Final Report

Energy and water benchmarking and efficiency culture change

Energy and water intensity benchmarking, and the development of an efficiency culture in red meat processing

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Contents

1.0 Executive Summary

The objectives of the energy and water benchmarking and the culture change diagnostic sessions are to engage with AMPC members to assess energy and water intensity improvements since the last report in 2020, to build an initial understanding of the maturity of energy management systems and first steps towards achieving a strong culture in energy efficiency. The major achievements of the benchmarking sessions are high levels of member engagement and interest in the results.

1.1 Benchmarking Results

The overall results of the benchmarking sessions shown in Table 1 indicate that average energy intensity has remained steady and water intensity has increased since 2020. The variation in water intensity could be due to lower levels of production in 2022 (95% production capacity in 2020 and 82% in 2022). Both the average energy and water intensity will vary due to the mix of plant types and the number of members participating in the benchmarking project. However, there are many benchmark ratings in the 2022 results and several exceptional benchmark ratings indicating that the 'good' rating is now average performance[1]. As a result, a new category of "best practice" has been suggested as an update to the benchmarking tool.

Table 1 Benchmark results for 2020 and 2022 (see Appendix 9.1 for 2022 site details)

Resource intensity	2020 High	2020 Low	2020 Average[2] (± variation)	2020 Benchmark ratings*	2022 High	2022 Low	2022 Average (± variation)	2022 Benchmark ratings*
Electrical intensity (kWh/tHSCW)	428	194	309 (±39%)	15 G, 2 F	577	169	313 (±84%)	19 G, 3 F
Thermal intensity (MJ/tHSCW)	3,772	725	2,186 (±73%)	10G, 4F, 2 P	3,701	791	2,187 (±69%)	9 G, 7 F, 1 P
Total energy intensity (MJ/tHSCW)	5,314	1,556	3,297 (±61%)	N/A	5,069	1,537	3,315 (±53%)	N/A
Water intensity (kL/tHSCW)	11.1	5.1	7.8 (±42%)	16 G, 1 F	16.3	3.8	9.0 (±80%)	20 G, 2 F

*Good (G), fair (F), and poor (P) ratings are based on comparison to idealised model for a plant with the same processes.

The wide range of electrical and thermal intensity results in 2020 and 2022 indicates that further improvement in energy efficiency is available. The benchmarking session discussions revealed that energy efficiency improvements seemed to have lost momentum while the there is a strong focus on renewable energy supply. Some of the key areas of interest are heat pumps, solar PV with batteries, biogas capture and reuse, and biomass boilers. This finding reinforces the need to develop and maintain an energy efficiency culture. The second phase of this project explores the need for an efficiency culture (see section 1.2).

Despite the slight decrease in performance over the last 2 years, water management practices have improved significantly over the last 13 years (see Table 2), and the overall water intensity ranged from 3.8 kL/tHSCW to 16.2 kL/tHSCW with an average of 9 kL/tHSCW ± 80%. There is still a very high variation which indicates significant

[1] The AMPC energy and water benchmarking tool is based on an idealised model of RMP plant operation drawn from previous benchmarking data and the Eco-Efficiency Manual for Meat Processing - Meat and Livestock Australia Ltd, 2002. Since this time RMP plants have improved energy and water management significantly and this indicates that a new rating for Best Practice is warranted.

[2] Weighted average for all sites benchmarked.

savings are available. The best water intensity of 3.8 kL/tHSCW was achieved by a cattle processing plant with rendering using bore water and over 30% water recycling. A general finding was that those plants with bore water tended to have a better water intensity than those supplied with town water. The key driver for the water intensity improvements seems to be due to the limited supply available from bore water systems. Although town water supply can be less limited the ability to improve water intensity is still the same. Therefore, the lowest water intensity of 3.8 kL/tHSCW could be replicated and achieve over 100% reduction in many other sites. Some other key areas of focus for further water intensity improvement are hot water consumption control and integrated water and wastewater treatment.

This year, an extra section for carbon emissions intensity was added to the benchmark report. This section included advice about renewables and decarbonisation projects. The key factors affecting carbon emissions are source of electricity supply (carbon grid intensity varies for each state of Australia) and the fuel source (natural gas, coal, or other fuels). The carbon intensity range for electricity use ranged from 20 kgCO_2e/tHSCW to 332 kgCO_2e/tHSCW and the thermal carbon intensity ranged from 52 kgCO_2e/tHSCW to 414 kgCO_2e/tHSCW (see Appendix 9.2). Each site has a unique carbon intensity and the opportunities for decarbonisation vary considerably depending on the type of energy supplies involved. Several AMPC members are just starting the emissions reduction journey however several companies are well advanced in decarbonisation planning, with activities including establishing emissions reduction targets and installing renewable energy generation (mainly solar PV panels and biogas or biomass boilers). The decarbonisation pathway for red meat processing is further explored in the AMPC project 2023-1004.

1.2 Efficiency culture change

The results of EPR 2022 report produced by CSIRO indicates about 15% to 20% improvement in energy, water, and carbon intensity last 13 years, however the improvements in all intensities have slowed, the energy intensity has reversed to a moderate increase in the last 8-year period. Most members see the value of the energy and water savings projects however many businesses do not implement the improvements. There could be many issues holding back further improvement including the lack of an efficiency culture (e.g., setting energy saving targets).

Table 2 - EPR resource intensity results

Resource intensity	2009	2014	2020*	2022*
Energy intensity (MJ/tHSCW)	4,108	3,005	3,316	3,435
Water intensity (kL/tHSCW)	9.4	8.6	7.9	8.0
Carbon intensity** (kg CO_2e/tHSCW)	554	432	397	447

*A comparison with intensity values shown in Table 1 shows variations which are due to different levels of participation – 31 members provided data for the EPR project conducted by CSIRO and 22 members out of that same group participated in the benchmarking project conducted by Energetics.

**Carbon emission calculations include an estimate of wastewater carbon emissions (see Appendix 9.4).

Efficiency culture maturity was measured using a management systems diagnostic called One2Five Express Energy (see Appendix 9.6 for star rating and Appendix 9.7 for the elements of management systems assessed). This tool is a propriety tool which follows the ISO 50001 International Energy Management Systems (EnMS) Standard and provides a rating of 1- to 4-stars. Five AMPC members participated in the management systems diagnostic sessions and the results provided a good initial glimpse of the level of maturity of management systems and the potential opportunity for efficiency culture improvement. The star ratings ranged from 4-star demonstrating formal systems in place to 2-star indicating basic systems with one member achieving a 3-star for strong progress towards formal systems (see Appendix 9.6 for star ratings). The energy and water intensities achieved by the member (Nolan

Meats, see page 15 for case study) with the 4-star rating are in the best performance for all participating AMPC members demonstrating alignment between good performance and a mature efficiency culture with formal management systems (see Appendix 9.8).

