FIEA Management Seminar

“MAINTECH 2005”

Improving Machine and Maintenance Technologies in the Mill

Electrical Inspections & Energy Management = Big Savings

Brian Kepple/ Erin Roughton
Energy Auditor/ Managing Director
Energy Management Solutions Ltd
P O Box 1740
Nelson
New Zealand
Ph: 03 5458 711
Fax: 03 5458 712
brian.kepple@emsol.co.nz
erin.roughton@emsol.co.nz
## Contents

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Summary</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Overview of Timber Industry</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Energy Use</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Energy Costs</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Savings Potential</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Achieving the Big Savings</td>
<td>8</td>
</tr>
</tbody>
</table>
1 Summary

Energy audits offer sawmills an opportunity to identify and achieve significant savings in both thermal fuel and electrical energy costs. Energy Management Solutions Ltd completed recently a review of energy audits at nine sawmill sites and identified cost savings opportunities of 17% on average, and up to 31% of the total site energy costs.

Electrical energy savings are a high proportion of these savings since the electrical energy costs are relatively high, at over 62% of the total energy costs. This means that at many sites there are more cost effective electrical savings opportunities than thermal fuel opportunities. However many electrical savings also arise from new technology requiring more investment and expert input to fully evaluate and implement.

2 Overview of Timber Industry

Wood processing is the single largest energy consuming industrial sector in New Zealand. In 1997 it accounted for 11% of New Zealand’s total energy use and 9% of the electricity use. (EECA 1998). Sawmilling is a small but significant part of the wood processing industry, accounting for 4 to 6% of the wood processing sector’s energy use.

Energy Management Solutions Ltd (Emsol) has in the past three years audited five sawmills. Recently we have combined the results of these audits with the results of four other audits made available from EECA.

The averaged results from these nine sawmills, located from Rotorua to Southland, are used here as a basis for industry wide estimates.

All sawmills were predominantly processing Radiata pine. However one site processed Douglas Fir, which was up to one third of its total throughput.

Production from these mills covered the range from annual inputs of 10,000 m³ to 240,000 m³. Kiln production varied from zero to 90,000 m³ annually.

3 Energy Use

The sawmills have two major energy requirements. The largest is thermal energy for the drying kilns and the other is electricity for powering the various motors and providing lighting at the site.

Thermal energy is generated from a number of different fuels at the various sites audited. However wood-waste residues were the most common fuel source.
From the nine sawmills, 89% of the total energy (kWh) used was thermal energy with electricity making up the remaining 11%. Fuels used to provide thermal energy were wood-waste (typically kiln-dried planer shavings and sawdust), gas, coal and oil. Diesel is mainly used by forklifts and log loaders.

A feature of the sawmills that utilised wood-waste residues for thermal energy was little monitoring of the quantities of wood-waste was undertaken. The figures in the above table were derived from estimates of the throughput of wood and estimates from the thermal energy demand. The lack of monitoring was due to the wood-waste being a by-product of production and therefore didn’t require any monitoring for billing purposes. Site 9 uses significantly less thermal energy than the other mills because it doesn’t kiln-dry any timber.
4 Energy Cost

Electricity represents almost all the purchased energy costs for sites that utilise a large amount of their own wood-waste to meet their thermal energy requirements. Electricity and boiler fuel costs are similar at sites, such as at Site 7, that utilise fuels other than wood-waste or alternatively when they have to buy wood residue. This is shown in the table below:

Annual Energy Cost

<table>
<thead>
<tr>
<th>Site</th>
<th>Electricity</th>
<th>Wood Waste</th>
<th>Coal</th>
<th>Gas</th>
<th>Recycled Fuel Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>41%</td>
<td>59%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>63%</td>
<td>21%</td>
<td></td>
<td></td>
<td>16%</td>
</tr>
<tr>
<td>4</td>
<td>90%</td>
<td></td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>100%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>70%</td>
<td></td>
<td></td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>56%</td>
<td></td>
<td></td>
<td></td>
<td>44%</td>
</tr>
<tr>
<td>8</td>
<td>100%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Excludes transport fuels.

Fossil fuels, mainly LPG, coal, diesel and recycled fuel oil, comprised 32% of the energy and 33.5% of the energy cost. These fuels are generally used for kiln drying as well, and sometimes supplementing or drying wood waste fuel.

Electricity comprises 11% of the total energy use and 62.5% of the energy cost.
At the sites that have kiln-drying facilities, boiler fuel represents between 84% and 94% of the total energy used but only represents between 0% and 59% of the purchased energy costs.

