

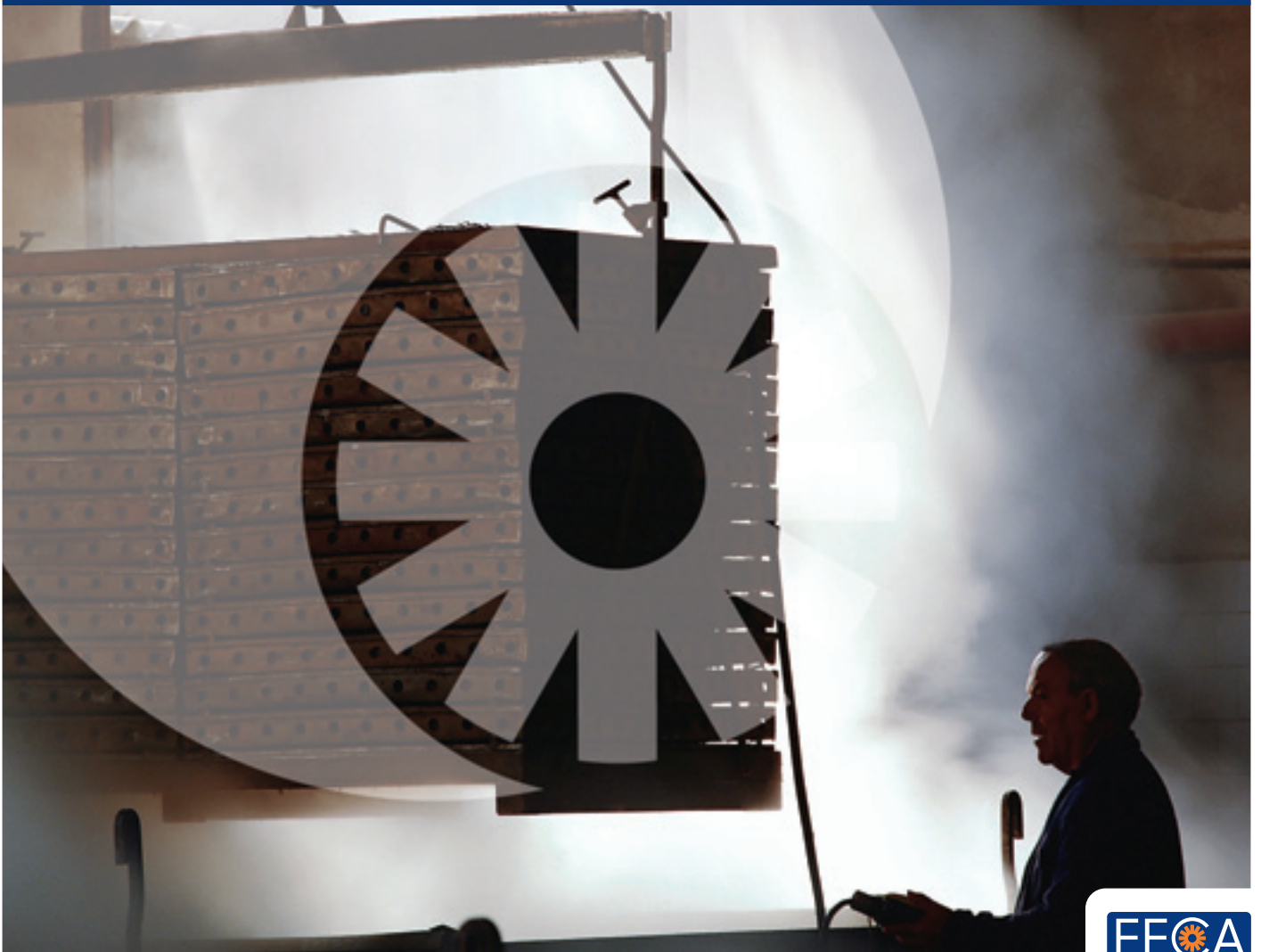


REVIEW OF

Energy Use in Specific Meat and Fish Processing Plants

and opportunities for energy savings

MARCH 2005



Prepared for the Energy Efficiency and Conservation Authority (EECA) and the New Zealand Climate Change Office by Veritas Business Services.

Disclaimer

While the information contained in this report is provided in good faith, no responsibility can be accepted by Veritas Business Services or its proprietor for the decisions, actions or other use of the information made by the client or the client's representatives.

Contents

Executive Summary	02
Priority One: Immediate Application	02
Industry Actions	02
Energy Procurement	02
Energy Audit Process	02
Post-Audit Process – Energy Management	03
Government Actions	03
Priority Two: For Development	03
Industry Actions	03
Government Actions	03
Predicted Savings	03
Introduction	04
Audit Sites and Products Produced	06
Site D	06
Meat Industry Group 1	06
Meat Industry Group 2	07
Meat Industry Group 3	07
Observations	08
Processes	08
Plant	09
Buildings	10
Actions Taken	11
Existing Energy Consumption	15
Annual Energy Consumption and Type of Energy Used	15
Energy End Users	16
Electricity	16
Coal	17
Gas	17
Alternative Energy Sources	18
Opportunities for Improving Energy Performance	19
Recommendations	21
Priority One: Immediate Application	21
Industry Actions	21
Energy Procurement	21
Energy Audit Process	21
Post-Audit Process – Energy Management	21
Government Actions	21
Priority Two: For Development	22
Industry Actions	22
Government Actions	22

Executive Summary

- Ten audits were examined; nine for meat processing plants and one for a fish processing plant.