This result is further reinforced by a study[3] conducted in the US that found companies which achieved ISO 50001 certification, delivered average savings of 10% within 18 months. Furthermore, 75% of the savings delivered were low-cost measures requiring no capital investment.

Management systems could be a key area of development for AMPC members in the next few years due to the need to operationalise energy management and decarbonisation commitments. Robust structured management systems will help members:

- negotiate the on-going change in energy supply sources, costs, and security,
- leverage the evolution of modern industrial energy equipment, automation, and processes, and
- reduce the cost and effort required to achieve cost effective transition to a low carbon economy.

1.3 Conclusions summary

- The benchmarking sessions, workbooks and the reports were well received by members. The benchmarking project has become a standard way of measuring energy and water performance which is used by members to help gauge how well they are improving performance. Comparison of benchmarking ratings with previously results (2020 report) was used to help show that progress.
- Data quality is highly variable. We suggest that the EPR data collection workbook is updated to include basic data checks and range checks which could be drawn from previous EPR data workbooks.
- Also, it may be better to include the EPR project with the benchmarking and management systems projects to eliminate the rework of data and streamline the reporting process.
- Benchmarking workbook updates identified during the benchmarking sessions were:
    - Include an explanation of the benchmark modelling to explain how the rating scales vary for each type of site. This was raised by several members during the benchmarking workshops. The explanation is that the benchmarking modelling includes rating scale adjustments to allow for lower than 100% production capacity, and the number of processes used on the site.
    - Include fellmongering in hide processing – this a significant thermal energy use in sheep hide processing for removal of wool.
    - Include frozen offal in product output (not tracked as HSCW and not shown previously).
    - Non-rendering plant energy balance correction was implemented during the benchmarking sessions.
    - Update best practice modelling using best performers in 2022 and 2020 (previous base was 2019).
    - Introduce a new rating for “best practice” above the “good” rating.
    - Update carbon emissions calculations to include site fugitive emissions such methane from anaerobic ponds and refrigerants losses. (See Appendix 9.4 for wastewater carbon emissions calculations used in the EPR 2022 report).

[3] Assessing the Costs and Benefits of the Superior Energy Performance Program

- The benefits of the benchmarking workbook and sessions are:
  - Raised levels of awareness in new technologies, renewable energy options and electrification.
  - Comparison of benchmark results with 2020 benchmarking project allowed members to see how well they have progressed or not.
  - For those members with multiple sites, comparison of benchmarking results helps to build collaboration between sites where learnings from a good performer can be transferred to less advanced sites.
- The benchmarking project provides a preliminary assessment of the level of savings and types of opportunities required to improve performance. The identification of energy savings is also an important part of the development of the decarbonisation pathway for each AMPC member. Further details of the decarbonisation pathway options are available in project 2023-1004.
- Further development of an efficiency culture in the RMP may provide an important part of the on-going management of energy and decarbonisation projects. An effective management system will provide cost savings, reduce capital, and resource costs for energy management and help build a sustainable result.
- It is recommended that further programs to explore efficiency culture development including the use of managment system diagnostics, and training for energy management systems (EnMS) be included in future AMPC projects.

2.0 Introduction

The project consists of two stages.

- 1st stage sectoral energy & water benchmarking tool review, improvement, and workshops
- 2nd stage sectoral assess & develop a top-down efficiency culture in red meat processing.

2.1 Stage 1 – Energy and water benchmarking

The 2020 benchmarking tool was updated to replace information links and adjust business case calculations. Research was conducted to develop recent case studies that demonstrate the value of energy and water intensity improvement projects. A presentation was developed for the introduction of the benchmarking sessions. A series of benchmarking workshops were held with AMPC members, and a benchmark report was provided to each AMPC member including energy and water intensity ratings, and a list of key projects and actions that AMPC members can take to improve energy, water, and carbon management with references. This is the same approach used in previous years.

2.2 Stage 2 – Energy efficiency culture maturity assessments

To achieve effective implementation and sustainable outcomes, businesses require a strong culture for change and to be led by a highly supportive and interested management team. The second stage of this project involves a diagnostic review to assess the level of maturity of the AMPC members' business management systems such as policy, targets, plans, training, people, and project implementation practices and identify areas of improvement. Especially those areas which are creating barriers to further improvement in energy and water management.

The intent of this work is to help AMPC members take the next step towards improving and maintaining energy and water intensity improvements using a structured management systems approach such as ISO50001.

3.0 Project Objectives

The project objectives are as follows:

- To find exemplar projects and case studies for energy and water efficiency improvements to build the business case for implementing improvement projects and developing an efficiency culture to achieve sustainable results.
- To provide value to AMPC members using the energy and water benchmarking tool and expert advice
- To assess the correlation between management systems development with the adoption of an efficiency culture and the improvement of energy and water efficiency
- To identify the key cultural elements needed to enhance the implementation of energy and water efficiency projects and activities.

4.0 Methodology

The project was conducted in two stages, including:

4.1 Stage 1

A summary of the methodology to update benchmarking tool is as follows:

- Collect data from AMPC member web sites and AMPC reports for energy and water efficiency projects recently implemented to be included in the benchmarking presentation.
- Review energy and water management systems used by AMPC members to create presentation.
- Update the benchmarking tool with new opportunities and update existing analysis of opportunities and support inks where necessary.
- Present the tool and presentations for final AMPC approval.

Benchmarking workshops were held for 22 participants as a value add for completion of the data required for the 2022 Environmental Performance Review (EPR). The following methodology was applied:

- For those AMPC members participating in the 2022 EPR, we updated the benchmarking workbook using EPR data. This involved checking the data quality and accuracy.
- We held online (Teams) conference meetings with AMPC members to review benchmarking tool results and to discuss energy and water improvement projects.
- Each member received a summary report of the meeting including opportunities discussed, benchmark results and references for further project research.
- This work was used to identify areas for benchmarking tool updates and improvements.
- We discussed the possibility of a management system diagnostic (efficiency culture maturity assessment) in this meeting to test the level of interest.

4.2 Stage 2

The efficiency culture change sessions included:

- Provide presentation of the culture change approach to energy and water efficiency improvement.
- Using the results of the benchmarking tool as a guide, we worked with AMPC to select sites/businesses for a management system diagnostic.
- Trained facilitators delivered the online One2Five diagnostic session. There is an enterprise diagnostic tool and an express version. The express version is designed for businesses with limited management systems or just starting the journey, and the larger version for those business with ISO 9001 (International quality standard) and ISO14001 (International environment managment systems standard) experience. We worked with AMPC to decide on the best version for each AMPC member. The express version was selected for all members.
- A diagnostic report with commentary on actions for each AMPC member company was provided. The report includes a description of management systems, introduction of One2Five structure, diagnostic session

attendees, star-rating results, element ratings, critical actions with facilitator comments, and benchmarking with industry groups.