This difference in energy cost means that electricity savings are often more cost effective than thermal savings. It may justify more costly investments in electrical equipment to achieve smaller energy savings. Examples of this are found with controls such as variable speed drives, and higher efficiency motors and new technology lighting.

Thermal energy use is concentrated around the kiln-drying and treatment stages. Electricity use, however, is spread over the full range of production stages. The table below shows a segregation of the electricity use by each of the two main production stages.

### Annual Electricity Consumption (kWh) by stage

<table>
<thead>
<tr>
<th>Site*</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>9</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill</td>
<td>36%</td>
<td>32%</td>
<td>32%</td>
<td>27%</td>
<td>52%</td>
<td>44%</td>
<td>100%</td>
<td>46%</td>
</tr>
<tr>
<td>Kilns</td>
<td>61%</td>
<td>63%</td>
<td>50%</td>
<td>62%</td>
<td>43%</td>
<td>45%</td>
<td>0%</td>
<td>46%</td>
</tr>
</tbody>
</table>

*Sufficiently segregated information was only available for seven sites

On average 46% of the electricity use at the sawmills is used in the milling stage of production. Electrical energy is used predominantly to power the motors on site. These motors drive the saws, conveyors, pumps, fans and compressors. The sites audited by Emsol had between 80 and 200 motors on-site, which ranged in rated power to 185 kW.

Kiln-drying is the most energy intensive stage in the sawmill production process. The kilns are the major end-use for the thermal energy and the electrical load associated with the kilns and boiler-house represents on average 46% of the electricity used on-site. The major electrical loads are the kiln fans and boiler-house pumps and fans.

Intensity of electricity use for a site is the Electricity Use Index normally measured as electrical kWh per cubic metre of mill output. The nine sawmills surveyed ranged from 40.5 kWh/m$^3$ for one mill which does not do any kiln drying, to 96.9 for a mill that brings in additional sawn timber for kiln drying. The average of the eight sawmills using kilns was 82.4 kWh/m$^3$.

Intensity of total energy usage is the Energy Use Index, measured in either GJ/m$^3$ or kWh/m$^3$ relative to the mill output. The nine sawmills surveyed ranged from 97 kWh/m$^3$ for the one mill which does not do any kiln drying, to 1300 for a mill that brings in additional sawn timber for kiln drying. The average of the eight sawmills with kilns was 401 kWh/m$^3$. 

5 Savings Potential

There is significant scope for greater energy efficiency in sawmills. The study carried out by Emsol found overall energy savings potential comprised 3.1% of the total energy usage, which is 2.5 kWh/m³/year per site or about 1,000,000 kWh annually per sawmill. This saving is quite a small percentage of the total energy because a large proportion of the total energy is derived from wood waste. Since the wood waste has very little commercial value it does not offer many cost effective savings opportunities.

The value of savings opportunities averaged over the nine sawmills was $88,000 per year or 17% of their energy costs. The range of cost savings was from 7.4% to 31%.

The chart below shows the ten main areas in which recommendations were made and the energy auditors expected energy savings. Note that for a few recommendations the energy savings are quite small, but cost savings from reduced electricity peak charges and reduced machine maintenance costs make them very worthwhile.

![Energy Savings Expected from Main Recommendations](chart.png)

The major opportunities for energy savings are related to the boiler and kiln: improving insulation, ensuring that boilers are properly tuned, recovering heat and minimising steam losses. Note that on average these savings are 2/3 wood waste and 1/3 fossil fuels. These savings may often be achieved by improving existing maintenance practices. Savings tend to be more cost effective for fossil fuel than for wood waste fired boilers.

The opportunities for electricity energy savings often come from utilising newer technology requiring greater investment in plant and operator training. Although
these opportunities require more investment and operator training than thermal energy opportunities, they tend to be more cost effective and may also improve productivity.

6 Using Energy Audits to Achieve the Big Savings

What are energy audits?

An audit is a ‘health’ check on energy services provided in your business. It will answer questions such as:
“How much energy do I use?”
“How much do I spend on energy?”
“Is this high or low?”
“What savings can I make from energy saving measures?”
“What will these savings cost to implement?”

There are many interpretations of energy audits. These range from a quick walk through your site identifying areas of energy waste to comprehensively measuring, analysing energy flows on each equipment item and reporting accurately potential energy savings.


