ENGINEERING SERVICES

final report

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Prepared by: Craig Willis

ISECO Engineering Services

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Meat & Livestock Australia Limited
Locked Bag 991
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LEVEL 2 ENERGY AUDIT REPORT FOR AN ABATTOIR

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CONTENTS

1. EXECUTIVE SUMMARY

ISECO Engineering has been engaged to perform a Level 2 Energy Audit for the abattoir at their production facility in regional Australia.

This energy audit report:

- Evaluates overall energy consumption
- Illustrates current energy use
- Identifies and outlines potential areas of energy and cost savings.

ENERGY CONSUMPTION BASELINE

The overall energy consumption of the site is summarised as follows:

Table 1 - Energy Baseline Reporting last over 12 month Period: 07/2011 – 06/2012

Energy type	% of GJ	% of annual energy cost	% of greenhouse emissions
Electricity	**26%**	**76.5%**	**49%**
Coal	**74%**	**21%**	**51%**
Gas (LPG)	**<1%**	**2.5%**	**<1%**

KEY PERFORMANCE INDICATORS

Plotting total energy consumption against total effective production results in useful indices that can be used to establish and/or compare against process, plant, sector or industry benchmarks. A dependable KPI requires clear boundaries and accurate administration. For the abattoir the following KPIs could be established:

Table 2 – Key Performance Indicators by units of production

	Financial year	Industry Benchmark
KPI	**2011-2012**	**2008-2009**
MJ per tonne of hot standard carcase weight (MJ/tHSCW)	2,825 MJ/ton	4,108 MJ/Ton[1]
Kilograms of carbon dioxide equivalent emissions per tonne of hot standard carcase weight ($kgCO_{2-e}$ /tHSCW)	365 $kgCO_{2-e}$/tHSCW	554 $kgCO_{2-e}$/tHSCW

This meat production facility was interrupted by an extreme weather event in the beginning of 2011 which impacted the operations of the abattoir. Also the abattoir’s management has been instrumental in the design of their plant and facility, in areas of production processes and equipment, their understanding of the meat industry and engineering techniques has produced a plant that is below the benchmarks that were generated in 2008 by the Red Meat Industry.

RECOMMENDATIONS

Based on site observations, data analysis and discussion with the abattoir regarding their operational priorities and plans, ISECO Engineering recommends the following options to improve the Abattoir’ energy efficiency and performance:

- **Refrigeration System**
  - Install a single low stage machine with high efficiency motor to the refrigeration plant
  - Install VSD on new low stage compressor
  - Install high efficiency electric motors on existing compressors
  - Install off peak thermal storage
  - Reduce condenser pressure (excess condenser capacity obtained with thermal storage option)
  - Install PLC automation of compressors, loading and staging.

[1] MLA Industry Environmental Performance Review 2010

- **Compressed air system**
    - Install VSD drives on lead compressed air compressors
    - Reduce leaks and upgrade and repair system supply lines

- **Upgrade Facility lighting systems**
    - Replace 230 existing 36W T8 Fluorescent lamps with 28W T5 lamps and electronic ballasts located in cold rooms, hallways and production areas
    - Replace 112 existing high bay 400 W Mercury Vapour lights with 150W LED lights located in the work shop, rendering plant and production areas
    - Replace 10 existing exterior flood lights with 90W LED lights located around the external perimeter and drive ways

- **Power Generation**
    - Install 800kW steam Cogeneration plant using coal as an energy source.
    - Install 100kW Solar PV installation

This equates to:

- **A significant saving in electricity**
- **2,731 tonnes of greenhouse gas emissions reductions annually**

The estimated capital cost to implement all these opportunities is $3,179,740 with a simple payback of over 5 years.

Alternatively, the implementation of these opportunities excluding power generation, both PV installation and Cogeneration plant, was considered

This equates to:

- **A significant saving in electricity**
- **2,441 tonnes of greenhouse gas emissions reductions annually**

The estimated capital cost to implement these opportunities is $874,740 with a simple payback of 2-5 years.

Recommendations are listed in Table 3 below by functional area. The table includes both energy efficiency recommendations and energy performance recommendations. Energy performance recommendations are still valuable energy management tools but do not necessarily provide a direct reduction in energy consumption e.g. renewable electricity generation, peak shifting, renegotiating energy contracts.

Table 3 - Summary of Recommendations

Energy and cost saving opportunities						
Description of opportunity	Capital cost	Simple payback in years	GHG saving tCO_{2-e}	Fixed price $/$tCO_{2-e}$		Business case no.
				$24.15	$25.40	
Refrigeration						
Replace low stage compressor	$250,000	> 5 years	422	$10,188	$10,716	
Ice tanks/glycol upgrade	$380,000	> 10 years	908	$21,932	$23,067	
Lower head pressure	$15,000	< 2 years	399	$9,644	$10,142	
Packaged business case	$645,000	> 5 years	1,729	$41,764	$43,925	Case 1
Compressed Air						
132kW compressor VSD	$55,000	2-5 years	188	$4,551	$4,787	
45kW compressor VSD	$40,000	> 5 years	64	$1,552	$1,632	
87kW compressor VSD	$45,000	< 2 years	279	$6,749	$7,099	
Leak detection and reduction prog.	$10,200	< 2 years	92	$2,217	$2,331	
Packaged business case	$150,200	2-5 years	624	$8,966	$9,430	Case 2
Lighting						
New twin 28W T5 with elect ballast	$19,550	2-5 years	15	$373	$392	Case 3
Linear LED Lamps 2 x 24W	$36,800	> 5 years	22	$534	$562	
T8 to 28W T5 Conversion Kit	$18,400	2-5 years	15	$373	$392	
Replace 112 of 400 W Mercury Vapour						
150W LED	$56,000	2-5 years	59	$1,426	$1,499	Case 4
HI Bay – 400W metal halide	$30,000	2-5 years	19	$449	$472	
4x54W fluorescent	$72,800	> 5 years	40	$966	$1,016	
200W induction lamp	$89,600	> 5 years	44	$1,063	$1,118	
Replace 10 x 600W exterior flood lights						
Flood light – 150W metal halide	$3,000	< 2 years	10	$249	$262	
90W LED	$3,990	< 2 years	13	$310	$326	Case 5
Power generation						
Steam 800kW	$2,080,000	> 10 years	132			Case 6
Install 100kW Solar PV array	$226,000	> 5 years	159.2			Case 7
						Reduction in site use
Total Implementation	$3,179,740	> 5 years	2,731	$65,971	$69,380	53%
Total implementation excl Power	$874,740	2-5 years	2,441	$58,946	$61,991	27%

The Client has indicated that there is a preference for LED lighting to replace high bay Mercury Vapour Lamps due to the reduction in maintenance and the use of non-glass lamps in food production areas.

2. BACKGROUND

ISECO Engineering has been engaged by the abattoir to complete a Level 2 Energy Audit for the production facility in a regional area.

Conducting an energy audit and assessing energy efficiency opportunities can provide many benefits to businesses[2], including:

- Reduced expenditure on energy, capital and maintenance
- Increased profits
- Improved productivity, product quality and staff engagement
- Closer alignment of energy procurement with actual energy needs
- Improved awareness of CO_2 emissions resulting from energy use
- Awareness of external funds and grants to assist with implementing energy efficiency projects.

2.1 Site Description

The abattoir is located in a regional area and includes meat processing facilities. The site operates between the hours of 5:00am and 11:00pm five days per week. The facility operations include but are not limited to:

- Kill floor
- Boning Rooms
- Meat Chillers
- Meat Freezers
- Rendering Plant
- Administration
- Miscellaneous

2.1.1 Audit Limitations

The abattoir is 100% committed to implement energy saving projects that have a good rate of return, depending on the capital cost. It is noted that the abattoir has been operating on this location for many years. Commitment to a project with a life that extends beyond the age of the business is unlikely.

2.2 Methodology

After proposal acceptance, energy data is collated. Data normally includes but is not limited to:

- Periodic accounts for site energy usage; typically a combination of electricity, coal and LPG
- Any sub metering information

All sources of energy shall be considered as per the Australian and New Zealand Standard™ for Energy Audits - AS/NZS 3598:2000.

A site inspection is carried out during which the auditor:

- Familiarises themselves with the site & operations
- Takes notes of environmental & operational conditions
- Takes photos of relevant equipment & processes
- Takes measurements of relevant parameters as required
- Inspects key energy end-use equipment
- Installs sub-metering and data-loggers on nominated plant
- Reviews energy intensive processes
- Reviews plant condition and performance
- Identifies potential cost-effective energy savings

[2] Energy Efficiency Opportunities Assessment Handbook, Commonwealth of Australia, 2011

Data is then subject to further investigation. More information may be requested from:

- Operational staff
- Manufacturers
- Distributors
- Service & Maintenance providers

Data is condensed and organised. Calculations transform raw inputs into practical information to distinguish ideas from real opportunities and finally, the report is written.

3. ENERGY CONSUMPTION

3.1 Energy baseline

The site uses three types of energy sources:

- Electricity is used for lighting, refrigeration and other associated electrical machinery.
- Coal is used for producing steam for hot water and rendering
- LPG gas is used in the rendering plant for cooking blood products and to produce some additional hot water.

