ENERGY AND WATER BENCHMARKING TOOL FOR A RED MEAT PROCESSING PLANT

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1.0 EXECUTIVE SUMMARY

Profit margins have tightened and energy costs have risen in the energy-intensive red meat processing industry. Plant owners rarely have suitable energy and water benchmarks to compare themselves to peers, and they find identifying feasible opportunities for them to improve performance in these areas is not always straightforward, despite a wealth of academic literature.

This project addressed this by building an offline Excel tool available to all AMPC members, designed for easy accessibility and use to all plant sizes of the membership base. The tool aims to allow plant owners to benchmark their energy and water performance, compare it to an industry standard plant and review energy and water saving opportunities appropriate to the plant's arrangement and performance.

The tool was built in four steps: first reviewing literature to gather information, then building the energy and water model, testing with real-world plant data and lastly, requesting industry feedback.

There are several key design aspects of the tool. First, energy and water use was apportioned across facilities within a plant, which allowed the tool to model plants with a variety of facility combinations. Second, having benchmarked a plant's performance, the tool categorises that performance as good, fair or poor and in turn only presents opportunities suitable to that performance: a poorly performing plant must start with the basics first. Third, should the user submit cost data into the tool, economic metrics related to performance improvements are adjusted to reflect those costs, including adjusting the payback period. Fourth, a plant's benchmark results are presented as three dial gauges for each metric (electrical, thermal and water) with a needle indicator to compare the plant to both an industry-leading and poorly-performing plant of equivalent size, facilities and species mix.

During testing the tool modelling required expansion in order to allow facility-level production throughputs: for example, allowing for externally-sourced rendering.

Industry feedback on this tool covered several areas: the importance of up-to-date and quantified benchmarks; a transparent modelling process; quantified opportunities with additional financial metrics; and a wide range of input types for energy and water sources. This feedback was considered and implemented where it aligned to the tool's objectives.

Having completed the tool, a review of the design brief and associated modelling decisions revealed that these decisions had notable effects on how the tool could be used and also outlined potential further developments. First, keeping data input to a period of annual (rather than, say, monthly) retained focus on the tool as a strategic benchmark, rather than its potential use as an operations tool for performance tracking. Second, utilising a single benchmark figure for such a broad range of processing plants was not most appropriate for some plant types, such as rendering plants, but was required in order to retain the tool's flexibility. Third, a further development in modelling would be to utilise a plant's submetered data (where available) to refine the modelling and benchmarks. Fourth, a major development in the tool would be to convert it to an online tool, whereby industry members can participate in up-to-date anonymised benchmarking with peers and further refine the modelling.

2.0 INTRODUCTION

Profit margins have tightened in the industry due to competition from red meat substitutes, such as chicken and pork. Meanwhile, energy costs have increased dramatically, particularly over the last few years, further pressuring this energy-intensive industry.

Many plant owners only have an approximate gauge of how well their plant performs against their peers. Benchmarks are used in all industries for organisations to understand their competitive position within an industry and to identify areas of improvement. For the red meat processing industry, benchmarking data may be outdated or simply unsuited to a particular plant's arrangement of facilities.

Lastly, despite a wealth of literature on best-practice energy and water use in a plant, it may be unclear to a plant owner what project opportunities are best suited to their plant, how to quantify these opportunities and what to do next to progress these opportunities into projects.

With this background, this research project aimed to provide AMPC members with a tool to benchmark their energy and water use against their peers, and to identify opportunities to improve their performance in water and energy use. Benchmarking data is based on best-practice plants, and modified to suit the particular plant's arrangement of facilities. Project opportunities are linked to AMPC's extensive body of research into water and energy use on a red meat processing plant.

Currently this tool is distributed in an offline format as a Microsoft Excel file. There would be benefit in converting this tool to an online format in a future project, allowing AMPC members to anonymously benchmark against up-to-date benchmark data submitted by their peers.

3.0 PROJECT OBJECTIVES

This project aimed to create an offline tool to allow plant owners to benchmark their energy and water performance, compare it to an industry standard plant and review energy and water saving opportunities appropriate to the plant's arrangement and performance.

The project objectives as specified in the research agreement were to:

- Create an energy model for red meat processing plants broken into major processing areas and equipment
- Create an economic model utilising the energy model to evaluate the impact of energy efficiency improvements
- Provide an option for water efficiency modelling and benchmarking
- Create a webinar to promote the use of this tool

In fulfilling these objectives the goal was to deliver an easy-to-use tool accessible to all AMPC members irrespective of size, and to connect members to AMPC's extensive knowledge base.

4.0 METHODOLOGY

The broad approach applied to build the tool was:

1. Conduct a literature review. Identify key red meat industry reports, energy studies and literature suitable for identifying opportunities, benchmarking and modelling.
2. Build the energy and water model. Use data from the literature review to shape the approach.
3. Test the model with real-world data. Input data from prior energy studies and industry experience to check the suitability of tool's results. Adjust the tool as needed.
4. Request feedback from industry. Present and distribute the tool to key industry participants for feedback on all aspects of the tool. Adjust the tool as needed.

The following subsections in this section provide further detail on step 2: how the energy and water model was built. Section *5.0 Project Outcomes* provides further detail on steps 3 and 4: testing and industry feedback, in addition to presenting the final layout of the tool.

4.1 Modelling the energy and water use of a plant

This is the first of four subsections detailing how the energy and water model was built for the tool. This subsection describes the overarching principles used to model a plant. The second subsection describes the method for calculating the plant's performance. The third subsection describes the method for determining appropriate opportunities. The fourth subsection presents the logic diagram summarising the process applied by the model.

4.1.1 Defining the plant boundary, inputs, outputs and costs

The first step in modelling is defining a boundary around what is being modelled. Here, the boundary was simply the plant's geographic boundary. That is, all water, electricity, gas, animals and meat or other products crossing the boundary were considered inputs or outputs, however not all of these were relevant to modelling the energy and water use of a plant. Listing out the relevant products is not beneficial to understand the model at this point, but rather if the reader would like to jump ahead these are displayed in the figures of the final tool under section *5.3.1 Input Page*.