Major Findings

- Energy Use Indicators (EUIs) are a myth at the industry level.
- There is no consistent application of MAF regulations.
- Energy management and monitoring facilities and processes are underdeveloped and impeding energy awareness, cost and efficiency.
- Preferred energy purchase contract structures and contract negotiation procedures do not encourage energy efficiency. They are very risk-averse.
- There is a need to involve corporate interests where corporate management processes impact on energy efficiency at the site level.
- Energy audits need to focus more on matching resources to demands in addition to optimising individual plant efficiency.
- The depth of analysis of electricity line charges is limited, resulting in potential cost savings being overlooked.
- Energy audits do not identify energy management processes and practices as a natural corollary.
- Alternative plant fuels, both external and internal, need continuing support in their development.
- Energy management training needs to be widely encouraged within the meat and fish processing industries.
- Major plant (boilers, refrigeration) is not routinely evaluated for economic performance. “If it ain’t broken, don’t fix it” seems to be a general view held by the industries.
- Site plans reflect historic needs and require optimising for current needs.
- Government financial support of energy audits alone is insufficient to encourage significant energy savings.
- The present audit standard AS/NZS 3598:2000 “Energy Audits” is inadequate for industrial sites.

Recommendations

Priority One: Immediate Application

Industry Actions

- Although Energy Use Indicators (EUIs) are inappropriate at the industry level, they have practical application at the site level and their use is to be encouraged.
- The meat processing industry should be encouraged to reach consensus on a consistent application of MAF regulations. This would have energy use consistency outcomes that are likely to equate with energy efficiency.
- Where SCADA systems are upgraded or replaced, the functions of energy monitoring, reporting and management need to be included as a design requirement. This would assist in embedding energy management.

Energy Procurement

- Major industrial users should be encouraged to consider electricity supply contracts which have some spot pricing exposure. While not saving energy per se, the exposure would encourage a greater awareness of energy use and provide a further motivation for efficient energy use. A dual benefit is that the shared risk (with the retailer) generally results in lowered electricity costs over the medium term.

Energy Audit Process

- Where site processing is subject to corporate requirements, corporate management should be included in the energy management process. In particular, in the audit commissioning process.
- Audit reports should encourage processes to integrate so that resources (steam, hot water, refrigeration, etc.) match demands.
- Audit reports need to contain more depth of analysis regarding line charges. When cost drivers are defined, cost reductions through better demand and power factor management become more apparent.

-
- Audit reports should contain more depth of economic analysis so that simple payback does not remain the only measure. Many audit recommendations take more than one year to implement yet they generally meet other economic criteria, e.g. Net Present Value and Internal Rate of Return tests.

Post-Audit Process – Energy Management

- Energy management is a natural progression from the benchmarking and directional outcomes of the audit report. Audit reports should contain some direction in a “where to from here” section so that a basic structure for incorporating energy management into ordinary management processes is achieved. In particular, this applies to the initial steps of monitoring and targeting.

Government Actions

- Continue support for the development of alternative fuels deriving from internal sources such as waste. In particular, boiler fuels could be considered. Effluent tallow appears to be a resource requiring further development. Bio-gas from bio-digesters is another source. Presently, effluent is regarded, by definition, as waste.
- Continue support for the development of alternative fuels deriving from external sources. Experimentation with solar water heating or pre-heating should be encouraged. The solar water heating industry appears to have reached a suitable level of maturity for industrial application and the economics need re-examining.

Priority Two: For Development

Industry Actions

- Industry energy management training needs to emphasise the ubiquitous application of the energy management concept from design and purchasing through to operation and maintenance. This includes everything from the strategic requirements of policy development through to operational procedures. This should also include energy cost monitoring.
- Audit clients need to be encouraged to undertake routine evaluation of their plant to ensure that the existing plant remains the most economic choice for a site. Such reviews should factor in current and prospective energy use (and costs) and capacity requirements. The audit reports examined suggested that this is never done.
- Site design, redesign or refurbishment needs to consider whether centralisation or decentralisation of major plant would most benefit its operation.

Government Actions

- Consideration could be given to some form of financial incentive to upgrade old plant with modern, energy efficient plant. Britain’s “The Carbon Trust” scheme is recommended as an example of such a scheme.
- The present standard, AS/NZS 3598:2000 “Energy Audits” needs urgent revision to provide generic guidelines for industrial sites.

Predicted Savings

- Savings for each of these items would be entirely speculative. However, as the available action plans indicate, only a small proportion of the identified easy-to-do low cost (T1) savings have been implemented under the current structure. Implementing the Priority One recommendations in this report could conceivably double that achievement.

Introduction

The objective of this report is:

“To analyse the energy audits completed at 10 meat and fish processing plants and prepare a report identifying energy use, savings potential and actions required to achieve savings as a sector study for the CCO SME project regarding implications of a future carbon tax.” Contract reference: Cons547 Veritas Business Services.

The specific audits provided by EECA covered the following sites:

Site	Type of Processing	Date of Audit	Auditor or Audit Company
Site E	Meat	June 2004	Energy Auditor A
Site F	Meat	June 2004	Energy Auditor A
Site G	Meat	July 2004	Energy Auditor A
Site H	Meat	July 2004	Energy Auditor A
Site A	Meat	April 2002	Energy Auditor A
Site B	Meat	April 2002	Energy Auditor A
Site C	Meat	March 2002	Energy Auditor A
Site D	Fish	September 2001	Energy Auditor B
Site I	Meat	February 2004	Energy Auditor A
Site J	Meat	February 2004	Energy Auditor A

A recent submission from the meat industry provides a useful overall insight into the role played by energy in its operations:

“The meat processing industry is a large consumer of energy. The estimated annual cost is approximately \$200million. This represents around 5% of total plant operating costs. In 2001, electricity accounted for approximately 70% of the energy costs with gas and coal accounting for the remainder. Refrigeration is the largest user of electricity followed by boilers producing steam and hot water – two important components of a successful meat industry.” Submission by the Meat Industry Association on the Resource Management (Energy and Climate Change) Amendment Bill, 29 Sept 03, cl 1.3.