The energy uses are broken down in more detail in section 5.0

Table 4 – Energy Baseline: Reporting Period: 07/2011 – 06/2012 Financial Year

Energy type	% of GJ	% of annual energy cost	% of greenhouse emission
Electricity	**26%**	**76.5%**	**49%**
Coal	**74%**	**21%**	**51%**
Gas (LPG)	**<1%**	**2.5%**	**<1%**

Figure 1 - Breakdown of 2011-2012 energy consumption

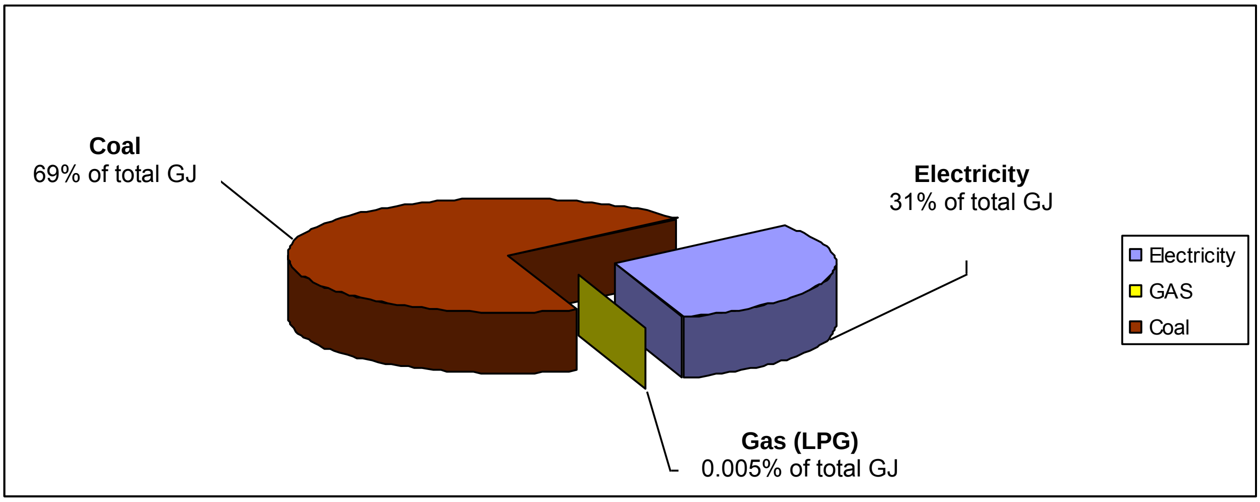
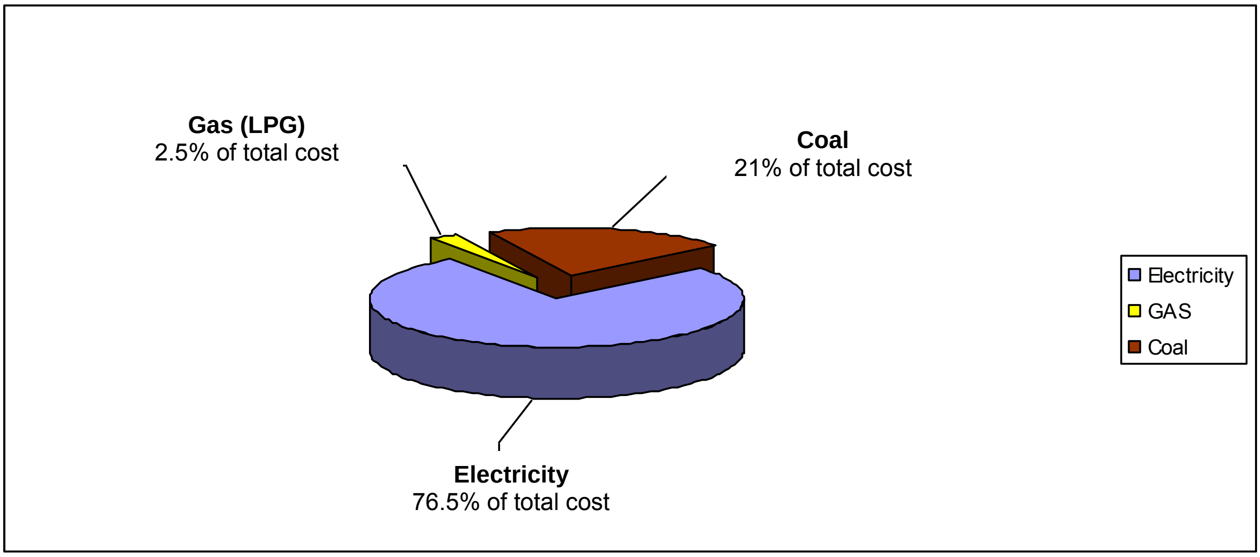


FIgure 2 - Breakdown of 2011-2012 energy cost



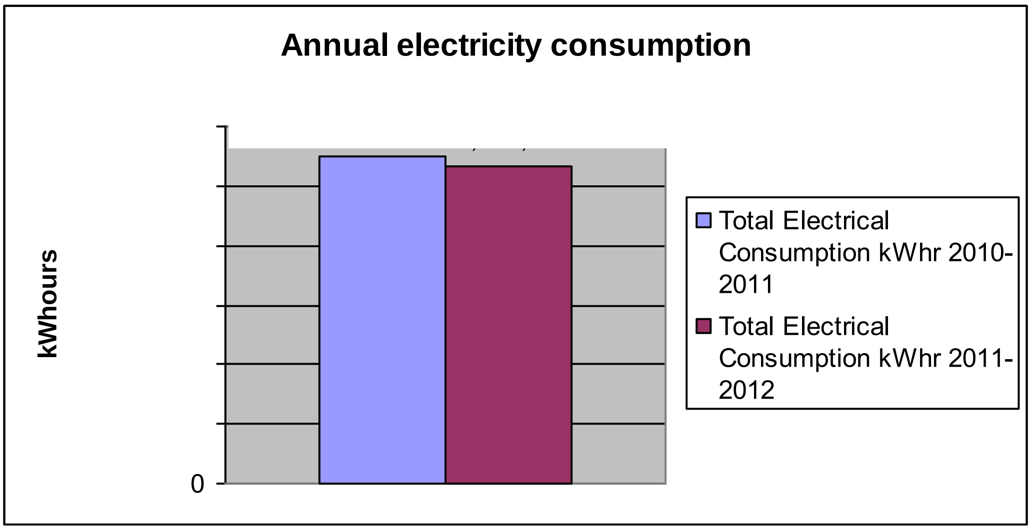
Consumption of natural gas is less than 0.005% of total energy consumption and 2.5% of energy expenditure.

3.2 Electricity consumption analysis

In the relevant sections below, graphs are provided showing annual and monthly consumption data in kilowatt-hours.

3.2.1 Annual comparison

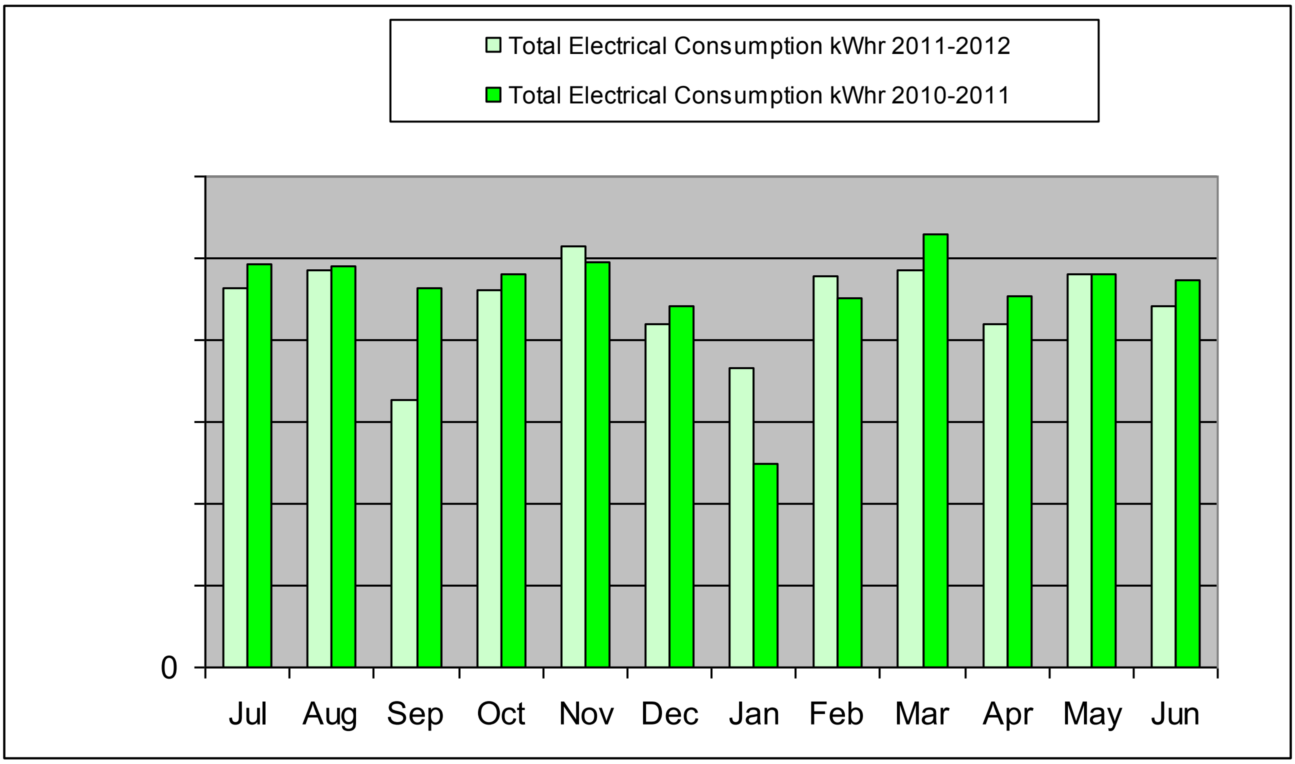
Figure 3 - Comparison of consumption 2010-2011 and 2011-2012 financial years



A 3% decrease in electricity consumption can be observed from 2010-2011 to 2011-2012. Decreased production is the main reason for this, due to an extreme weather event.

