

AMPC Energy and Water Benchmarking

Emissions, Energy & Water intensity benchmarking, improvement workshops, and the development of community trust through evidence-based case studies and an efficiency culture

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1.0 Abstract

The Energy and Water Benchmarking project was undertaken to help Australian meat processors improve energy and water efficiency, reduce emissions, and prepare for future climate reporting requirements. Benchmarking performance and hosting energy, water, and emissions-focused discussions across multiple facilities highlighted key trends, as well as opportunities for cost savings and sustainability improvements, addressing the industry's need for practical and actionable insights.

The project involved hosting 33 virtual benchmarking sessions with 34 participating members, supported by individually tailored reports. Several case studies were developed from the literature review and member discussions. Data was collected, validated, and analysed to ensure accuracy, and feedback from members was incorporated to refine AMPC's Energy and Water Benchmarking tool and workshop materials.

Key results include improved benchmarking tools, case studies showcasing best practices, and tailored reports. Members received insights into their performance and priority improvement opportunities, supported by practical recommendations.

Participating members were given access to reliable benchmarking tool and data, relevant opportunity recommendations for reducing energy and water use, emissions reduction and guidance for ASRS compliance. These outcomes support cost efficiency, environmental performance, and long-term competitiveness for Australian meat processors.

2.0 Executive summary

AMPC's objectives of hosting energy and water benchmarking sessions are to support red meat processors in improving resource efficiency, and reducing emissions. The project, delivered by ERM Energetics, was structured in three stages: a literature review, an update to the benchmarking tool, and the delivery of one-on-one benchmarking workshops with AMPC members.

The literature review identified best practice case studies and success factors for fostering an efficiency culture. These insights informed enhancements to the benchmarking tool, including new resource-saving opportunities, updated emissions factors, and improved rating systems.

By the end of the project, 33 benchmarking workshops were conducted with 34 sites, resulting in a tailored report for each participant, and several case studies. The sessions revealed increased adoption of energy and water efficiency technologies, growing interest in biogas and heat recovery systems, and highlighted the importance of cultural change in achieving sustainable outcomes.

Key findings include:

- Slight improvement in energy and water performance since FY20, with gains in electrical and water efficiency
- Thermal performance remains a challenge, partly due to legacy systems (e.g., coal-fired boilers)
- Significant variability in emissions intensities, influenced by wastewater treatment methods and fuel types.
- Stronger engagement from members with prior benchmarking experience and those seeking to understand their performance relative to peers.

AMPC is recommended to promote best practice case studies, enhance cultural change initiatives, and refine data collection processes. These actions will help AMPC members build a robust resource efficiency culture and meet emerging climate reporting requirements.

3.0 Introduction

The project consisted of four stages:

- 1st stage – literature review to develop evidence-based case studies for plant best practice / high performers, including the latest best practice emissions, energy and water improvement opportunities
- 2nd stage - update the benchmarking tool to include outcomes of the literature review and address changes proposed in 2023
- 3rd stage - participant emissions, energy and water benchmarking tool preparation and review, with plant recommendations and performance improvement workshops
- 4th stage – recruitment of top 3 plant performers for an ASRS Readiness Assessment and assessment & development of a top-down efficiency culture process using Energetics' energy management systems diagnostics tools.

Stage 1: Literature review

The scope of this stage was to provide a summary of the literature review on case studies that include examples of best practice energy and water efficiency projects, and the success factors supporting the development of an efficiency culture.

The benefits of this research included:

- Prepared the material for AMPC member workshops,
- Informed, educate, and inspire AMPC members on best practice opportunities with proven results across the industry, and help identify if they are suitable for their businesses,
- Informed the benchmarking tool update in Stage 2 with new resource efficiency and decarbonisation opportunities,
- Demonstrated evidence of key success factors for embedding a resource efficiency culture in meat processing businesses,
- Understood AMPC member goals and priorities in sustainability and identify barriers to implementing a resource efficiency culture.

Stage 2: Benchmarking tool update

The scope of this stage was to provide an updated energy and water benchmarking tool, incorporating the findings and recommendations from the benchmarking sessions with AMPC members in 2023, as well as the result of the literature review conducted in Milestone 1.

The following updates were implemented:

- Updating the library of resource saving opportunities, with the addition of 10 new opportunities. The opportunity selection logic was also improved to ensure results are more relevant for members.
- Introducing a new rating “Best Practice” above the “Good” rating, based on the best performers in 2022 and 2023
- Adding rating system scale explanation
- Adding fugitive emissions sources (refrigeration system and wastewater treatment)
- Including fellmonger in hide processing (for sheep hide processing for the removal of wool)
- Including frozen offal in product output
- Update emissions factors

Stage 3: Energy and water benchmarking sessions

The scope of this stage included:

- prepare and finalise the presentation material, with improvements from engaging with AMPC members in the earlier sessions. The key improvement was to shift the focus of the workshop discussions to the benchmarking results and priority improvement opportunities.
- manage, schedule, and complete 35 x 1:1 Benchmarking workshops with individual reports
- collaborate with members to address missing or inaccurate data, ensuring more reliable ratings and report insights
- develop three case studies from benchmarking workshop insights
- deliver a single pack of all benchmarking tools and reports as delivered to the 34 participating members
- prepare presentation material to provide overview on mandatory climate reporting requirements for the industry, discuss findings from the members' ASRS Readiness Assessment results, and develop a list of management systems diagnostic questions.