5.0 Project Outcomes

5.1 Energy and water benchmarking

The results of the 2022 and 2020 sessions are summarised in Table 3. This analysis is based 22 AMPC members who participated in the benchmarking sessions, 5 more than in 2020.

Table 3 Energy and water intensities and benchmark ratings

Resource intensity	High	Low	Average (± variation)	2020 Benchmark ratings*	High	Low	Average (± variation)	2022 Benchmark ratings*
Electrical intensity (kWh/tHSCW)	428	194	309 (±39%)	15 G, 2 F	577	169	313 (±84%)	19 G, 3 F
Thermal intensity (MJ/tHSCW) (rendering)	5,321	1,329	2,727 (±95%)	7 G, 4 F, 3 P	3,701	1,171	2,458 (±51%)	9 G, 7 F, 1 P
Thermal intensity (MJ/tHSCW) (non-rendering)	1,329	725	1,002 (±33%)	3 G	2,293	791	1,266 (±81%)	4 G, 1 F
Thermal intensity (MJ/tHSCW) (all sites)	3,772	725	2,186 (±73%)	10G, 4F, 3 P	3,701	791	2,187 (±69%)	13G, 8F, 1 P
Total energy intensity (MJ/tHSCW)	5,314	1,556	3,297 (±61%)	N/A	5,069	1,537	3,315 (±53%)	N/A
Water intensity (kL/tHSCW)	11.1	5.1	7.8 (±42%)	16 G, 1 F	16.3	3.8	9.0(±80%)	20 G, 2 F

*Good (G), fair (F), and poor (P) ratings are based on comparison to idealised model for a plant with the same processes.

The comparison of 2022 and 2020 results indicates that the average electrical intensity has not changed significantly. However, there is a wider variation of values shown in the 2022 data.

The 2022 average thermal intensity for rendering plants has improved by about 10% compared to 2020 value whereas the thermal intensity has increased by 25% for the non-rendering plants. These results vary due to the number and types of plants in each benchmark period, there were 17 participates in 2020 and 22 participates in 2022. Overall, there has been negligible change in overall thermal intensity.

The 2022 water intensity is 15% greater than the 2020 water intensity. It is challenging to draw any strong trends from these comparisons. This may be due to the sample size and/or a more diverse range of sites participating in the 2022.

The 2022 minimum intensity values are lower than the 2020 values which indicates that some of the sites have improved significantly. The minimum energy and water intensity values are good indicators of best practice. This improvement is even more significant when we consider the average level of production capacity in 2020 was 95% and the average in 2022 was 82% (lower production capacity is usually associated with lower energy and water performance). These values are far lower than the benchmark model predicted which means the benchmark tool needs to be updated and include a new category for best practice. This change has been recommended in the conclusions section of this report.

The results are discussed in the following:

- Electrical intensities vary from as low as 169 kWh/tHSCW to 577 kWh/tHSCW with an average intensity of 313 kWh/tHSCW. The benchmark ratings show over 90% good ratings with a fair rating or better. This is similar to the 2020 results. The main types of electrical projects discussed during the benchmarking sessions included solar PV, batteries, refrigeration upgrades and heat pumps (see Appendix 9.3). The Hardwick Meat heat pump project (see Bibliography) provided an excellent case study for other members to evaluate the potential of this approach for their site.
- Thermal intensities range from 791 MJ/tHSCW to 3,701 MJ/tHSCW with an average of 2,187 MJ/tHSCW. The thermal intensity for non-rendering plants ranged from 791 MJ/tHSCW to 2,293 MJ/tHSCW and the rendering plants thermal intensity range from 1,171 MJ/tHSCW to 3,701 MJ/tHSCW (see Appendix 10.1). The total thermal benchmark ratings varied considerably with 13 good, 8 fair and 1 poor ratings, little change to the 2020 results where there were 10 good, 4 fair and 3 poor ratings. The high variability of the thermal intensities could be partially explained by the lower production levels on some sites; however, the age of rendering plants and the efficiency of steam generation also have a major impact on the thermal intensity. In several cases sites are considering replacing old fossil fuel-fired boilers with biomass and biogas boilers and the use of heat recovery to reduce thermal energy use was discussed. A new research project (see Bibliography) into the use of mechanical vapour recompression (MVR) in rendering systems was included in some benchmarking reports. MVR has been used in several food industries for decades including the dairy industry where it is employed to reduce energy use in the concentrated milk production (see Bibliography).
- Water intensity ratings varied from 3.8 kL/tHSCW to 16.3 kL/HSCW with 91% good ratings with two fair ratings (see Appendix 10.1). Benchmarking results show mostly good results which is like the 2020 results. There were many water efficiency improvement projects mentioned during the workshop including hot water systems optimisation, upgrade of sterilisers, use of water recycling, cattle wash studies, new cattle wash plants, automation to reduce water use in non-production periods. One example of automation included the activation of a shut-off valve when the hot water flow to slaughter floor reduced to a programmed minimum value which indicated production had stopped.
- The carbon intensity varied from 552 kgCO_2e/tHSCW to 93 kgCO_2e/tHSCW (see Appendix 10.2) with an average value of 337 kgCO_2e/tHSCW for the 22 participating member sites. This average value is lower than the EPR report value of 447 kgCO_2e/tHSCW. CSIRO calculations included energy related emissions and carbon emissions from wastewater (see Appendix 9.4). The main factors accounting for site differences in the carbon emissions are:
    - Electricity grid carbon intensity is dependent on Australian state in which the site is located. (See Appendix 9.5 for more details)
    - Different fuels used at each site with higher emissions due to high carbon content fuels such as coal and lower emissions from renewable energy sources such as biomass or biogas combustion.

5.2 Efficiency culture change

Efficiency culture maturity was assessed using a management systems diagnostic called One2Five Express Energy. This tool is an Energetics propriety tool which follows the ISO 50001 International Energy Management Systems (EnMS) Standard and provides a rating of one to five stars. Five AMPC members participated in the management systems diagnostic sessions and the results provided a good initial glimpse of the level of maturity of management systems and the potential opportunity for efficiency culture improvement for AMPC members. The star ratings ranged from 4-star demonstrating formal systems in place to 2-star indicating basic systems with one member achieving a 3-star indicating strong progress towards formal systems (see Appendix 9.6 for star ratings)

The results of the management systems diagnostic sessions indicate that AMPC members in the red meat processing industry are like most other industrial sectors assessed by One2Five where management systems are generally in their formative stages at a 2-star rating. The good news is that there is a lot of potential savings to be made by implementing effective well-structured management systems (demonstrated through ISO50001 accreditation). A study[4] in the US found that companies which achieved ISO 50001 certification as part of the US Department of Energy Superior Energy Performance programme, delivered average savings of 10% within 18 months. Furthermore, 75% of the savings delivered were low-cost measures requiring no capital investment.