3.2.2 Monthly/Seasonal comparison

Figure 4 – Comparison of monthly consumption 2010-2011 and 2011-2012

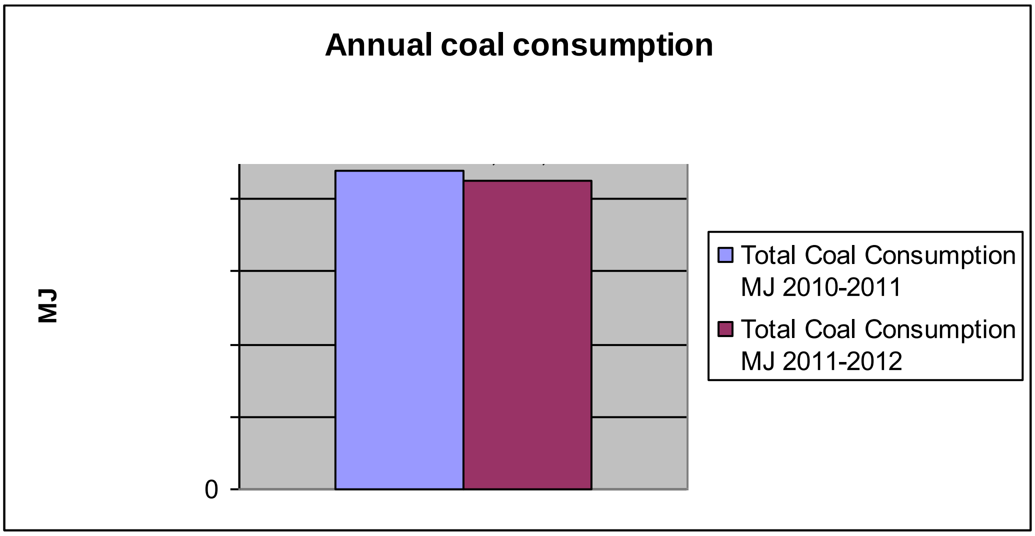


The monthly consumption from July 2010 was of similar magnitudes through to June 2012; generally electricity consumption is similar month by month with reduction of consumption in January and September 2011 due to an extreme weather event and plant shut downs.

3.3 Coal consumption analysis

3.3.1 Annual comparison

Figure 5 – Comparison of consumption 2010-2011 and 2011-2012



A decrease in coal consumption can be observed from 2010-2011 to 2011-2012. Decreased production is the main reason for this, due to an extreme weather event.

3.3.2 Monthly comparison

Figure 6 – Comparison of monthly consumption 2010-2011 and 2011-2012

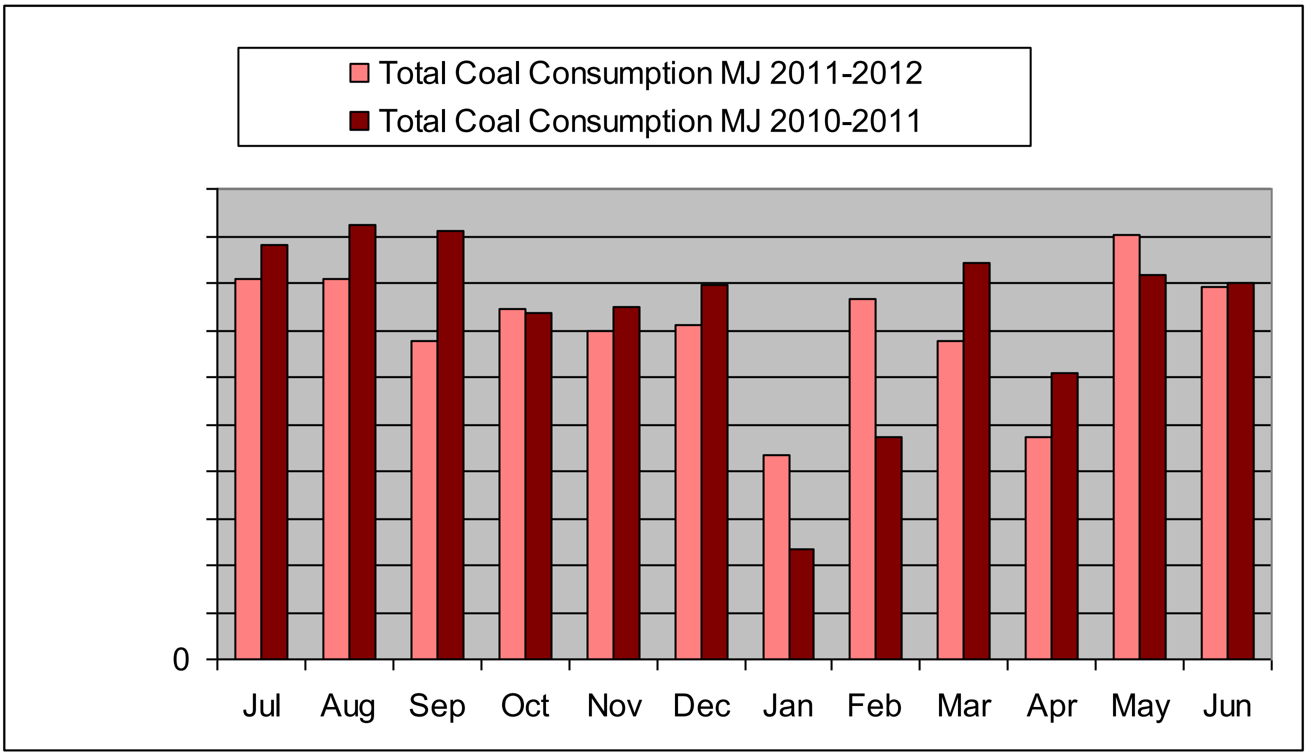
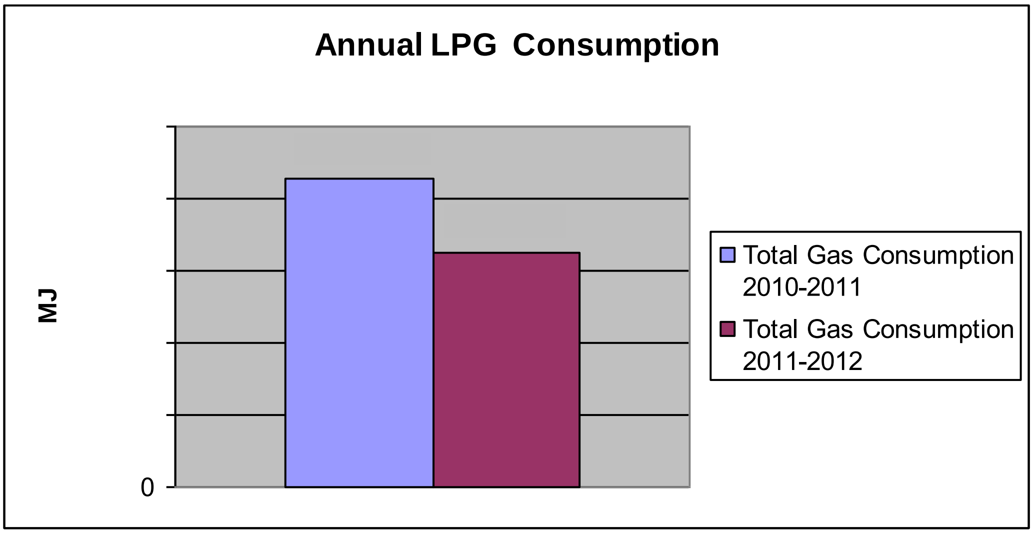


Figure 6 shows the coal consumption per month over the years 2010-2011 and 2011-2012. Coal is used to produce steam and is used in the plant. A reduction of consumption occurred in January and February 2011 due to an extreme weather event and plant shut downs.

3.4 Gas (LPG) consumption analysis

3.4.1 Annual comparison

Figure 7 – Comparison of LPG consumption 2010-2011 and 2011-2012



A 24% decrease in consumption can be observed from 2010-2011 to 2011-2012. Decreased production is the main reason for this, due to an extreme weather event. The cost of LPG per MJ is much higher than coal and electricity due to associated delivery costs and the current market value.