Stage 4: Energy and water benchmarking sessions enhancement

This stage was repurposed from hosting ASRS Readiness Assessment sessions for the top performers, to enhancing the quality of the benchmarking sessions and delivering additional value for participants.

The following enhancements and deliverables were completed:

- Energy and Water Benchmarking Tool refinement.
- Presentation material improvement
- Data accuracy support
- Specific-member summary report
- Case study development
- Tool and report consolidation
- ARSR readiness assessment material preparation.

4.0 Project objectives

The key objective of this project is to help AMPC members develop a resource efficiency culture and reduce emissions by benchmarking their performance, providing expert advice on relevant improvement opportunities, as well as educating senior managers on the benefits of a management systems approach and key success factors.

This can be achieved by:

- **Research and knowledge building:** Research publicly available resources to find:
 - exemplar emissions, energy and water efficiency improvement projects, and
 - evidence for sustainable results achieved by the development of an efficiency culture.
- **Hosting individual workshop:** Provide individually tailored improvement workshops to 2024 Environmental Performance Report (EPR) respondents using the emissions, energy and water benchmarking tool and expert advice.
- **Providing education and support:** Support the selected members to:
 - understand the relevant measures to improve their performance, and
 - identify key cultural elements needed to develop and enhance an efficiency culture.
- **Offering the latest market update:** Provide guidance on latest mandatory climate related financial disclosure requirements. Share resource management insights and build community trust through transparent evidence-based case studies.

5.0 Methodology

Stage 1: Literature review

Literature review and desktop research was conducted to:

- find the latest case studies and examples of emissions, energy, and water efficiency improvement projects implemented by red meat processing plants in Australia
- identify the success factors that will support the development of an efficiency culture at red meat processing plants

These findings were then tested, and additional information gathered via one on one engagement with selected AMPC members. However, no member responded to the invitation to verify the findings.

Stage 2: Benchmarking tool update

The updates were implemented in AMPC's Energy and Water Benchmarking tool (except for the rating system scale explanation, which will be added to the presentation slides).

Stage 3: Energy and water benchmarking sessions

All members who participated in the FY 2024 Environmental Performance Review (EPR) were invited to attend an energy and water intensity benchmarking workshop delivered by ERM Energetics. In total 34 sites indicated a desire

to participate in the workshops and consent to their EPR data being supplied to ERM Energetics. 33 workshops were ultimately held with AMPC members from April to May 2025. The following methodology was applied:

1. For those AMPC members indicated a desire to participate, a copy of the Energy and Water Benchmarking Tool was populated with EPR data. This involved checking the data quality and accuracy.
2. Online meetings with member site representatives were held via MS Teams to discuss the benchmarking tool results and explore relevant opportunities for improving resource efficiency.
3. Each member received a summary report of the meeting outlining the benchmarking results and suggested opportunities for improvement, as well as a copy of the populated tool, and a copy of the presentation material used during the session.

During the delivery of the Benchmarking sessions, some minor improvements and updates to the Benchmarking tools were identified. Some of them were implemented as a part of this stage, and the most updated version of the tool was delivered to all participating members.

Stage 4: Energy and water benchmarking sessions enhancement

This work was carried out in collaboration with AMPC and incorporated feedback from members in earlier sessions to ensure the information presented was relevant, practical, and beneficial for participants.

6.0 Results

Engagement with AMPC members

Members of AMPC who took part in the Environmental Performance Report (EPR) project were invited to engage in the Energy and Water Benchmarking Workshops organized by ERM. Out of the 43 EPR participants, 35 expressed their interest in joining the Energy and Water Benchmarking Project. ERM reached out to these 35 members to confirm their involvement and arrange the workshops, resulting in a total of 33 workshops being conducted (one workshop combined two related member processing sites, while one was cancelled due to scheduling conflicts). ERM Energetics implemented a flexible and proactive communication strategy to accommodate all participants, even as some sessions required rescheduling due to availability issues.

In total, 101 personnel from plants and corporate offices participated in the benchmarking workshops, reflecting a substantial level of engagement with AMPC members. Each participating member attended a 1-hour virtual session, which provided dedicated time to review benchmarking outcomes and explore improvement opportunities.

Following the sessions, 34 members received a customised report summarizing key discussion points and identified opportunities. These reports act as a practical reference for monitoring performance, implementing recommendations, and planning future actions, ensuring that members derive enduring benefits from the process. The one member, for which a workshop could not be scheduled, received a copy of the Benchmarking Tool prefilled with their data to allow them to visualise their energy and water performance results.

Ongoing communication through emails and phone calls was maintained before and after the sessions to confirm details, clarify data, and address any gaps in the EPR. This collaborative method ensured the accuracy and relevance of benchmarking results, allowing members to pinpoint significant areas for enhancement. In total, around 40 hours were dedicated to discussions with member representatives outside of the sessions and individual reports, culminating in over 74 hours of engagement throughout the project.