6.0 Discussion

6.1 Energy and water benchmarking

During the benchmarking sessions there was several questions regarding the benchmarking rating process. The following discussion provides an overview of the benchmarking modelling and rating calculation process.

The energy and water benchmarking modelling process

The benchmarking process was designed to provide a comparison of an idealised energy and water benchmark model with the actual site performance. This means that the site benchmark ratings of good, fair, and poor are compared with the idealised model, not with other sites.

The rating diagram shown in Figure 1 shows a range of values from 760 MJ/tHSCW to 5,500 MJ/tHSCW (good (green), fair (orange) and poor (red)) and site value of 757 MJ/tHSCW. The range is calculated from predicted intensities for a site with the same processes. The model calculations indicate that this site has achieved a good benchmark rating.

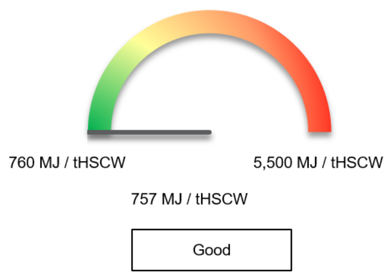
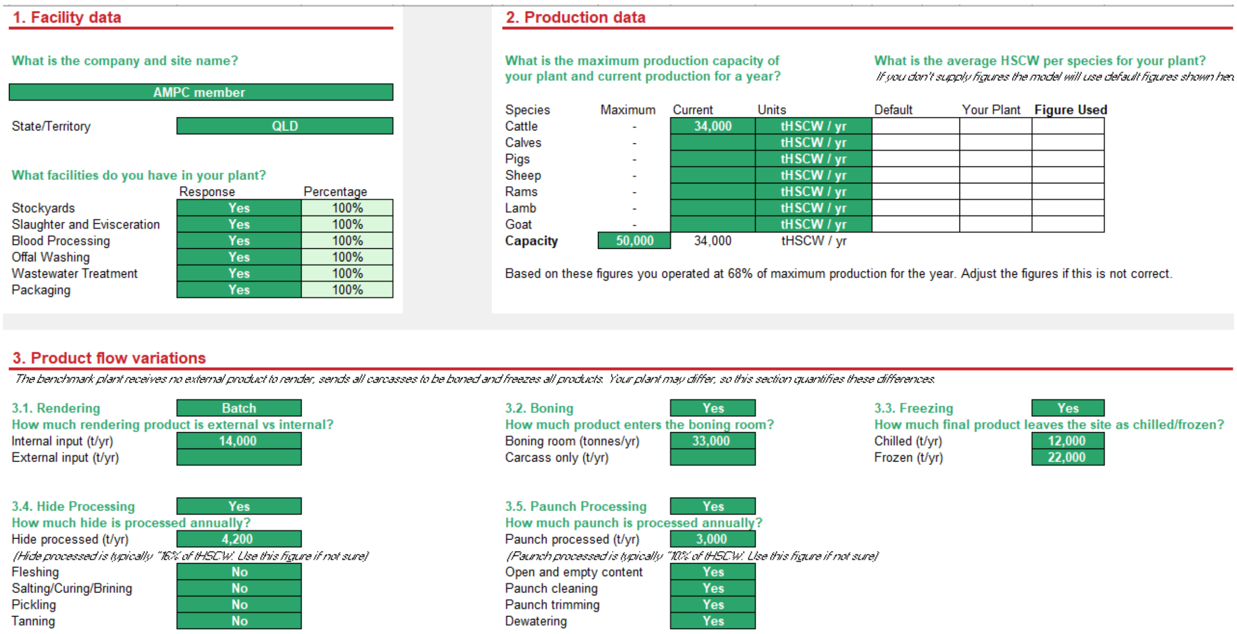


Figure 1 Benchmark rating

[4] Assessing the Costs and Benefits of the Superior Energy Performance Program

The idealised model is based on the best practice found for each major process unit within a red meat processing plant. This model assigns a percentage of total electricity, thermal and water consumption to each major process in the plant. The facility data (see Figure 2) is broken into processing units of stockyards, slaughter and evisceration, blood processing, offal washing, wastewater treatment and packaging. Other processes including rendering, hide processing, boning room, paunch processing and freezing and chilling are treated separately due the potential variations in process flow through these units.



1. Facility data

What is the company and site name?

AMPC member

State/Territory	QLD	

What facilities do you have in your plant?

	Response	Percentage
Stockyards	Yes	100%
Slaughter and Evisceration	Yes	100%
Blood Processing	Yes	100%
Offal Washing	Yes	100%
Wastewater Treatment	Yes	100%
Packaging	Yes	100%

2. Production data

What is the maximum production capacity of your plant and current production for a year?

What is the average HSCW per species for your plant?

If you don't supply figures the model will use default figures shown her

Species	Maximum	Current	Units	Default	Your Plant	Figure Used
Cattle	-	34,000	tHSCW / yr			
Calves	-		tHSCW / yr			
Pigs	-		tHSCW / yr			
Sheep	-		tHSCW / yr			
Rams	-		tHSCW / yr			
Lamb	-		tHSCW / yr			
Goat	-		tHSCW / yr			
Capacity	50,000	34,000	tHSCW / yr			

Based on these figures you operated at 68% of maximum production for the year. Adjust the figures if this is not correct.

3. Product flow variations

The benchmark plant receives no external product to render, sends all carcasses to be boned and freezes all products. Your plant may differ, so this section quantifies these differences.

3.1. Rendering: Batch

How much rendering product is external vs internal?

Internal input (t/yr)	14,000
External input (t/yr)	

3.2. Boning: Yes

How much product enters the boning room?

Boning room (tonnes/yr)	33,000
Carcass only (t/yr)	

3.3. Freezing: Yes

How much final product leaves the site as chilled/frozen?

Chilled (t/yr)	12,000
Frozen (t/yr)	22,000

3.4. Hide Processing: Yes

How much hide is processed annually?

Hide processed (t/yr)	4,200

(Hide processed is typically ~16% of tHSCW. Use this figure if not sure)

Fleshing	No
Salting/Curing/Brining	No
Pickling	No
Tanning	No

3.5. Paunch Processing: Yes

How much paunch is processed annually?