There was no literature immediately available to provide similar insights into aquaculture. However the fishing industry’s submission on the implementation of the Kyoto Protocol outlines the perceived impact this will have on them and in particular identifies refrigeration as a major user and the associated plant as ageing:

- “Energy costs for transport and processing are likely to increase;
- The costs of renewing refrigeration and insulation equipment (a common component of both vessels and processing facilities) could increase as a result of the Protocol’s coverage of some synthetic gases;
- These increases will all threaten the competitiveness of the industry internationally and reduce industry profitability, although the degree of impact will depend on the policies of our trade competitors in the periods leading up to, during, and after 2008-2012.” New Zealand Seafood Industry Council, Submission to the New Zealand Climate Change Programme on Ratification of the Kyoto Protocol, Dec 2001.

Clearly, energy costs, direct and indirect, are of concern to both industries.

Deriving indicative per unit energy usage for the fish processing industry has the same difficulties as for the meat processing industries. Fish processing energy requirements, besides varying on a per-site basis, also vary depending on whether the plant is processing:

- whole fish, and whether fresh or frozen,
- filleted fish, and whether fresh or frozen,
- canned fish, or
- others, e.g. shrimp, crab, surimi, etc.

Notwithstanding the above differences, a Canadian investigation found that the most common use of energy in processing was for refrigeration, which accounted for 65%-85% of electricity use. Kelleher G, Kolbe E, Wheeler G: "Improving Energy Use and Productivity in West Coast and Alaskan Seafood Processing Plants", Oregon State University, 2001. Further, although not directly comparable with operating costs as discussed for meat processing above, energy use accounted for an average of 2.2% of annual sales. If sales are assumed to be three times operating costs, then the 2.2% figure becomes comparable to the 5% value reported for the New Zealand meat industry and perhaps an indicator of processing energy costs within the New Zealand fish processing industry.

Audit Sites and Products Produced

Site D

Although only briefly covered in the audit, the website for Site D describes them as:

“a vertically integrated seafood business and a supplier of premium ocean fresh seafood product.”

The entire operation includes a fishing fleet operation, both contracted and asset owned and managed, a processing and refrigeration plant and a distribution operation. Only the processing plant was covered in the audit. Their plant processing produces:

“Whole fish to fully processed skinless, boneless fillets in either chilled or frozen form.”

The Auckland processing plant is a purpose-built 35,000 sq ft (3,252 m²) processing plant with a 1,000 tonne cold storage facility. The plant has the capacity to process 10,000 tonnes of fish annually.

Meat Industry Group 1

Meat Industry Group 1 comprises nine processing sites in the North Island. Two of these are represented in the audit reports. According to Meat Industry Group 1’s website, as a group they are:

“processing and exporting more than xxxxxx tonnes of quality beef and lamb products every year.”

The sites for which energy audits were carried out were:

Staff levels, taken from the website, have been included to indicate differences in plant size.

Site	Location	Operation	Staff Level
Site I	XXXX	Beef and calves	400
Site J	XXXX	Beef, lamb, calves, sheep and pelt processing	730

⁵ Information obtained from their website at www.alliance.co.nz

⁶ Information obtained from their website.

Meat Industry Group 2

The Meat Industry Group 2 has xxxx processing sites throughout New Zealand. Three have been audited. These are:

Site	Location	Operation
Site A	XXXX	Lamb and sheep processing
Site B	XXXX	Lamb, sheep and cattle processing
Site C	XXXX	Lamb, sheep and cattle processing

Meat Industry Group 3

Meat Industry Group 3 has a total of xxxx processing sites throughout New Zealand. Of these, four have been audited. These are:

Site	Location	Operation	Staff Level
Site E	XXXX	Beef processing	620
Site F	XXXX	Lamb and mutton	780
Site G	XXXX	Beef processing	420
Site H	XXXX	Bobby veal, lamb/mutton	130

Staff levels, which are available from the website, have been included to indicate differences in plant size.

Observations

Processes

Each site has its own characteristic workload patterns with respect to shifts, daily volumes processed and seasonal patterns. However, individual plant processing operations are frequently based on corporate direction, i.e. site operations are optimised from a corporate (multi-site) requirement rather than an individual site perspective. Individual site optimisation must occur within corporate operational requirements based on the priorities of overall demand, site facilities, shared operations (e.g. blood collection at one site and blood processing at another) and labour cost. Energy cost, being a relatively low cost item (at 5% of operational costs), is not an operational consideration. It is, however, of tactical (budget) importance with the primary tool of management seen as the opportunity to “negotiate” pricing prior to the start of a new energy supply contract.

As operational optimisation is at a corporate level, energy audits would be more effective if they were commissioned at the same level and had both corporate and site reporting requirements. This would overcome site-only optimisation, which may be compromised by corporate directives regarding their operation, and promote a better understanding of energy use implications of corporate directives at a corporate level.

Processing demands are often slower at the start and end of each season, making for inefficient resource use due to the low utilisation of plant resources. This can be due to the minimal levels at which plant must operate, so that at low processing levels unavoidably higher energy per unit end product is incurred. Batch processing would overcome this but may not integrate with product throughput requirements for a multi-site operation.