FY24 intensity results

Thermal intensities range from 288 MJ/tHSCW to 10,546 MJ/tHSCW, with a median intensity of 2,074 MJ/tHSCW. The thermal intensity for non-rendering plants ranged from 288 MJ/tHSCW to 3,575 MJ/tHSCW and the rendering plants thermal intensity range from 1,066 MJ/tHSCW to 10,546 MJ/tHSCW (see Appendix 1 and Figure 1).

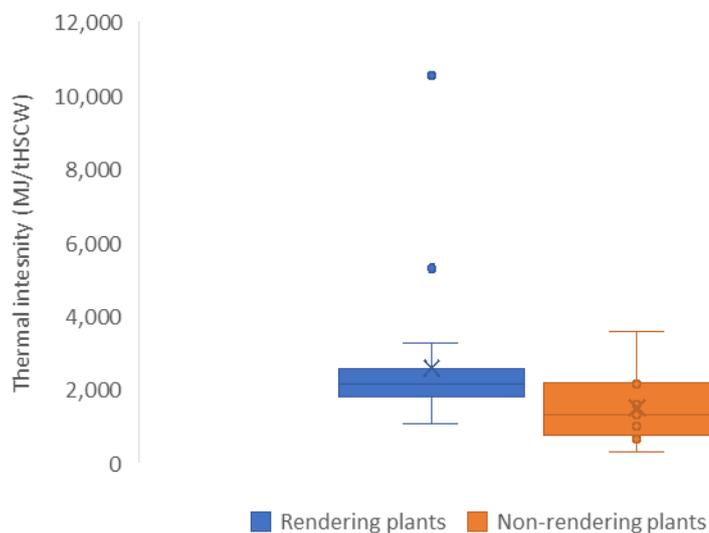


Figure 1: Thermal intensity for rendering and non-rendering plants

Electrical intensities ranged from 152 kWh/tHSCW to 852 kWh/tHSCW with a median intensity of 264 kWh/tHSCW.

Water intensity ratings vary from a minimum of 2.6 kL/tHSCW to a maximum of 21.6 kL/tHSCW. The median water intensity was found to be 7.2 kL/tHSCW.

The carbon intensity of sites varied widely as can be observed in Appendix 2. Scope 1 emissions intensity varied from 15 kgCO₂-e/tHSCW to 611 kgCO₂-e/tHSCW with a median intensity of 164 kgCO₂-e/tHSCW. Scope 1 emissions varied dramatically depending upon the wastewater treatment system at each facility, and was also affected by whether the site had rendering or not and fuel choice for process heating. This is illustrated in Figure 2 below. Scope 2 emissions ranged from zero at Midfield Meats who are procuring 100% renewable electricity via PPA to 310 kgCO₂-e/tHSCW. Combined scope 1 and 2 emissions varied from 77 kgCO₂-e/tHSCW to 895 kgCO₂-e/tHSCW with a median intensity of 360 kgCO₂-e/tHSCW. The 2024 EPR report by CSIRO quoted 330 kgCO₂e / tHSCW as the industry average. This discrepancy was because not every member who participated in the EPR took part in the benchmarking sessions. The CSIRO also used the average number, not the median.

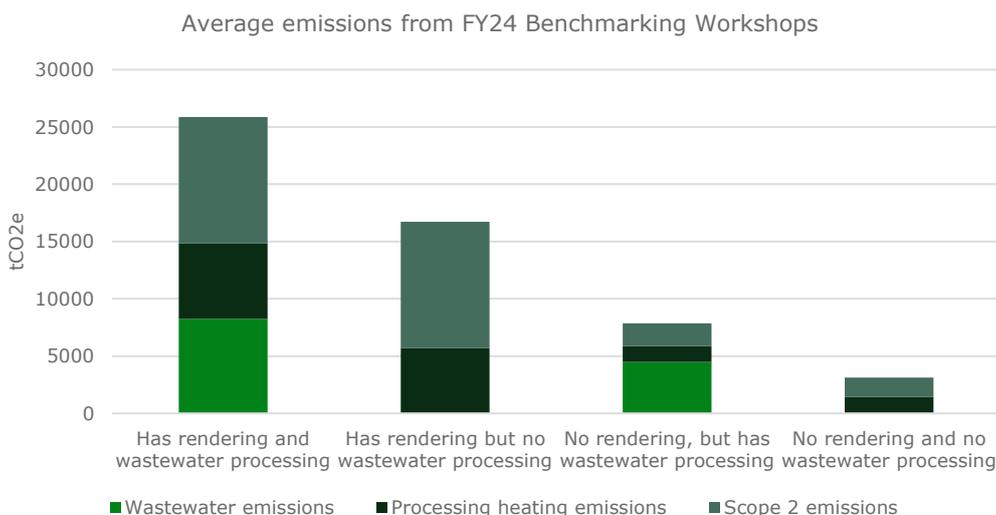


Figure 2: Average emissions by facility type for FY24 Benchmarking Workshops

Relevant resource efficiency and decarbonisation measures

During the workshops, ERM Energetics discussed a range of improvement measures which could apply to the site.