Paunch processed (t/yr)	3,000

(Paunch processed is typically ~10% of tHSCW. Use this figure if not sure)

Open and empty content	Yes
Paunch cleaning	Yes
Paunch trimming	Yes
Dewatering	Yes

Figure 2 Facility, production and product variations data entry screen

The benchmark rating (good, fair, and poor) is calculated based on the number of processes included in the site and the variations of process. The model includes adjustment factors for:

- Production capacity – A plant operating at reduced production will have a higher energy and water intensity than a plant operating at 100% capacity due to the base loads of boilers and other equipment. If the plant is operating at lower than 100% capacity, a weighting factor is applied to increase the benchmark ratings.
- Process content – each process unit is assigned a percentage of the total energy and water use. If a site does not have a particular process unit, then the energy and water use is not assigned to this unit.
- Rendering or non-rendering – thermal energy use in a rendering plant can be as much as 70% of total site thermal energy use. If the site does not have rendering than a separate thermal energy model is used to distribute the thermal energy to each process.
- Chilled and Frozen – electricity intensity is adjusted to allow for additional energy required to freeze products.

6.2 Efficiency culture

Efficiency culture change takes many years to embed into an organisation, the first few diagnostics conducted during this project have provided a glimpse of the level of maturity of management systems in AMPC member sites. A review of One2Five star ratings for energy and water (over the last 10 years) indicates that most businesses start at a 1-to-2-star rating (see Figure 3 and 4) and it takes some time to progress to 4- and 5-star ratings, if at all. This is an important point to make, the level of maturity does not need to be 5-star. A 3-to-4-star rating may be the right level of maturity for your business.

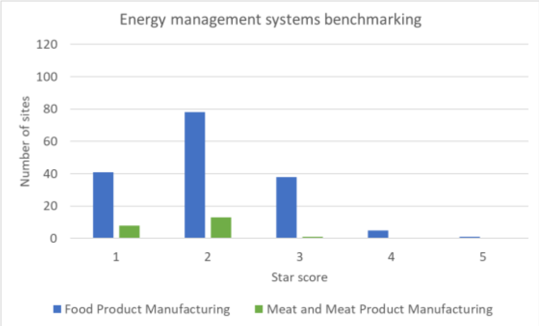


Figure 3 One2Five energy star rating for food industry

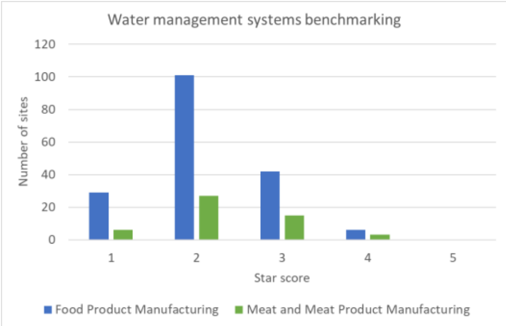


Figure 4 One2Five water rating for food industry

Most of the AMPC members have experience in developing and maintaining management systems for Quality Assurance (QA) and Safety. The structure and key elements of an effective management system for energy and water are very similar. There is a need for strong leadership and governance, plans and targets, data and information and an on-going review and update to achieve best practice results. An energy or water management system needs to become an integral part of the business systems and practices so that it is business as usual. This is achieved by integrating energy management practices into current systems such as including an energy efficiency assessment to capital expenditure forms and adding energy management to the agenda of weekly operation meetings.

Another important benefit of strong management systems is that energy efficiency and process optimisation are implemented as first actions/projects because they provide the best paybacks. It is important to reduce energy use as much as possible before the transition to renewable energy sources and technologies. Energy efficiency improvements have paybacks from under 1 to 3 years in most cases whereas the decarbonisation technologies such as solar PV and heat pumps have paybacks more than 5 years in many cases. For example: If 10% energy savings are achieved due to improved management and good housekeeping, the cost of a new biomass boiler could be 10% less than one purchased before the improvements thanks to a reduced capacity requirement. As AMPC members start the decarbonisation journey, the key starting point is to optimise energy use in the current equipment and processes and then consider the next steps to decarbonisation. This is further explored in the decarbonisation pathway update project (2023-1004)

A review of the most frequent critical actions from the five diagnostics (see Appendix 10.4) shows the top three actions needed are awareness and training, planning and operating practices. Support for these actions could include encouraging members to attend energy management training courses which are suitable for engineers and business professionals (see Appendix 9.10). Further support for planning and operating practices can be found in previously developed AMPC energy management planning guidelines and technology guidelines for key processes and equipment such as boilers, refrigeration, and compressed air. However, there may be a need to update these guidelines before release.

6.3 Best Practice case study Nolan Meats

To test the hypothesis that good management systems achieve good benchmarking results, the star ratings, % score and energy and water intensities were compared for each AMPC member (see Appendix 9.8). Nolan Meats (Site 1 in Appendix 9.8) achieved a 4-star One2Five express energy rating and is among the best energy intensity and is the best water intensity benchmark for all participating AMPC members (see Site 3 in Appendix 9.1). This shows there is alignment between good performance and strong management systems.

The following case study provides an overview of the management systems, and technology and process improvements implemented by Nolan Meats to achieve Best Practice.

6.3.1 Best practice example for high water & energy efficiency red meat processing plant

Facility description

- Beef processor operated at 45% capacity during FY 2022
- medium sized plant,
- operation included rendering, 60% of product frozen and remainder chilled, chilled hide processing,
- 85% town water supply & 15% bore, 15% water re-use.

Plant Performance

Water Intensity	Energy Intensity	Emissions Intensity
3.8 kL / t HSCW	1171 MJ / t HSCW, thermal	Scope 1. 61 kg CO2e / t HSCW
	312 kWh / t HSCW, electrical	Scope 2. 252 kg CO2e / t HSCW
	2295 MJ / t HSCW, total energy	

Management & Controls

Communication	Plant signage around turn-off / on procedures. Plant news around efficiency project objectives and achievements.
People	Efficiency team (i.e. senior manager, plant engineer, sustainability manager, and asset maintenance) have written responsibilities for energy & water efficiency.
Schedule checks	Systematic maintenance schedule and review.
Measurement & planning	Sub-metering & monitoring with periodic trending reviews by efficiency team. Supplier contracts reviewed and negotiated periodically.
Targets	SMART targets set by team for efficiency outcomes. Recognition for achievement / or learning outcomes for under-achievement.
Asset modelling	Lifetime efficiency modelling is conducted on major assets to understand lifecycle comparisons across water & energy consumption, maintenance, and capital costs.
Management buy-in	Senior management project approval process is well understood and prioritised for efficiency projects.
Innovation	Planning now in place by team for renewables (solar) and bioenergy investments (biogas / biomass) after all efficiency projects have achieved targets with MV&R.