3.3.2 Monthly comparison

Figure 8 – Comparison of monthly LPG consumption 2010-2011 and 2011-2012

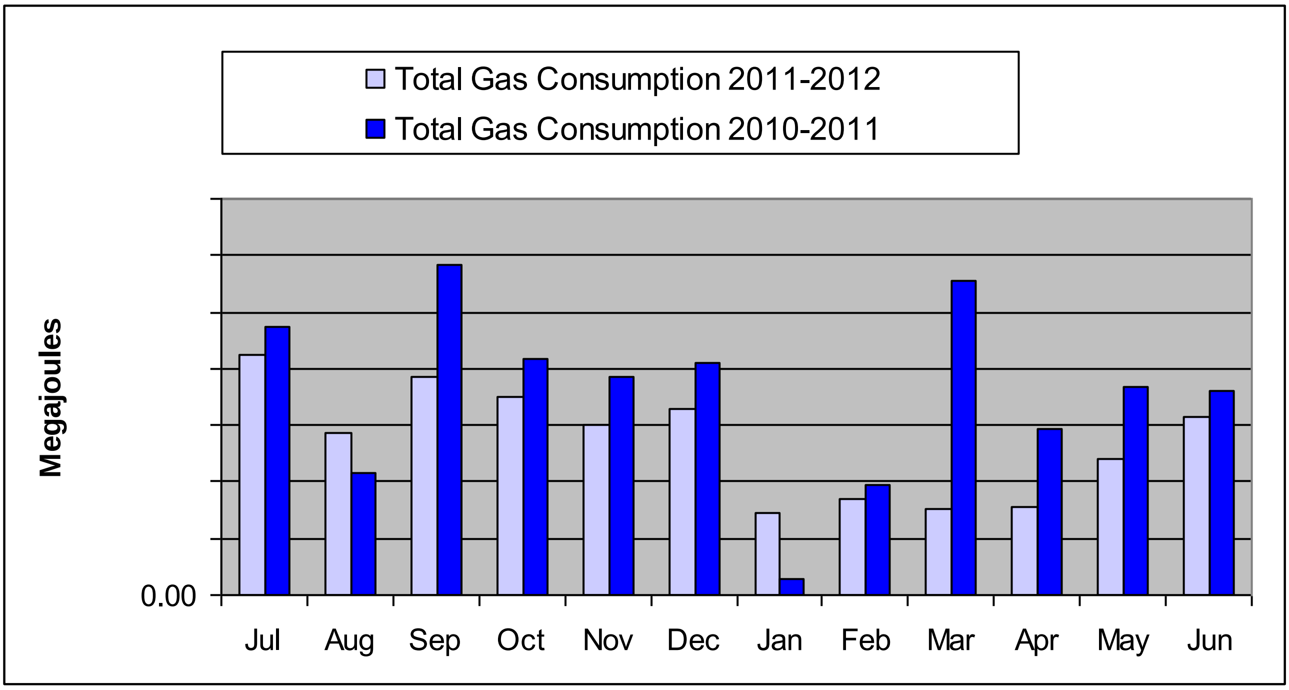


Figure 8 shows the gas consumption per month over the years 2010-2011 and 2011-2012. Gas is used throughout the year for blood drying and factory wash water. Again, the impact of the extreme weather event can be seen on the usage in January 2011.

3.5 Tariff analysis

The abattoir pays an average price for electricity, coal and LPG gas. For most payback calculations, where applicable, kWh consumption costs and kW demand costs have been calculated using the appropriate tariff figures to give a more accurate result.

In terms of electricity costs, some months were 40% above the average annual $/kWh rate and some months were 15% below the average annual $/kWh rate. This provides an indication of the adverse effects high demand fixed/variable charge has on electricity costs.

Over 2011-2012, only 46% of the total electricity charges were the result of energy consumption; 54% of the charges were the direct result of Fixed/Variable demand and Network charges. The demand is an expensive component that strongly influences the average price of the supplied energy. Many of the recommendations in this report aim to reduce the demand cost incurred at this site. Tight planning, changes in operating conditions and sequencing of equipment can result in significant savings without the need for capital outlay.

The abattoir is considered a large business for LPG gas supply purposes. However, the gas supplier may be open to negotiations and could offer the abattoir a discount on their current plan. This is not a different tariff as such but can provide a welcome saving.

3.6 Key drivers of energy use change

Primary factors that influence energy use:

- Production rates
- Climate
- Installed equipment operation

3.7 Key performance indicators

Plotting total energy consumption against total production results in useful indices that can be used to establish and/or compare against process, plant, sector or industry benchmarks. A dependable KPI requires clear boundaries and accurate administration. For the abattoir the following KPIs could be established:

Table 5 – Key Performance Indices by units of production

	Financial year	**Industry Benchmark**
Unit of production	**2011-2012**	**2008-2009**
MJ per tonne of hot standard carcase weight (MJ/tHSCW)	2,825 MJ/ tHSCW	4,108 MJ/ tHSCW[3]
Kilograms of carbon dioxide equivalent emissions per tonne of hot standard carcase weight ($kgCO_{2-e}$ /tHSCW)	365 $kgCO_{2-e}$ / tHSCW	554 $kgCO_{2-e}$ / tHSCW

This meat production facility was interrupted by an extreme weather event in the beginning of 2011 which impacted the operations of the abattoir. Also the abattoir's management has been instrumental in the design of their plant and facility, in areas of production processes and equipment, their understanding of the meat industry and engineering techniques has produced a plant that is below the benchmarks that were generated in 2008 by the Red Meat Industry.

4. BREAKDOWN OF SITE ENERGY USE

This breakdown of site energy use provides the abattoir with an understanding of where and how energy is used on site. This helps to identify the largest energy users on site and what areas, equipment or processes should be the highest priorities for achieving energy efficiency.

A breakdown of the site's energy use was calculated for all energy consuming assets using the following inputs:

- estimated hours of operation for each asset
- discussions with site staff
- equipment name plates and output ratings

An equipment inventory and each of the variables utilised in these calculations is provided as Appendix A. Table 6 provides reconciliation between this inventory and the total billed energy use and the total energy consumption estimated by this audit. A 10% or less difference between the billed and audited totals provides assurances that all significant equipment has been included in the audit and that there are no obvious billing errors.

Table 6 – Reconciliation of Site Energy Use

	2011-2012	**RMPI 2009[4]**
	Actual	**Bench mark**
Electricity Index (MJ/t HSCW)	**735**	**976**
Fuel (Gas/Coal) Index (MJ/t HSCW)	**2,090**	**2,391**
Total Energy Index (MJ/t HSCW)	**2,825**	**3,367**

[3] MLA Industry Environmental Performance Review, 2010
[4] MLA Red Meat Processing Industry Energy Efficiency Manual, 2009

FIgure 9 – Breakdown of energy consumption by end-use equipment

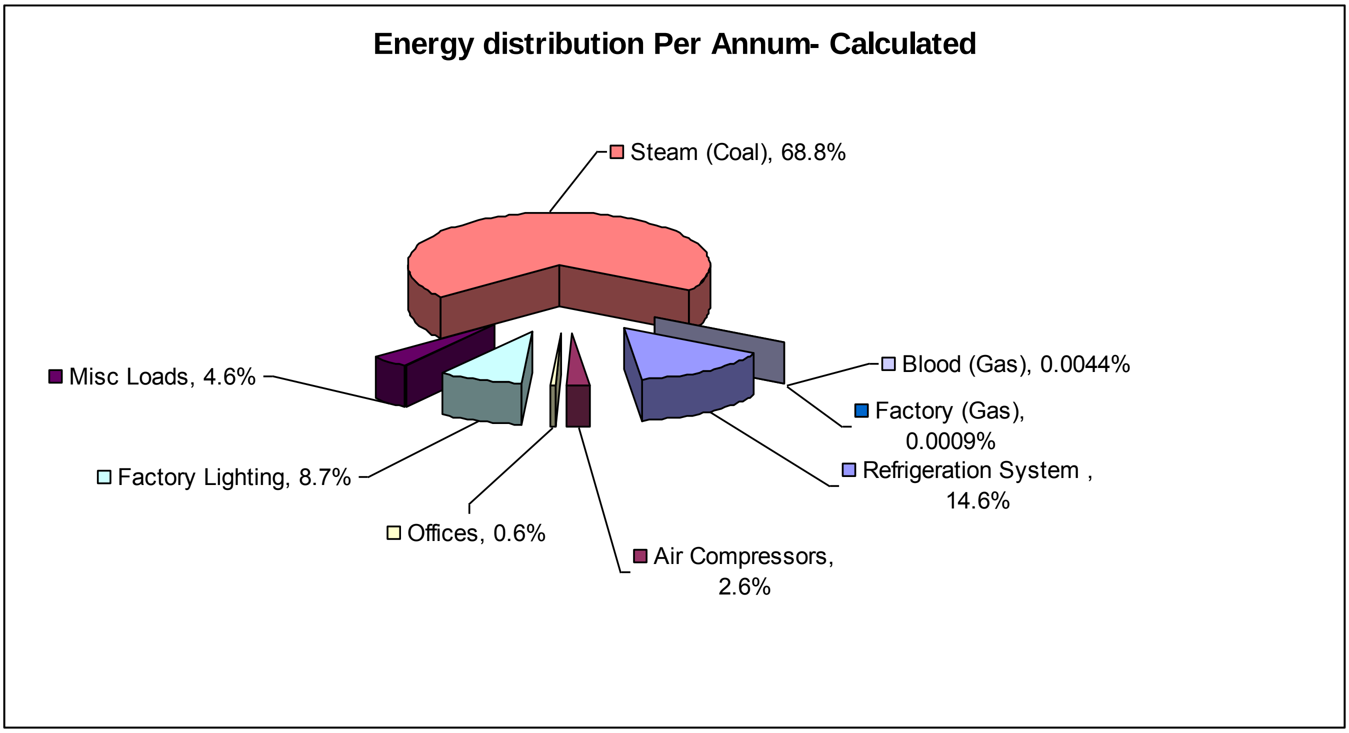


Table 7 – Energy end use breakdown (calculated)

Energy End Use	% of Total Energy Use
Refrigeration Compressors	10.9%
Refrigeration Condensers	0.6%
Refrigeration Evaporators	1.7%
Refrigeration Miscellaneous	1.4%
Air Compressors	2.6%
Steam	68.8%
Gas	0.005%
Process Miscellaneous	4.3%
Lighting	8.7%
Office	0.6%

In can be seen from the table above the biggest energy user is the coal fired boilers make up to 68.8% of total site energy consumption, with refrigeration processes consuming almost 15%.