Level 1
“A Level 1 audit, sometimes called overview, allows the overall energy consumption of the site to be evaluated, to determine whether energy use is reasonable or excessive. It provides initial benchmarks of the site so that the effect of energy measures can be tracked and evaluated. It may be in the form of a desktop study; however the information given to, or gathered by, the auditor needs to be sufficient to enable the overall level of efficiency of the site to be determined.

NOTE: A Level 1 audit is expected to give an overview which provides rough orders of savings and costs. Accuracy of figures would generally be within plus or minus 40%”

Level 2
“A Level 2 audit identifies the sources of energy to a site, how much energy is supplied, and what the energy is used for. It also identifies areas where savings may be made, and recommends measures to be taken, giving a good idea of costs and potential savings.

NOTE: A Level 2 audit is an energy use survey which is expected to provide a preliminary assessment of costs and savings. Accuracy would generally be within 20%.”

Level 3
“A Level 3 audit provides a detailed analysis of energy usage, what savings can be made, and the cost of achieving those savings. It may cover the whole site or may concentrate on an individual
item, such as a single industrial process or one of the services. The auditor may often employ a specialist to carry out specific parts of audit or may need to install local metering and logging.

The report from a level 3 audit often forms the justification for substantial investment by the owner or an energy performance contractor. Detailed economic analysis with appropriate level of accuracy is required.

NOTE: A Level 3 audit is expected to provide a firm estimate of savings and costs, with accuracies within +10% for costs and -10% for benefits.”

Any energy audit, whether it’s a Level 1, 2 or 3, on its own does not result in savings (Refer to the sections that follow).

What are the benefits for your business of commissioning an energy audit?

An energy audit is one of the key tools to help a business achieve energy efficiency improvements.

The following is a list of benefits your business would expect from energy savings and improved energy efficiency:

• Reduced energy costs relative to income (energy audits of sawmills commonly identify between 10 and 25% of savings eg Emsol identified at Waimea Sawmillers Ltd in 2003 low cost energy savings up to 4% and higher cost savings up to 18%)
• Increased profits for your business,
• Reduced maintenance requirements for your plant; for example operating fans and other equipment only when needed results in improved site energy efficiency and fewer motor failures.
• Avoided investments in costly equipment; eg reducing loads or eliminating equipment by efficiency improvements avoids the need for larger or more expensive equipment. Heat recovery on kilns or improved insulation can result in a smaller boiler needed.
• Increased comfort for your employees; for example more efficient equipment such as conveyors and motors running smoothly results in less noise.
• Reduced demand on New Zealand’s energy resources
• Reduce carbon dioxide emissions

How to achieve increased profits?

One of the benefits of an energy audit is receiving a list of recommended savings measures that when implemented will help increase profits.

This is achieved by reducing energy costs relative to production, which requires reducing:

\[
\frac{\text{energy costs ($)}}{\text{volume quality timber production (m}^3)}
\]

This relationship is made up of two parts:
1. The amount you pay for energy (eg $/kWh and $/kVA); multiplied by
2. The amount of energy used per production (eg kWh/m\(^3\) and kVA/m\(^3\))
When you reduce one of these components you increase profits.

**What is involved in completing an energy audit in your sawmill?**

A typical process for completing an audit and achieving savings is illustrated in the diagram below:

1. **Collate all existing data**
2. **Analyse benchmarks / tariffs**
3. **Site inspections / measurements**
4. **Evaluate all savings options**
5. **Feedback / Reporting**
6. **Prioritise and implement projects**

**Collate existing data**

One of the first steps is to collate all energy costs, energy consumption and rates of energy use. This includes parameters such as power factor. In addition, energy data should be itemised for each month for the previous 24 months and include all electricity meters and fuels such as diesel, gas, wood and vehicle fuels.

Monthly production data should be provided for the whole site, and sometimes for each department. These production figures should correlate with the same months as the energy use data.

Other information to collate and review includes specifications and maintenance manuals of equipment and buildings. These should be reviewed for at least the largest energy using equipment.
Any energy audits that have been completed during the previous five years would be reviewed so that evaluations are not repeated. In addition, past recommendations not implemented can be questioned as to whether they are still relevant.

Operation and process manuals specify important maintenance requirements, set points and other variables that affect energy consumption. For example, options for sharpening planer blades will be included in its operations manual and include a section on the effects of sharpening blade at various angles and frequency.