4.1.2 Identifying a plant's key facilities

The next step in modelling was to identify what variables most affected the energy and water use in a facility. Besides production and species mix, the facilities on a plant were a major variable affecting energy and water use. As facilities vary from plant to plant the model had to be flexible enough to accommodate any combination of facilities. While the method for modelling this facility variance is covered later in this chapter, this subsection identifies the key facilities in a plant that were used in the model to define a full-facility plant.

For this, the facilities in such a plant were modelled from a simplification of Figure 1. Here, the model used the facilities shown in green and red, and excluded those in yellow and blue.

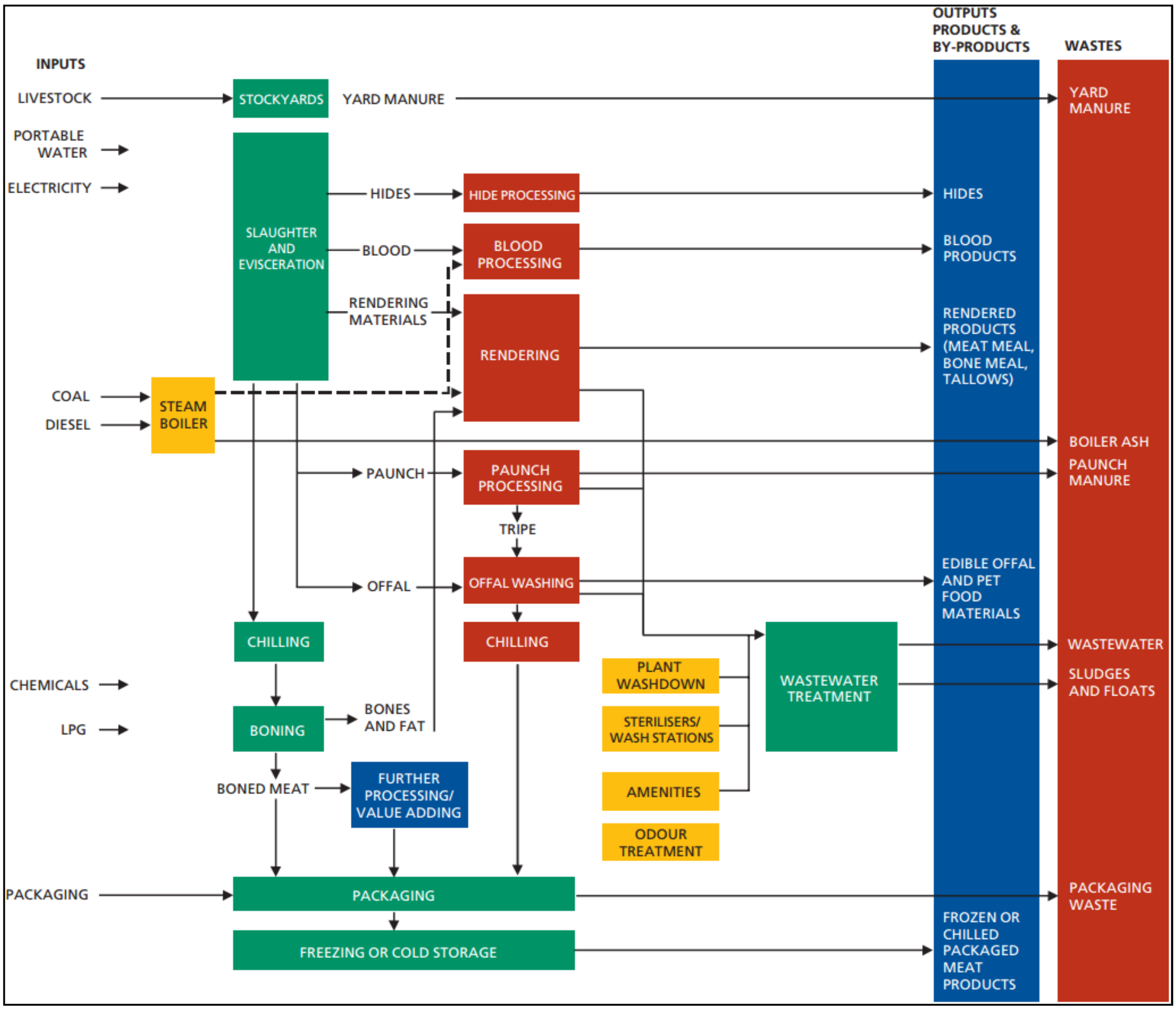

Figure 1: A facility breakdown for a red meat processing plant. The tool used a simplified model of this breakdown by retaining only green and red facilities and excluding all yellow and blue facilities (MLA, 2002).

4.2 Methodology for calculating benchmark performance

4.2.1 Defining the benchmarks and units of measure

Other key decisions of modelling were to define the benchmark and costs to be used. For benchmarks, the units of measure and boundary definitions are described in Table 1. For costs, the units of measure and boundary definitions are described in Table 2.

Table 1: Definitions and units of measure for each benchmark in the tool.

Benchmark	Unit of Measure	Shown As	Comments on boundary
Thermal Energy	Gigajoules per tonne of Hot Standard Carcass Weight	GJ / tHSCW	All energy sources entering the plant for thermal purposes, and all biogas produced at the plant.
Electrical Energy	Kilowatt-hours per tonne of Hot Standard Carcass Weight	kWh / tHSCW	All grid electricity entering the plant, and all electricity generated at the plant.
Total Energy	Gigajoules per tonne of Hot Standard Carcass Weight	GJ / tHSCW	This is the summation of thermal and electrical energy.
Water	Kilolitres per tonne of Hot Standard Carcass Weight	kL / tHSCW	All water entering the plant, irrespective of source.

Table 2: Definitions and units of measure for each cost measure in the tool.