4.1 Electricity use breakdown

Figure 10 – Breakdown of electricity consumption by end-use equipment

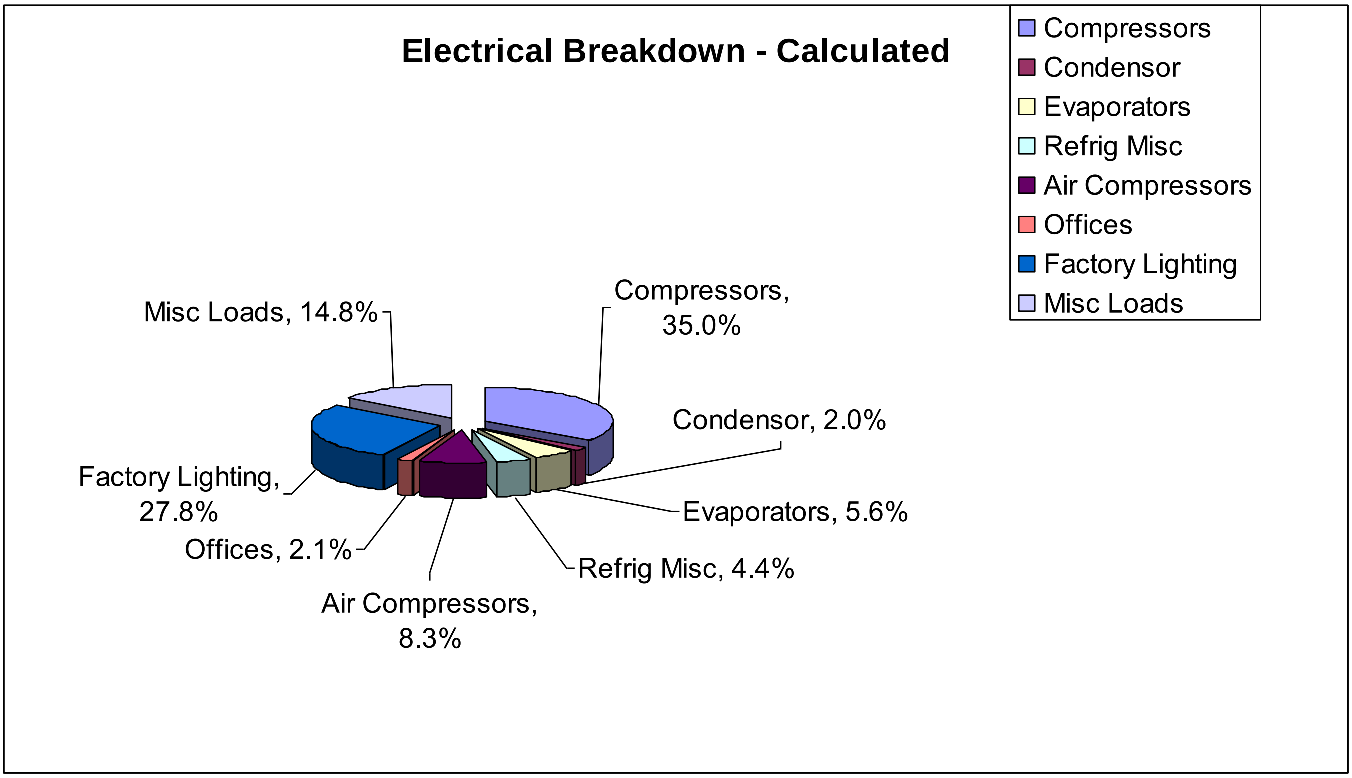


Table 8 – Electricity end-use breakdown calculated

Energy End Use	% of Total Energy Use
Refrigeration Compressors, Condensers & Miscellaneous Equipment	47.0%
Air Compressors	8.3%
Lighting	27.8%
Office & HVAC	2.1%
Process Miscellaneous	14.8%

The breakdown of electrical loads show the refrigeration is the major user at 47%, with factory lighting coming second at 27.8%. Air compressor consumption is in the order of 8%, but is an area where some good payback times can be achieved for proposed improvement projects.

4.2 LPG Gas use breakdown

There are only two LPG gas consumers and gas consumption is less than 0.005% of total energy consumption.

FIgure 11 – Breakdown of gas consumption by end-use equipment 2011-2012

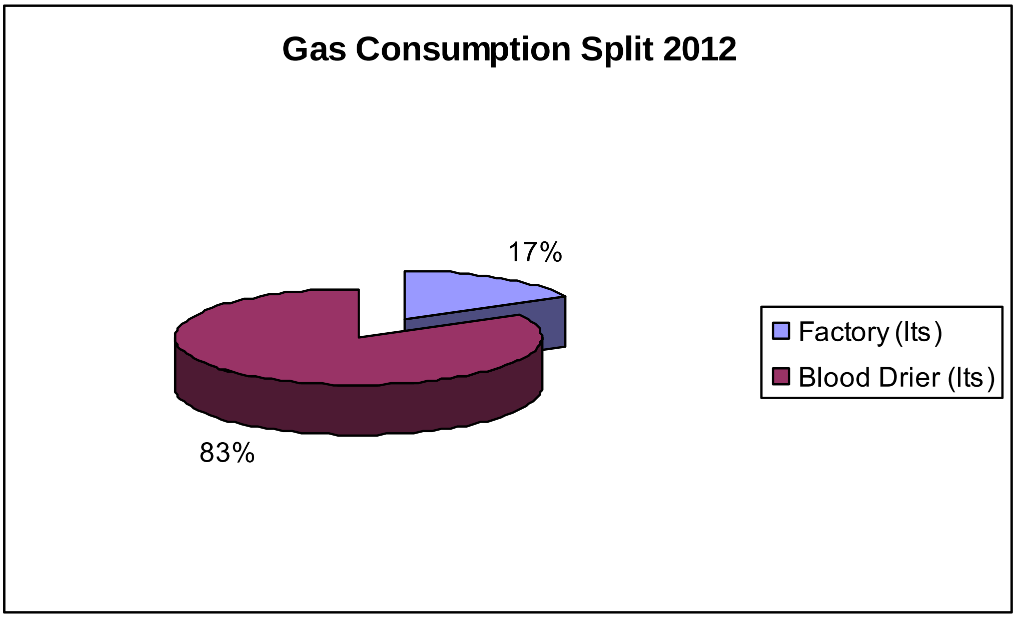


Table 9 Gas consumption

Energy End Use	% of Total Energy Use
Gas (Factory)	17%
Gas (Blood Dryer)	83%

4.3 Coal use breakdown

Table 10 Coal use

Energy End Use	% of Total Energy Use
Coal (Steam)	100%

5. CURRENT ENERGY USE AND OPPORTUNITIES

The following section discusses the energy uses on site as outlined in Section 5. For each of these end uses, significant potential energy efficiency opportunities and energy performance opportunities are outlined. Energy efficiency opportunities include using energy efficient equipment and energy saving practices. Energy performance opportunities can include fuel switching, renewable electricity generation and sub-metering. Calculations and assumptions for each opportunity are provided in Appendix B.

Building envelope opportunities are not relevant at this site. The building is already fully insulated in refrigerated areas.

5.1 Lighting

A variety of lighting technologies can be found at the abattoir including:

- ➢ Industrial E40 base high-bay lights with lamps:
  - ✓ 400W high-pressure mercury
- ➢ Single & twin 4' G13 base B2 ballast fluorescent tube fittings with lamps:
  - ✓ 36W T8
  - ✓ 40W T12
- ➢ 500 W Exterior Flood Lights with lamps:
  - ✓ 150W Metal Halide
  - ✓ 90W LED

Table 11 Typical Site luminance

Area and task	AS 1680 Requirements
Factory – industrial tasks	140 – 400
Offices & Retail space	240 – 400
Drive ways	80

Identified lighting opportunities

The existing lighting systems are old technologies and are currently being replaced with new lighting systems such as LED; the driver has been to reduce maintenance costs. The most attractive option in terms of implementation, reliability and cost has been carried through to the summary, as savings on multiple options are not cumulative.

