year) and reduce demand by 3.7kVA (saving $410), which results in total savings of $460 per year.

A new motor of 22 kW costs $3,240 plus installation costs giving a 6.9 year payback.
A 22 kW premium high efficiency motor costs $3,330 plus installation costs, and will save 1.1% of energy and reduce loads by 4 kVA, giving a total saving of $495 per year, which gives a 6.7 year payback. This assumes the 75 kW motor being replaced is new and will be scrapped.

The 75kW motor is not new and is due for replacement in five years time, which would cost $6850. The net present value of replacing the 75 kW motor now with another 75 kW, instead of in five years time, is an additional $3444 discounted at 15%.

However as a second option, installing a high efficiency 22 kW motor at $3,330 now instead of a 75 kW motor in five years time has an additional net present cost at 15% of -$76, which is a $76 saving, in addition to the energy cost savings.

T2 Recommendation
Replace fan motor on the sawdust dryer to boiler storage ducting with a 22 kW high efficiency motor to IEC 34-1. Save $76 initially and another $495 a year. Payback is immediate.

5.2.2 Boilers and steam

There are two Feelt steam boilers fuelled with wood residues; 4.25 MW and 2.25 MW supplied by Georges Engineering. The boilers have their steam supply pipes joined near their outlets to one main steam supply pipe line. The boilers are designed to a maximum operating pressure of 150PSI (10.3 bar) and their upper limit trip setting is 9 bar. The target operating pressure is often set at 8 bar; however often they can not achieve full pressure and operate below 8 bar. The highest noted by staff on site has been 8.5 bar.

The boilers provide steam for the kilns and it is found they do not have enough capacity to provide heat if all kilns are running at the same time. Also lack of boiler fuel supply can sometimes be an issue, which means kilns need to be shut down and drying delayed.

There are two water supply pumps for each boiler and usually one only is operating.

The kiln supplier advised that one kiln of 60m^3 size or 10,000m^3 timber dried a year requires 1 MW of boiler capacity plus 10% for flash steam losses. Approximately 48,448m^3 was dried from July 2003 to June 2004. Therefore the six kilns operating at Wood Processors Ltd with a combined drying capacity of 360m^3 should require 5.5 MW of boiler capacity.

The under performance of the boilers is likely due to operating the boilers at below 85% of their design capacity, achieving below average boiler efficiency and excessive losses in the steam distribution system. Boiler efficiency will be affected by a number of factors such as variations in fuel quality and moisture content and control of corresponding air supply.

The boilers have been tuned in the past; not regularly though. Flue gas emissions are tested as needed. Flue gas temperatures have been measured to be high, which indicate low efficiency. A standard maintenance is completed every three months and overhauls each year.

There had been excessive clinker build up in the large boiler and therefore the manufacturer changed the air supply to be delivered underneath only instead of both underneath and via the top of the boiler.

The boiler tubes are cleaned every three months with a router, which involves the boiler being cold and being down for 12 hours. In addition to this, the boilers should be cleaned more regularly with a hot brush to maintain boiler capacity between each three month period. Staff have noticed boiler pressure increases to above 8 bar after cleaning the tubes and then drops again after a few weeks.

The temperature of surface of the infeed water pipe to the boilers was measured on 26/8/04 at 80^{O}C and outfeed steam pipe 150^{O}C. Boiler surface was 160^{O}C. The large boiler was operating at 5.2 bar at the time.

A target efficiency for wood fired boilers as advised by two suppliers should be 78 – 80%. The boiler efficiency should be measured and compared with a target efficiency. Indications are that the efficiency is 75%, refer to table above in Section 3.5. By achieving 78% efficiency will save $29,140 a year in fuel savings.

Efficiencies would be achieved by applying a combination of number of possible changes. These would include improving control of fuel types and moisture content delivered to the boiler, matching air supply by improved control eg oxygen trim, recovering heat from flue gas losses.

T2 Recommendation
Measure and improve the efficiency of the boilers by adopting improved fuel and air supply control, possible heat recovery and improved maintenance. Save $29,140 a year where boiler efficiency increases from 75% to an industry target 78%.

Based on discussions with NZ Boiler Modifiers the cost including heat recovery would be in the order of $130,000.

Steam Distribution System

The steam distribution system includes approximately 500 m of supply and condensate return pipes, a condensate tank and two return pumps. Most of the pipe lines are insulated and most valves and flanges not insulated. In addition, a section of pipe near the condensate return tank had insulation missing, which had a surface temperature 160^{O}C. 40 exposed valves were measured at between 130^{O}C and 150^{O}C.

An average surface temperature of 160^{O}C for 8000 hours a year on 10m of exposed 75mm diameter pipe (eg there are a number of short lengths exposed next to kilns) and an average surface temperature of 140^{O}C for 40 uninsulated valves have a combined heat loss reduced of approximately 145,000 kWh a year. 126,560 kWh a year would be avoided with improved insulation. This would save $3140 a year in reduced steam demand. Individual valves will be losing approximately 4000 kWh a year and costing $100 a year each in fuel losses.

Insulation suppliers advise the cost of a valve insulation blanket installed is $100-$180 and 10 m of pipe insulation $500.

T1 Recomendation
Insulate all exposed valves and lengths of pipe work that do not effect steam control valves. Savings will be $3140 a year and insulation cost installed $7700.

Steam leaks were noted in a number of places, particularly around the condensate tank area from flanges in the supply side. One steam leak can cost up to $10,000 a year in energy wasted. Refer to the steam guide in the Appendix 6. At Wood Processors Ltd the cost of fuel is 4.2 $/GJ instead of $10/GJ in the guide and hours of operation are 160 a week instead of 40. With a small steam leak costing $500 a year in the guide then a small steam leak at Wood Processors Ltd will cost $845 a year. Six leaks stopped will save $5060 a year. Two leaks were seen to occur at flanges eg near condensate tank and staff advised four steam traps were leaking.