Cost	Unit of Measure	Shown As	Comments on boundary
Thermal Energy	Dollars per gigajoule	$ / GJ	Annual spend on thermal energy costs. Where possible, the user should enter the cost per unit of energy, rather than including the fixed cost (which would not change irrespective of consumption). This allows energy savings to be more accurately priced.
Electrical Energy	Dollars per kilowatt-hour	$ / kWh	Annual spend on electrical energy costs. Where possible, the user should enter the cost per unit of energy, rather than including the fixed cost (which would not change irrespective of consumption). This allows energy savings to be more accurately priced. For solar PV, this may mean a very low cost value, if not zero.
Total Energy	Dollars per gigajoule	$ / GJ	This is the summation of thermal and electrical energy costs.
Water	Dollars per kilolitre	$ / kL	Annual spend on water costs. This includes costs to bring on site and costs for all wastewater discharge.

4.2.2 Modifying the benchmarks based on facilities and species mix

Many plants are not full-facility plants – that is, they do not have all the facilities shown in Figure 1. In order to model these plants, first the energy and water use in a full-facility plant was apportioned for each facility. Once apportioned, a plant with fewer facilities was modelled by deducting the energy and water use of the missing facilities from the total energy and water use of a full-facility plant.

Lastly, the model needed to cater for different species processed at the plant. This decision was largely informed by the results of the literature review: prior studies had simply applied an 'adjustment factor' to multiply the benchmark figure for a plant processing cattle for smaller species.

4.2.3 Calculating the benchmark range and figures

An industry-leading full-facility plant processing cattle was selected as the benchmark plant. The performance of this plant was calculated for each of the benchmarks in Table 1 and set as the industry-leading figures. A poor-performing plant was set as the upper threshold of performance for each benchmark.

This poor-performing plant did not represent a specific plant, but was the result of an aggregation of data from the literature review. Specifically, the typical range of performance for a benchmark was first determined from two sources: the range of benchmarks found in the review, as well as real-world plant data. Once this typical range was found, it was used as a multiplier with the industry-leading benchmark plant's performance, with the result representing the performance of an equivalent poor-performing plant. This process was applied to determine the range of energy benchmarks and again to determine the range of water benchmarks.

The benchmark plant's performance was modified in the following ways:

1) Based on the facilities selected by the user, the benchmark plant was stripped of the energy and water use allocated to facilities not present in the user's plant.
2) Where some facilities had specific options for modifying throughput (such as external rendering) and the user nominated throughput, the energy and water use for these facilities were modified to increase or decrease usage from this facility. More on this in *5.2 Modelling partial facilities and external inputs*.
3) If the user's plant was not running at full capacity, an upwards adjustment factor was applied to the benchmark site to increase usage for the less-efficient operations.
4) Based on the user's selection of species throughput, the benchmark site was modified to allow for the user's species mix. Smaller species have a different energy intensity and water intensity per tonne processed than large species.

The user's plant performance was calculated for each benchmark category by summing the relevant usage of energy or water and dividing by the plant's tHSCW production.

4.2.4 Categorising and presenting performance results

After calculating the benchmark plant's performance and the poor-performing plant's performance the range between these benchmarks was divided into three groups: poor, fair and good. If the user's plant performance was close to the benchmark plant's performance for that metric (be it thermal, electricity, or water) it was categorised as good (for that metric), and so on towards poor for results near the poor-performing plant. This was repeated for each metric, so a user's plant had a category for each metric. Should the user's plant exceed the range in either outperformance or underperformance, the range was stretched to place the user's plant at the edge of that range.

Each of the benchmark metrics was displayed in the form of a colour-coded 180° dial-gauge (skip to Figure 11 to see this dial-gauge). This presented an easy-to-measure performance check for the user to gauge their performance.

The next section describes how the categorisation of performance for each metric determined which performance opportunities were presented to the user.

4.3 Methodology for determining appropriate opportunities

Opportunities to improve the energy or water performance on a plant were collated during the literature review, before being summarised and quantified as an 'opportunity library' within the tool. Each opportunity had key metrics relating to expected savings, typical payback periods, operating costs and any facility pre-requisites.

This subsection describes how the opportunities were categorised within an energy management framework, how economic metrics were calculated and finally how appropriate opportunities were identified for presentation to the user.

4.3.1 The energy and water management framework pyramid

A good energy and water management framework starts with getting the basics right. Only when a plant is doing the basics should more advanced activities take place. These activities can be visualised as a pyramid, with basic activities at the base and more advanced activities forming each successive layer to the peak.

Using this framework, each opportunity within the opportunity library was categorised under three groups, from basic to advanced: housekeeping, process improvement and efficient equipment, and renewables and cogeneration.

4.3.2 Calculating economic metrics

The challenge when modelling different-sized plants is figuring out how to calculate the costs and savings of a particular project – say, a boiler improvement – when the cost is a function of the size of the boiler, which is usually proportional to the size of the plant. As such, scaling projects that could save energy or water in order to calculate realistic capital expenditure (CAPEX), saving and payback periods for these projects can be difficult. To overcome this challenge, this tool quantified each opportunity by two primary variables: first, the percentage of water or energy (electrical or thermal) saved by a typical plant if the opportunity is implemented, and second the typical expected payback period to pay off the initial investment in the project.

From these figures the volume of energy or water savings for each opportunity can be back-calculated, since the user inputs the plant's total energy and water usage into the tool. Further, the dollar value of these savings can also be calculated using the user's cost data, if available, or otherwise using the default cost rates built into the tool.

Then, the CAPEX is calculated by first calculating the expected savings using the default cost rates (irrespective of the user's cost data). These expected savings are then multiplied by the expected payback period to back-calculate the CAPEX cost.

With the CAPEX cost estimate, the actual savings (using the user's cost data, where possible) is calculated by dividing the CAPEX cost estimate by the actual savings. This is the 'adjusted payback period', which allows for sites that may have very expensive thermal, electrical or water costs. On these sites, savings would appear more attractive and therefore payback periods are lower for projects that would otherwise have too high a payback period. Should the user not supply cost data, the 'typical expected payback period' built into the tool will be used.