Technology & Process

Thermal efficiency	• oxygen trimming for boiler • economiser on boiler • condensate recovery and de-aerator for condensate • HEX for HW production • scanning procedure and analysis for thermal energy & boiler losses
Electrical efficiency	• staging for compressors and engines • VSD controls on lead compressors and engines • refrigeration VHPC

	• LED lighting
Water / Energy nexus	• motion activated sprays for handwash, sterilizers and viscera table • boiler optimisations have also improved water efficiency

Management systems diagnostic results

One2Five Express Energy benchmarking results for meat processing show Nolan Meats with a 4 stars rating is in the top ratings out of 25 meat processing plants from several countries over the last 20 years (see Figure 5).

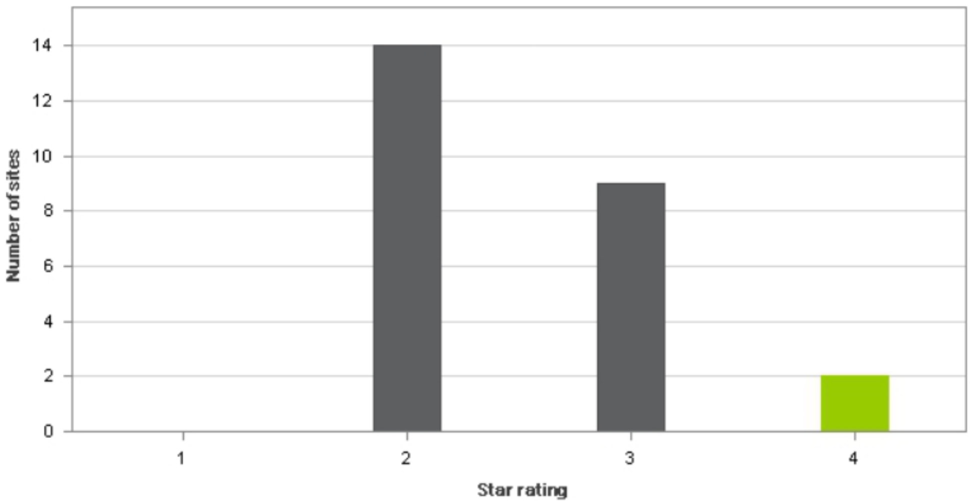


Figure 5 Meat processing One2Five Express Energy star ratings

7.0 Conclusions / Recommendations

- The benchmarking sessions, workbooks and the reports were well received by members. The benchmarking project has become a standard way of measuring energy and water performance which is used by members to help gauge how well they are improving performance. The benefits of the benchmarking workbook and sessions are:
  - Raised levels of awareness in new technologies, renewable energy options and electrification.
  - Comparison of benchmark results with 2020 benchmarking project allowed members to see how well they have progressed or not.
  - For those members with multiple sites, comparison of benchmarking results helps to build collaboration between sites where learnings from a good performer can be transferred to less advanced sites.
- AMPC members continue to implement a wide range of energy and water efficiency projects and recently heat pumps have become strong interest for many sites due to the technology becoming more widely available, volatile energy costs and the need for decarbonisation. The ARENA part-funded demonstration Hardwick Meats heat pump, solar PV and battery project provides excellent implementation reports which will help AMPC members to manage the challenges and reap the benefits of heat pump, battery, and solar PV projects.
- Data quality is highly variable. We suggest that the EPR data collection workbook is updated to include basic data checks and range checks which could be drawn from previous EPR data workbooks. For example – a

previous production value shows 50,000 tHSCW however the latest data shows 45,500,000 (This may be a value in kgHSCW). A range check would show "out of range". Also, it may be better to include the EPR project with the benchmarking and management systems projects to eliminate the rework of data and streamline the reporting process.

- There needs to be a stronger focus on efficiency of energy and water use to reduce the energy, water and carbon footprint before alternative energy systems are installed.
- The highly volatile prices in the electricity, natural gas, coal, and fuel supplies across Australia are improving the business case for energy efficiency.
- The benchmarking project provides a preliminary assessment of the level of savings and types of opportunities required to improve performance. The identification of energy savings is also an important part of the development of the decarbonisation pathway for each AMPC member. Further details of the decarbonisation pathway options are available in project 2023-1004.
- Further development of an efficiency culture in the RMP may provide an important part of the on-going management of energy and decarbonisation projects. An effective management system will provide cost savings, reduce capital and resource costs foe energy management and help build a sustainable result.
- It is recommended that previously developed AMPC energy management planning guidelines and technology guidelines for key processes and equipment such as boilers, refrigeration, and compressed air are updated before release.
- It is recommended that further programs to explore efficiency culture development including the use of managment system diagnostics, and training for energy management systems (EnMS) be included in future AMPC projects.
- Benchmarking workbook updates identified during the benchmarking sessions were:
    - Include an explanation of the benchmark modelling to explain how the rating scales vary for each type of site. This was raised by several members during the benchmarking workshops. The explanation is that the benchmarking modelling includes rating scale adjustments to allow for lower than 100% production capacity, and the number of processes used on the site.
    - Include fellmongering in hide processing – this a significant thermal energy use in sheep hide processing for removal of wool.
    - Include frozen offal in product output (not tracked as HSCW and not shown previously).
    - Non-rendering plant energy balance correction was implemented during the benchmarking sessions.
    - Update best practice modelling using best performers in 2022 and 2020 (previous base was 2019).
    - Introduce a new rating for "best practice" above the "good" rating.
    - Update carbon emissions calculations to include site fugitive emissions such methane from anaerobic ponds and refrigerants losses (see NGER guidelines for refrigerants and methane released from wastewater handling (industrial)), (see Bibliography).

8.0 Bibliography

The author should include all references used in the report or referred to for background information. This must be done using the Harvard Referencing Style Guide.