In general refrigeration systems have seen a significantly uplift in performance since previous years, with many sites reporting they had recently replaced Ammonia compressors, installed Variable Speed Drives (VSDs) to control compressor output, and adopted floating head pressure control to align the discharge pressures with the ambient wet bulb conditions for heat rejection in evaporative condensers. Improved sequencing and optimisation of refrigeration compressors was seen as an opportunity which had merit across several sites.

Water efficiency has been a significant focus of management efforts, with many sites adopting clear metering and monitoring of water performance in different areas of the plants and activities (e.g. processing floor, boning room, cleaning) and investment in water efficiency measures (e.g. centralised control of supplies to allow an operator to switch off supplies outside of shift times, bringing cleaning operations inhouse from contractors allowing greater control over water usage, and improved use of automated sensors to turn off water at stations when water isn't required). Many of these water efficiency measures applied equally to all sites and, in some cases, learnings from one site could easily be translated to other sites with good results.

Several plants were in the process of major rebuilds for rendering plant, with many looking at upgrading rendering cookers to higher efficient technologies, like indirect steam disc dryers, and improving heat recovery with new condensing economisers. Several sites had completed biogas capture and reuse projects, either via installation of new Covered Anaerobic Lagoons (CAL), repairs to old CALs, or installation of biogas trains to supply biogas to boilers for combustion. In most cases these projects involved replacement or upgraded of old gas fired boilers to allow co-firing with biogas. Installation of biogas capture and reuse via CAL installation were seen as a key action for many sites with wastewater processing, with several having it on the longer term capital plan or seeking head office approval for the investment.

Some sites, included best practice technology, such as heat recovery from wet rendering vessels using vacuum condensers, or adoption of econoliser sterilisation technology – spray sterilisers with inbuilt electric reheat elements to maintain temperature at sterilisation level.

Interest in and experience with heat pump technology was mixed, with many concerned that the technology wasn't sufficiently mature to replace traditional hot water generation via steam boilers or hot water generators. Additionally, those sites with rendering plants, did not see a case for adopting heat pump technology for hot water production, as they typically experienced a surplus of hot water generated off rendering heat recovery

Several sites still utilise thermal coal in steam boilers with no reported plans to replace. Whilst these sites noted that biomass represented the logical alternative, there were concerns about the capital cost associated with the technology and a lack of desire to disrupt highly reliable coal boilers for steam production.

Evidence based case studies for best performers

Following the benchmarking session workshops, ERM Energetics reviewed the results and feedback from the plant representatives to identify three processing facilities which warranted showcasing as a case study.

Case study 1 – Midfield Meats

Midfield Meats demonstrated strong performance, achieving best practice ratings for electrical and water intensity and a good rating for thermal energy. The facility's success is underpinned by a strong resource efficiency culture in upper management, as well as significant investment in energy and water efficiency improvements. Key initiatives include using geothermal water sources coupled with heat recovery, automated storage and retrieval system, extensive water metering and performance monitoring, and dry-cleaning practices. Midfield's commitment to decarbonisation is evident through its transition to 100% renewable electricity and strategic removal of cogeneration assets that didn't align with their net zero strategy.

Case Study 2 – G&K O'Connor

G&K O'Connor achieved best practice ratings for both thermal and electrical energy performance and a good rating for water efficiency. The site's achievements reflect a strong internal culture of resource efficiency, and a commitment to continuous improvement through strategic partnerships and innovation. This is evident by the ARENA-funded *Closing the Loop on Process Energy and Emissions* project. Notable initiatives include heat recovery systems, upgraded metering for energy and water, VEEC-generating electrical upgrades, LED lighting, and floating suction pressure controls in refrigeration evaporator fans. The facility has also installed a 1.25 MW solar system and developed a decarbonisation roadmap, with implementation now in progress.

Case Study 3 – JBS Rockhampton

JBS Rockhampton achieved a best practice rating for water consumption, complemented by good ratings for thermal and electrical energy. The site has implemented extensive water-saving measures, including solenoid valve-controlled water lines, centralised control of hand wash and sterilisers, extended metering, VSD control, and water recycling systems. Energy efficiency improvements include flash steam recovery from condensate return, boiler blowdown heat recovery, and VSD-controlled refrigeration compressors. Rockhampton is also exploring biomass boiler options to further decarbonise its operations, supporting attainment of its targets for renewable energy and emissions reduction.

Future improvements

Towards the end of the FY22 benchmarking exercise an error was discovered in the benchmarking tool which incorrectly calculated the thermal reference case for sites without rendering operations. This resulted in the sites receiving better thermal ratings than was the case. This is demonstrated by 9 of the 11 sites without rendering scoring a poor thermal energy rating in the FY24 workshops.

Early in the FY24 benchmarking an abundance of “best practice” ratings were being allocated, particularly for the electricity intensity component of the assessment. ERM Energetics addressed this by tightening the threshold for which a site would be awarded the best practice rating, with intensity values now being required to be 15% *better* than the reference case to be considered best practice. This reflected the large steps the industry has taken in improving energy and water performances in the last five year, meaning the original reference case data built into the Benchmarking Tool is becoming updated. In the next iteration of the project the underlying reference case should be updated using the latest industry energy and water usage data. This includes recognising structural differences between processing plants – those with value-add facilities and those without, and contract export facilities against volume facilities.