4.3.3 Sorting and filtering opportunities for presentation

Once opportunities are quantified, the tool applies four processes to select what opportunities are presented in the outputs sheet: category, payback, ranking and filtering.

First, opportunities that are not appropriate for the user's plant performance for that category are filtered out. That is, if the user's plant has poor thermal performance then an advanced thermal opportunity would be filtered out.

Second, opportunities with a payback period that exceeds the threshold specified by the user are filtered out of the list, irrespective of the magnitude of saving. Unless the user raises this payback period threshold these opportunities will not appear in the final report. There is, however, a counter on the final report indicating for each metric how many opportunities were filtered out due to exceeding the user's threshold. This allows the user to return to the input page and modify the threshold as needed.

Third, for each metric the remaining opportunities are ranked by total savings – largest savings first. Fourth, of these sorted opportunities, only the top four are presented for each metric.

4.4 Modelling Logic Flowchart

The implementation of the fundamental modelling decisions outlined in the previous subsections can be described in a logic flow chart. This chart, shown in Figure 2, shows how the tool transforms the user's inputs to produce the tool's outputs.

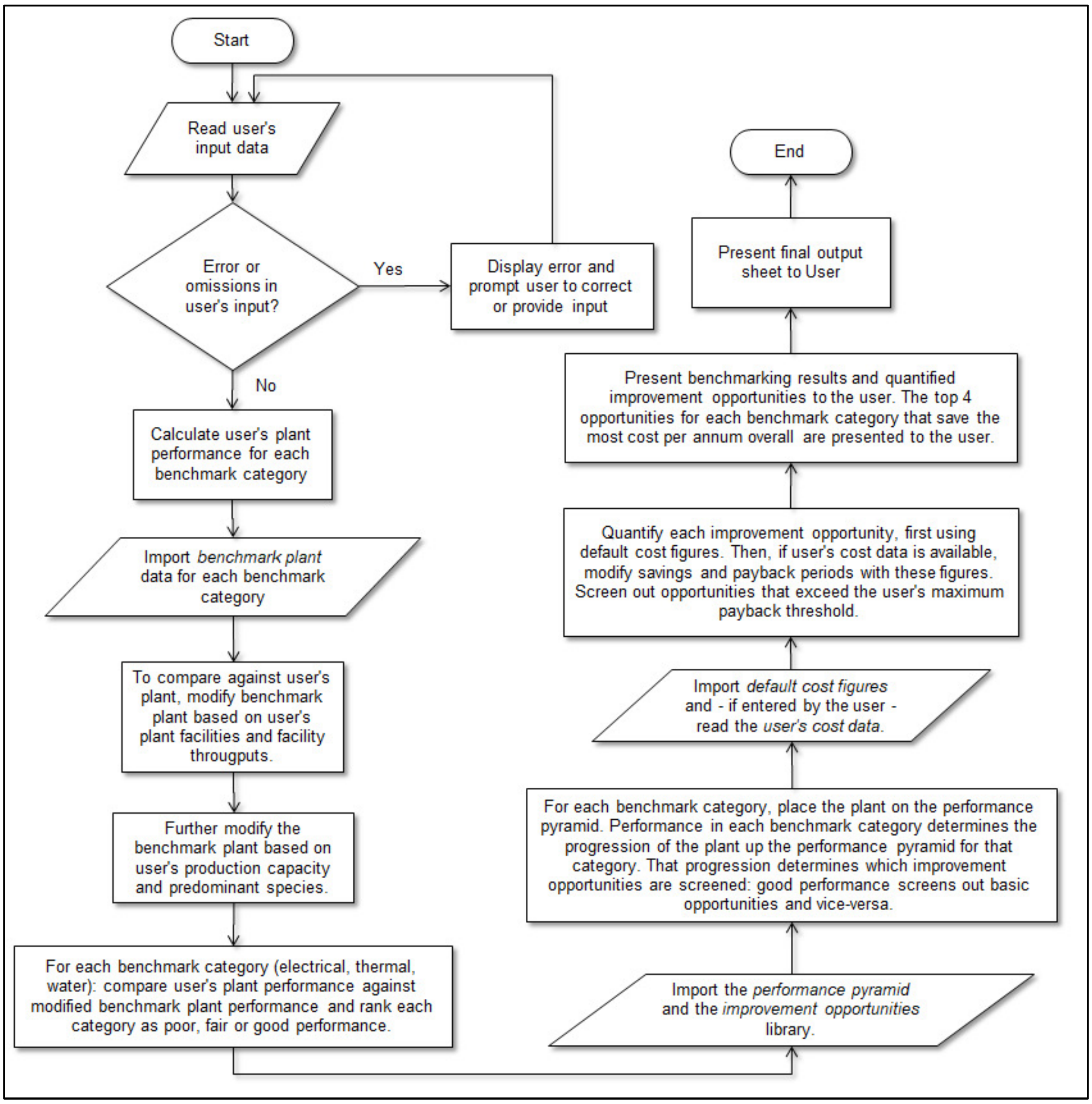

Figure 2: Logic flowchart of the tool, showing the process of reading the user's data, calculating benchmarks and opportunities, and presenting the results back to the user. Rhomboids indicate a data import, rectangles indicate a process, and diamonds indicate a decision.

5.0 PROJECT OUTCOMES

This section describes the results of applying the approach described in *4.0 METHODOLOGY*. In particular, the outcome of testing and feedback from the industry is described here. To cover these outcomes, this section is divided into subsections. First is a summary of the feedback received from the industry on the tool. Second are details on a more complicated element of the tool – facility throughputs – which was built due to an issue that arose while testing real-world data. Third, the tool's appearance – shaped by the industry feedback – is presented.

5.1 Industry Feedback

Having completed a basic design of the tool, industry leaders were then engaged to provide feedback. Overall, the feedback was constructive and helpful. Given the volume of feedback it was clear the industry was interested in such a tool. Table 3 outlines the main items of feedback; against each item is an italicised response to the feedback.