Generally there is no departmental accountability for energy use, i.e. accountability is only at the site level. Energy management is either not in place or not developed. There is a general need to measure energy at a detailed and meaningful level if individual plants and processes are to be benchmarked and their efficiencies improved. There is a variety of readily available publications that describe this monitoring and targeting process.

Monitoring and targeting is underutilised across the board. “What you can’t manage you can’t measure” does not appear to be recognised. More energy metering is required (gas, steam, electricity, hot water, demand and flows, pressures) but more internal energy-use accountability needs to be in place. Electrical and steam check metering is often installed but meter accuracy and utilisation is uncertain. There are instances of meters that cannot be integrated with SCADA equipment and can only be hand-read. The cost justification for their replacement is usually the labour saving from having the meters read electronically, instead of manually, and integrated with the SCADA system.

Processes are not integrated so that, for example, the boiler firing level tracks steam and/or hot water demand. Typically, boilers are run at levels in excess of demand. This is due to several reasons, none of which withstand scrutiny, e.g. a “safety” margin for operation, routine practice.

Electricity contracts are of the premium type, i.e. fully hedged. With the maturing (and relative stability) of the spot market, companies could be encouraged to consider partial spot market exposure as a way of reducing their electricity purchasing costs. This would require contract periods of 2 years or more, plus an ability to tolerate higher monthly cash flow variances around budgeted monthly electricity cost figures.

Plant is frequently left running unnecessarily over meal breaks. This is plant that does not be required to be run for, say, hygiene reasons. Turning such plant off is an obvious low-cost process opportunity to reduce unnecessary energy use.

In each of the audits the analysis of power factor and its implications for line charge cost reductions was somewhat light. Although not reducing a site's energy consumption it does assist in reducing network losses which represents a national contribution to energy efficiency. The cost of upgrading or installing power factor correction is offset by reduced line charges and simple economic analyses can easily be made to determine cost-effectiveness – which is typically positive. Varying interpretations of MAF regulations impact on each site's energy end-use, e.g. lighting levels, chiller operation, wash basins, etc. There is a need for consistent approach and an industry initiative to this effect would probably produce this result with a consequent energy efficiency benefit.

There is a need to incorporate energy efficiency into all aspects of site operation and development, e.g. purchasing, refurbishment, capital equipment, processes. As a policy it is absent in almost all cases.

For Site D, energy efficiency was driven by a doubling in electricity costs when true energy purchases were revealed after a metering error was corrected. It is not clear that energy management was subsequently embedded after the audit process was completed.

There is a consistently simplistic client view of the economics of each recommendation: if it cannot pay for itself within one year, it isn't worth doing. This approach ignores the true value of many of the recommendations and in effect the company denies itself many longer-term net benefits. This may be driven by the need to return significant shareholder value on an annual basis, but at the expense of longer-term added value. It also results in capital investment in ageing plant being procrastinated until the plant is approaching failure or new and/or additional processes require its replacement.

Plant

Economic evaluation of plant is not routinely carried out to affirm or show otherwise that installed plant remains the most economic choice for a site. Such evaluation would include not only operating and maintenance costs but also energy efficiency of existing plant and would compare current choices against alternative options including new technology. This would be an ongoing activity with the objectives of maintaining current and future company competitiveness and profitability.

Plant utilisation varies widely depending on the requirement for stock or catch processing.

Associated with this is the need to review plant capacity requirements on an ongoing basis. Much of the installed plant has excess capacity, is consequently underutilised and its low loadings contribute to lowered operating efficiency. Capacity needs to be optimised when new plant is purchased with provision for additional modular plant where capacity "hedging" is necessary.

Plant installations are typically centralised, particularly refrigeration plant. It is unclear if this arrangement contributes to energy efficiency as well as operator convenience. Locating plant near "load centres" is important to minimise distribution lines and subsequent losses. However, decentralising may be appropriate where there are disparate load centres that would be better served by individual plant. The option of decentralisation does not appear to have been generally explored.

Energy efficient technology appears to be typically limited. For example, the routine use of refrigeration desuperheaters is not apparent.

Many plants have SCADA units but these are by and large used for managing processing only, i.e. there is no application for energy management.

Sometimes the audits uncovered plant design errors, e.g. the use of liquid ammonia as an oil coolant in a heat exchange process.

There is a general lack of awareness of the energy efficiency consequences of not maintaining plant, e.g. deteriorating insulation on hot and cold lines not being replaced, leaking refrigeration door seals.

Most plant boilers, particularly for steam generation, were constructed in the 1980s. Replacement is not a consideration unless plant failure occurs. There is no routine evaluation of capital plant cost-effectiveness.

Plant upgrades need to be integrated with delivery requirements, i.e. flow rates, temperatures, pressures and energy transport media should efficiently match the requirement of the production process they are servicing. There is little evidence of pinch technology being applied.

At Site B, local hydro generation is available but not integrated with production due to competing water resource use. There was no recommendation to consider resolving this, nor the value of the resolution. Shared local generation is a unique situation amongst the sites covered in the audit reports. However it should be followed up.

Effluent tallow has been briefly considered as boiler fuel. Tallow is a likely feedstock for bio-diesel in New Zealand. The economics need clarification, and carbon costs need factoring in to truly evaluate its worth.

Refrigeration is a major user in fish processing which clearly benefits from improvements in refrigeration technologies that both optimise the plant inherently and the way in which plant meets demand.

Over-lighting is a very common audit finding, notwithstanding lighting standards. In the audits, comment is made about MAF setting lighting levels. In fact MAF regulations simply echo NZS 1680.2.4: "Lighting Levels – Industrial Tasks and Processes".

Associated with this is the inadequate use of daylight via skylighting in particular and inadequate lighting controls to ensure appropriate lighting levels through switching specific luminaire groups. It is often found that one switch controls an entire factory or office area.