5.1.1 Twin 4' G13 base B2 fluorescent tube fittings & 36W T8 tubes located in Cold Rooms, hallways and production areas.

OPTION 1 Replace 230x twin 4' G13 base B2 ballast fluorescent tube fittings & 36W T8 tubes with 230x twin 4' G5 base A2 Electronic ballast fluorescent tube fittings & 28W T5 high-efficiency tubes

- Capital cost: $19,550
- Payback: 2-5 years

OPTION 2 Replace 230x twin 4' 36W T8 tubes with 230x twin 4' 24W G13 base LED tubes (TUBE ONLY UPGRADE)

- Capital cost: $36,800
- Payback: over 5 years

OPTION 3 Replace 230x twin 4' G13 base B2 ballast fluorescent tube fittings & 36W T8 tubes with T8 to T5 Upgrade kit with electronic ballast (TUBE + FITTING UPGRADE KIT)

- Capital cost: $18,400
- Payback: 2-5 years

All of the above options annual savings value includes maintenance and the lamp life.

5.1.2 Industrial high-bay lights located in the work shop, rendering plant and production areas.

OPTION 1 Replace 112x 400W MV / high-bay with 150W LED High Bay Lamps

- Capital cost: $56,000
- Payback: 2-5 years

OPTION 2 Replace 112x 400W MV / high-bay with 250W Metal Halide lamp high-bay

- Capital cost: $33,600
- Payback: 2-5 years

OPTION 3 Replace 112x 400W MV / high-bay with 4X54W Fluorescent Lamps

- Capital cost: $72,800
- Payback: over 5 years

OPTION 4 Replace 112x 400W MV / high-bay with 200W Induction lamp high-bay

- Capital cost: $33,600
- Payback: 2-5 years

6.1.3 Exterior Flood located in the around the external perimeter and Drive ways.

OPTION 1 Replace 10x 500W Exterior Flood Lights with 150W Metal Halide Lamps

- Capital cost: $3,000
- Payback: less than 2 years

OPTION 2 Replace 10x 500W Exterior Flood Lights with 90W LED lamp

- Capital cost: $3,990
- Payback: less than 2 years

All of the above options annual savings value includes maintenance and lamp life.

5.2 Air Compressors

The plants compressors run throughout the year and supplies compressed air to abattoir equipment & processes. At the abattoir, a total of 4 industrial air compressors are in commission:

- No. 1 Sullair Compressor 132kW Drive
- No.2 Champion Air Compressor 87kW Drive
- No.3 Champion Air Compressor 45kW Drive
- No.4 Champion Air Compressor 45kW Drive

Table 12: Compressors were logged for one month period with the following results.

Data 5/11/2012 - 3/12/2012	Air Comp Discharge Pressure	Blow tank blow press	Comp 1 Sullair Comp Run	Comp 2 Load solenoid	Comp 3 Load solenoid	Comp 4 Load solenoid
Average	530.43	445.55	67%	29%	37%	7%

It can be seen in the table above that compressors on average do not run 100% loaded. Also reviewing the data it can be seen that at times compressors were running together unloaded. The two lag units do the majority of the required load with the smaller machines running during low loads at night and to maintain leakage rates during the week.

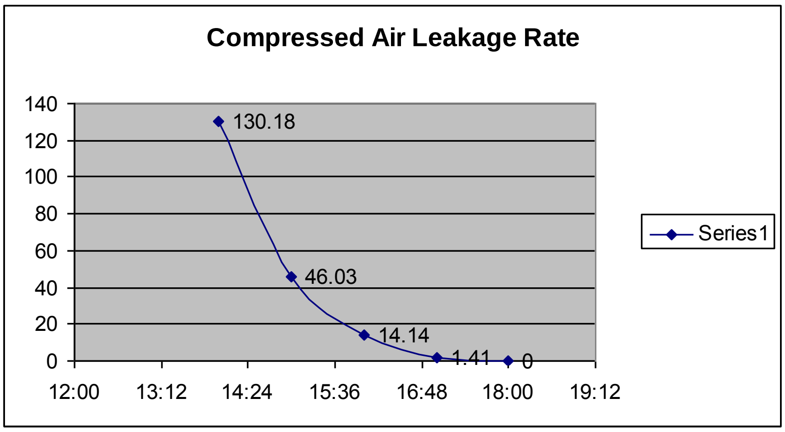
Identified Air Compressor opportunities

The four air compressors are fixed speed with constant speed unloading for capacity control. An unloaded rotary screw compressor can still draw 20% of full-load current without doing any useful work, creating an opportunity for variable speed drives for the air compressors.

In a multiple air compressor setup there is often an opportunity in controls, balancing the capacity and compressors with the required duty.

Air leaks can add significantly to the operating costs of compressed air systems, it is estimated typically this system is losing 100% of air capacity of one 45kW Compressor. An air leak test could identify any problems in this area and should be considered. An ongoing leak prevention program should be put in place to identify, track and repair air leaks in compressed air systems to increase system performance and efficiency.

Figure 12: Loss of system pressure (kPa) over time from the point the compressed air machines were turned off until the system pressure is lost.



Finally, logged data will provide information on compressor loading. Inefficiencies in compressor output and motor load can be identified and used in assessing equipment sizes and capacity.

The most attractive option in terms of implementation, reliability and cost has been carried through to the summary, as savings on multiple options are not cumulative. The lead compressors should be equipped with a VSD to closely match air demand.

6.2.1 Sullair 132kW Air Compressor Lead No.1

Install Variable Speed Drive on Sullair 132kW Air Compressor.

- Capital cost: $55,000
- Payback: 2-5 years

6.2.2 Champion 85kW Air Compressor Lead No.2

Install Variable Speed Drive on Champion 85kW Air Compressor.

- Capital cost: $45,000
- Payback: less than 2 years

The savings are greater on this compressor, as it spend more of its life in part load compared to Compressor No.1.

6.2.3 Leak Detection and reduction program

- Capital cost: $10,200
- Payback: less than 2 years

5.3 Refrigeration

The abattoir operates with a pumped ammonia two stage refrigeration plant. Of the compressors installed, up to four of the eight machines are used to meet the high and low stage loads. Installed above the plant room are three evaporative condensers, these units match the required heat rejection requirements with no excess capacity. The plant is monitored with a SCADA monitoring system and controlled with a PLC/semi manual system. Liquid ammonia is pumped from Low and High temperature Accumulators vessels in the plant room and distributed out to refrigerated rooms, boning room, automated chiller and freezer.
A Vilter ammonia reciprocating compressor located next to the rendering plant serves a cold store which is a standalone system used for cooling hides:
Main Plant equipment operating at the time of the inspection:

- No.3 Mycom 200VSD Low-stage screw compressor with149 kW motor
- No.5 Mycom 160 LG-M Low-stage screw compressor with35 kW motor
- No.6 Mycom 200 SG-M Low-stage screw compressor with 45 kW motor
- No.7 RWB-23-316 Frick High Stage screw compressor with 500kW motor

All electric drive motors are fixed speed drives.
Compressors No.1, 2, 4 and 8 were not operating.

- No.1 Condenser VXC 275
- No.2 Condenser VXC 590
- No.3 Condenser Model unknown.

Identified refrigeration opportunities

5.3.1 Install new low stage compressor with high energy efficiency motor and VSD to meet the entire peak load

- Existing multiple low stage compressors each running multiple inefficient motors compound the energy losses.
- Annual Savings total includes kWh savings and demand savings due to reduced motor loads.

5.3.2 Install ice tank/Glycol system into Boning room to Load shift to off Peak Tariff, Optimize refrigeration plant control.

- Remove existing ammonia evaporators from Boning Room and install recirculated Glycol room cooling coils.
- Install Plate heat exchanger to provide cooling for ice building in tank and Room loads.
- Install Ice tank to build ice during off peak periods
- Associated glycol pumps and pipework
- Lower compressor head pressure due to lowered peak loads.
- Annual Savings total includes kWh savings and demand savings due to reduced motor loads.

5.3.3 Control and Monitoring Technologies for consideration: Lower Operating head pressures.

Once the ability to successfully modify the refrigeration PLC programming has been confirmed, the following items should be considered to complete the ability to optimise control and monitor site electricity consumption:

Item	Requirements	Estimated Capital cost	Potential Savings
1) Compressor and condenser starting sequencing to be automatically selected from interface to match load and optimise compressor efficiency by keeping slide valve 100% loaded	Additional PLC programming and investigation of existing PLC control sequencing. SCADA plant screens	Combined SCADA programming estimated at $15,000	Savings as discussed in Business case No.1
2) Develop SCADA Glycol temperature set-point screen that allows a range of Glycol temperatures to be set in relation to ice tank temperatures with the aim of running at -2°C for the normal operational loads and dial down to -6°C to build ice during off peak hours to increase thermal storage	PLC programme adjustments	Inc. above	Savings as discussed in Business case No.1
3) Refrigeration plant power monitoring, set up new power monitoring page on SCADA to provide kW	Add to SCADA and provide plant room power overview screen , trend logs and pre-set alarm entry and indication	Programming Included above and Monitoring hardware would be at additional cost.	No direct savings, but any site that wants to reduce energy consumptions must first be able to measure and record it.