Table 3: Itemised list of industry feedback, including the response to including this in the tool.

Item	Description	Response
Quantify benchmark performance figures.	**Where there are dial gauges or results of benchmark calculations presented graphically, these should be accompanied by quantified figures, not only for the user's plant, but for the benchmark plant and lagging plant.**	***Implemented: dial gauges were subsequently quantified as described.***
Transparent modelling processes.	**It should be clear to the user how the user's data was manipulated to calculate the outputs displayed.**	***Implemented: the instructions and this Final Report describe the methodology applied to manipulate the user's data to produce the outputs.***
Quantified opportunities.	**Opportunities should not be limited to text describing the kinds of opportunities the user should pursue, but should attempt to quantify the cost, savings and payback expected for specific examples of opportunities.**	***Implemented: opportunities were estimated to two significant figures for capital expenditure, annual savings and expected payback period.***
A range of inputs for energy and water.	**The user should have a breadth of options to input energy and water use against. This includes LPG, coal, solar PV, biomass, town water and bore water.**	***Implemented: users can enter a range of energy and water inputs.***
More granular time periods.	**The tool should be capable of analysing a more granular period, not just a full year – say weekly or monthly data – for ongoing performance benchmarking purposes.**	***Not implemented: the tool is a strategic (rather than operations) tool, aimed to identify CAPEX projects for investment opportunities, rather than tracking performance benchmarking to optimise an operations-focused outcome.***
More advanced financial metrics.	**The tool should provide more financial metrics to sift out poorly-ranking improvement opportunities. Such metrics include Internal Rate of Return (IRR).**	***Not implemented: although IRR is an important tool for larger or more advanced organisations to assess the attractiveness of opportunities, it does not assist all members and adds complexity to the tool.***

Item	Description	Response
Up-to-date benchmarks.	Wherever possible the tool should use the latest benchmarking data in order to stay abreast of improvements across the industry.	*Pending: should the tool be updated to an online platform in a subsequent project it should include facilities to submit and retrieve up-to-date benchmark data.*
Anonymising of submitted benchmark data.	Should the tool be capable of recording and transmitting the user's benchmark data, this data should be anonymised and only submitted at the user's explicit approval.	*Not applicable: the tool does not currently have facilities to transmit the user's benchmark data, except for the user sending the populated tool as-is to AMPC.*

5.2 Modelling partial facilities and external inputs

One of the outcomes of this project came about while testing the tool with real-world data. During the testing phase a rendering plant with external sources of rendering could not be accurately modelled as the tool did not have the option to allow external throughput into the rendering facility. As such, without such an input the water and energy performance of the plant was not accurate. The resolution of this issue – that is, allowing for facility-specific throughputs – is described in this subsection.

This issue was not restricted to rendering, but to freezing and boning too: several plants with freezers do not freeze all material put through the plant, nor do plants with boning rooms put all carcasses through the boning room. Such plants do not align to the original methodology applied to establish the benchmarking tool (that is, the benchmark of a full-facility plant with no external sources of rendering with all material going through all facilities). If a user nominated a facility on their plant, the tool would model all relevant production going through that facility (be it a freezer, renderer or boning room). That is, there was no 'adjustment factor' applied for such plants that only freeze or bone some material.

In order to build each 'adjustment factor' for each affected facility in the plant, two numbers were required – one from the benchmark plant and one from the user's plant. Each of these numbers would represent the expected output of that facility compared to the overall production of the plant, which was in tHSCW. For example, for the boning facility, this number would simply represent the boning yield (as a percentage of HSCW). With these two numbers, the 'adjustment factor' would be the ratio of these two numbers, and used to increase or decrease the energy and water use of that facility to accommodate the 'extra' or 'partial' production through that area of the plant for the user's unique conditions.

For the benchmark plant, this number had to be found from the literature review (as there was no real-world data available for the benchmark plant). From this review, the mass throughput identified in Figure 3 was used. When viewing this figure, the terminology between the figure and this report is not consistent, so Table 4 clarifies this, along with the typical result for each ratio for the benchmark plant. Using these ratios, the expected production figures for rendering and boning were estimated for the benchmark plant.