The sourcing of coal by using the cost of delivered energy as a means of making a choice between options is commended as a good economic and energy efficient strategy. However, the inefficiencies of using coal (e.g. limited economisers because of acidic content of flue gas) need to be factored in.

Line charges need more analysis to ensure that cost drivers are identified and the savings effects of reduced electrical demand, capacity optimisation and network configuration are known. For example, most line charges have cost drivers relating to dedicated on-site assets (transformers, switchgear, etc.), power factor, electrical demand and (sometimes) energy-dependent variable charges. Knowing the impact of these and the flexibility that can be applied to them can often result in

energy economies.

Direct connection to Transpower was suggested in one instance (Site E) as a means of reducing the line charges. The development of any off-take substation (grid exit point) will require the acquisition of competencies by the company in an area that is not core to their business. This is likely to render the project concept infeasible for any time in the future.

Resource consents for exhaust emissions and non-potable water offtakes and discharges are likely to become more difficult to obtain or renew over time. This provides a further impetus for energy and resource efficiency with economic benefits. Further, a more detailed understanding of plant resource requirements would enable a more precise determination of volumes required for resource consents. The value of resources such as water (potable or non-potable) is enhanced through heating, filtering, pumping and chemical treatment. The economics of discharging this added-value resource are often not understood.

Buildings

There was no information about the buildings or their construction that would enable commentary on their energy efficiency. In some audits, copies of plan drawings were included but these did not assist in this area.

The importance of including energy efficiency as a design criterion in new buildings or fit-outs of existing buildings should be noted and integrated as an energy management practice at each site.

Actions Taken

In four cases there were no action plans available. For those that were it was clear that only the easiest items were implemented. The audit items (T1 or T2) that were implemented were inadequate to meet EECA's requirements for funding. There are several observations that can be made:

- There is a reticence to implement audit recommendations. The cause(s) of this is unclear but the following possibilities are suggested:
 - The limited credibility of the audit with the client and the apparent impracticality of the audit recommendations, i.e. is the client persuaded that the recommended actions will achieve the required outcome, are remedial cost estimates realistic, does the client believe that the savings identified are achievable?
 - Conflicting advice from servicing contractors regarding audit recommendations. Who can the client believe?
 - The depth of knowledge of the servicing contractors regarding the energy efficiency options for the plant they are servicing. Are the servicing contractors being needlessly conservative in their advice and simply relying on experience which may not include energy efficiency optimisation?
- Although speculative, it is likely that each audited firm has failed to implement energy management as an operational necessity to maximise the value of the audit.
- Further, it is likely that energy management policies and strategies have not been developed within the audited firms. They are likely to have agreed to an audit as the consequence of rising energy or fuel costs and have seen the audit as an end in itself, i.e. having implemented the chosen recommendations, no further action is considered necessary.
- The government funding of energy audits, while substantive, does not appear to be a sufficient incentive in itself to progress audit recommendations.
- Audits need to be "sold" to clients as the beginning of a process, i.e. as the implementation of energy management, delivering initial benchmarking with the related opportunity of developing energy management strategies, policies and operating regimes.
- Qualifying audits need to include a way forward for companies to embed energy management into their practices.
- The present standard, AS/NZS 3598:2000 "Energy Audits" needs urgent revision to provide generic guidelines for industrial sites. It is apparent that it was written with commercial office buildings in mind rather than a diversity of industrial sites.

Audit Item	Audited Firm's Comment	Annual Energy Saving, kWh	Electricity Demand reduction, kW	Energy Purchase Cost Annual Savings	Payback Period, years
Site E					
Repair air leaks, shut off compressors in non-production hours.	Repair leaks, include checks in monthly maintenance. Air compressor controls and time clock to be included in new SCADA.	652,962	132	\$52,237	0.25
Reduce air flow through cold store doors		83,514	52	\$8,126	0.25
Totals		736,476	138⁷	\$60,363	
Totals as Proportion of T1 Energy Savings Identified in Audit					
		Unknown	Unknown	14.7%	
Site F					
Shut down 30% of chillers 1-7 in 5 monthly low-kill period.		127,500	–	\$10,200	0
Shut down carcass chiller No. 8B in 5 monthly low-kill period.		332,625	–	\$26,610	0
Repair air leaks, shut off air compressors after hours.		211,750	–	\$16,940	0.4
Fit VSD's to York tunnel fans and operate on low speed on weekends and low-kill period.		257,500	–	\$20,600	2
Totals		929,375	–	\$74,350	
Totals as Proportion of T1 Energy Savings Identified in Audit					
		Unknown	Unknown	16.6%	

⁷ Reductions are unlikely to be simultaneous and therefore cannot be directly added. A figure of 0.75 x Σ demands was used.

Audit Item	Audited Firm's Comment	Annual Energy Saving, kWh	Electricity Demand reduction, kW	Energy Purchase Cost Annual Savings	Payback Period, years
Site G					
Reduce refrigeration condensing	Costs higher than audit estimate. New pressures in summer and winter. condenser to be fitted in 2006. A separate letter contained some specific comments on each efficiency option suggesting that the many recommendations of the audit were impractical.	477,590	40	\$39,640	1.17
Totals		477,590	40	\$39,640	
Totals as Proportion of T1 Energy Savings Identified in Audit					
		Unknown	Unknown	131%	
Site H					
Reduce condensing pressure on main evaporative condenser.	Done	79,532	0	\$6,124	0.1
Reduce condensing pressure on offal freezers.	Midlands Industrial Refrigeration are investigating but do not recommend lowering the temp as it may adversely affect other parts of the refrigeration operation. With new TX valves and instrumentation the savings may be achieved.	77,130	0	\$5,939	0.3
Shut off air compressor on Saturdays	Done. Timer has been fitted.	11,170	0	\$1,294	0.6
Totals		167,832	0	\$13,357	
Totals as Proportion of T1 Energy Savings Identified in Audit					
		Unknown	Unknown	36%	
Site A					
No action plan available.					