Recommendations

Item 5.3.3.Item (3) is an add-on’s to the basic system that enables energy savings to be more reliably delivered. Subject to satisfactory implementation of Item 5.3.3.Item (1) above, they should be considered for capital allocation and could be combined with 5.3.2 and other projects above to achieve an acceptable payback. As a minimum, Item (3) should be considered to allow real time measurement of power consumptions and management of maximum demand.
Item 5.3.1 would be implemented independent to items 5.3.2 and 5.3.3. Items 5.3.2 and 5.3.3 should be considered together. All proposals 5.3.1, 5.3.2 and 5.3.3 combined show a payback of over 5 years which could be reduced to acceptable levels with the governments Clean Technologies Investment Program (CTIP) Grant.

Overall for above projects 5.3.1, 5.3.2, 5.3.3

- Capital cost: $645,000
- Payback: over 5 years

Savings are based on kWh energy reductions and Demand reductions

5.4 Energy Generation

5.4.1 Grid Connected steam turbine generation (coal fired).

Install 800kW Coal Fired Steam turbine

- Capital cost: $2,080,000*
- Payback: over 10 years

Savings are based on kWh energy reductions.

During Peak electricity demand periods an opportunity exists to generate electricity with steam. However the existing steam boilers on site can not generate enough steam pressure to operate a steam turbine to generate electricity, therefore an additional high pressure coal fired boiler would be required together with a steam turbine/ electrical generation skid, and is included in the capital cost above.

Note: *Budget Capital cost based on "Report Economic and technical potential for cogeneration in industry"; MLA December 2010.

5.4.2 Grid connected solar PV

Install 100kW Solar PV installation

- Capital cost: $225,000
- Requires: 707m^2
- Payback: over 5 years

Savings are based on kWh energy reductions.

Peak demand is normally recorded during the daytime creating an opportunity to shave the demand in these hours with Solar PV. It should be noted that the demand savings have to be assumed low. Technically, a cloud could block the sun and drastically reduce the output of the array. This has to happen only once per month during to negate any savings you may have had.

Recommendations:

5.4 cogeneration using coal fired steam does not meet acceptable payback periods and even with a CTIP grant would not do so. Solar PV may be worth considering if it would meet the requirements of the CTIP Grant.

Items not considered:

- Boiler Economiser unlikely to be cost effective given the cost of coal.
- Refrigeration heat reclaim, since hot water from steam again is not cost effective.

6. SUMMARY OF RECOMMENDATIONS

Energy and cost saving opportunities						
Description of opportunity	Capital cost	Simple payback in years	GHG saving tCO_{2-e}	Fixed price $/$tCO_{2-e}$		Business case no.
				$24.15	$25.40	
Refrigeration						
Replace low stage compressor	$250,000	> 5 years	422	$10,188	$10,716	
Ice tanks/glycol upgrade	$380,000	> 10 years	908	$21,932	$23,067	
Lower head pressure	$15,000	< 2 years	399	$9,644	$10,142	
Packaged business case	$645,000	> 5 years	1,729	$41,764	$43,925	Case 1
Compressed Air						
132kW compressor VSD	$55,000	2-5 years	188	$4,551	$4,787	
45kW compressor VSD	$40,000	> 5 years	64	$1,552	$1,632	
87kW compressor VSD	$45,000	< 2 years	279	$6,749	$7,099	
Leak detection and reduction prog.	$10,200	< 2 years	92	$2,217	$2,331	
Packaged business case	$150,200	2-5 years	624	$8,966	$9,430	Case 2
Lighting						
New twin 28W T5 with elect ballast	$19,550	2-5 years	15	$373	$392	Case 3
Linear LED Lamps 2 x 24W	$36,800	> 5 years	22	$534	$562	
T8 to 28W T5 Conversion Kit	$18,400	2-5 years	15	$373	$392	
Replace 112 of 400 W Mercury Vapour						
150W LED	$56,000	2-5 years	59	$1,426	$1,499	Case 4
HI Bay – 400W metal halide	$30,000	2-5 years	19	$449	$472	
4x54W fluorescent	$72,800	> 5 years	40	$966	$1,016	
200W induction lamp	$89,600	> 5 years	44	$1,063	$1,118	
Replace 10 x 600W exterior flood lights						
Flood light – 150W metal halide	$3,000	< 2 years	10	$249	$262	
90W LED	$3,990	< 2 years	13	$310	$326	Case 5
Power generation						
Steam 800kW	$2,080,000	> 10 years	132			Case 6
Install 100kW Solar PV array	$226,000	> 5 years	159.2			Case 7
						Reduction in site use
Total Implementation	$3,179,740	> 5 years	2,731	$65,971	$69,380	53%
Total implementation excl Power	$874,740	2-5 years	2,441	$58,946	$61,991	27%

The Client has indicated that there is a preference for LED lighting to replace high bay Mercury Vapour Lamps due to the reduction in maintenance and the use of non-glass lamps in food production areas.

7. BUSINESS CASES

<table>
<tr><td>BUSINESS CASE 1</td><td colspan="2">Install Low stage Compressor with VSD, Ice tank, glycol plate, and glycol coils in Boning Room. Lower discharge pressure.</td></tr>
<tr><td>Detailed Description</td><td colspan="2">It is proposed to reduce the power demand, a glycol system be installed that utilises thermal ice storage during off peak times. This also allows the discharge pressure to be lowered during peak time further lowering the absorbed power. The project includes full design, supply, installation, connection and testing.
Code Requirements
The modifications works should be developed in compliance with :
AS /NZS 1677.2 Refrigerating systems – Safety requirements for fixed applications
AS /NZS 3000 SAA Wiring Rules
AS/NZS 3666.1 Air –handling and water systems of buildings – Microbial control
Cost
Budget Quotations were calculated by ISECO</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Reduced demand periods throughout the year</td></tr>
<tr><td>Capital cost
$</td><td>Payback period
(years)</td></tr>
<tr><td>$645,000*</td><td>> 5 years</td></tr>
<tr><td>Implementation Plan</td><td colspan="2">• Confirm scope of work and technical specification using Abattoir input and refrigeration specialist (if required)
• Obtain final quotations from nominated specialist contractors (refer to Appendix B for a list of potential contractors).
• Assess tenders and appoint contractor
• Prepare implementation plan for decommissioning of current equipment and installation of new system.
• Inspect work in progress and complete defects list
• Confirm updated documentation and commissioning results are included in on site manuals.</td></tr>
<tr><td>M & V Plan (using the Deemed Energy Savings Method)</td><td colspan="2">• Monitor plant operation for a period of 12 months including weekend operation before and after implementation of upgrades, using loggers record refrigeration compressors power usage and condenser fan power and pump power usage.
• Obtain BOM weather data for the monitoring periods before and after, dry bulb and wet bulb.
• Calculate difference between the average temperatures during the measurement periods before and after
1. Use ESS agreed method to calculate the following
2. Normalised consumption for the logged period before and after the change
3. Use the above to check the simulated annual consumption before and after the oil cooler changes
4. Confidence factor and
5. Energy savings
• This method was chosen because it allows savings for this project to be measured over a relatively short period which should not require too much normalisation due to ambient or production changes. It also allows calibration of the calculation model for part of the annual load profile. This allows validation of assumptions which can then increase the confidence factor of the model for the remaining portion of the annual load profile.</td></tr>
</table>

Note: Estimated Budgets subject to a ±10% error margin.

<table>
<tr><td>BUSINESS CASE 2</td><td colspan="2">Install bolt-on VSD to the No.1 (132kW), 2(45kW) & 3(87kW) Compressed air compressors and repair system leaks.</td></tr>
<tr><td>Detailed Description</td><td colspan="2">This is a common occurrence as air demand simply fluctuates but the system needs to be able to satisfy the needs in times of high demand. This business case recommends the installation of a VSD on to three compressors to enable efficient operation. This solution assumes that a central controls system is in place to control compressor operation in respect to each other.

Cost:

A cost estimate was sourced from:
• CAPS Australia

Refer to Appendix B – Air Compressors for assumptions utilised in calculating savings.</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Reduced wear and tear resulting in lower maintenance costs
• Reduced noise</td></tr>
<tr><td>Capital cost
$</td><td>Payback period
(years)</td></tr>
<tr><td>$150,200</td><td>2-5 years</td></tr>
<tr><td>Implementation Plan</td><td colspan="2">• Present final results
• Explore other options listed in Appendix B – Air Compressors
• Source more quotations as required
• Asses tenders, appoint contractor</td></tr>
<tr><td>M & V Plan (for forward creation under Project Impact Assessment Method)</td><td colspan="2">• Data loggers have recorded the pre-project energy consumption of the compressed air systems
• Post-project sub-metering & data-logging will provide evidence of savings and satisfy a confidence factor of 1.</td></tr>
</table>