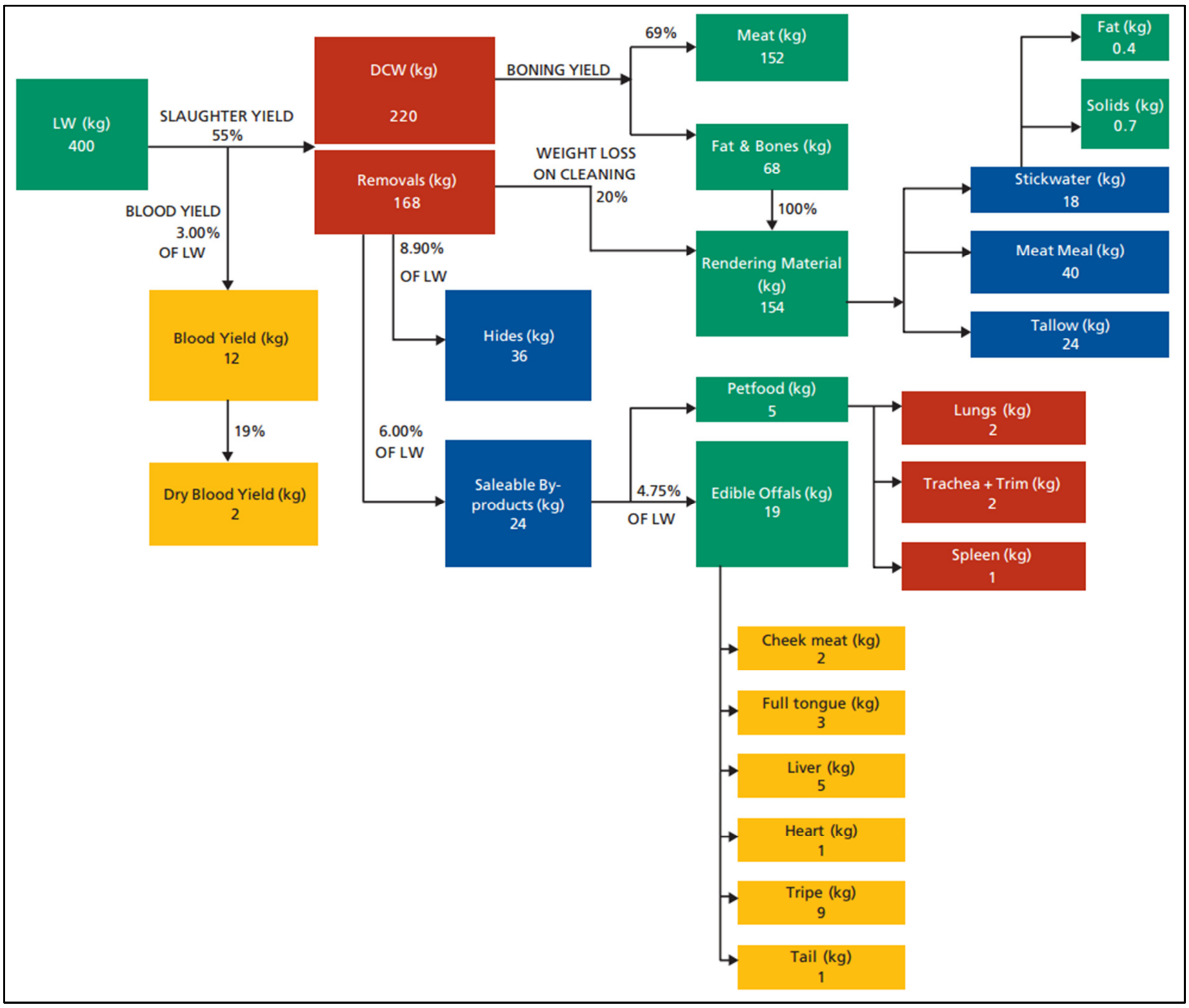

Figure 3: Indicative mass yield for processing cattle (MLA, 2002).

Table 4: terms used to describe production ratios in the literature review compared to the tool.

Ratio	Terms used in Figure 3	Terms used in tool	Comments
Boning production to overall plant production	$\frac{Meat}{DCW}$	$\frac{Boning}{tHSCW}$	**Around 69% yield.**
Rendering production to overall plant production	$\frac{Rendering\ Material}{DCW}$	$\frac{Rendering}{tHSCW}$	**Around 70%.**

For the user's plant, the user is prompted to input the relevant production going to boning, rendering or freezing (where these facilities are present). From these facility-level production figures, along with the overall production, the actual ratios for these facilities are calculated.

With both numbers now calculated, each representing the production ratio from each plant, the 'adjustment factor' for each facility is calculated. This factor is then applied to uplift or de-rate the water and energy use of that particular facility in the adjusted benchmark plant only (the user's water and energy use are left unchanged from inputted values).

The result of constructing this adjustment factor was the capacity for the tool to modify the benchmark plant to replicate a user's plant under different arrangements: a plant with external rendering, a plant with only some products frozen and others just chilled, a plant only boning some of the throughput, or some combination of these.

5.3 Tool's final look-and-feel

This subsection presents the final look and feel of the tool, having incorporated industry feedback and the facility-level production modelling elements. The tool has an introduction, an input page and an output page.

5.3.1 Input Page

The input page is composed of several sections: plant name and facilities (Figure 4), production data (Figure 5), production adjustments (Figure 6), consumption data (Figure 7), investment decision data (Figure 8), preliminary benchmark results (Figure 9)

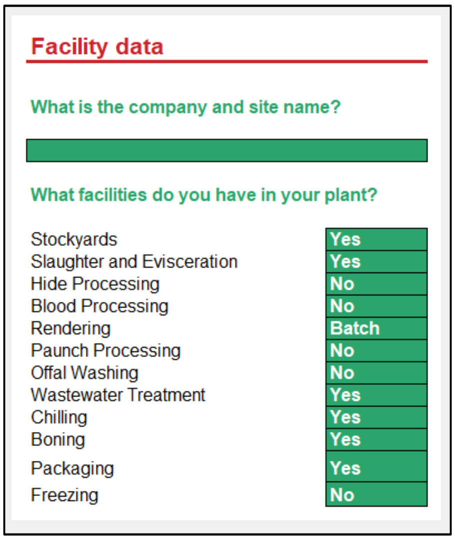

Figure 4: Input page, facility data. Facility questions are drop-down boxes and are required.

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 here.

Species	Maximum	Current	Units	Default	Your Plant	Figure Used
Cattle	-	2,100	tHSCW / yr	450 kg		450 kg
Calves	-	400	tHSCW / yr	250 kg		250 kg
Sheep	-	1,600	tHSCW / yr	130 kg		130 kg
Lamb	-	-	Head / yr	30 kg		30 kg
Goat	-	-	Head / yr	50 kg		50 kg
	5,000	4,100	tHSCW / yr			

Based on these figures you operated at 82% of maximum production for the year. Adjust the figures if this is not correct.

Figure 5: Input page, production data. Production is required; units are drop-down boxes. Weight figures are optional.

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.

How much rendering product is external vs internal?		How much product is boned vs carcass only?		How much product is frozen vs chilled?	
Internal input (tonnes / yr)	2,100	Boning room (tonnes / yr)	1,010	Chilled (tonnes / yr)	3,100
External input (tonnes / yr)	-	Carcass only (tonnes / yr)	3,090	Frozen (tonnes / yr)	1,000

Figure 6: Input page, production flow adjustments. All are required if facilities are present, else they do not appear.

Consumption data

What is your annual consumption and spend of the following commodities?
The cost section is optional but important if you would like the model to more accurately calculate your costs and savings.