Tool improvement implemented during the benchmarking sessions:

- Adjustment of best practice rating (to at least 15% below the reference case)
- Fixing a bug that miscalculated the thermal reference case for facilities without rendering operations
- Adjusted the default case energy and water prices, as the previous values had been implemented in 2020
- Changed the grouping of some opportunities to recognise that cogeneration using natural gas has limited applicability in the context of a decarbonising electricity grid and high gas prices, and introduce electrification measures alongside “renewables”.
- Added a range suggestion for packaging percentage use based on facility output (retail ready, primal cuts, carcasses)

Potential improvements for future benchmarking exercises:

- Include in the EPR how much products is stored in the chillers / freezer in tonnes, instead of percentages. This recognises that the total product in cold storage may not be equal to the total tHSCW
- Consider incorporating indicative values for product and offal weights (e.g. similar to existing values for paunch and hide) in the benchmarking tool to support users with limited data availability.
- To streamline the user experience, certain tool inputs could be made optional or supported with default values. For example, packaging assumptions, assumed facility features, or wastewater treatment details for non-rendering sites.
- Update default carcass weights in the tool as the cattle number was low compared to current beast weights.
- Include instructions in the wastewater treatment section to align calculation of wastewater emissions with NGER Method 1 or 2 approaches, to avoid a combination of approaches being used.
- For sites with covered anaerobic lagoons, inputs needs to be checked, including:
 - Capping the biogas generation based on the amount of wastewater treated
 - Link the entered thermal biomethane numbers and the wastewater biomethane numbers in the tool to avoid double entering and sources of confusion.
 - Include a methane percentage input section.
- Update the opportunity library with the latest decarbonisation measures and remove opportunities which are no longer relevant.

7.0 Discussion

Key findings from the benchmarking sessions

In general, the energy and water benchmarking results for FY24 were similar or slightly better performance than for FY20. On reflection, the poorer performance of FY22 energy and water intensities was attributed to the disruptions cause by COVID-19 and stock availability issues following a period of destocking during the drought in 2017-2019. Out of the 34 sites benchmarked, 28 and 25 sites were rated as “good” for electrical performance and water performance respectively, while a small number of sites were classified as “best practice” (3 for electrical and 5 for water). Compared to electrical and water, thermal performance generally scored worse, with 16 of the 34 sites receiving a “poor” rating on thermal intensity for FY24. This compared with 1 of 22 for FY22, however this was predominantly due to a tool error occurring in the FY22 tool which incorrectly attributed “good” performance ratings to some non-rendering plants.

From engagements with member sites several key trends were identified. These included:

- Adoption of energy and water efficiency technology has accelerated in recent years, with many sites having undertaken recent upgrades in refrigeration plant and multiple water saving initiatives
- Several sites have seen the benefits of establishing a resource efficiency culture to drive continuous improvement in energy and water intensities
- Coal fired boilers are persistent in the industry, particularly in QLD, and while processors are interested in biomass few have taken the opportunity to fuel switch
- Previously the benchmarking tool did not quantify fugitive emissions from wastewater treatment, and following the implementation of this feature in the FY24, it was seen that wastewater emissions are significant - representing 40% (on average) of operational emissions from processors
- Processors are adopting biogas capture and reuse via Covered Anaerobic Lagoons, with 9 of 33 members in the Benchmarking Workshops having already adopted this technology, and many more planning for investment in coming years

EPR data quality was highly variable between members, and some major data points used in the tool are not specifically asked for in the EPR survey. For example, the amount of actual product produced by members was provided, while the tool uses thSCW value. An improvement for future years could be to identify the data not requested by the EPR survey and send out a bulk pre-workshop RFI well ahead of time, although this approach would then mean that any data asked for in the EPR survey but not provided would still be missing.

Data collection was a challenge for the ERM team for the following reasons:

- The EPR survey did not ask for every data point required as discussed above.
- Originally ERM would analyse the survey and identify data that needed to be requested from the member pre-workshop, however this process was relatively time consuming. It was then agreed that AMPC would follow up on this data instead of ERM, however these emails only included requests for data that wasn't asked for the in EPR survey, and didn't request data that had been left off the survey by the member. After a couple of weeks of this process these emails ceased to be sent by AMPC without ERM being notified, so from that point on no extra data was provided pre-workshop. It should be noted that only around 50% of sites actually responded to these emails anyway.

- A number of times in workshops it became clear that significant amounts of EPR data for certain sites was inaccurate. This was sometimes due to the person completing the data having since left the respective business, and other times due to the person completing the survey not having access to correct information.
- Post workshop ERM typically sent out RFI emails to confirm a number of data points which were unclear during the workshop. Response times for these emails were quite long, with reminder emails required to be sent frequently. Some sites never responded with the requested data and large assumptions needed to be made to complete the reports. Other sites confirmed data that was very likely incorrect, leading to outlier benchmarking performances, beating their water best practice reference case by 60%, or having a thermal intensity of 10,546 MJ/tHSCW which is almost 2x higher than the next highest thermal intensity of 5,307 MJ/tHSCW.
- There was a range of data types that were provided incorrectly, with no specific standouts apart from biogas data. There was frequently confusion from members on how to provide biogas data due to the way the EPR survey is set up. These issues included confusion over what units to provide data in (GJ or m³), whether volume values were supposed to represent total biogas volume or partial biomethane volume, and what the biomethane percentage is in the biogas. This is partially caused by the EPR survey assuming 60% biomethane volume which is lower than typically reported from sites.