Audit Item	Audited Firm's Comment	Annual Energy Saving, kWh	Electricity Demand reduction, kW	Energy Purchase Cost Annual Savings	Payback Period, years
Site B					
No action plan available.					
Site C					
No action plan available.					
Site D					
No action plan available.					
Site I					
No action plan available.					
Site J					
No action plan available.					

Existing Energy Consumption

Annual Energy Consumption and Type of Energy Used

The annual energy consumptions and types of fuel used are shown in the table below. Note that fuel energies have all been converted to GWh to enable easy comparisons.

Site	Electricity, GWh	Gas, GWh	Coal, GWh	Total, GWh
Site D	1.12	0.25	–	1.37
Site A	38.9	–	96.56 ⁸	135.46
Site B	22.5	–	78.11 ⁹	100.61
Site C	25.3	–	71.32 ¹⁰	96.62
Site E	50.51	39.97 ¹¹	15.38 ¹²	105.86
Site F	83.78 ¹³	34.54 ¹⁴	–	118.32
Site G	27.98	–	5.35 ¹⁵	33.33
Site H	13.43	4.35 ¹⁶	–	17.78
Site I	18.20	31.92	–	50.12
Site J	19.11	45.42	–	64.53

The choice of fuel is likely to be related to a number of factors:

- Availability. For example, natural gas is reticulated throughout the North Island but in the South Island only some urban areas have gas reticulated (e.g. Christchurch). Electricity, however, is universally available.
- Expertise and plant within the company. Competencies in coal-fired boilers and plant within the company may favour the use of such plant at other sites.
- Fuel prices. Rising gas costs, together with the above factors, may make coal-fired plant more economically attractive.

⁸= (12,891 tonnes x 15.24 MJ/kgm + 12,594 tonnes x 15.07 MJ/kgm) x 1,000 kgm/tonnes x 0.9 after moisture x 0.2778 x 10⁻⁶ GWh/MJ → 96.56 GWh

⁹= (16,983 tonnes x 15.24 MJ/kgm + 3,557 tonnes x 15.07 MJ/kgm) x 1,000 kgm/tonnes x 0.9 after moisture x 0.2778 x 10⁻⁶ GWh/MJ → 78.11 GWh

¹⁰= 11,411 tonnes x 25 MJ/kgm x 1,000 kgm/tonnes x 0.9 after moisture x 0.2778 x 10⁻⁶ GWh/MJ → 71.32 GWh

¹¹= 143,889 GJ x 277.8 x 10⁻⁶ GWh/GJ → 39.97 GWh

¹²= 2,797 tonnes x 22 MJ/kgm x 1,000 kgm/tonnes x 0.9 after moisture x 0.2778 x 10⁻⁶ GWh/MJ → 15.38 GWh

¹³= 83.1 GWh main site + 0.68 GWh pumps

¹⁴= 124,330 GJ x 277.8 x 10⁻⁶ GWh/GJ → 34.54 GWh

¹⁵= 914 tonnes x 23.4 MJ/kgm x 1,000 kgm/tonnes x 0.9 after moisture x 0.2778 x 10⁻⁶ GWh/MJ → 71.32 GWh

¹⁶= 15,649 GJ x 277.8 x 10⁻⁶ GWh/GJ → 4.35 GWh

Energy End Uses

In many cases the information available from the audits did not conform to AS/NZS 3598:2000. In particular, energy balances were typically unavailable. This precluded the categorisation of energy use into other than broad headings. Estimates of energy use were made for some of the headings but should be taken as indicative only.

Electricity

Refrigeration and production lines were the two primary applications of electricity.

Site	Refrigeration ¹⁷	Compressed Air	Lighting	Production Line ¹⁸	Pumping	Air Conditioning ¹⁹	Office Equipment	Other Services
Site D	92%	–	6%	–	–	~1%	~0.5%	–
Site A	48%	4% (est.)	3% (est.)	43%	2% (est.)	–	–	–
Site B	56%	3.5% (est.)	2.5% (est.)	36%	2% (est.)	–	–	–
Site C	55%	4% (est.)	3% (est.)	36%	2% (est.)	–	–	–
Site E	10%	10%	2% (est.)	71%	6%	–	–	–
Site F	50%	6%	0.5% (est.)	22%	13%	7%	–	2%
Site G	40%	5%	–	18%	10%	26%	2%	–
Site H	53%	5%	–	38%	–	–	–	4%
Site I	45%	4%	8%	27%	10%	1%	–	5%
Site J	44%	3%	7%	23%	10%	–	–	13%

¹⁷This includes centralised refrigeration plant, often referred to in the audits as the “engine room”, and freezer plant.

¹⁸This includes all aspects of production other than those shown under other headings, and specifically includes fellmongering, rendering and tanning operations.

¹⁹This includes air conditioning and ventilation fans, where specifically identified.

Coal

Coal is used to fire boilers that, in turn, provide the steam and hot water energy for end-use purposes.

The end-use purposes are listed below.

Site	Rendering	Hot Water	Wool Drying	Space Heating	Tannery	Other
Site D	Not used					
Site A	30%	54%	–	7%	3%	6%
Site B	47%	37%	2%	14%	–	–
Site C	57%	22%	7%	10%	4%	–
Site E	46%	50%	–	–	–	4%
Site F	Not used					
Site G	–	100% ²⁰	–	–	–	–
Site H	Not used					
Site I	Not used					
Site J	Not used					

Gas

The two primary applications for gas were steam and hot water generation.