	Annual consumption		Annual spend ($ p.a.)	Commodity rates to be used in the tool: Calculated rate	Default rate	Figure Used	Units
Natural Gas		GJ		$ -	$ 8.00	$ 8.00	$ / GJ
Coal	5	tonnes		$ -	$ 7.00	$ 7.00	$ / tonnes
LPG	464,000	litres	$ 665,000.00	$ 1.43	$ 0.70	$ 1.43	$ / litres
Tallow	-	tonnes		$ -	$ 800	$ 800	$ / tonnes
Fuel Oil		litres		$ -	$ 1.50	$ 1.50	$ / litres
Biogas - flared		GJ		$ -	$ 2.00	$ 2.00	$ / GJ
Biogas - used in process		GJ		$ -	$ 3.00	$ 3.00	$ / GJ
Grid Electricity	984,900	kWh	$ 283,164.00	$ 0.29	$ 0.20	$ 0.29	$ / kWh
Solar PV Electricity	140,000	kWh		$ -	$ 0.10	$ 0.10	$ / kWh
Town Water	49,925	kL	$ 348,000.00	$ 6.97	$ 2.00	$ 6.97	$ / kL
Bore Water		kL		$ -	$ 0.20	$ 0.20	$ / kL
Recycled Water	15,000	kL	$ -	$ -	$ -	$ -	$ / kL
Wastewater	20,000	kL	$ 125,000.00	$ 6.25	$ 2.50	$ 6.25	$ / kL

Figure 7: Input page, consumption data. Consumption is required, cost is optional. Note how the rates at 'Figure Used' change depending on the presence of absence of cost data.

Investment decision data

What is the maximum payback period you will consider for a performance improvement project?

6 years

Figure 8: Input page, investment decision data. Payback period is required.

Benchmark results

	Usage per tonne	Unit cost rate	Cost per tonne
Thermal	2,941 MJ / tHSCW	$ 55.14 /GJ	$ 162 / tHSCW
Electricity	274 kWh / tHSCW	$ 0.25 / kWh	$ 69 / tHSCW
Total Energy	*3,929 MJ / tHSCW*	*$ 58.86 /GJ*	*$ 231 / tHSCW*
Water	12.2 kL / tHSCW	$ 9.47 /kL	$ 115 / tHSCW

The benchmark results are in tHSCW processed not total tonnes processed.

As such, benchmarks have also been adjusted upwards for external rendering input, where relevant.

If these figures do not look correct, amend your production and consumption figures.

LINK: Progress to Output Report

Figure 9: Input page, preliminary benchmark results. No input required on this sheet (grey background); link to Outputs.

5.3.2 Output Page

The output page has four sections arranged vertically, and prints to a pdf spanning at least four pages, with at least one page for each section. The first page is an overview of the benchmarking results, in addition to explaining the energy and water management framework (Figure 10). The remaining three pages cover each of the benchmark metrics (thermal, electrical, water) and each page has: a description, benchmark results for each metric presented in a dial gauge form, a text description of the improvement areas, and quantified improvement opportunities (Figure 11).

LINK: Return to Inputs Page

Export to PDF

Energy and water modeling results for User's Plant

Benchmarking Results

The benchmark results here are in tHSCW processed not total tonnes processed. As such, benchmarks have also been adjusted upwards for external rendering input, where relevant.

	Benchmarks	Unit cost	Cost per tonne
Thermal	**2,941 MJ / tHSCW**	**$ 55.14 /GJ**	**$ 162 / tHSCW**
Electricity	**274 kWh / tHSCW**	**$ 0.25 / kWh**	**$ 69 / tHSCW**
Total Energy	***3,929 MJ / tHSCW***	***$ 58.86 /GJ***	***$ 231 / tHSCW***
Water	**12.2 kL / tHSCW**	**$ 9.47 /kL**	**$ 115 / tHSCW**

Energy and Water Management Plan

Improving energy and water performance on a plant must be performed in stages. Once opportunities in the foundational stage are implemented then opportunities in the subsequent stage may be considered. These stages are shown in the pyramid on the right, starting with Housekeeping.

To identify where your plant is on this pyramid, we benchmarked your performance against an industry-leading plant in: thermal energy, electrical energy and water use metrics.

For each benchmarked metric you are placed on this pyramid. A description of this placement is provided and you are then presented with opportunities appropriate to this placement.

Each opportunity has indicative savings, CAPEX cost, payback period range and a link to further information. Opportunities are sorted by largest savings first. Opportunities that exceed your payback period threshold are filtered out of the list.

As a starting point, you should first develop an Energy Management Plan:
http://www.ampc.com.au/2013/10/An-Energy-Management-Plan-for-Red-Meat-Processing-Facilities

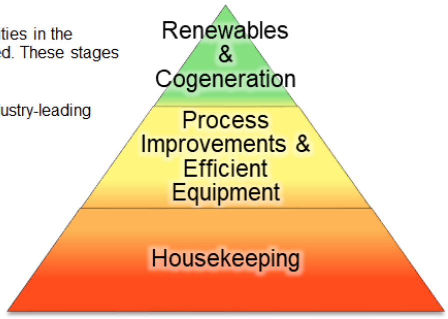

Figure 10: Output page, first page. Benchmark results, Energy and Water Management Plan, an 'export to PDF' button and a link back to the Input page.

Benchmarking results - electrical energy, User's Plant

Your electricity performance has been compared to an industry-leading plant with similar facilities and adjusted based on the species mix and your current operating capacity. Performance benchmark figures shown are rounded to two significant figures.

The next step in an effective electricity efficiency improvement plan is to assess the scope for improving the energy efficiency of key electrical equipment such as refrigeration systems, air compressors and lighting systems.

Once the housekeeping and energy efficiency elements are under control the next step in the program is to improve electrical energy use at a process level. This involves reviewing electrical energy use in plant areas such as improving insulation in chillers and freezers, enclosing cold areas to reduce heat gain, and use of plate freezers instead of blast freezers.