Repairing leaks at flanges can be done with Spirowind, a special gasket and costs about $350 plus an hour for installation per leak.

T1 Recomendation
Stop all steam leaks at flanges and valves. Six leaks stopped will save $5060 a year. Use for example Spirowind on flanges and a cost of $2460 to fix six leaks.

5.2.3 Kilns

There are six kilns in operation.

The drying stages include:

- Presteaming
- Drying
- Cooling
- Equalising
- Steaming

Kilns have between four and nine fans with motors rated between 5.5 and 11 kW. These fans reverse every four hours.

Packs of timber to dry are made up with a constant height and width and the length varies. Baffles are used around the ends and top of each Pack to improve the efficiency of air flow. However these are damaged on some kilns and not being used or are missing eg two baffles were missing on one kiln. Operators also advised that baffles are often not used because the Packs are too short and not using them saves about 10 minutes per load.

A report completely recently by the kiln suppliers advise that misuse of baffles will reduce efficiency of a kiln by 10% on average. Discussions with the suppliers and another mill, Radiata Sawmillers, who has improved its kiln operation recently confirmed this suggestion.

A 10% improvement in drying efficiency will save 4.74 GWh a year of wood fuel and 228,000 kWh a year of electricity. The cost savings in wood fuel saved is at the price of the most expensive wood shaving because the volume saved is less than volume of the most expensive wood shaving bought. Electricity and wood savings combined is $97,000 a year.

The cost of repairing baffles would be $2200 per baffle, as advised by the kiln suppliers. Training staff to use baffles correctly would cost an additional $1800. The additional time to load kilns would be 30 minutes a day on average and for 320 days a year would be $19,200 a year. This reduces the annual savings to $77,800.

T2 Recommendation

Fix and load packs to use full baffles. Increase average kiln efficiencies by 10%. This saves a net $77,800 a year, which includes energy savings minus additional labour costs. Other costs include an initial $15,000 to repair six baffles and to train staff.

Fan speeds

Control of kiln fans can help control peak loads and offer significant savings opportunities by improving the efficiency of their use during the drying process. The normal option to achieve this is to slow the fan speeds using Variable Speed Drives (VSDs). The existing kiln fans have variable speed drives and are not used for this purpose. Fan speed should be controlled by a sensing controller monitoring temperature or humidity as appropriate.

Studies by the NZ Drying Enterprise have shown that electricity savings of 12% can be made without affecting the quality or speed of production by controlling the speed of the fans for 30% of the drying time.

Significant electricity savings are achieved because power consumption by fans decreases with the cube of their speed. For example a 6% reduction in fan speed will reduce electricity demand by 17%.

A 6% electricity consumption savings and a 10 kVA reduction will save $13,600 a year. It is assumed that at least one kiln would always have a fan load reduced from 50 kVA to 40 kVA by running its fans at a slower speed. Consumption will reduce from 2,000,000 kWh a year to 1,880,000 kWh a year.

Caution is needed not to overheat the motors if slowing their speed significantly.

T2 Recommendation

Use existing variable speed drives to control speed of kiln fans for 30% of the drying process. Control by kiln humidity or temperature to maintain drying times. Save $13,600 a year.

The kiln suppliers advised this will cost in the order of $20,000 to establish the appropriate sensors and control system, which includes the additional time to implement and train the kiln operator.

Consideration of new kilns should include their efficiency including energy efficiency.

5.3 Planer shed

The planer shed accommodates a Wexel 40-ZN planer, multi-rip saw and small band saw. There is a single speed main extraction fan for the planer and bandsaw. There are times when the bandsaw only operates, which is for an estimated 5% of the time. For example, during the site visit in August the bandsaw was operating and the planer was not.

The Planer operates approximately 70-75% of the time and most often without the two small saws running. Often when there is little need for planing then staff use the small saws instead to catch up on making fillet sticks.

The Planer Shed has an air compressor of capacity 22kW. During the site visit there were two noticeable air leaks. This supports the case for making routine checks to fix leaks across the whole site. Refer to section 5.1.2 above.

Sawdust removed from the multi-rip saw has an independent duct and fan to the planer and bandsaw duct and is stored in a hopper nearby. Note however this is linked to the first duct with a damper gate in the duct. The purpose is when treated timber is planed, which is rare, 1% of the time, the shavings is ducted to this same hopper and not to the Shavings store, which is fuel for the boiler.

The second fan and duct for the multi-rip saw is inefficient because the duct tees into a large duct (duct for the treated shavings) and travels 3 – 4 times the distance it needs to with additional elbows. Because the multi-rip is used infrequently (2-3 hours per week on average) the cost to change the duct outweighs benefits from electricity savings.

If the use of the saw is increased this should be reviewed.

Shavings are sucked by a fan from the Planer building to storage bins near the boiler house for fuel supply. The fan motor is 56 kW and, as measured by the auditor's data logger, draws 48 kW during breaks when the planer is not operating and up to 54 kW during production.

This fan is always left running when the planer is not operating. This occurs most often during scheduled and unscheduled breaks. Based on discussions with the planer supervisor and reviewing electricity half hour use data in the planer department there is approximately 250 hours a year of scheduled breaks and 100 hours of other times when the planer is not operating. Switching the planer fan off during these times will save 16,800 kWh a year and at 11.1 c/kWh $1865 a year.

A time delay switch should be installed to ensure the fan switches off 3 – 4 minutes after the planer is switched off. The cost to purchase the switch and pay the on-site electrician's time to install it will be approximately $450.

T1 Recommendation
Install a timer switch on the main planer ducting fan and save $1865 a year at a capital cost of $450.

5.4 Treatment plant

5.4.1 Motors and pumps

The treatment plant operates 11 hours a day for five days a week and sometimes in the weekend. Batches of timber are loaded into one end of a treatment cylinder, which is horizontal. It is emptied at the other end and chemicals are washed down with a hose. The cycle is between 2 and 4 hours.