8.0 Conclusions

This project confirms that while technical solutions are critical, their success is amplified by a robust resource management culture. AMPC should:

- Promote case studies to inspire member adoption of best practices.
- Emphasise cultural change in workshops and member training resources.
- Expand access to the information contained in the Energy and Water Benchmarking Tool, including the opportunity library, e.g. through the establishment of an online library of energy, water and emissions reduction opportunities.
- Dedicated briefings and resources targeted at senior management, to increase engagement with and secure their buy-in to resource efficiency activities.
- Encourage senior management engagement and internal training programs.

These actions will help AMPC members achieve meaningful improvements in emissions, energy, and water efficiency, and foster a culture of sustainability across the industry.

The benchmarking sessions were typically well received by members, with most welcoming the chance to discuss the performance of their site and any improvement opportunities that could be applied moving forwards. Attendance levels ranged from site to site, with some sites having a broad range of stakeholders participating, and other sites only having a single representative attend who did not have the full coverage of knowledge on the site performance. Members who had previously participated in benchmarking sessions were typically interested in their comparative performance over the years, and new members were usually interested in finding out how their performance holds up against a reference case specific to their operations.

9.0 Recommendations

The Energy and Water and Benchmarking Workshops continues to provide a valuable resource to AMPC members, to benchmark their energy, water, and emissions performance against the industry and, importantly for those returning members, to track their performance improvements over time.

As illustrated in the sector wide benchmarking results, members have made significant improvements in their resource efficiency through investments in energy and water efficiency, and renewable energy projects. To ensure the tool remains up-to-date with the current performance of the red meat processing industry, it is recommended that the Energy and Water Benchmarking Tool reference plant are revised using data from the last two benchmarking projects. This will ensure plants can identify where they sit in relation to others in the industry and continue to strive for best practice, rather than slowing down efforts to reducing resource utilisation. Additionally, the opportunity library, whilst updated in this project, will need further development to respond to the focus by industry on decarbonisation of stationary energy systems at processing sites (e.g. replacement of coal and gas fired boilers with biomass fired boilers and heat pump technology).

Finally, this report recommends that AMPC plan for a continuation of the Energy and Water Benchmarking Workshops using FY26 EPR data, to build on the great engagement achieved in the FY24 project.

10.0 Project outputs

Literature review

The literature review achieved the following outcomes:

- Identified five evidence-based case studies demonstrating best practice in energy and water efficiency.
- Highlighted emerging technologies such as heat pumps, biogas systems, and advanced refrigeration.
- Provided insights into the role of cultural and behavioural change in achieving sustainable outcomes.
- Established foundational knowledge to inform updates to the benchmarking tool in Stage 2.
- Supported the development of tailored workshops and educational materials for AMPC members.

Benchmarking tool update

The following changes were implemented to the Benchmarking tool, in conjunction with the additional 10 opportunities to the tool's library.

Update	Benefit for AMPC and members
Updating the library of resource saving opportunities	Provide members with additional suggested opportunities to improve their resource efficiency and facilitate decarbonisation. These opportunities include up-to-date measures and decarbonisation technologies, and provide more optionality for tool output recommendations to users.
Introducing a new rating "Best Practice" above the "Good" rating, based on the best performers in 2022 and 2023	Recognise members with outstanding benchmarking results (based on results from previous benchmarking workshop projects), and improve tailoring of opportunity recommendations to those sites.

Adding rating system scale explanation	Demonstrate to members the nature of the rating scales used to benchmark performance, in particular that they are not static but vary based on the type of sites and the activities conducted. This was raised as a potential cause for confusion in previous workshops.
Adding fugitive emissions sources (refrigeration system and wastewater treatment)	Provide a more complete picture of the site's emissions, allowing more accurate emissions benchmarking. Including fugitive emissions will also allow inclusion of initiatives to abate them such as refrigerant switching and biogas capture and reuse and link the corresponding emissions benefit.
Including fellmonger in hide processing (for sheep hide processing for the removal of wool)	Improve the benchmarking result by considering the additional energy and water required.
Including frozen offal in product output	Improve the benchmarking result by considering the additional energy required.
Update emissions factors	Update all emissions factors (by state) in the tool in line with FY24 NGER Determination (location-based method).

Energy and water benchmarking sessions

A total of 33 energy and water benchmarking sessions were conducted, with 34 sites benchmarked (one double session was conducted with 2 participants), with high levels of engagement. All participants were provided with an individually tailored report that summarised the benchmarking result, key discussion points, and relevant opportunities. Three case studies were developed based on the workshop discussion, outlining top-performing sites' benchmarking results, processes and facilities, and examples of best practices.