170 kWh / tHSCW

500 kWh / tHSCW

274 kWh / tHSCW

Fair

0 opportunities were screened out due to exceeding the payback period

Performance Opportunity Example	Savings ($ / year), to 2 digits	CAPEX ($), to 2 digits	Payback range (years)	Link to more information
Install energy and water flow meters for major loads and monitor use via a central process control system or web based system.	$28,000	$27,000	0.7 - 1	Link
Extend energy and water monitoring system to provide online alarms and SMS alerts available remotely.	$28,000	$27,000	0.7 - 1	Link
Replace degraded refrigeration compressors. Most compressors will be degraded if they are over 20 years old and have not been upgraded during that time. Degradation in performance of up to 30% or more is possible.	$11,000	$34,000	2 - 4	Link
Replace old lighting technology with LED lighting or induction lighting systems. Both of these technologies will reduce energy use and last 2 to 3 times longer than most older technologies such as metal halide and fluorescent tubes.	$8,900	$17,000	1 - 2	Link

Figure 11: Output page, subsequent pages. Benchmark results for each metric (in this case, electrical), a text description of the improvement areas, and quantified improvement opportunities. Also on this page is a counter above the table showing the number of opportunities screened out due to exceeding the payback period.

6.0 DISCUSSION

Three areas of discussion arise from the results of the benchmarking tool, each covered in the following subsections. First, the impact that the project brief (and subsequent design decisions) had on the utility of the tool to industry. Second, a discussion on some of the specific issues found while building a benchmarking tool to cater to the broad red meat processing industry. Third, identifying what some of the tool's potential future development pathways could be.

6.1 Ramifications of design decisions

Design decisions made while implementing the project brief had impacts on how flexible the tool was for industry use. The project brief was to construct a tool to model the energy and water use of a plant with the view of suggesting performance improvement opportunities relevant to the user's plant. In addition to this, the tool was to cater to a broad range of industry members – from large to small – in order to maximise the value to AMPC members.

With this brief, there were three design decisions made to facilitate such a tool that also restricted the tool's flexibility.

One, the data input period for production, energy use and water use was a year rather than a month or even a week. Industry feedback was to include more granular time periods to facilitate an operations-style use of the tool (Table 3). This feedback was not implemented as the tool was aimed at identifying performance opportunity improvement projects, not facilitating day-to-day operations. As such project assessments take some time within a business, it was not expected that this tool was used frequently enough to be considered a tool for operations. Further to this, an annual time period removes the assessment and corrections for seasonal usage throughout the year that would be present in a more granular time period.

Two, benchmark results were presented in a simplified dial gauge (Figure 11). Similar to the feedback for more granular time periods, industry feedback was to use more advanced forms of benchmarking. One such graph could be a trend of the benchmark results over time, say monthly. Although such a feature may assist an operations-style use of the tool, again this tool sought to focus the user's attention on improvement projects so such a trend does not best facilitate this outcome.

Three, financial modelling was restricted to calculating the payback period only, rather than more advanced metrics such as internal rate of return (IRR). Although IRR is an important tool for larger or more advanced organisations to assess the attractiveness of opportunities, it does not assist all members and adds complexity to the tool's use and interface. Such outcomes did not align with the overall brief and as such, IRR calculations were not implemented.

6.2 The peculiarities of broad benchmarks

This subsection describes some of the issues found in building a benchmark tool that was broad enough to benchmark the diverse red meat industry.

First, the standard approach to adjusting for a plant with differing species mix is to adjust the overall result by an adjustment factor derived from a literature review and analysis. This treatment is generally sufficient for benchmarking purposes. However, a more robust approach would be to develop an energy and water model for a small-body plant (such as all-sheep) and apportioning usage across the facilities of such a plant. By having two such models (beef and sheep) if a user's plant is a blend of small-body and large-body the energy and water use across these models can be blended accordingly to more accurately benchmark such a plant.

Second, for such a broad tool, the appropriateness of the selected benchmark units is worth review. As the tool was capable of benchmarking such a broad range of red meat processing – from external rendering plants through to carcass-only abattoirs – the benchmark units, all based on tHSCW killed, may not represent the most appropriate benchmark for that plant type. An overt example of this is a boning plant, which receives chilled carcasses before boning, packaging and freezing them – with no slaughter on the plant. Such a plant may be better benchmarked against the total production frozen, or input of carcasses. Similarly a rendering plant with external input may be better benchmarked against tonnes of material input to rendering, rather than tHSCW slaughtered. In any case, the decision to retain the tHSCW metric was driven by the need to retain a common metric across the variants of plants in the AMPC member base.

6.3 Potential further developments

While there are several developments the tool could undergo, such as focusing more on operations benchmarking or adding more advanced financial metrics (see 6.1 Ramifications of design decisions), this subsection focuses on two options.

The first option is the inclusion of submetered data into the tool. As energy and water metering on real-world plants increases, the tool's modelling could be expanded to include metered data for parts of the plant and major facilities within the plant. By utilising such metered data the tool's modelling accuracy would improve.

The second option is to move the tool from offline to online. Currently the tool is designed to work as a downloadable offline tool. However, the tool could be improved by moving it online, where users' data submitted to AMPC could be used to further refine the modelling and to create an overall view of the energy and water performance of the red meat processing industry. Such a modification of the tool would also allow benchmarks to be more frequently updated – a benefit for industry participants as their plant can be checked against other plants with very recent data.

7.0 CONCLUSIONS/RECOMMENDATIONS

This tool can be used with a broad range of plants in the red meat processing industry in order to benchmark the plant's performance and identify potential opportunities to improve that performance.

The design approach is strategic rather than operational. That is, the tool has been designed for use in strategic and capital investment contexts to identify broad opportunities and projects, rather than an operations-focused use with weekly or monthly benchmark performance trending.

The user interface, both in terms of inputs and outputs, has been kept simple in order to cater to the breadth of the AMPC membership base – from large to small plants.

Upgrading the tool to an online platform would allow AMPC members access to up-to-date benchmarking, should the membership base consent to the submission of their own benchmark data to form this database.

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