The pressure inside the cylinder is reduced for about half an hour to a vacuum using a 11kW pump to remove moisture and open the timber cells. Immediately following this, premixed treatment chemicals are pumped into the cylinder from a neighboring storage vessel flooding the timber. The cylinder is then pressurised to 1400 kPa using a 5.5kW pump. The pump holds the pressure for about two hours depending on the process required.

Vacuum is applied briefly again to remove excess surface moisture.

Efficiency options such as using gravity to transfer treatment chemicals into the cylinder were considered. However the additional time and costs of production excluded this option.

There were no cost effective energy efficiency improvements identified at the Treatment plant; however this should be reviewed if the plant is expanded.

5.5 Lighting

Although lights are a relatively small user of electricity they still incur approximately $26,900 (5.7%) of electricity costs a year.

The high intensity discharge (HID) lighting is the largest lighting load at 47kW, using about 73% of the total lighting energy.

5.5.1 Lighting types

HID lamps usually take several minutes to re-strike and achieve operating temperature with full output. High efficiency lamps are best used for the largest and highly lit areas where lights need to be on continuously for long periods

Most of the indoor workshop and production area lighting is by metal halide HPI and self-ballasted ML mercury HID lamps. These are generally appropriate, giving an adequate lux level (light output) from a good height giving good overall coverage.

However the metal halide lamps have almost three times the light output per Watt than the Mercury lamps, so that a 250W metal halide will replace one 500W self-ballasted mercury lamp, and a 400W metal halide will generally replace two 500W self-ballasted mercury lamps.

The metal halide has a significantly higher cost than a mercury lamp at around $400 each initially depending on the type of fitting required. This includes $300 to fit a ballast permanently and $100 for a more expensive lamp. In addition, the metal halide lamp has more than twice the rated life than the mercury lamp and therefore saves on maintenance costs. It has a life of 20,000 hours compared with 8,000 hours.

Replacing a 500W mercury self-ballasted lamp with a 250W metal halide will reduce the load by 250W. These normally operate for 3000 hours per year and will save 750 kWh, which for 18 lamps at 10.3c/kWh saves $1,390 per year. The peak reduction saves a further $500, totalling $1,890 per year, giving a 3.8 year simple payback period.

The difference in net present cost of buying and installing the next lamp is near zero. The life of the mercury lamp will be 2.6 years and the life of the metal halide lamp 6.6 years.

T2 Recommendation
Replace 18 indoor self-ballasted ML500 lamps with 250W metal halide fittings when lamps need replacement. Cost is $7,200 saving $1,890 a year.

The offices are mainly lit by fluorescent tubes, with a few incandescent lamps and quartz iodide lamps. Generally fluorescent lights are five times more efficient than incandescent, and about three times more efficient than the quartz iodide lamps. Accordingly fluorescent lamps are used in all rooms where lights are continuously on, and in some production areas where headroom is limited or softer light and cooler colour rendering is beneficial.

Incandescent lights are only appropriate for storage areas where the lights are only very occasionally turned on, giving a long payback on the capital cost of fluorescents. Incandescent lamps were found in 17 places, with ten of these in constant use.
These should be replaced with compact fluorescent lamps, using a 26 Watt compact fluorescent lamp to replace a 100 Watt incandescent. The net saving of 74 Watts for 2000 hours per year at 11.1 cents per kWh and load reduction of 0.75 kVA at $110/kVA gives an annual saving of $245.

T1 Recommendation
Replace 10 incandescent lamps with 26W compact fluorescent lamps .
Cost is $50 saving $245 a year giving a 3 month payback.

5.5.2 Switching off lighting

At Wood Processors Ltd mill many of the lights are on 24 hrs a day. In addition, during a number of visits lighting was often left switched on in areas with more than adequate natural light or in unoccupied areas. This likely occurs because lights are switched on early in the day when it is dark and then they are not switched off during the day.

Making someone responsible for switching off lights when not needed would help make further savings. A total of over 65 kW of lights is installed on the site costing an estimated $26,900 per year in electricity use.

Areas of particular concern are the 28 outdoor 400W floodlights, which should be switched off during most of the day- time. These lights can be switched off for on average 4 hours each day, for 250 days a year saving at 11.1 c/kWh and reducing peak load by 11.2 kVA giving a saving of some $2,500 a year.

Arrange for cleaners and an operator in each department to switch off un-needed lights during the day and at the end of each day.

T1 Recommendation
Arrange for one person in each department to be responsible for switching off lights when an area is vacated for more than ten minutes, or when not needed. This will save approximately $2,500 a year. Labelling relevant light switches and setting up a staff reminder will assist this and cost about $500.

5.6 Office, Workshop and support services

The cafeteria includes a fridge, two microwaves, a pie warmer and 20 gallon hot water cylinder. The offices use portable fan heaters 2.4 kW each, heat pumps Panasonic 4 kW and office equipment. Lights have been included above. These areas should be used to demonstrate by example habits of being energy efficient. The office accommodates managers and keeping lights and equipment switched off when rooms are unoccupied will set a good example. Also the cafeteria is a common area and obvious energy efficient habits and equipment will be seen by all staff. For example often lights are on for more than ten minutes when the area is not occupied. These should be switched off by reminding users or using a occupancy sensor.

Approximately 1200W of lighting switched off four hours a day when not needed will save 1200 kWh a year or $130 a year.

6. Energy Management Programme

The Energy Management evaluation form included in Appendix 2 is used to measure the "health" of Wood Processors Ltd's energy management programme. It is useful to identify areas for improvement. These are explained in the following sections.

6.1 Policy

There is no specific Energy Management Policy and plan in place at Wood Processors Ltd. Energy is primarily paid as another fixed cost as part of a business plan.

The introduction of a formal and approved energy management policy (one to two pages only) demonstrates to staff and interested parties an on-going commitment to improving energy efficiency. It provides a person, who has one of their roles as energy manager, with the necessary direction to commit appropriate resources for achieving cost effective energy savings.