ARENA, 2023, Hardwick Meat heat pump Installation and Power Upgrade Demonstration, viewed 27th June 2023 - <Hardwick Meatworks Heat Pump Installation and Power Upgrade Demonstration - Australian Renewable Energy Agency (ARENA)>

Clean Energy Regulator, National Greenhouse and Energy Reporting (NGER) guidelines, viewed 27th June 2023 - <NGER Technical Guidelines 2017-18 (cleanenergyregulator.gov.au)>

Department of Climate Change, Energy, the Environment and water, February 2023, Australian National Greenhouse Accounts Factors, < Australian National Greenhouse Accounts Factors (dcceew.gov.au)>

Energy efficiency and Conservation Authority New Zealand (EECA), MVR (Mechanical Vapour Recompression) Systems for Evaporation, Distillation and Drying, viewed 1 September 2023, <Mechanical-vapour-recompression-for-evaporation-distillation-drying.pdf (genless.govt.nz)>

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RACE2030, 2023, Techno-economic feasibility study of Mechanical Vapour Recompression for improving Energy Efficiency in Meat Rendering, viewed 28th June 2023 - <Techno-economic feasibility study of Mechanical Vapour Recompression for improving Energy Efficiency in Meat Rendering - RACE for 2030>

9.0 Appendices

9.1 Summary of benchmarking results

Site No:	Thermal intensity (MJ/tHSCW)	Electrical intensity (kWh/tHSCW)	Energy intensity (kWh/tHSCW)	Water intensity (kL/tHSCW)	Thermal benchmark rating	Electricity benchmark rating	Water benchmark rating
1*	934	273	1,917	5.8	good	good	good
2	2,364	577	4,441	6.2	fair	good	good
3	1,171	312	2,294	3.8	good	good	good
4	1,497	244	2,375	8.0	fair	good	good
5	2,636	282	3,651	16.3	good	good	fair
6	1,825	255	2,743	8.7	good	good	good
7	2,687	258	3,616	11.7	poor	good	good
8	2,675	422	4,194	8.9	fair	fair	good
9	2,692	424	4,218	7.8	good	fair	good
10	2,269	255	3,187	7.3	good	good	good
11	2,909	290	3,953	8.8	fair	good	good
12	2,113	332	3,308	7.5	fair	good	good
13*	1,383	302	2,470	7.0	good	good	good
14	3,347	306	4,449	9.6	good	good	good
15	1,550	372	2,889	6.9	good	good	good
16*	2,293	245	3,175	14.9	good	good	fair
17*	929	169	1,537	3.9	good	good	good
18	2,788	278	3,789	9.3	good	good	good
19*	791	254	1,705	5.4	good	good	good
20	1,894	275	2,884	6.5	fair	good	good
21	3,701	380	5,069	10.6	good	fair	good
22	3,668	388	5,065	11.6	fair	good	good
Average (fair)	2,187	313	3,315	8.5	7	3	2
Maximum (poor)	3,701	577	5,065	16.3	1	0	0
Minimum (good)	791	169	1,705	3.8	14 (63%)	19 (86%)	20 (91%)

*non-rendering plants

9.2 Summary of carbon intensity results

Site no:	Scope 1* (Fossil fuel) carbon emissions intensity ($kgCO_2e/tHSCW$)	Scope 2 (electricity) carbon emissions intensity ($kgCO_2e/tHSCW$)	Scope 1 & 2 (energy use) carbon emissions intensity ($kgCO_2e/tHSCW$)
1	49	250	299
2	20	392	412
3	61	253	314
4	78	239	317
5	115	192	307
6	94	206	300
7	198	111	309
8	138	414	552
9	157	344	501
10	203	207	410
11	150	235	385
12	109	269	378
13	84	296	380
14	41	52	93
15	128	110	238
16	151	167	318
17	48	115	163
18	249	225	474
19	48	109	157
20	98	223	321
21	332	308	640
22	83	66	149
average	120	217	337

*Includes fuel combustion emissions but excludes site gas emissions such as methane (biogas) and refrigerant losses.

9.3 Summary of decarbonisation projects discussed in the benchmarking sessions.

Site no:	Solar PV	Battery	Biomass	Biogas	Heat pumps	Refriger-ation upgrades	Upgrade rendering	Heat recovery air comp	Cogen-eration	Replace old boiler
1	yes			yes	yes	yes				
2	yes	yes			yes					
3	yes	yes	yes		yes					
4	yes	yes	yes				yes			
5	yes	yes	yes							
6	yes		yes	yes						
7	yes			yes		yes				
8						yes	yes	yes		
9										
10	yes		yes	yes	yes	yes				
11	yes				yes	yes		yes		
12	yes	yes	yes	yes			yes		yes	
13	yes			yes	yes	yes				
14	yes	yes			yes	yes	yes			
15	yes					yes				
16			yes			yes				
17	yes			yes	yes			yes		yes
18	yes		yes		yes					
19	yes		yes							
20	yes			yes						
21	yes		yes		yes	yes				
22						yes		yes		
	18	**6**	**10**	**8**	**10**	**11**	**4**	**4**	**1**	**1**

9.4 Wastewater carbon emissions calculation (EPR 2022 report)

The following method was used in the EPR 2022 to calculate carbon emissions from wastewater treatment plants.

- GHG emissions from wastewater were calculated following the National Greenhouse and Energy Reporting (Measurement) Determination, Compilation No.14 dated 1/7/2022, specifically Part 5.4, pages 357-365.
- Insofar as possible, site-specific data were used, otherwise default values were used.
- This was not a life cycle assessment. Therefore, GHG emissions from wastewater treated offsite (e.g., discharge via sewer) were not included.
- COD of wastewater entering treatment plant (t) was calculated using site-specific data where possible by multiplying quantity of wastewater (ML/y) by COD of wastewater(mg/L). Where site-specific data for COD was unavailable, a default value of 6.1 kg/m3 was used (Table, p. 361), i.e., 6100 mg/L. Where BOD was reported, it was converted to COD using a factor 2.6 (Section 5.43, p.362).
- For the fraction of COD removed from wastewater as sludge, a factor of 0.15 was used, where relevant, in the absence of site-specific data.
- Where site-specific data were unavailable for % of COD remaining in treated wastewater an average value of 6.76% was used, being the average obtained from sites that did report.
- The IPCC default methane correction factors were used (p.360).
- Methane captured (m3) was converted to CO2e using factor 0.0006784 x 28 (IPCC AR5)
- For flared biogas, energy content 0.0377 GJ/m3 and emission factor 6.43 kg CO2e/GJ

The above information was provided by CSIRO.

A similar method is proposed to be added to the energy and water benchmark tool.

9.5 National Greenhouse Accounts Factors for grid electricity

This table is a copy of the grid electricity carbon emission factors from the 2022 National Greenhouse Accounts Factors report.