11.0 Bibliography

N/A

12.0 Appendices

12.1 Appendix 1 Summary of benchmarking results

Site No:	Thermal intensity (MJ / tHSCW)	Electrical intensity (kWh / tHSCW)	Energy intensity (kWh / tHSCW)	Water intensity (kL / tHSCW)	Thermal rating	Electricity rating	Water rating
1	1,066	225	1,874	3.6	Best Practice	Good	Best Practice
2	10,546	469	12,234	16.8	Poor	Fair	Fair
3*	288	153	839	2.6	Good	Good	Best Practice
4	1,337	171	1,952	5.1	Good	Best Practice	Best Practice
5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
6*	1,594	324	2,760	14.8	Poor	Fair	Good
7a	2,072	296	3,137	7.9	Poor	Good	Good
7b	2,563	342	3,794	6.0	Poor	Good	Good
8*	1,011	163	1,599	8.1	Poor	Good	Good
9*	2,154	559	4,165	13.5	Poor	Fair	Fair
10*	1,313	177	1,949	6.2	Poor	Good	Good
11	3,101	315	4,234	12.8	Good	Good	Fair
12	2,220	266	3,178	6.6	Good	Good	Good
13*	793	165	1,386	3.7	Poor	Good	Best Practice
14	2,541	246	3,427	9.3	Poor	Good	Good
15*	2,341	167	2,941	6.8	Poor	Good	Good
16	1,989	250	2,888	5.6	Fair	Good	Good
17	3,277	256	4,198	10.8	Poor	Good	Good
18	2,076	350	3,338	7.3	Fair	Good	Good
19	2,603	367	3,924	6.7	Good	Good	Good
20	1,585	152	2,134	6.2	Best Practice	Best Practice	Good
21	2,345	293	3,400	9.7	Good	Good	Good
22	2,078	356	3,361	6.5	Good	Good	Good
23*	663	204	1,399	4.6	Poor	Good	Best Practice
24	2,364	279	3,370	7.7	Good	Good	Good
25	1,826	207	2,570	7.1	Good	Good	Good
26	2,256	301	3,339	8.9	Good	Good	Good
27*	1,338	249	2,234	7.3	Poor	Good	Good
28	2,040	235	2,888	6.5	Good	Good	Good
29	1,355	266	2,312	7.5	Poor	Good	Good
30	2,306	254	3,219	5.8	Good	Good	Good

Site No:	Thermal intensity (MJ / tHSCW)	Electrical intensity (kWh / tHSCW)	Energy intensity (kWh / tHSCW)	Water intensity (kL / tHSCW)	Thermal rating	Electricity rating	Water rating
31	1,784	357	3,070	11.8	Good	Good	Good
32	5,307	262	6,250	7.9	Poor	Good	Good
33	1,541	289	2,583	6.6	Best Practice	Good	Good
34*	3,575	852	6,641	21.6	Poor	Poor	Poor
Median	2,074	264	3,103	7.2			
Maximum	10,546	852	12,234	21.6			
Minimum	288	152	839	2.6			

* Represents sites without rendering operations

Benchmark rating	Thermal		Electricity		Water	
	Count	Percentage	Count	Percentage	Count	Percentage
Best Practice	3	9%	2	6%	5	15%
Good	13	38%	28	82%	25	74%
Fair	2	6%	3	9%	3	9%
Poor	16	47%	1	3%	1	3%
Total	34	100%	34	100%	34	100%

12.2 Appendix 2 Summary of carbon intensity results

Site no:	Scope 1 intensity (kgCO _{2e} / tHSCW)	Scope 2 intensity (kgCO _{2e} / tHSCW)	Scope 1 & 2 intensity (kgCO _{2e} / tHSCW)	Main thermal fuel ¹	Wastewater treatment system	Capturing biogas?
1	216	159	375	Natural Gas	Anaerobic lagoon (>2m deep)	No
2	478	310	788	Custom biomass	Anaerobic lagoon (>2m deep)	No
3	15	101	116	Natural Gas	Managed aerobic	No
4	77	0	77	Natural Gas	Managed aerobic	No
5	n/a	n/a	n/a	n/a	n/a	n/a

¹ Defined as the largest contributor to the thermal energy intensity of the site.

Site no:	Scope 1 intensity (kgCO _{2e} / tHSCW)	Scope 2 intensity (kgCO _{2e} / tHSCW)	Scope 1 & 2 intensity (kgCO _{2e} / tHSCW)	Main thermal fuel ¹	Wastewater treatment system	Capturing biogas?
6	151	214	365	LPG	Anaerobic lagoon (>2m deep)	No
7a	575	195	770	Natural Gas	Anaerobic lagoon (>2m deep)	No
7b	53	174	227	Custom biomass	Managed aerobic	No
8	564	77	641	LPG	Anaerobic lagoon (>2m deep)	No
9	610	285	895	Diesel	Anaerobic lagoon (>2m deep)	No
10	61	91	151	Custom biomass	Anaerobic lagoon (<2m deep)	No
11	196	161	356	Natural Gas	Anaerobic lagoon (>2m deep)	Yes
12	223	176	399	Natural Gas	Anaerobic lagoon (>2m deep)	Yes
13	137	84	221	Natural Gas	Anaerobic digester/reactor	No
14	242	57	299	Fuel Oil	Anaerobic lagoon (>2m deep)	No
15	611	5	615	LPG	Anaerobic lagoon (>2m deep)	No
16	103	165	268	Natural gas	Anaerobic lagoon (>2m deep)	Yes
17	314	197	511	Fuel Oil	Anaerobic lagoon (>2m deep)	No
18	107	270	377	Natural gas	Managed aerobic	No
19	55	55	110	Custom biomass	Managed aerobic	No
20	82	116	198	Natural gas	Managed aerobic	No
21	458	208	666	Coal	Anaerobic lagoon (>2m deep)	No
22	291	253	544	Coal	Anaerobic lagoon (>2m deep)	Yes
23	107	47	154	LPG	Unmanaged aerobic	No