The cost to produce a policy would be about $300 in time spent.

Included in this should be a 12 month action plan that would be updated annually. Use the recommendations in this audit to formulate the action plan.

T1 Recommendation
Produce and activate an approved site energy management policy with a 12 month action plan.

6.2 Organisation

Energy management has occurred on an adhoc basis, due to the lack of formal policy and non-specific energy management responsibilities. Energy efficiency initiatives need a strong business case to be competitive with a range of other site development proposals.

The Engineering Manager has recently taken on responsibility for initiating an energy management programme. Other staff such as department supervisors, engineer and equipment operators could have input to ideas and changes. Some teams such as the Kiln Focus Group have started to address some energy efficiency issues.

As a first measure for a site wide programme one person should being given formal recognition of overall responsibility for energy management and promoting energy efficiency.

This person should be at management level and probably be the Site, Operations or Process Manager or Chief Engineer. They would develop a comprehensive and brief energy management plan, formulate a suitable business plan and apply for the requisite funding essential for the energy management policy to be effective. The list of recommendations in this audit would be used to establish an action list.

In addition, a team involving a member from each main department should meet every 3 – 4 months to encourage communications and sharing of ideas across departments.

T1 Recommendation
Wood Processors Ltd should make one person responsible for energy management as a part time role. Sample job descriptions and responsibilities are available from EECA . It is recommended this person be at management level and be the main energy coordinator/ manager.

6.3 Marketing

There is little awareness raising to encourage staff to identify or implement energy efficiency opportunities. For example seeking savings ideas is rarely carried out.

Increasing awareness to operators of energy efficiency opportunities would improve savings. This would be done in a planned and systematic approach by discussions to seek ideas, use notice boards, staff meetings, events which could easily and cheaply be utilised to achieve “buy-in” to the energy efficiency message.

A plan and then formal launch of energy savings programme would help develop and maintain input from staff. This should be followed soon with a “brainstorming” session by each department, then adopting of ideas, and continually reporting progress. Recommendations in this report should be included.

Energy use charts should be displayed in some buildings or in staff newsletters or notice boards in the cafeteria. These should show energy index (energy use/cost per m^3 production) trends for each month; particularly if the effort by staff is showing a difference. A Business-As-Usual (BAU) line could be included.

T1 Recommendation
Adopt a formal energy management programme. This would include the following:
Announcement of programme plan and person with main role of “Energy Manager”
Hold group brainstorming/planning meetings (perhaps by department)
Include ideas from this report if not already mentioned
Adopt savings ideas
Report back energy use/cost by month and relative to production (ie savings should not adversely effect production)
Possibly introduce a competition across departments

6.4 Investment

The investment criteria is to aim for an IRR of 15%.

6.5 Monitoring

There is no reporting of energy use or monthly costs. It was an involved exercise to obtain the past 36 months of energy use and costs for this audit. Note however production is reported monthly and includes this for each department and process.

Energy use and costs should be collated and information presented in graphical form as trends from month to month. In addition energy consumption relative to production (in terms of kWh per m^3) should be monitored.

Real time data and department EUIs would assist operators in managing electricity use in their areas of responsibility. These would be achieved by establishing an energy management monitoring, targeting and control system.

At this site it would be appropriate to summarise reports and presented to management and staff at least quarterly.

EECA advise that "implementing a M&T system will lead to savings of 5-25% of the annual energy expenditure. This estimate is based on international experience of similar systems. Therefore, a budget for implementing the system in the order of 5% - 10% of the annual energy expenditure is considered reasonable." A conservative 2% would cost $16,000 at Wood Processors Ltd.

"However, the system does not generate savings on its own; it relies on a commitment from management to examine the information provided and to take action based on the information to reduce energy costs."

Data collection mechanisms include:

- Using monthly utility invoices
- Manual meter readings and data entry
- Fully automated data acquisition systems

T2 Recommendation
Install and train staff in the use and capabilities of an Energy Management System. Cost $30,000. This is an integral part of load control and with recommended measures and will result in $16,000 savings a year.

7. Appendices

7.1 Appendix 1 – Site plan

Insert a copy of the site's plan here.

7.2 Appendix 2 – Energy Management Evaluation

Energy Policy	Score = 0 /8	**NO** **YES**
Has an energy policy been written ?		👎 N ☐ ☐ 👍
Do we have an energy management action plan looking out 12 months or more ?		👎 N ☐ ☐ 👍
Is our action plan regularly reviewed and updated ?		👎 N ☐ ☐ 👍
Is our energy policy part of an environmental or business strategy ?		👎 N ☐ ☐ 👍
Organisation	Score = 2 /10	
Has a person been made responsible for Energy Management?		👎☐ N/Y ☐ 👍
Is energy management written into that person's job description?		👎 N ☐ ☐ 👍
Does your energy manager have financial authority and management influence?		👎 N ☐ ☐ 👍
Do we have a group that regularly discusses energy issues ?		👎 ☐ N/Y ☐ 👍
Do other managers participate in energy management ?		👎 N ☐ ☐ 👍
Information Systems	Score = 0 /10	
Is energy use being regularly monitored ?		👎 N ☐ ☐ 👍
Is the organisation or process sub-metered ?		👎 N ☐ ☐ 👍
Are energy usage indices being calculated and tracked ?		👎 N ☐ ☐ 👍
Does the system help to identify faults and quantify savings ?		👎 N ☐ ☐ 👍
Are reduced consumption targets being set?		👎 N ☐ ☐ 👍
Marketing	Score = 6 /12	
Do we have an appropriate staff awareness or staff training programme ?		👎 ☐ N/Y ☐ 👍
Do we report energy use trends to the users ?		👎 N ☐ ☐ 👍
Do we have any incentives for employees to suggest ideas ?		👎 ☐ N/Y ☐ 👍
Is senior management regularly updated with developments ?		👎 ☐ ☐ Y 👍
Is senior management advised of energy saving opportunities ?		👎 ☐ ☐ Y 👍
Are our energy efficiency achievements promoted externally?		👎 N ☐ ☐ 👍
Investment	Score = 5 /10	
Has the appropriate time been spent implementing the energy management programme ?		👎 N ☐ ☐ 👍
Do energy projects have the same criteria as other projects ?		👎 ☐ ☐ Y 👍
Do we have a budget specifically for energy management projects ?		👎 N ☐ ☐ 👍
Do projects or purchase's take ongoing energy costs into account ?		👎 ☐ N/Y ☐ 👍
Are benefits other than cost reduction assessed with energy efficiency projects?		👎 ☐ ☐ Y 👍