**Analyse benchmarks and tariffs**

Establish the site energy use index and compare with benchmarks. This is a measure of energy (GJ) used relative to production (m$^3$). This could be in terms of kWh/ m$^3$ or GJ/m$^3$. Production may be the volume (m$^3$) of wood entering or exiting the mill or the volume of timber dried in kilns or both. Parameters are selected that are most appropriate for each particular site.

This type of analysis is used to compare relative efficiencies from month to month (refer to the chart below). Annual indices for part or the whole site are compared with industry benchmarks. Benchmarks are available from a number of forest industry associations, EECA or Energy Management Solutions Ltd. New Zealand benchmarks for electricity use in sawmills range from 42 to 83.3 kWh/m$^3$/year and is typically 70 kWh/m$^3$/year published by NZ Forest Industries Council from a survey of sawmills in 1996. The group of nine sawmills surveyed by Emsol had an average of 81 kWh/m$^3$/year.

Typical benchmarks relevant to common sawmill sites are:

- **Mill** 20 to 30 kWh/ m$^3$
- **Kilns** 50 to 70 kWh/ m$^3$ (electricity) / (500 kWh/ m$^3$ heat)
- **Planers** 8 to 16 kWh/ m$^3$
- **Office/workshop** 0.8 kWh/ m$^3$
- **Whole site** 70-600 kWh/ m$^3$

No or low capital cost saving measures are often achieved by analysing energy supply tariffs and managing mill operations to utilise the least expensive energy options. For example, analysing a site such as Waimea Sawmillers Ltd identified it was paying 40% of its electricity costs in terms of $/kVA and 60% in terms of $/kWh. Some savings were achieved by reducing peak kVA loads and consuming relatively more kWhs during less expensive night and weekend periods.

The effect of the electrical energy savings opportunities that were implemented from September 2003 are clear in the following chart. Each point shows the previous twelve months electrical energy use divided by the corresponding mill production in cubic metres.
Electricity tariff rates vary by network company, energy supplier, site management and type of electricity meter. Meters are often Time-Of-Use (TOU) meters, and sometimes Anytime metering is used.

Electricity costs that vary with load (kVA) often vary by season (winter versus summer) and typically are based on the single highest month in a year or an average of 12 months.

Electricity consumption (kWh) costs will vary by season and time of day or night. In addition, a proportion of network charges may depend on consumption, as well as load. Often electricity costs at night (after 11pm) will be less expensive than at other times.

Power factor affects how much you pay for electricity, particularly if you use TOU meters. The highest proportion of loads at sawmills are motors, which typically induce a poor (or low) power factor, and increased kVA loads.

The most favourable power factor is 100% while 70% or less can be commonly found in sawmills. A 30% drop in power factor could increase annual electricity costs by 12%. A rule of thumb is to aim for power factor at above 95%, using power factor correction equipment where needed.

**Establish Energy balance**

Establishing an energy balance of the sawmill site is an important part of the process of a Level 2 audit. This process compares the amount of energy used in a year (by summatting invoices) with the amount of energy the site should use (by calculation). Where differences arise it can often lead to identifying areas of inefficiency. This process in one audit identified that a boiler and hot water distribution system was using excessive electricity compared with the volume of wood being dried.
Site inspections

An energy auditor will inspect equipment and processes on site in order to identify other inefficiencies. It includes checking areas of inefficiencies already identified from the evaluations described above. An important part of the site inspection is to meet and discuss with a number of on-site staff their operations, practices and habits. In addition, many staff have ideas about what works well and what could be improved in their area of operation and expertise.

There are a large number of energy savings measures that could cost effectively be implemented in sawmills in New Zealand. What is relevant at one site will not always be relevant at the next site. For example, at Waimea Sawmillers Ltd staff are excellent at switching off equipment during breaks, such as lunch time; while another site left fans running that should be switched off for the half hour, which would save $1000 a year.