Table 1 Indirect (Scope 2 and Scope 3) emissions from consumption of purchased electricity from a grid

State, Territory or grid description	Scope 2 Emission Factors		Scope 3 Emission Factors	
	kg CO_2-e/kWh	kg CO_2-e/GJ	kg CO_2-e/kWh	kg CO_2-e/GJ
New South Wales and Australian Capital Territory	0.73	202	0.06	15
Victoria	0.85	238	0.07	20
Queensland	0.73	202	0.15	41
South Australia	0.25	72	0.08	23
Western Australia - South West Interconnected System (SWIS)	0.51	164	0.04	12
Tasmania	0.17	47	0.01	3
Northern territory - Darwin Katherine Interconnected System (DKIS)	0.54	152	0.07	19
Western Australia - North Western Interconnected System (NWIS)	0.58	160	NE	NE
National	0.68	189	0.09	25

Sources: Primary data sources comprise National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Schedule 1), Australian Energy Statistics, Clean Energy Regulator, and AEMO data and Department of Climate Change, Energy, the Environment and Water.

Notes:

- Data are for financial years ending in June.
- An adjustment has been made to include methane emissions from hydro dams. This adjustment impacts Tasmania and the Snowy Hydro (NSW and VIC).
- For the purposes of calculating electricity emission factors, all small scale solar generation is assumed to be exported to the grid.
- Depending on the intended use, the publication of these revised factors does not necessarily imply any need to revise past estimates of emissions. Previously published emission factor estimates available in previous NGA Factors Workbooks.
- NE = not estimated. No data available to support the provision for a scope 3 factor for this grid.
- For further information see Appendix 4 Methodology for calculating electricity

9.6 One2Five Express Energy star ratings

One2five calculates the overall star rating based on the level of development for each element shown in Appendix 10.2.

One2Five Express Energy Star rating	Star Rating description
4	Your organisation has developed formal systems for energy management
3	Your organisation has made substantial progress in developing processes for energy management
2	Your organisation has started to address energy management
1	Your organisation has yet to address the management of energy

9.7 One2Five Express Energy diagnostic elements

One2Five Express Energy provides a series of questions to test the level of development for the following 15 elements of the management system.

Element	Element description
Leadership	A feature of every successful management program is commitment and leadership from top management.
Accountabilities	Accountabilities assesses whether you have the right people accountable for managing energy costs and the extent to which they can act.
Awareness and Training	Awareness activities and training examines the way people in the organisation are supported and motivated to drive energy efficiency improvements.
Understanding of Savings Opportunities	Understanding your energy saving opportunities enables you to target your investments.
Planning	Effective planning for energy management progresses effectively with your business plans.
Targets and KPIs	Establishing relevant performance targets and key performance indicators (KPIs), and in establishing action plans to meet these targets.
Budgets and purchasing	Budgets are an effective way to track and manage energy costs. Budgeting processes exist within businesses and provide a cost-effective management tool.
Energy Load Management	Energy supply evaluates your understanding of issues that affect the quality and reliability of your energy supply.

Energy Supply	Evaluates the effectiveness of processes to minimise supply costs for energy for the best overall business outcomes.
Operating Procedures	Operating procedures evaluates the development and application of standard operating procedures and work instructions for energy-intensive equipment.
Maintenance Procedures	Maintenance procedures examines practices to minimise energy wastage, maintain high energy efficiency of equipment and manage waste energy as part of normal business practice.
Innovation	Innovation examines the effectiveness of systems for ensuring that you achieve energy-efficient outcomes whenever you get the chance to design/purchase/repair plant or equipment.
Metering and Monitoring	This element evaluates how well you can measure and track the use of energy and identify variances from target levels.
Reporting Systems	The best way to design effective reporting and feedback systems is to make sure accountabilities are correctly established and engage the operations people using the information to design their own reports.
Achievement	Achievement evaluates the actual performance in achieving measurable results in energy efficiency. Outcomes are compared to targets.

9.8 Summary of star ratings and performance indicators

AMPC member	One2Five express energy Star rating	% score	Thermal intensity (MJ/tHSCW)	Electrical intensity (kWh/tHSCW)	Water intensity (kL/tHSCW)
1	4	88%	1,171	312	3.8
2*	3	64%	929	169	3.9
3	2	40%	2,364	577	6.2
4	2	35%	1,497	244	8.0
5	2	29%	1,550	372	6.9

*Non rendering

9.9 Critical actions summary

Action	Frequency	Key Element	Action descriptions
4.2	5	Awareness and training	Regularly advise staff of practical opportunities to reduce energy costs (including your energy rate structure).
3.2	4	Planning	Incorporate energy cost reductions in overall cost saving targets for your business.
7.1	4	Operating practices	Ensure your staff turn off equipment when not needed (e.g., during breaks, after hours, weekends). Confirm that they have the valves/switches in place to turn off supply to key areas.
2.1	3	Understanding of saving opportunities	Conduct a review to identify opportunities to reduce energy costs with minimal capital investment.
9.2	2	Reporting systems	Develop a process to routinely report on relevant energy consumption for your business (e.g. monthly energy consumption report to management and/or on staff notice board).
1.1	1	Leadership	Convince your owner/plant manager of the need to tell key staff that the business is to reduce energy costs.
4.1	1	Accountabilities	Assign at least one person in your business responsibility for reviewing monthly/quarterly energy bills prior to payment.
5.1	1	Budgets and purchasing	Treat energy projects on their merits and use the same investment criteria (e.g. financial hurdle rate or IRR) as for other investments.
8.1	1	Innovation	Conduct sessions with your staff to seek out practical ideas and innovative approaches to improve energy efficiency (e.g. in staff meetings/workshops).
9.1	1	Metering and monitoring	Record your overall monthly or quarterly energy costs and/or consumption.

9.10 Energy management training courses

Training course		Details
CEM	Certified Energy Manager	This program helps educate and qualify individuals involved in optimising the use of energy in buildings and industrial systems. By obtaining the CEM certification, candidates gain industry and peer recognition by demonstrating their understanding of energy-efficiency principles, practices, and technologies. The program raises the professional standards, both technical and ethical, of those engaged in energy efficiency and energy management.
CMVP/PMVA	Certified Measurement and Verification Professional or Performance Measurement and Verification Analyst	Professional certification establishes the primary standard for individuals applying performance, measurement, and verification concepts to energy efficiency projects.
Energy auditing	ASNZS 3598 standard training	The program is practical and hands-on, using workshops and group exercises to lead participants through the process of delivering an Australian Standard compliant energy audit relating to: • 3598.1 Energy Audits - Commercial buildings; and • 3598.2 Energy Audits - Industrial and related activities.
EnMS Advisor	Energy Management Systems (EnMS) Advisor Certification	The Certified EnMS Advisor utilises the EnMS Advisor training course to support energy and related services professionals with gaining the requisite knowledge to successfully pass the assessment and support businesses with establishing and maintaining EnMS. An EnMS integrates an energy management framework into existing business systems, enabling businesses to understand their energy use and implement a strategic approach to energy management.

The Energy Efficiency Council (EEC) provides all of these courses.