TOTAL SCORE: (2 points per "yes" tick, 1 point per midpoint tick)	13/50

7.3 Appendix 3 - Energy Balance

		kWh/yr	kWh/yr								
		Calculated	Invoice								
Transformer 1	Kilns 4 5 6	368,855	351,364								
Transformer 2	Boiler	309,166	306,135								
Transformer 3	Planer Kilns 1,2,3 Treatment	1,811,149	1,882,091								
Transformer 4	Mill, sawdust dryer, workshop	913,580	892,627								
Transformer 5	Office	26,947	27,995								
		3,429,697	**3,460,212**				**weeks /year**		**48**		

Transformer		**kWh/yr**	**ave load kW**	**Hours/ year**	**% load**	**KW**	**Hours/ year (wkend)**	**Hours/ year (week)**	**Hours / wkend**	**Hours / week**	**Hours/ week outside main production**
1	Motor debarker 1	4668	2.2	2122	0.4	5.5	57.6	2064.0	4.0	43.0	
1	Motor debarker conveyor 1	3902	1.5	2602	0.5	3.0	57.6	2544.0	4.0	43.0	10.0
1	Motor debarker conveyor 2	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor debarker 2	5304	2.5	2122	0.5	5.0	57.6	2064.0	4.0	43.0	
1	Motor debarker 3	191	0.09	2122	0.5	0.2	57.6	2064.0	4.0	43.0	
1	Motor debarker 4	4243	2	2122	0.4	5.0	57.6	2064.0	4.0	43.0	
1	Motor debarker conveyor 3	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor debarker conveyor 4	5834	2.75	2122	0.5	5.5	57.6	2064.0	4.0	43.0	
1	Motor debarker conveyor 5	10608	5	2122	0.5	10.0	57.6	2064.0	4.0	43.0	
1	Motor debarker conveyor 6	15700	7.4	2122	0.2	37.0	57.6	2064.0	4.0	43.0	
1	Motor debarker conveyor 7	15912	7.5	2122	0.5	15.0	57.6	2064.0	4.0	43.0	
1	Motor headrig conveyor 1	7956	3.75	2122	0.5	7.5	57.6	2064.0	4.0	43.0	

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
1	Motor headrig conveyor 2	7956	3.75	2122	0.5	7.5	57.6	2064.0	4.0	43.0	
1	Motor headrig conveyor 3	3182	1.5	2122	0.5	3.0	57.6	2064.0	4.0	43.0	
2	Motor headrig 1	22277	10.5	2122	0.07	150.0	57.6	2064.0	4.0	43.0	
1	Motor headrig 2	306	0.144	2122	0.8	0.2	57.6	2064.0	4.0	43.0	
1	Motor headrig 3	3819	1.8	2122	0.8	2.3	57.6	2064.0	4.0	43.0	
1	Motor headrig 4	78499	37	2122	0.2	185.0	57.6	2064.0	4.0	43.0	
1	Motor headrig 5	3819	1.8	2122	0.8	2.3	57.6	2064.0	4.0	43.0	
1	Motor headrig 6	1909	0.9	2122	0.8	1.1	57.6	2064.0	4.0	43.0	
1	Motor headrig 7	3902	1.5	2602	0.5	3.0	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 4	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 5	4878	1.875	2602	0.5	3.8	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 6	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 7	7154	2.75	2602	0.5	5.5	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 8	7154	2.75	2602	0.5	5.5	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 9	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor headrig conveyor 10	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
2	Motor Mill Compressor	78170	31.5	2482	0.35	90.0	57.6	2424.0	4.0	43.0	7.5
2	Motor edger conveyor 1	2334	1.1	2122	0.5	2.2	57.6	2064.0	4.0	43.0	
2	Motor edger conveyor 2	2546	1.2	2122	0.4	3.0	57.6	2064.0	4.0	43.0	
1	Motor edger 1	63648	30	2122	0.2	150.0	57.6	2064.0	4.0	43.0	
2	Motor edger 2	18670	8.8	2122	0.4	22.0	57.6	2064.0	4.0	43.0	
2	Motor edger 3	202	0.095	2122	0.5	0.2	57.6	2064.0	4.0	43.0	
2	Motor edger 4	318	0.15	2122	0.6	0.3	57.6	2064.0	4.0	43.0	
2	Motor edger conveyor 3	5724	2.2	2602	0.4	5.5	57.6	2544.0	4.0	43.0	10.0
2	Motor edger conveyor 4	4243	2	2122	0.5	4.0	57.6	2064.0	4.0	43.0	
2	Motor edger conveyor 5	5203	2	2602	0.5	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor resaw conveyor 1	2862	1.1	2602	0.5	2.2	57.6	2544.0	4.0	43.0	10.0