Site no:	Scope 1 intensity (kgCO ₂ e / tHSCW)	Scope 2 intensity (kgCO ₂ e / tHSCW)	Scope 1 & 2 intensity (kgCO ₂ e / tHSCW)	Main thermal fuel ¹	Wastewater treatment system	Capturing biogas?
24	68	184	252	Natural gas	Anaerobic digester/reactor or	Yes
25	292	136	429	Natural gas	Anaerobic lagoon (>2m deep)	No
26	238	214	451	Coal	Anaerobic lagoon (>2m deep)	Yes
27	558	170	728	LPG	Anaerobic lagoon (>2m deep)	No
28	73	167	240	Natural gas	Anaerobic lagoon (>2m deep)	Yes
29	135	136	270	Natural gas	Anaerobic lagoon (>2m deep)	No
30	272	180	452	Coal	Anaerobic lagoon (>2m deep)	No
31	94	104	198	Biogas - flared	Anaerobic lagoon (>2m deep)	Yes
32	20	202	221	Custom biomass	Managed aerobic	No
33	49	205	255	Natural gas	Anaerobic lagoon (>2m deep)	Yes
34	178	196	374	Natural gas	Managed aerobic	Yes
Median	164	169	360			
Maximum	611	310	895			
Minimum	15	0	77			

12.3 Appendix 3 Summary of decarbonisation projects discussed in the benchmarking sessions²

Site no:	Solar PV	Battery	Biomass	Biogas	Heat pumps	Refrigeration upgrades	Compressed air upgrades	Air infiltration reduction	Condensate return	Improve insulation	Upgrade rendering	Heat recovery	LED lighting	Improve metering	Electric spray sterilisers	Boiler upgrades
1	✓		✓		✓	✓		✓	✓			✓			✓	
2			✓	✓		✓	✓		✓	✓	✓	✓			✓	
3	✓				✓	✓		✓				✓	✓	✓	✓	✓
4			✓			✓	✓				✓	✓			✓	✓
6	✓				✓	✓	✓	✓		✓		✓	✓	✓	✓	✓
7a	✓			✓	✓	✓						✓		✓	✓	✓
7b	✓		✓	✓		✓				✓		✓		✓	✓	✓
8	✓		✓	✓	✓	✓		✓		✓		✓	✓		✓	✓
9	✓			✓	✓	✓	✓			✓		✓	✓		✓	✓
10	✓		✓	✓	✓	✓				✓			✓		✓	✓
11				✓	✓	✓			✓		✓	✓			✓	✓
12				✓	✓	✓	✓	✓	✓			✓				✓
13	✓			✓	✓	✓	✓	✓		✓		✓	✓	✓		✓
14				✓	✓	✓	✓			✓		✓			✓	✓
15	✓			✓	✓	✓		✓				✓		✓	✓	✓
16	✓			✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓
17	✓				✓	✓	✓				✓	✓			✓	✓
18	✓		✓			✓	✓		✓		✓	✓			✓	

² Site 5 and site 32 have been omitted from analysis as they did not attend benchmarking sessions.

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Final Report

Site no:	Solar PV	Battery	Biomass	Biogas	Heat pumps	Refrigeration upgrades	Compressed air upgrades	Air infiltration reduction	Condensate return	Improve insulation	Upgrading	Heat recovery	LED lighting	Improve metering	Electric spray sterilisers	Boiler upgrades
19			✓		✓	✓	✓			✓	✓	✓			✓	✓
20	✓		✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	
21			✓	✓	✓	✓		✓	✓		✓			✓	✓	✓
22			✓	✓	✓	✓	✓		✓		✓			✓	✓	✓
23	✓			✓	✓	✓				✓		✓	✓	✓	✓	✓
24	✓		✓	✓	✓	✓			✓			✓		✓	✓	
25	✓		✓	✓	✓	✓			✓		✓	✓			✓	✓
26	✓		✓	✓	✓		✓				✓	✓				✓
27	✓	✓			✓	✓	✓					✓		✓	✓	✓
28	✓		✓	✓		✓	✓					✓			✓	✓
29	✓			✓	✓	✓			✓		✓	✓		✓	✓	
30	✓		✓		✓	✓						✓				✓
31	✓			✓		✓				✓	✓	✓				✓
33				✓	✓	✓	✓			✓	✓				✓	
34	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓
Total	24	1	17	24	27	31	17	9	13	13	16	29	9	15	28	26