<table>
<tr><td>BUSINESS CASE 3</td><td colspan="2">Place existing T8 Fluorescent Lamps with T5 Lamps and electronic ballast located in Cold Rooms, hallways and production areas.</td></tr>
<tr><td>Detailed description</td><td colspan="2">This project involves the upgrading of 230 T8 Fluorescent lamps to an energy efficient T5 lamp together with electronic ballasts.
Code Requirements:
The proposed electrical installation should be developed in compliance with the following standards and codes:
• Australian Building Codes Board (ABCB)
• AS 3000
• Minimum lighting levels</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Increase in light performance in quantity and consistency
• Reduced operation of high-bay lights</td></tr>
<tr><td>Capital cost $</td><td>Payback period (years)</td></tr>
<tr><td>$19,550</td><td>2-5 years</td></tr>
<tr><td>Implementation plan</td><td colspan="2">• Obtain quotations from nominated contractors , review and award contact</td></tr>
<tr><td>Risk management</td><td colspan="2">• Installation and commissioning</td></tr>
<tr><td>M & V Plan</td><td colspan="2">• Data loggers have recorded the pre-project energy consumption of the main supply
• Post-project sub-metering & data-logging will provide evidence of savings and satisfy a confidence factor of 1.</td></tr>
</table>

<table>
<tr><td rowspan="1">BUSINESS CASE 4</td><td colspan="2">Replace existing High Bay 400W Mercury Vapour lamps with energy efficient LED Lamps located in the work shop, rendering plant and production areas.</td></tr>
<tr><td>Detailed description</td><td colspan="2">This project involves the upgrading of 112 x 400W mercury vapour lamps with energy efficient LED lamps.
Code Requirements:
The proposed electrical installation should be developed in compliance with the following standards and codes:
• Australian Building Codes Board (ABCB)
• AS 3000
• Minimum lighting levels</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Deliver better lighting levels
• Reduce maintenance
• Reduce lost production time during brown outs.</td></tr>
<tr><td>Capital cost
$</td><td>Payback period
(years)</td></tr>
<tr><td>$56,000</td><td>2-5 years</td></tr>
<tr><td>Implementation plan</td><td colspan="2">• Obtain quotations from nominated contractors</td></tr>
<tr><td>Risk management</td><td colspan="2">• Installation and commissioning</td></tr>
<tr><td>M & V Plan</td><td colspan="2">• Data loggers have recorded the pre-project energy consumption of the main supply
• Post-project sub-metering & data-logging will provide evidence of savings and satisfy a confidence factor of 1.</td></tr>
</table>

<table>
<tr><th>BUSINESS CASE 5</th><th colspan="2">Replace existing 150W Flood lights with Energy efficient 90W LED Lamps.</th></tr>
<tr><td>Detailed Description</td><td colspan="2">This project involves the upgrading of 10 x150W Metal Halide Lamps with Energy efficient LED lamps.
Code Requirements:
The proposed electrical installation should be developed in compliance with the following standards and codes:
• AS 3000
• Minimum lighting levels</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Deliver better lighting levels
• Reduce maintenance</td></tr>
<tr><td>Capital cost
$</td><td>Payback period
(years)</td></tr>
<tr><td>$3,990</td><td><2 years</td></tr>
<tr><td>Implementation Plan</td><td colspan="2">• Present final results
• Upon decision source more quotations (if required)</td></tr>
<tr><td>Risk management</td><td colspan="2">• Installation and commissioning</td></tr>
<tr><td>M & V Plan</td><td colspan="2">• Data loggers have recorded the pre-project energy consumption of the main supply
• Post-project sub-metering & data-logging will provide evidence of savings and satisfy a confidence factor of 1.</td></tr>
</table>

<table>
<tr><td>BUSINESS CASE 6</td><td colspan="2">Install grid-connected 800kW Steam Boiler and turbine/ generator</td></tr>
<tr><td>Detailed Description</td><td colspan="2">There is an opportunity to install a dedicated Coal fired steam Boiler, turbine and generator Skid to reduce the consumption of imported electricity. The project includes full design, supply, installation, connection and testing.
Code Requirements:
The proposed installation should be developed in compliance with the following standards and codes:
• AS 3000 - 2007 - Wiring rules
• AS 3008 - 1.1.2009 - Selection of Cables
• AS 1768 – Lightning protection
• AS 1170.2 – Wind loads
• AS 4777 – Grid connections of Energy Systems via Inverters
• Local Supply Authority - Service and installation Rules
Cost:
A Based on capital costed stated In Report “Economic and technical potential for cogeneration in industry”: Published by Meat & Livestock Australia December 2010.</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Reduced electricity demand in demand periods throughout the year</td></tr>
<tr><td>Capital cost
$</td><td>Payback period
(years)</td></tr>
<tr><td>$2,080,000</td><td>> 10 years</td></tr>
<tr><td>Implementation Plan</td><td colspan="2">• Present final results
• Upon decision source more quotations (if required)</td></tr>
<tr><td>Risk management</td><td colspan="2">• Dedicate space in boiler house.
• Instigate training for new equipment</td></tr>
<tr><td>M & V Plan</td><td colspan="2">• Data loggers have recorded the pre-project energy consumption
• Post-project sub-metering & data-logging will provide evidence of savings and satisfy a confidence factor of 1.</td></tr>
</table>

<table>
<tr><td>BUSINESS CASE 7</td><td colspan="2">Install grid-connected 100kW Solar PV array</td></tr>
<tr><td>Detailed Description</td><td colspan="2">There is an opportunity to include an appropriately sized Solar PV array in an Ausindustry Clean Technology grant application. The subsequent generation of STCs brings the payback down to less than 5 years. It is proposed to install a 100kW PV array to reduce the consumption of imported electricity. The project includes full design, supply, installation, connection and testing.
Code Requirements:
The proposed installation should be developed in compliance with the following standards and codes:
• AS 5033 – Installation of photovoltaic (PV) arrays
• AS 3000 - 2007 - Wiring rules
• AS 3008 - 1.1.2009 - Selection of Cables
• AS 1768 – Lightning protection
• AS 1170.2 – Wind loads
• AS 4777 – Grid connections of Energy Systems via Inverters
• Local Supply Authority - Service and installation Rules
Cost:
A quote was sourced from:
• Applied SolarWind Solutions
• SolarSwitch
A breakdown of costs is provided in the quotes (refer to Appendix E).
Refer to Appendix B – Solar PV for assumptions utilised in calculating savings.</td></tr>
<tr><td rowspan="3">Operational benefits</td><td colspan="2">• Reduced demand in demand periods throughout the year</td></tr>
<tr><td>Capital cost
$</td><td>Payback period
(years)</td></tr>
<tr><td>$225,000</td><td>> 5 years</td></tr>
<tr><td>Implementation Plan</td><td colspan="2">• Present final results
• Upon decision source more quotations (if required)</td></tr>
<tr><td>Risk management</td><td colspan="2">• There is enough north-facing roof-space for ca. 100kW
• A structural engineer should inspect the proposed roof construction to ensure the roof construction is sound and can carry a solar PV array.</td></tr>
<tr><td>M & V Plan</td><td colspan="2">Savings should be calculated using the SGU STC calculations for small-scale solar panel systems:
• For an eligible system (100kW or less)
• By (or on behalf of) the owner of the system
• Within 12 months of the installation
• When the system is completely and correctly installed
• For each deemed period
• The installer is correctly registered and accredited
• And all the documentation has been supplied and signed</td></tr>
</table>

8. FUNDING AND FURTHER IMPLEMENTATION SUPPORT

Low Carbon Australia Energy Efficiency Program

Low Carbon Australia manages an $84.6m investment fund which provides finance to improve energy efficiency and achieve carbon abatement in the property and industry sectors.

Low Carbon Australia does not provide grants, instead providing a range of funding options including:

- direct or co-financed loans
- operating leases
- financial leases
- on bill financing (where repayments are made through utility bills), and
- Environmental Upgrade Agreements.

The eligibility criteria for Low Carbon Australia is very broad

- *Technology scope:* wide technology scope, all commercially available energy efficiency and/or GHG reduction technologies are eligible
- *Sector eligibility:* wide building and industry scope, all non-residential buildings and industrial processes are eligible.

For more information and to apply:
Phone: 02 9191 9315
Email: info@carbontrustaustralia.com.au
Web: http://www.lowcarbonaustralia.com.au/

Note: Energy Saver Implementation Support can assist with the application process to this scheme

Clean Technology Food and Foundries Investment Program

The Clean Technology Food and Foundries Investment Program is a $200 million competitive, merit-based grants program, for food and foundry manufacturers across Australia. The Program is delivered by AusIndustry, a division of the Department of Industry, Innovation, Science, Research and Tertiary Education. AusIndustry is supported in delivering this program by Innovation Australia, an independent statutory body.

To be eligible the applicant must be a manufacturer operating in the food or foundries industries within Australia. There is no minimum energy usage requirement for this program.

Funding will be based on a co-investment ranging between $1 for each dollar of government funding to $3 for each dollar of government funding depending on the size of the organisation and the grant application. Minimum grant size for the program is $25,000.

Eligible activities are capital investment and associated activities that generate carbon and energy savings, specifically:

- Replacement of existing manufacturing plant, equipment and processes
- Modifications to existing manufacturing plant, equipment and processes
- Changes to energy sources for the existing or replacement manufacturing plant or processes
- Replacing or modifying existing manufacturing facilities to enable production of new low emissions products.

The program is now open for applications.

For more information and register your interest:
Phone: AusIndustry hotline on 13 28 46
Email: hotline@ausindustry.gov.au
Web: www.ausindustry.gov.au/programs/CleanTechnology/Pages/default.aspx

Please note: This funding information is only a guide; it is not exhaustive, nor specific to any organisation. These programs may change and it is the organisation's obligation to contact the funding body directly for current eligibility criteria and updated information.