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
1	Motor resaw conveyor 2	4243	2	2122	0.5	4.0	57.6	2064.0	4.0	43.0	
1	Motor resaw conveyor 3	2334	1.1	2122	0.5	2.2	57.6	2064.0	4.0	43.0	
1	Motor resaw conveyor 4	4878	1.875	2602	0.5	3.8	57.6	2544.0	4.0	43.0	10.0
1	Motor resaw conveyor 5	5834	2.75	2122	0.5	5.5	57.6	2064.0	4.0	43.0	
1	Motor resaw conveyor 6	5834	2.75	2122	0.5	5.5	57.6	2064.0	4.0	43.0	
1	Motor resaw conveyor 7	4243	2	2122	0.5	4.0	57.6	2064.0	4.0	43.0	
1	Motor resaw conveyor 8	3925	1.85	2122	0.5	3.7	57.6	2064.0	4.0	43.0	
1	Motor resaw 1	37234	17.55	2122	0.26	67.5	57.6	2064.0	4.0	43.0	
1	Motor resaw 2	5092	2.4	2122	0.6	4.0	57.6	2064.0	4.0	43.0	
1	Motor resaw 3	28642	13.5	2122	0.3	45.0	57.6	2064.0	4.0	43.0	
1	Motor resaw 4	2801	1.32	2122	0.6	2.2	57.6	2064.0	4.0	43.0	
1	Motor resaw 5	4683	1.8	2602	0.45	4.0	57.6	2544.0	4.0	43.0	10.0
1	Motor resaw 6	4683	1.8	2602	0.45	4.0	57.6	2544.0	4.0	43.0	10.0
2	Motor deck conveyor 1	5251	2.475	2122	0.45	5.5	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 2	2100	0.99	2122	0.45	2.2	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 3	3819	1.8	2122	0.45	4.0	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 4	2100	0.99	2122	0.45	2.2	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 5	2100	0.99	2122	0.45	2.2	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 6	234	0.09	2602	0.45	0.2	57.6	2544.0	4.0	43.0	10.0
2	Motor deck conveyor 7	716	0.3375	2122	0.45	0.8	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 8	2864	1.35	2122	0.45	3.0	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 9	3819	1.8	2122	0.45	4.0	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 10	3819	1.8	2122	0.45	4.0	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 11	2100	0.99	2122	0.45	2.2	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 12	3819	1.8	2122	0.45	4.0	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 13	878	0.3375	2602	0.45	0.8	57.6	2544.0	4.0	43.0	10.0
2	Motor deck conveyor 14	2100	0.99	2122	0.45	2.2	57.6	2064.0	4.0	43.0	

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
2	Motor deck conveyor 15	2100	0.99	2122	0.45	2.2	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 16	5251	2.475	2122	0.45	5.5	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 17	1756	0.675	2602	0.45	1.5	57.6	2544.0	4.0	43.0	10.0
2	Motor deck conveyor 18	5251	2.475	2122	0.45	5.5	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 19	1432	0.675	2122	0.45	1.5	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 20	1432	0.675	2122	0.45	1.5	57.6	2064.0	4.0	43.0	
2	Motor deck conveyor 21	5251	2.475	2122	0.45	5.5	57.6	2064.0	4.0	43.0	
1	Motor chipper 1	112553	50.4	2233	0.45	112.0	57.6	2175.6	4.0	45.3	
1	Motor chipper 2	11054	4.95	2233	0.45	11.0	57.6	2175.6	4.0	45.3	
1	Motor chipper 3	2218	0.99	2240	0.45	2.2	64.8	2175.6	4.5	45.3	
1	Motor sawdust drier 1	49346	18.7	2639	0.85	22.0	190.8	2448.0	13.3	43.0	8.0
2	Motor sawdust drier 2	1979	0.75	2639	0.5	1.5	190.8	2448.0	13.3	43.0	8.0
2	Motor sawdust drier 3	1979	0.75	2639	0.5	1.5	190.8	2448.0	13.3	43.0	8.0
1	Motor sawdust drier 4	104099	41.25	2524	**0.55**	**75.0**	75.6	2448.0	5.3	43.0	8.0
1	Motor sawdust drier 5	11356	4.5	2524	0.6	7.5	75.6	2448.0	5.3	43.0	8.0
1	Motor sawdust drier 6	4997	1.98	2524	0.9	2.2	75.6	2448.0	5.3	43.0	8.0
1	Motor sawdust drier 7	1514	0.6	2524	0.8	0.8	75.6	2448.0	5.3	43.0	8.0
1	Motor sawdust drier 8	5552	2.2	2524	0.4	5.5	75.6	2448.0	5.3	43.0	8.0
		0	0	2064			0.0	2064.0		43.0	
4	Motor planer conveyor 1	3802	2.2	1728	0.4	5.5	0.0	1728.0		36.0	
4	Motor planer conveyor 2	3888	2.25	1728	0.3	7.5	0.0	1728.0		36.0	
4	Motor planer conveyor 3	127	0.88	144	0.4	2.2	0.0	144.0		3.0	
4	Motor planer conveyor 4	21	0.148	144	0.4	0.4	0.0	144.0		3.0	
4	Motor planer conveyor 5	86	0.6	144	0.4	1.5	0.0	144.0		3.0	
4	Motor planer conveyor 6	63	0.44	144	0.4	1.1	0.0	144.0		3.0	
4	Motor planer conveyor 7	43	0.3	144	0.4	0.8	0.0	144.0		3.0	
4	Motor planer conveyor 8	43	0.3	144	0.4	0.8	0.0	144.0		3.0	