Site	Rendering	Steam Generation	Space Heating	Hot Water	Other
Site D	–	–	–	100%	–
Site A	Not used				
Site B	Not used				
Site C	Not used				
Site E	2%	82%	–	10%	6%
Site F	–	44%	1%	42%	13%
Site G	Not used				
Site H	–	–	–	99%	1%
Site I	45%	See other categories	–	41%	14%
Site J	57%	–	–	43%	–

²⁰No steam generated at this site. The hot water is used for production operations through a heat exchanger.

Alternative Energy Sources

Alternative energy sources were not explored in the audits. Two alternatives appeared to warrant further investigation.

Solar Hot Water Heating

The requirement for large volumes of hot water and steam suggest that solar hot water heating has an industrial role. Solar hot water heating technology is well advanced overseas, particularly in Australia. In New Zealand the uptake is limited and primarily in the domestic sector. Commercial applications have focused on the dairy sector and in particular on milking processes and milk holding. Large-scale applications still require opportunities for development although the technology does not appear to be limited in this regard.

Such applications should be explored for their practicality. Reported estimated payback periods of 3 years make them economically attractive²¹.

Bio-Gas

In the audits for the meat works above, effluent processing is typically achieved by using oxidation ponds. Replacing oxidation ponds with bio-digesters to harvest methane for gas is an emerging technology that requires a large-scale commercial opportunity for further support and development as the economics need proving. There are many advantages including Resource Management Act compliance with waste minimisation, reduced external energy sourcing dependency, and lowered nitrogen levels in disposed effluent.

It is an energy efficiency option that should be further explored.

²¹www.reidtechnology.co.nz/reid15.html

Opportunities for Improving Energy Performance

Only limited energy use data was available for analysis and it was not consistently presented for each site, precluding a common baseline.

Energy Use Indicators (EUIs) have proved a challenge to develop. On a site-by-site basis the intention of EUIs is to provide a means of comparing the energy use of sites of a similar processing nature, i.e. meat, fish, plastics, etc., using single figure. This provides a means of benchmarking sites and allows comparisons between them for the purpose of improving the energy efficiency of each site. EUIs normally take the form of energy per unit of finished product. There are a number of assumptions behind each such figure:

- All raw materials are processed to the same end product. In any processing plant, different raw material components are processed to different products, each with different energy requirements in the processing.
- All raw materials are processed within the factory. However, partially-processed product is sometimes finished at another factory.
- There are varying interpretations of regulatory factory operating requirements.

These assumptions significantly dilute the value of a site EUI. While varying operating times and raw material volumes can be normalised on a “per plant” basis, departures from the above assumptions cannot easily and practically be addressed.

To deal with the above difficulties, EUIs could be further developed internally for benchmarking sub-processes so that the above assumptions could be met. Externally, these could then be used for comparing energy efficiency for each product on a site-by-site basis. To further improve their comparative value:

- agreement between sites would need to be established so that regulatory factory operating requirements had a common interpretation, and
- imports and exports of energy use would need to be taken into account where partially-processed product is received into or sent from a site. This could be done by each exporting site calculating the EUI for each partial product and advising it to the receiving factory.

The opportunities for improving energy performance are two-fold:

- Those that are associated with the overall process of energy management of which energy auditing is a part. This aspect has been covered in “Actions Taken” above.
- Those that are associated with a site. From the audits considered there are some common items relating to plant and processes.

The firms that are the subject of this report predominantly have the following two plant items that would account for more than 90% of energy consumption at each site:

- Boilers for the purpose of steam or hot water production. The boilers are predominantly coal-fired with the remainder on gas. Typically they are of late 20th century manufacture and have little or no “native” energy efficiency controls built in. Retrofits and component upgrades account for the energy improvements obtained to date. Given the reticence by owners to make capital investments in new plant unless a catastrophic failure has occurred, retrofits and component upgrades are likely to continue to be the primary way of delivering improved energy efficiency.
 - The downstream energy distribution systems of steam and hot water have also benefited from retrofits and upgrades. An improved appreciation of the function of insulation is likely to see better maintenance of this component. Design improvements would provide a further avenue for energy efficiency but, again, capital cost and plant operation requirements may prove to be barriers.
- Refrigeration, in particular refrigeration plant with NH₃ (ammonia) as the refrigerant. All refrigeration plant is electrically driven, and improving energy performance in refrigeration reduces electricity consumption. From the audits, a recurrent problem appears to be process settings. Addressing this is relatively straightforward by utilising competent refrigeration engineers to routinely tune the plant for optimum performance in addition to their current objective of maintaining its operation.

Focusing on these two plant items enables the identification of the major site opportunities for energy efficiency improvement.

These plant items account for most of the remaining consumption:

- Air Compressors
- Pumping and Ventilation
- Lighting.

Improvements in these areas bring relatively minor efficiency gains (accounting for less than 10% of all improvements).

Boiler energy efficiency improvement opportunities that are likely to find favour with clients are those that involve retrofits (operating expense) as opposed to replacement (capital investment). Retrofits, while useful, are unlikely to be as cost-effective as plant replacement: competition for capital finance among competing projects within a company is typically intense, and those with payback periods of less than one year are normally the winners. Energy efficiency improvements, while economic, usually have payback periods greater than one year. The same can be said of refrigeration.