Below is a list of some of the common energy savings measures identified at various sawmills:

**Mill**
- Increase and maintain power factor above 95%
- Increase staff awareness of energy efficiency habits
- Avoid using compressed air hoses for cleaning equipment; use blowers or brushes
- Check motor inventory: optimise loads, sizes and operating times, efficiencies, bearing conditions
- Review Saw Doctor sharpening frequencies
- Reduce saw thicknesses
- Compressed air: stop leaks and review size, pipe routes, pressure requirements
- Use Variable Speed Drives (VSD) and cogged drive belts
- Optimise start-up procedures
- Manage operations to run motors at full load or switch off
- Upgrade light levels and types and use only when needed
- Switch-off unused equipment during breaks

**Kilns/ boilers/ presses**
- Increase and maintain power factor above 95%
- Increase staff awareness of energy efficiency habits
- Change kiln charge schedules to reduce peak loads
- Change charge times and use cheaper electricity
- Insulate pipes
- Use VSDs on fans and pumps
- Use heat recovery for boiler feed water and kilns
- Tune the boiler more frequently
- Reduce the water temperature
- Use alternative fuels to electricity
- Consider cogeneration after implementing energy efficiency

Other areas
- Increase and maintain power factor above 95%
- Measure and display planer loads
- Check planer blade sharpening procedures
- Reduce planing by reducing timber thicknesses
- Reduce fan and duct sizes, but avoid clogging ducts
- Check and adjust treatment plant pressure
- Remind staff to switch off unused equipment and lights in offices and Workshop
- Switch-off equipment during breaks
- Upgrade light levels and types, install sensors and use lights only when needed

How can your business achieve the savings identified in an audit?

To achieve savings in your business, an energy audit should be part of an Energy Management programme. This involves setting targets, planning, monitoring energy use and costs, designating individuals to be responsible for implementing savings measures and reporting and raising staff awareness about their responsibilities.

Energy savings measures compete with other investment initiatives for resources. These may include expansion of the plant or adding a new product line. Whether it's an energy saving measure or another initiative each should be compared with a common investment policy that includes all costs and benefits. Energy saving measures can result in additional benefits such as improved working conditions for staff and therefore increased productivity.

Many energy saving measures require staff involvement. These are usually the measures with the shortest payback because they involve changes in procedures and staff habits, which are low in cost to implement. For example reminding staff to switch off unused equipment, fans, compressors or lights!

In order to help maintain input by staff it helps to show staff the benefits of their efforts. This is achieved by ongoing monitoring, measuring results and providing feedback in the savings or present rewards/prizes for their efforts.

One of EECA’s roles is to assist business improve their energy efficiency. EECA has a number of programmes such as Emprove, which is specifically designed to help business. It provides guidance, planning advice, and grants for audits. It also helps business get started with, and measure performance of, its energy management programme.
When to start an energy audit

One of the common reasons why businesses do not start an energy audit is because all staff are committed to other priorities. Although the business has the interest and skills within its company to carry out the audit they never seem to either start or finish an audit.

Meanwhile there are savings to be achieved with paybacks ranging from a few months to three to four years. The best time to start an audit is now and start reaping the benefits; unless a comprehensive energy audit was completed in the past three to five years.

Where can your business get help with completing an energy audit?

There are a number of businesses, such as Emsol, that specialise and are Accredited in energy auditing. They are registered with Energy Management Association of New Zealand (EMANZ), who has a list of Accredited Auditors.

Grants to help with the cost of commissioning an audit are administered by EECA. Grants for a full Level 2 audit are:

- 50% of audit costs up to $10,000 plus
- 30% of costs up to $20,000 plus
- 20% of costs up to $30,000
- $10,000 audit qualifies for a $5,000 grant
- $20,000 audit qualifies for an $8,000 grant
- $30,000 audit qualifies for a $10,000 grant

In addition, two special grants for electricity audits are available for business sites that use more than 10 GWh per year or 50 GWh per year respectively.

Why commission help?

Just as you may call upon the services of a solicitor to resolve a legal matter or an accountant to audit finances, so there is a need to employ the services of a specialist to resolve energy problems and identify opportunities. Reasons to commission help include:

- Ensuring an audit is completed when you do not have the time
- Obtaining an independent viewpoint
- Employing specialist knowledge with a range of experience
- Receiving a comprehensive report; and
- Utilising a formal document with a list of investment recommendations
References:

Electrical Savings from Fan Speed Reduction in Lumber Dry Kilns; and Lumber Drying Energy Efficiency Audit, Waimea Sawmillers Ltd; Emsol 2003
Energy Requirements of Forest Industry Scenarios; Forest Industries Energy Research 1981
Energy Use in the Forest Processing Industry; Forest Research 2002
Forest energy under the microscope; Energy Wise News 2002
Get energy management information with an energy audit; EECA 1997

For more information
Contact:
Erin Roughton or Brian Kepple
erin.roughton@emsol.co.nz
brian.kepple@emsol.co.nz
Ph: 64-3-545 8711
Or
Ph: 025-495 288