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
4	Motor planer conveyor 9	1521	0.88	1728	0.4	2.2	0.0	1728.0		36.0	
4	Motor planer 1	2765	1.6	1728	0.4	4.0	0.0	1728.0		36.0	
4	Motor planer 2	5702	3.3	1728	0.3	11.0	0.0	1728.0		36.0	
4	Motor planer 3	6804	4.5	1512	0.3	15.0	0.0	1512.0		31.5	
4	Motor planer 4	665	0.44	1512	0.4	1.1	0.0	1512.0		31.5	
4	Motor planer 5	665	0.44	1512	0.4	1.1	0.0	1512.0		31.5	
4	Planer Head #1 Motor	9072	6	1512	0.2	30.0	0.0	1512.0		31.5	
4	Planer Head #2 Motor	3326	2.2	1512	0.2	11.0	0.0	1512.0		31.5	
4	Planer Head #3 Motor	5594	3.7	1512	0.2	18.5	0.0	1512.0		31.5	
4	Planer Head #4 Motor	3326	2.2	1512	0.2	11.0	0.0	1512.0		31.5	
4	Planer Head #5 Motor	9072	6	1512	0.2	30.0	0.0	1512.0		31.5	
4	Planer Head #6 Motor	3326	2.2	1512	0.2	11.0	0.0	1512.0		31.5	
4	Planer Head #7 Motor	4536	3	1512	0.2	15.0	0.0	1512.0		31.5	
4	Planer Head #8 Motor	4536	3	1512	0.2	15.0	0.0	1512.0		31.5	
4	Motor planer 6	67738	39.2	1728	0.7	56.0	0.0	1728.0		36.0	
4	Motor Multi- Rip motor 1	1875	13.02	144	0.7	18.6	0.0	144.0		3.0	
4	Motor Multi- Rip motor 2	1598	11.1	144	0.3	37.0	0.0	144.0		3.0	
4	Motor Multi- Rip motor 3	108	0.75	144	0.5	1.5	0.0	144.0		3.0	
4	Motor Planer Shed Compressor	3802	2.2	1728	0.1	22.0	0.0	1728.0		36.0	
4	Motor Multi- Rip motor 4	396	2.75	144	0.5	5.5	0.0	144.0		3.0	
4	Motor Multi- Rip motor 5	2160	15	144	0.5	30.0	0.0	144.0		3.0	
3	Boiler #1 Water Pump 1	10886	1.35	8064	0.9	1.5	2304.0	5760.0	48.0	120.0	
3	Boiler #1 Water Pump 2	39917	4.95	8064	0.9	5.5	2304.0	5760.0	48.0	120.0	
3	Boiler #1 FD Fan	149184	18.5	8064	0.5	*37.0*	2304.0	5760.0	48.0	120.0	
3	Boiler #1 Grit Refire Fan	4435	0.55	8064	0.5	1.1	2304.0	5760.0	48.0	120.0	
3	Boiler #2 Water Pump #1	21773	2.7	8064	0.9	3.0	2304.0	5760.0	48.0	120.0	
3	Boiler #2 FD Fan	48384	6	8064	0.8	*7.5*	2304.0	5760.0	48.0	120.0	

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
4	Motor boiler 1	7096	0.88	8064	0.8	1.1	2304.0	5760.0	48.0	120.0	
4	Motor boiler 2	6209	0.77	8064	0.7	1.1	2304.0	5760.0	48.0	120.0	
4	Motor boiler 3	6048	0.75	8064	0.1	7.5	2304.0	5760.0	48.0	120.0	
4	Motor boiler 4	7096	0.88	8064	0.8	1.1	2304.0	5760.0	48.0	120.0	
4	Motor boiler 5	2089	0.259	8064	0.7	0.4	2304.0	5760.0	48.0	120.0	
4	Motor boiler 6	6048	0.75	8064	0.1	7.5	2304.0	5760.0	48.0	120.0	
4	Motor Condensate Return Pump #1	2903	3.6	806	0.9	4.0	230.4	576.0	4.8	12.0	
4	Motor Condensate Return Pump #2	26127	3.6	7258	0.9	4.0	2073.6	5184.0	43.2	108.0	
4	Kiln #1 Fan #1	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #1 Fan #2	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #1 Fan #3	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #1 Fan #4	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #1 Fan #5	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
5	Kiln #1 Fan #6	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
6	Kiln #1 Fan #7	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
7	Kiln #1 Fan #8	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
8	Kiln #1 Fan #9	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #2 Fan #1	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
4	Kiln #2 Fan #2	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
4	Kiln #2 Fan #3	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
4	Kiln #2 Fan #4	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
4	Kiln #2 Fan #5	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
5	Kiln #2 Fan #6	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
6	Kiln #2 Fan #7	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
7	Kiln #2 Fan #8	64872	10.625	6106	0.85	12.5	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #1	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #2	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
4	Kiln #3 Fan #3	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #4	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #5	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #6	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #7	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #8	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #3 Fan #9	57087	9.35	6106	0.85	11.0	1497.6	4608.0	31.2	96.0	
4	Kiln #4 Fan #1	28544	4.675	6106	0.85	5.5	1497.6	4608.0	31.2	96.0	
4	Kiln #4 Fan #2	28544	4.675	6106	0.85	5.5	1497.6	4608.0	31.2	96.0	
4	Kiln #4 Fan #3	28544	4.675	6106	0.85	5.5	1497.6	4608.0	31.2	96.0	
5	Kiln #4 Fan #4	29729	4.675	6359	0.85	5.5	1751.0	4608.0	36.5	96.0	
4	Kiln #6 Fan #1	19094	6.375	2995	0.85	7.5	1497.6	1497.6	31.2	31.2	
4	Kiln #6 Fan #2	19094	6.375	2995	0.85	7.5	1497.6	1497.6	31.2	31.2	
4	Kiln #6 Fan #3	19094	6.375	2995	0.85	7.5	1497.6	1497.6	31.2	31.2	
4	Kiln #6 Fan #4	19094	6.375	2995	0.85	7.5	1497.6	1497.6	31.2	31.2	
5	Kiln #5 Fan #1	44279	7.225	6129	0.85	8.5	1751.0	4377.6	36.5	91.2	
5	Kiln #5 Fan #2	44279	7.225	6129	0.85	8.5	1751.0	4377.6	36.5	91.2	
5	Kiln #5 Fan #3	44279	7.225	6129	0.85	8.5	1751.0	4377.6	36.5	91.2	
5	Kiln #5 Fan #4	44279	7.225	6129	0.85	8.5	1751.0	4377.6	36.5	91.2	
4	Motor treatment 1	1178	0.55	2142	0.1	5.5	25.2	2116.8	5.3	44.1	
4	Motor treatment 2	1178	0.55	2142	0.1	5.5	25.2	2116.8	5.3	44.1	
4	Motor treatment 3	1178	0.55	2142	0.1	5.5	25.2	2116.8	5.3	44.1	
4	Motor treatment 4	1178	0.55	2142	0.1	5.5	25.2	2116.8	5.3	44.1	
4	Motor treatment 5	2356	1.1	2142	0.1	11.0	25.2	2116.8	5.3	44.1	
4	Motor treatment 6	598	0.279	2142	0.3	0.9	25.2	2116.8	5.3	44.1	
Lights Mill		81446	28	2909	1	28.0	86.4	2822.4	6.0	58.8	
Lights Outside		40723	14	2909	1	14.0	86.4	2822.4	6.0	58.8	