New Zealand is not alone in this phenomenon and at least one country has endeavoured to remove this barrier to improvement. Britain²² A similar loans scheme also operates in Scotland. provides interest-free loans to small- to medium-sized businesses to assist them to upgrade old, inefficient equipment with modern energy efficient replacements:

“Energy-Efficiency Loans are designed to save you money when you replace your existing equipment with a more energy-efficient version. So, if you're a small or medium-sized business, you could borrow £'a35,000 to £'a3100,000 at 0% fixed interest to fund the purchase of equipment such as lighting, boilers or insulation²³.”*

“We will consider any energy-saving investment where the estimated value of energy saved over the first 5 years exceeds the capital amount²⁴.”

Firms that would qualify are defined as:

“Essentially private sector organisations that fall within the definition of Small & Medium-sized Enterprises (SMEs) in England, Wales and Northern Ireland, that have been trading for at least 12 months and have an acceptable credit rating²⁵”*

although companies trading in the sectors of agriculture and fisheries, transport, and export-related areas do not qualify.

An SME is defined as having:

- “1) Less than 250 employees*
- 2) Less than 40m Euros Turnover (approximately £325m) or*
- 2b) Less than 27m Euros assets (approximately £317m)*
- 3) No controlling interest more than 25% by a non-SME (i.e. it is part of a larger organisation).²⁶*

This definition would need to be reworked for the New Zealand commercial environment.

For larger organisations Britain has a further scheme called the Enhanced Capital Allowance (ECA):

“Capital allowances on plant and machinery are generally given at 25% a year on a reducing balance basis. However, with ECAs, businesses can write off 100% of the cost of energy saving equipment against their taxable profits within the first year of investment. Businesses claim the allowance on their income tax or corporation tax returns.

“Only investment in products approved for the Energy Technology List can qualify for an ECA claim. Those organisations who are not eligible to make ECA claims can still benefit from ongoing energy savings by using the Energy Technology List as a procurement tool.”²⁷

This, or a similar scheme, is recommended for consideration in the New Zealand context.

²²A similar loans scheme also operates in Scotland

²³www.thecarbontrust.co.uk/energy/pages/page72.asp

²⁴www.thecarbontrust.co.uk/energy/pages/page304.asp

²⁵www.thecarbontrust.co.uk/energy/pages/page314.asp

²⁶www.thecarbontrust.co.uk/energy/pages/page314.asp

²⁷www.thecarbontrust.co.uk/energy/pages/page68.asp

Recommendations

Based on the foregoing analysis the following prioritised recommendations are made. These are divided into “Priority One” and “Priority Two” on the basis of the prospective time before they can be achieved. However, the differences between the two priorities are small and the implementation of both groups should be simultaneous.

Priority One: Immediate Application

Industry Actions

- Energy Use Indicators (EUIs) are a myth at the industry level. However, they have practical application at the site level and their use is to be encouraged.
- The meat processing industry should be encouraged to reach consensus on a consistent application of MAF regulations. This would have energy use consistency outcomes that are likely to equate with energy efficiency.
- Where SCADA systems are upgraded or replaced, the functions of energy monitoring, reporting and management need to be included as a design requirement. This would assist in embedding energy management.

Energy Procurement

- Audit clients should be encouraged to consider electricity supply contracts which have some spot pricing exposure. While not saving energy per se, the exposure would encourage a greater awareness of energy use and provide a further motivation for efficient energy use. A dual benefit is that the shared risk (with the retailer) generally results in lowered electricity costs over the medium term.

Energy Audit Process

- Where site processing is subject to corporate requirements, corporate management should be included in the energy management process. In particular, in the audit commissioning process.
- Audit reports should encourage processes to integrate so that resources (steam, hot water, refrigeration, etc.) match demands.
- Audit reports need to contain more depth of analysis regarding line charges. When cost drivers are defined, cost reductions through better demand and power factor management become more apparent.
- Audit reports should contain more depth of economic analysis so that simple payback does not remain the only measure. Many audit recommendations take more than one year to implement yet they are generally no less economic than those that take only one year.

Post-Audit Process – Energy Management

- Energy management is a natural progression from the benchmarking and directional outcomes of the audit report. Audit reports should contain some direction in a “where to from here” section so that a basic structure for incorporating energy management into ordinary management processes is achieved. In particular, this applies to the initial steps of monitoring and targeting.

Government Actions

- Continue support for the development of alternative fuels deriving from internal sources such as waste. In particular, boiler fuels could be considered. Effluent tallow appears to be a resource requiring further development. Bio-gas from bio-digesters is another source. Presently, effluent is regarded, by definition, as waste.
- Continue support for the development of alternative fuels deriving from external sources. Experimentation with solar water heating or pre-heating should be encouraged. The solar water heating industry appears to have reached a suitable level of maturity for industrial application and the economics need redefining.

Priority Two: For Development

Industry Actions

- Industry energy management training needs to emphasise the ubiquitous application of the energy management concept from design and purchasing through to operation and maintenance. This includes everything from the strategic requirements of policy development through to operational procedures. This should also include energy cost monitoring.
- Audit clients need to be encouraged to undertake routine evaluation of their plant to ensure that the existing plant remains the most economic choice for a site. Such reviews should factor in current and prospective energy use (and costs) and capacity requirements. The audit reports examined suggested that this is never done.
- Site design, redesign or refurbishment needs to consider whether centralisation or decentralisation of major plant would most benefit its operation.

Government Actions

- Consideration could be given to some form of financial incentive to upgrade old plant with modern, energy efficient plant. Britain's "The Carbon Trust" scheme is recommended as an example of such a scheme.
- The present standard, AS/NZS 3598:2000 "Energy Audits" needs urgent revision to provide generic guidelines for industrial sites.