Transformer		kWh/yr	ave load kW	Hours/ year	% load	KW	Hours/ year (wkend)	Hours/ year (week)	Hours / wkend	Hours / week	Hours/ week outside main production
Lights Workshop		16088	4.9	3283	1	4.9	460.8	2822.4	12.0	58.8	
Lights Café		6117	1.8	3398	1	1.8	576.0	2822.4	12.0	58.8	
Lights Planer		11290	4	2822	1	4.0	0.0	2822.4	0.0	58.8	
Lights Treatment		11344	3.9	2909	1	3.9	86.4	2822.4	6.0	58.8	
Lights Boiler House		17885	2.7	6624	1	2.7	1920.0	4704.0	40.0	98.0	
Lights Office		9667	3.8	2544	1	3.8	192.0	2352.0	4.0	49.0	
Office heating/cooling		10560	4	2640	0.4	10.0	288.0	2352.0	6.0	49.0	
Office equipment		6720	2.5	2688	1	2.5	336.0	2352.0	7.0	49.0	

7.4 Appendix 4 – Calculations table

	Summary of Calculations												
		Not											
Paragraph	**Recommendations**	**Mutually**	**Total $**	**$(kVA)**	**$/ kVA**	**kVA**	**$(kWh)**	**c/kWh**	**kWh/yr**	**%**	**kWh**	**Cost to**	**Payback**
		Exclusive	**saved/yr**	**saved/ yr**		**reduction**	**saved/yr**		**saved**	**Improved**	**per year**	**implement**	**years**
	T1		**$38,810**	**$21,893**		**252**	**$16,917**		**409,365**				
4.2.1	power factor correction (82% to 96%) T3		$1,619	$1,619	$30	54.0	$0			15%		see below	
4.2.1	power factor correction (75% to 96%) T4		$14,438	$14,438	$110	131.3	$0					see below	
4.2.2	power factor correction (82% to 96%) T3 Winter		$4,083	$4,083	$80	51.0	$0			15%		$16,750	1.0
5.1.1	Balance phase voltages		$2,242	$440	$110	4.0	$1,802	11.1	16,242			$250	0.1
5.1.2	Stop Compressor air leaks		$3,120				$3,120	11.1	28,125			$1,500	0.5
5.1.2	Use air hoses less often and use blowers and brooms more often when cleaning after hours		$526				$526	11.1	4,740	30%	19,549	$400	0.8
5.2.2	Stop six steam leaks, refer to EECA Steam Leaks 1998		$5,063				$5,063	2.5	204,214			$2,460	0.5
5.2.2	Insulate 40 steam valves and 10m		$3,138				$3,138	2.5	126,565			$7,700	2.5

Paragraph	Recommendations	Mutually	Total $	$(kVA)	$/ kVA	kVA	$(kWh)	c/kWh	kWh/yr	%	kWh	Cost to	Payback
	pipe												
5.3	Link shavings fan switch to Planer operation		$1,864				$1,864	11.1	16,800			$450	0.2
5.5.1	Replace 10 incandescent lamps with CFLs.		$246	$81	$110	0.7	$164	11.1	1,480			$50	0.2
5.5.2	One person responsible for switching off unneeded lights.		$2,474	$1,232	$110	11.2	$1,242	11.1	11,200		11,200	$500	0.2
	T2		**$120,052**	**$2,031**		**18**	**$137,221**		**6,802,223**				
3.5	monitor wood use save electricty		$648	$0	$110	0.0	$648	10.6	6,125	2%	306,228	$689	1.1
3.5	monitor wood use save boiler fuel		$14,387				$14,387	1.5	947,261	2%	47,363,056	$15,311	1.1
5.2.1.1	Replace SD conveyor fan motor with high efficiency motor	4.2.1	$494.03	$436.35	$110	4.0	$58	11.1	520	1.10 %	104100	-$76	-0.2
5.2.3	Use VSD on kilns fans		$13,643	$1,100	$110	10.0	$12,543	10.6	118,577	6%	1,976,279	$20,000	1.5
5.5.1	Replace 18 self-ballasted lamps with metal halide		$1,888	$495	$110	4.5	$1,393	10.3	13,500		13,500	$7,200	3.8
6.1.1.2	Improve boiler efficiency to 78%	3.5, 5.2.2	$29,142	$0		0.0	$29,142	1.5	1,894,522	4%	47,363,056		
5.2.3	wood fuel repair kilns and baffles (assume 10% improvement)	6.1.1.2	$53,655				$72,855	1.5	4,736,306	10%	47,363,056		
5.2.3	electricity repair kilns and baffles (assume 10% improvement)	5.2.3	$24,144				$24,144	10.6	228,251	10%	2,282,506	$15,000	0.2

Paragraph	Recommendations	Mutually	Total $	$(kVA)	$/ kVA	kVA	$(kWh)	c/kWh	kWh/yr	%	kWh	Cost to	Payback
	T1 + T2 Total		**$157,958**	**$23,488**		**267**	**$153,670**		**7,194,529**				

7.5 Appendix 5 – Air leak costs

Insert copy of standard air leaks savings chart

7.6 Appendix 6 – Steam leak costs

Insert copy of standard steam leaks savings chart